

# **TENDER**

## **FOR**

**ICONIC FLOWER PAVILION AT RIDGE PARK ON EPCC MODE**

## **VOLUME II**

## **TECHNICAL SPECIFICATION AND SPECIAL CONDITIONS**

*Tender Documents consist of three parts as under:*

### **Part I & Part II**

**Tender Evaluation**

**&**

**Technical Bid comprising of–**

- Vol– I:      Detail of Tender & Conditions of Contract**
- Vol– II:     Technical Specifications & Special Conditions**
- Vol– III:    Site Plan, Scope of Works & Schedule of Finishes**

### **Part III**

**Financial Bid comprising of–**

- Vol– IV:     Financial Bid, Payment Schedule & Other Details.**

**Chief Town Planner**

**Gangtok Municipal Corporation**

**TENDER FOR**  
**ICONIC FLOWER PAVILION AT RIDGE PARK ON EPCC MODE**

**VOLUME-II**  
**TECHNICAL SPECIFICATIONS & SPECIAL CONDITIONS CONTENTS**

| <b>Sl. No.</b> | <b>Description</b>                                                                                       | <b>PageNo.</b> |
|----------------|----------------------------------------------------------------------------------------------------------|----------------|
| 1.             | Technical Specifications for Civil Works                                                                 | 1 to 23        |
| 2.             | Special Conditions & Specifications for piling works                                                     | 24 to 29       |
| 3.             | Technical Specifications for Water Supply & Sanitary works                                               | 30 to 41       |
| 4.             | Special Conditions and Specifications for Electrical works                                               | 42 to 161      |
| 5.             | Technical specifications for Passenger Lift/Dumb Waiter                                                  | 162 to 174     |
| 6.             | Special conditions for Lift Installation                                                                 | 175 to 177     |
| 7.             | Technical Specification, Design Parameter & Special Condition of Contract for Central HVAC System        | 178 to 231     |
| 7.1            | Special Conditions                                                                                       | 178 to 185     |
| 7.2            | Technical Specification of Central A.C. Plant with Chilled Water System                                  | 186 to 222     |
| 7.3            | Technical Specification of Central A.C. Plant with VRF System                                            | 223 to 231     |
| 8.             | Technical Specifications of Split/Window model type Air Conditioners                                     | 232 to 233     |
| 9.             | Special Conditions and Technical Specifications for Fire Protection & First Aid Fire Fighting Appliances | 234 to 248     |
| 10.            | All other internal services                                                                              | 249 to 280     |
| 10.1.          | Technical Specification for PA and Reinforced Sound System                                               | 249 to 253     |
| 10.2           | Technical Specification for Surveillance, Data Networking, Telephone and Access Control System           | 254 to 270     |
| 10.3           | Technical Specification for False ceiling and wall panelling and acoustics                               | 271 to 275     |

| <b>Sl. No.</b> | <b>Description</b>                                                                                          | <b>PageNo.</b>   |
|----------------|-------------------------------------------------------------------------------------------------------------|------------------|
|                |                                                                                                             |                  |
| 10.4           | TechnicalSpecificationforFurnitureand Furnishing                                                            | 276 to 280       |
| 11.            | AllotherExternalservices                                                                                    | <b>281to 301</b> |
| 11.1           | TechnicalSpecificationforEffluentTreatmentPlant                                                             | 281 to 288       |
| 11.2           | TechnicalSpecificationforSolarWaterHeater                                                                   | 289 to 290       |
| 11.3           | TechnicalSpecification forSitedevelopmentwith InternalRoad,Pathways,SurfaceDrains, Landscaping&Horticulture | 291 to 301       |
| 12.            | TechnicalSpecificationforCentralizedMedicalGasPipeline System                                               | 302 to 307       |
| 13.            | ListofApprovedManufacturers                                                                                 | 308 to 313       |

### **TECHNICALSPECIFICATIONS**

The work shall be executed as per following specifications:-

CPWD Specifications (Vol1) –2009

CPWD Specifications (Vol2) –2009

CWPD General Specifications for Electrical works Part I –Internal– 2013

CPWD General Specifications for Electrical works Part III –Lifts & Escalators – 2013

CPWD General Specifications for Electrical works Part IV – Substation -2013

CPWD General Specifications for Electrical work Part V –Wet Risers & Sprinkler System– 2013

CPWD General Specifications for Electrical Works Part VII– DG Sets – 2013

# **TECHNICAL SPECIFICATION FOR BUILDING WORKS**

## **CIVIL WORKS**

### **1.0 MATERIALS**

#### **1.1 GENERAL:**

All materials to be used in works shall conform to Indian Standards specification as published by I.S.I from time to time, and in the absence thereof, these materials are to be approved by the Engineer-in-Charge.

#### **1.2 BRICKS:**

##### **1.2.1 Conventional Burnt Clay Bricks:**

All bricks shall be 1<sup>st</sup> class of approved quality of standard specifications, made of good brick earth, uniform deep red, cherry colour, thoroughly burnt in kiln (machine made) without being vitrified, regular in shape and size, sound, hard, homogeneous in texture, true to shape and of standard dimensions and shall be free from cracks, chips, flaws, stones or humps of any kind and shall not show appreciable signs of efflorescence either dry or subsequent to soaking in water. The approx. size of bricks shall be 230mm x 110mm x 70mm (conventional) as per IS: 1077-1992 (Latest Revision). All the bricks should satisfy the relevant tests mentioned in IS: 1077-1992 (Latest Revision).

##### **1.2.2 Fly Ash Bricks:**

Visually the bricks shall be sound, compact and uniform in shape. The bricks shall be free from visible cracks, warpage and organic matters. The bricks shall be solid and with or without frog 10 to 20 mm deep on one of its flat side. The shape and size of the frog shall conform to IS: 12894-2002 (Latest Revision). In case of non-modular size of bricks, frog dimensions shall be the same as for modular size bricks. Hand-moulded bricks of 90 mm or 70 mm height shall be moulded with a frog 10 to 20 mm deep on one of its flat sides; the shape and size of the frog shall conform to IS: 12894-2002 (Latest Revision). Bricks of 40 or 30 mm height as well as those made by extrusion process may not be provided with frogs. The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in shape and color. The standard modular sizes of pulverized fuel ash-lime bricks shall be 190mm x 90mm x 90mm as per IS: 12894-2002 (Latest Revision). All the bricks should satisfy the relevant tests mentioned in IS: 12894-2002 (Latest Revision).

#### **1.3 COARSE AGGREGATES FOR CEMENT CONCRETE WORKS:**

Stone chips or stone aggregates for cement concrete (plain or reinforced) shall be hard, of uniform and fine texture, free from faults or planes of weakness and free from weathered faces and coatings. The aggregates or chips must be free from loam, clay or any surface coating, free from organic matter or other impurities and screened, free of dust and finally found suitable in the opinion of Engineer-in-charge.

**1.3.1 Sizes of Coarse Aggregates:** For various nominal sizes of graded coarse aggregates, gradings shall be in conformity with the requirements laid down in the Indian Standard Specification IS: 383-1963 (Latest Revision), when the coarse aggregate brought to the site is ungraded, single size coarse aggregate of different nominal

sizes conforming to the requirements vide

Table II of the IS Code shall be mixed at site with other ingredients of concrete either directly in the mixture or on the platform. These proportions may be varied some what by Engineer-in-Charge after making sieve analysis of the aggregates brought at site when considered necessary for obtaining better density and strength of concrete.

#### **1.4 Fine Aggregates/ SAND: -**

All sand shall be clean sharp and free from clay, loam, organic or any other foreign matter, shall be obtained from approved local source. The Contractor shall get the sample of sand to be used in different kinds of work approved by the Engineer-in-Charge before using the same in work. Sand which in the opinion of the Engineer -in -Charge or his representative is dirty must be washed to his satisfaction at the cost and expenses of the Contractor.

Sand for all cement concrete work must be coarse. Medium sand may be used for cement mortar, for masonry, plaster etc. Sand filling in plinth or foundation where specified may be done with fine sand or silver sand but should be free from clay or loam. In all cases, the fine aggregates shall conform to the specification as per IS:383-1963 (Latest Revision)

#### **1.5 CEMENT:**

Unless otherwise specified, cement shall be Ordinary Portland cement/Portland Slag cement /Portland Pozzolana Cement of grade 33 or 43 conforming to IS: 269 / IS:8112/ IS: 455/ IS:1489-1991 (Latest Revision) of approved make and brand.

It shall be stored in a dry place in regular piles not exceeding 10 bags high and in such a manner that it is adequately protected from moisture and contamination.

Different consignments shall be stacked separately so that they can be used in the order in which they are received.

#### **1.6 STEEL REINFORCEMENT:**

##### **MATERIALS:**

Mild steel reinforcement shall be hot rolled mild steel bars conforming to IS: 432 -Grade- I or IS:226-1962-“Standard Quality”. Other qualities of Steel shall not be acceptable.

Strength of hot rolled mild steel deformed bars shall conform to IS: 1139 and cold twisted deformed bars should conform to IS: 1786-2008 (Latest Revision).

Each consignment shall be of approved make and if necessary certificates of test performed by a recognised testing laboratory or the manufacturer shall be produced. These test certificates shall give the ultimate stress, yield stress, elongation and results of cold bend test.

Reinforcing steel of different varieties and sizes and types shall be stacked separately.

Reinforcement bars shall be stored at the site in such a manner as to prevent rusting and contamination of the surface by deleterious materials like dirt, oil, grease, paints, etc.

When placed in the work, reinforcement shall be free of loose mill scale, rust, dirt, oil, grease, paint etc.

Steel reinforcement shall always be protected from damages due to impact and rough handling.

### **FABRICATION,BENDING&SPLICING:**

Bars shall be cut to size and bent to shape in accordance with the appropriate dimensionss shown in the drawings. Bars shall be bent cold gradually by machine or any other means approved by the Engineer- in- Charge. Bars having cracks or splits shall be rejected. All bars shall be properly tagged for easy identification.

In no case shall the clear distance between two adjacent bars be less than the diameter of the bar (larger of the diameters to be considered if the adjacent bars of different diameters) or 6 mm more than the maximum size of coarse aggregate used in the concrete Guidance as per I.S. code 456 (Latest Revision).

Unless otherwise stated in the working drawing provisions of clause No. 26.4 of IS:456 (Latest Revision) regarding cover to the reinforcement shall be followed.

### **PLACING AND FASTENING:**

All steel reinforcement shall be accurately placed in position shown on the drawing and firmly held during the placing and setting of concrete. Bars shall be tied together with mild steel wire (annealed) not less than 0.9 mm dia. where the spacing of intersection is less than 30 cms in each direction alternative intersections shall be tied. Binders shall tightly embrace and shall be securely held. Placing of bars on layers of fresh concrete as the work progresses shall not be permitted. Adjusting bars spacing in concrete already poured shall not be permitted.

No reinforcement shall be bent when in position in the work without the approval of the Engineer-in-Charge whether or not it is partially embedded in concrete. Workmen will not be permitted to climb on bar extensions until the concrete has sufficient strength so as not to be damaged and no movement of the bars possible.

## **1.7 TIMBER:**

All timber shall be of specified type best quality well - seasoned and / or well - treated for preservation and protection against decay etc. It shall be uniform in substance, straight in fibre free from large or dead knots, sap, flaws, sun-cracks, shakes or blemishes of any kind. Any insect damage or splits across the grain shall not be permissible. The colour of the timber shall be uniform throughout, firm and shining with a silky lustre when planed and shall not emit dull sound when struck.

## **1.8 GLASS**

All glasses shall be of the specified type, colour, clear visibility and sound and shall be free from cracks, flaws spick bubbles and blemishes and shall not weigh less than 7.4 Kg. /Sq. m. unless otherwise specified. The float glass of any quality shall conform to IS: 14900-2000 (Latest Revision) and specification of toughened glass should conform to IS: 2553-1971, IS:6180-1971, IS: 6640-1972 of latest revision. The specification of structural glazing shall conform to the standard as mentioned in the scope of works (Vol-III).

## **1.9 TIMBER DOORS, WINDOW SETC. AND THEIR FITTINGS:**

Doors and windows work shall be carried out as per detailed drawings or as directed by the Engineer-in-Charge. Specified timbers shall be used, and it shall be sawn in the direction of the grains and be straight and square.

Fittings shall be of anodised iron, brass, and aluminium or as specified. These shall be well made, reasonably smooth and free from sharp edges, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. Iron fittings shall be finished bright or black enameled or copper oxidised. Brass fittings shall be finished bright, brass oxidized or chromium -plated (Electroplated). All fittings shall be finished bright or anodized, or as specified.

## **1.10 PAINT ETC.**

All paints shall be Hi- gloss Synthetic Enamel and shall be delivered in strong containers and marked with the colour of the paint, brand, volume of paint content in litres and of the best quality of approved make and brand as approved by the Engineer-in - Charge. Under no circumstance shall the paint be diluted with linseed oil or otherwise. Any paint although of approved brand, which so hardens in the container that it cannot be readily broken up with a stirrer to a smooth uniform painting consistency, shall be rejected. Any paint too thick for proper brush application shall be rejected. The Specification of all sorts of paints and painting works shall conform to the following Indian Standard Code of Practices of latest Revisions:

IS:2395 Part 1 & 2-1994  
IS:133-1975  
IS:2932-1974  
IS:2933-1975  
IS:5411 Part 1-1974  
IS:5411 Part 2-1972  
IS:427-1965  
IS:428-1969  
IS:5410-1969

## **2.0 EXECUTION**

### **2.1 GENERAL:**

All works shall be carried out in proper workmanlike manner. Items of works not covered by the following, shall be carried out as per best practice according to the directions of the Engineer-in - Charge and to his satisfaction. Unless otherwise specified in this section or in the description of item, the cost of all stages of works mentioned hereunder shall be deemed to have been included in the rates of items provided in the Tender.

### **2.2 EXCAVATIONS OF FOUNDATION AND FILLING UP TRENCHES:**

Foundation when excavated to the level shown in the drawing will be shown to the Engineer-in Charge and if on account of bad ground or for any reason whatsoever he decides to go deeper with the foundation, the Contractor shall excavate further to the depths required by the Engineer-in-Charge. In no case shall the foundation soleing or concrete be laid prior to receiving orders to that effect from the Engineer-in-Charge or his authorised representative.

2.2.1.1. The excavating shall include throwing the excavated earth at least one metre or half the depth of excavation, whichever is more, clear of the edge.

2.2.1.2. The excavated areas around the foundation of structures are to be filled up properly to the required levels with earth obtained from excavation or other materials as directed, well rammed with water and consolidated in layers not exceeding 150 mm. at a time. The quantity for this item of work will be measured on the basis of quantity of excavation paid for less the volume occupied by the structure in foundation.

## 2.3 CEMENT CONCRETE WORKS (PLAIN OR REINFORCED):

### SHUTTERING AND STAGING:

Wherever necessary, shuttering and staging must be provided. Unless otherwise stated no payment will be made for such shuttering or staging and the cost thereof will be deemed to have been covered by the rate of relevant finished item of work. Where payment for shuttering has been specified, the rate shall be deemed to cover the cost of the necessary staging as well. Payment if any, for shuttering will be on the basis of surface area of shuttering in actual contact with concrete.

Shuttering may be of steel sections sufficiently stiffened or approved dressed timber true to line, not less than 25 mm. thick. The shuttering surfaces which are in contact with concrete surfaces are to be smoothed except where otherwise stated. In every case, joints of the shuttering are to be such as to prevent the loss of liquid from concrete. In timber shuttering the joints must be perfectly covered with polythene sheets of approved quality. In case of steel shuttering also the joints are to be similarly lined.

All shuttering and framing must adequately be stayed and braced to the satisfaction of the Engineer-in-charge for properly supporting the concrete during the period of hardening. It shall be so constructed that it may be removed without shock or vibration to the concrete. The stays should invariably be straight in length. The bottoms of stays should be flat and should rest on a wider platform so as to minimise chance of settlement when concrete is vibrated.

Before the concrete is placed those faces of the formwork come in contact with the concrete shall be treated to prevent concrete adhesion to them and to reduce the risk of damage to the concrete when the formwork is struck.

Interior of all moulds and boxes must be thoroughly washed out with a hose pipe or otherwise so as to be perfectly clean and free from all extraneous matter prior to the deposition of concrete.

All form works shall be removed without shock or vibration. Before the form work is stripped, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has hardened sufficiently.

No plugs, bolts, ties, hold fasts or any other appliances whatsoever for the purpose of supporting the shuttering are to be fixed in the structure or placed in such a way that damage might result to the work in removing the same when the shuttering is struck.

### **STRIPPING TIME:**

Forms shall not be struck until the concrete has reached a strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work. Where possible, the formwork shall be left longer as it would assist the curing.

In normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods:

|                                                                |                                                            |
|----------------------------------------------------------------|------------------------------------------------------------|
| a) Walls, columns and vertical faces of all structural members | 24 to 48 hours as may be decided by the Engineer-in-Charge |
| b) Slabs (props left under)                                    | 3 days                                                     |
| c) Beams and soffits (props left under)                        | 7 days                                                     |
| d) Removal of props under slabs:                               |                                                            |
| (1) Spanning up to 4.5 m                                       | 7 days                                                     |
| (2) Spanning over 4.5 m                                        | 14 days                                                    |
| e) Removal of props under beams and arches:                    |                                                            |
| (1) Spanning up to 6m                                          | 14 days                                                    |
| (2) Spanning over 6m                                           | 21 days                                                    |

The above periods are minimum and may be extended for other type of cement used if necessary.

### **SCAFFOLDING:**

The scaffolding must be strong and rigidly stiffened with necessary cross bracers and always decked and boarded on the sills with close boarded ceiling and swings to prevent any injury to persons. Scaffolding with bamboos/ballies is not permitted. All scaffolding shall conform to the specification of IS: 3696-1987 (Latest Revision).

### **MIXING, PLACING AND COMPACTING:**

The proportion specified is by volume in dry condition of the different constituent. Boxes of suitable size shall be used for measuring sand and aggregate. Boxes of suitable size shall be used for measuring cement weighing 50 kg. and this shall be taken as 0.035 cubic metre. While measuring the aggregate, shaking, ramming or hammering shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowance for bulking be made. Cement is also to be measured in boxes unless otherwise directed in writing by Engineer-in-Charge.

All structural concrete shall be mixed in mixer machine of appropriate capacity & shall have to be vibrated with suitable vibrator (needle or form vibrator). Mixing shall be continued until there is a uniform colour and consistency, but in no case shall the mixing be done for less than two minutes. Concrete mix obtained from mixer machine should

be laid within 20 minutes from the time water is added to the dry mix. Beyond 20 minutes the mix should not be used in structural concrete.

As the bulking of sand may vary from day to day and at different parts of the day on account of varying moisture content, frequent tests for bulking shall be carried out with

the sand to be used and the amount of bulking allowed for in the field mix so as to keep the actual proportion constant throughout.

Only such quantities as are required for immediate uses are to be mixed at any one time. Sufficient water is to be added to obtain proper workability so that the mixture may flow readily round the reinforcement and into every part of the moulds. The workability shall be measured by the amount of slump.

The quantity of water is to be used for each mix of 50 kg. cement to give the required consistency shall not be more than 34 litres for 1: 3: 6 mix. 32 litres for 1: 2: 4 mix. 30 litres for 1: 1.5: 3 mix. and 27 litres for 1: 1: 2 mix. In the case of vibrated concrete, the limit specified may be suitably reduced to avoid segregation. Water cement ratio shall conform to IS: 456.

The total water content in each batch of concrete shall always be kept constant as the amount previously determined by trial mixes. The quantity of water to be actually added may, therefore, vary depending on the moisture content in the aggregates. In actual job if the quantities of the ingredients remain constant the amount of slump may be taken as

a good guide indicating the total water content in the mixture. The consistency and consequently the water content of the concrete shall, therefore, be kept constant and checked from time to time as work proceeds, by means of standard slump tests. The slump tests shall be carried out with concrete immediately after it has been mixed and before any initial set has commenced, the sample being taken perfectly at the point where the concrete is being delivered for placing in the moulds.

The consistency shall be recorded in terms of millimeters of the subsidence of the specimen during the test, which is known as Slump.

The following slump shall be adopted for different works:-

| SL. NO. | TYPE OF WORK                                                           | SLUMPS                  |                             |
|---------|------------------------------------------------------------------------|-------------------------|-----------------------------|
|         |                                                                        | When vibrators are used | When vibrators are not used |
| 1.      | Mass concrete in foundation footings and retaining walls and pavements | 10 to 25 mm             | 50 to 75 mm                 |
| 2.      | Mass concrete in R.C.C foundation, footings and retaining walls.       | 10 to 25 mm             | 80 mm                       |
| 3.      | Beams, slabs and columns simply reinforced                             | 25 to 40 mm             | 100 to 125 mm               |
| 4.      | The R.C.C section or section with congested steel                      | 40 to 50 mm             | 125 to 150 mm               |
| 5.      | RCC Piling Work (Self compacting)                                      | 120-160 mm              |                             |

#### PROTECTION AND CURING:

The Contractor shall adequately protect freshly laid concrete, for about 1 to 2 hours after its laying from too rapid drying due to sunshine, drying winds etc. and also from rains or surface water and shocks. About 24 hours after laying of concrete, the surface shall be cured by flooding with water or by covering with wet absorbent materials. The curing shall be done for a minimum period of 10 days. Over the foundation concrete the masonry work

ork maybe started after 48 hours of its laying, but the curing of cement

concrete shall be continued along with the masonry work for a minimum period of 10 days.

In case of cement concrete used as sub-grade for flooring, the flooring may be commenced within 48 hours of the laying of sub-grade. In case it is not possible to do so due to exigencies of work, the sub-grade shall be roughened with a steel wire brush without disturbing the concrete, wetted and neat cement slurry at the rate of 1.75 kg of cement per square metre applied to the base before laying floor. The curing is to be continued along with the top layer of flooring for a minimum period of 10 days.

## **2.4 1<sup>ST</sup> -CLASS BRICKWORKS:**

Cement mortar shall be prepared by mixing sand and cement in specified proportion. Sand shall be measured on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

Brick work shall be laid in English bond. The brick shall be laid by Laying method. A layer of mortar shall be spread on full width for suitable length of the lower courses. Each brick shall first be laid so as to project over the one below, both at the end and at the side, then pressed into the mortar and shoved into final position so as to embed the brick and to fill its inside face fully with mortar. Cut bricks shall not be used except where necessary.

Both the faces of walls of thickness greater than 25 cm (10") shall be kept in proper plane. All the connected brickwork shall be carried up nearly at one level and no portion of the work shall leave more than 1 m. below the rest of the work. The work shall be racked according to bond (and not left toothed) at an angle not steeper than 45°, where this is not possible.

Brick shall be so laid that all joints are quite full of mortar. The thickness of joints shall not exceed 10 mm. Bricks shall be laid with frogs upward except in the top course where frogs shall be placed downward. The face joints shall be racked to a minimum depth of 15 mm by racking tools daily during the progress of work when the mortar is still green, so as to provide proper key for plaster or pointing to be done. Where plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying.

The face of brick work shall be cleaned the very day that brick work is laid and all mortar droppings removed.

Green work shall be kept wet for a period of at least 7 days. The top of masonry work shall be left flooded at the close of the day. Scaffolding shall be sound and strong and holes left in masonry work for supporting the scaffolding shall be filled and made good before plastering.

## **2.5 DAMPPROOF COURSE:**

This shall be laid to specified thickness over walls for the full thickness of the super-structure walls. The surface shall be levelled and prepared before laying the cement concrete. Edge of damp proof course shall be straight, even and vertical. Side shuttering shall consist of wooden form and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the sides are removed, the surface should come out smooth without any honey-combing. The damp proof course shall be laid continuous and the surface shall be double chequered. Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry. Water

proofing materials of approved quality shall be added to the concrete mixture in accordance with the manufacturer's specification. No extra payment will be made for such admixture of waterproofing compound.

## 2.6 **CEMENT PLASTER:**

The proportion of mortar of exterior or interior plaster shall be as specified in the items of work.

The plaster shall be of thickness as specified and the surface shall be similarly cured as for concrete. The moulding shall be carried out as shown in the drawing and shall be separately measured in overall length unless otherwise specified in the items. Interior corners and edges of openings if so directed by the Engineer - in- Charge shall be rounded or chamfered with the same mortar for which no extra payment will be allowed. All cement concrete surface should be chipped off properly before taking up the plastering work.

## 2.7 **PAINTING:**

All surfaces for painting shall be properly sandpapered and cleaned and where necessary good quality ready-mixed putty shall be used to hide all holes, cracks, open joints etc. The rate for painting includes such work. Paint shall be applied with approved brushes and surfaces shall be sandpapered after drying of every coat. All work when completed shall present a smooth, clean solid and uniform surface, to the satisfaction of the Engineer-in-Charge.

- a) **Primer:** All surface for painting, if they are new, should have a coat of priming before application of the paint. The primer should be of approved quality of ready mix primer.

**Wood Primer:** Wood primer of approved brand and manufacture is to be applied on the wooden surface which would be free from moisture and loose particles.

**Steel Primer:** For steel surface red oxide primer, zinc chromate primer of approved brand and manufacture and as per direction of the Engineer - in -Charge is to be applied on the surface. The surface should be made free of grease, rust, moisture and loose particles. All blistered surface should be made free by hammering, filling or otherwise so as to have smooth surface before priming.

**Cement Primer Coat (Alkali Resisting Primer):** Cement primer coat is to be used as base coat on wall finish of cement, lime or lime cement plaster or on asbestos cement surface before application of any wall coating e.g. oil bound distemper, oil-based paints, synthetic enamel, plastic emulsion etc. on them. The cement primer is composed of a medium and pigments which are resistant to the alkalis present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil bound distemper or paints. Priming coat shall be preferably applied by brushing and not by spraying. Hurried primings shall be avoided particularly on absorbent surface. New plaster patches in old work before applying oil bound distemper paints etc. should also be treated with cement primer. The surface shall be thoroughly cleaned of dust, all white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sandpapered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of Paris with water on the entire surface including filling up the undulation and then sandpapering the same after it is dry. The cement primer shall be applied with a brush on the clean dry and smooth surface.

Horizontal strokes shall be given first. Vertical strokes are to be applied after horizontal stroke is absorbed on wall/ ceiling surface immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush mark. It shall be allowed to dry for at least 48 hours before oil bound distemper or paint is applied.

**Aluminum Paint:** Aluminum paint of approved brand and manufacture shall be used. The paint comes in compact dual containers with the paste and the medium separately. The two shall be mixed together to proper consistency before use. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted before the next coat is applied. The finished surface shall present an even and uniform appearance. As aluminium paint is likely to settle in the container, care shall be taken to frequently stir the paint during use.

**Plastic (Acrylic) Emulsion Paint:** Plastic (acrylic) emulsion paints are not suitable for application on external surface and surface which are liable to have condensation and are to be used generally on internal surface. For plastered surface a cement priming coat is required before application of plastic emulsion. Plastic emulsion paint of approved brand and manufacture and of the required shade shall be used. The paint will be applied in the usual manner with brush or roller. The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hardened the next coat can be applied. The time for drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces. Thinning will be particularly required for the undercoat which is applied on the absorbent surface. The quantity of thinner to be added shall be as per manufacturer's instructions. The surface on finishing shall present a flat, velvety, smooth finish.

If necessary more coats will be applied till the surface presents a uniform appearance.

#### **Precaution:**

Brushes should be quickly washed in water, immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.

In the preparation of walls for plastic emulsion painting, an oil base putty shall be used in filling cracks, holes etc.

Splashes in floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

Washing of surface treated with emulsion paint shall not be done within 3 to 4 weeks of application or the time specified by manufacturer.

## **2.8 OIL EMULSION (OIL BOUND**

### **DISTEMPERING) Touch Wood Finish-**

Touch wood polyurethane clear wood finish to be applied whenever specified as per the following direction of use: -

**Touch Wood Clear Matt:** This is to be applied on filled wood surface, (Apolite wood filler) which has been smooth sanded along the grains with emery paper No. 320. Staining

with Apcolite wood stainer is also to be done. It is to be ensured that surface coated is free from all loose dust. TOUCHWOOD Clear Mat is a single pack system. The contents should be well stirred through a clean muslin cloth prior to use. Two coats of touch wood would be applied by brush with thinner 101. The first coat of TOUCHWOOD Clear Mat should be allowed to dry for 6 to 8 hours prior to sanding and recoating. Containers should be well capped after use.

**Flat Wall Painting:** The flat wall paint shall be of approved brand and manufacture and of required shade. The surface shall be prepared as described in sub-head "Cement Primer Coat". Flat wall paint shall normally be applied on walls 12 months after their completion (in case of new work), in which case Distemper Primer will be sufficient. If the walls are to be painted earlier the primer coat shall consist of cement Primer.

When the surface is dry, painting with the wall in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and lightly rubbed with very fine grade of sand paper and loose particles brushed off before the next coat is applied. If after the final coat of wall paint the surface obtained is not up to the mark, further one or more coats as required shall be given to obtain a smooth and even finish at the cost of Contractor. If primer or wall paint gets thickened it shall be thinned suitably with the thinner as recommended by manufacturer.

**Weather Shield (Outside Painting):** All new surfaces to be dried out completely. To remove all loose and defective paint or powdery residue by thorough brushing and scraping, using a stiff wire or fibre brush followed by water jetting if required. Areas affected by mould, lichens, algae and moss to be treated with 1% solution of Surface Treatment Chemical (STC). Fill up minor cracks and defects with cement; larger holes and cracks with sand mixture. Allow to dry. Surfaces that remain powdery, friable or chalky after thorough preparations should be sealed with a coat of paint thinned (1:1).

Finishing:

Soft Glow Normal and sound surface: To apply two coats of paint.  
Parapet Wall: To apply three coats of paint.

Thinning:

Brush or roller: Add up to 1-part clean water to 2 parts of paint by volume. – As per manufacturer's instruction.

Conventional Spray: Add up to 1-part clean water to 10 parts of paint (10%) by volume. – As per manufacturer's instruction.

Clean Up:

Clean brush and other equipment with water immediately after

use. Safety, Health and Environmental Information:

Always store any approved brand of exterior paint in a cool dry place. Keep container tightly closed, out of children's reach and away from food. A suitable dust nose pad should be worn when rubbing the surface. Avoid inhaling vapor. Wear eye protection during application. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Remove splashes from skin with soap and water or recognized skin cleanser. Do not pour leftover paint down the drain. Seal and keep for disposal.

## **2.9 ARTIFICIAL STONE FLOORINGS:**

All cement concrete surface should be chipped off properly before taking up flooring work. The artificial stone floorings shall be laid in panels of shape and size as directed. The casting of the panels will be so programmed as to prevent bonding on the freshly laid panel with adjacent panels.

Unless otherwise specified, the underlay shall be with graded stone chips 12 mm down the thickness of topping shall be of 10 mm. thick and colouring pigment as may be required shall only be added with the topping. The topping and the underlay shall not be laid in one operation. After laying the „Underlay“ the surface shall be left out to dry. The toppings shall be laid only after the Underlay has sufficiently dried and after thoroughly brushing with handwire brush and sweeping clean and after application of slurry. The topping shall be finished with an English trowel and a piece of clean dry linen. During all the stages, the required level shall be carefully observed and maintained. Suitable grading, where required shall be provided in the flooring for water drainage as directed by the Engineer-in-Charge.

The corner between floor and wall shall be round off if directed by the Engineer- in - Charge for which no separate payment shall be made.

## **2.10 POLISHED STONE TILE WORKS:**

This item relates to the requirements of furnishing materials and installation of Polished Stone / Slab Tile work. The types of work that are mainly intended under this head are Granite, Marble, Kota, stone Dholpur stone, Agra red stone, Tandur, Shahabad or Cuddappah, Baroda green stone slabs in flooring and wall facing, as specified in the respective drawings of the buildings

### **Reference to Standard specifications:**

IS: 1805 (Latest Revision) - Glossary of terms relating to stone, quarrying and

dressings. IS: 1129 (Latest Revision) - Dressing of Natural Building Stones.

IS: 1143 (Latest Revision) - Laying and finishing of natural Building

stones. IS: 3316 (Latest Revision) - Specification for structural Granite.

IS: 7327 (Latest Revision) - Granite Surface plate

IS: 1128 (Latest Revision) – Lime-stone (Slabs and

tiles) IS: 1130 (Latest Revision) - Marble (Blocks, slabs and

tiles) IS: 3622 (Latest Revision) - Sand stone (Slabs and

### **Materials:**

Stone shall be of the best quality available in the locality and of specified colour. The stone shall stand weathering and when immersed in water for 24 hours shall not absorb more than 5% of its dry weight, when tested according to IS: 1124 (Latest Revision). All stones shall generally be freshly quarried and shall not have any streaks or flaws and shall be free from

discolorations, oil or any unwanted matter that may prevent adhesion of mortar or be otherwise harmful to the work. Particular attention shall be paid to uniformity of colour and matching patterns and grains. The thickness shall be as specified in the detailed specifications.

#### **Laying and Polishing:**

The tiles shall be machine cut to specified sizes and shall be of approved colour and quality. They shall be of specified thickness and laid to patterns as directed. The floor surface to be tiled shall be thoroughly brushed and scrubbed and profusely watered and cleaned. Mortar for bedding shall be as specified and shall be not less than 3/4" (20 mm) thick.

Immediately each stone is laid it shall be tapped with a wooden mallet and set joints shall be not more than 1 mm thick. The floor shall be perfectly even with no depressions or mounds as per levels indicated and joints shall be in line. Joints shall be grouted with cement mortar of matching colour with the tiles. The tiled surface shall be kept wet and allowed to set for 14 days. No movement of personnel be allowed over newly set tiles for at least 3 days.

After the work has set, the surface shall be machine polished to the satisfaction of the Engineer-in-Charge. The final polish shall be with Oxalic Acid.

### **2.11 GLAZED TILES/VITRIFIED TILES/CERAMIC TILES:**

#### **General:**

This item relates to the furnishing of materials and installations of glazed / vitrified / ceramic tiles in flooring, dado, and also in counters, shelves, sink etc. Tiles shall conform to IS: 777 (Latest Revision), IS-15622 (Latest Revision), IS-13755 (Latest Revision) workmanship shall be as per IS: 1443 (Latest Revision).

#### **Materials:**

The tiles shall be of first quality of approved manufacturers. The size of tiles shall be as specified as directed in the drawing and shall be at least 6 mm thick. No chipped, cracked, crazed or warped tiles shall be used. Glazed rounded corners and cups (convex or concave) shall be provided at corner of walls, edge, junctions of floor and dado etc., if so specified. The mortar shall be in the proportion 1:3.

#### **Laying:**

The fixings shall generally conform to IS: 1443 (Latest Revision).

#### **Workmanship:**

The surface to be covered shall be plastered rough to a thickness of 20 mm. Fix 12 mm size stone chips (5 no. one in each corner and one in the middle of each tile with Adhesive viz., Areldite or equivalent for keying action) and the tiles shall be soaked in water for at least 2 (two) hours prior to fixing at site. A thin layer of cement paste shall be buttered on the back of the tile and on the side after which the tile shall be pressed and tapped home taking care that the corner tiles are perfectly matching. After the backing coat has set the tile joints shall be grouted with neat, white cement slurry with necessary pigment. All surplus slurry that remains on the surface shall be carefully wiped off before it sets. Care shall be taken to ensure that the finished surface is absolutely plumb and to proper levels without any

profusions, waviness or zig- zag. Joints between tiles shall be uniform in straight level lines. After completion of the entire work or part of it, the surface shall be cleared of all stains, cement etc., by washing with oxalic acid (1:10) or any other approved compound.

## **2.12 CARPENTRYWORK:**

All doors, window frames must have plaster rabbit 12mm x 12mm. Rabbit for receiving shutter 12 mm deep. All portion of timber abutting against or embedded in masonry or concrete shall be painted with coal tar or creosote, before being placed in position. The door frames without sills while being placed in position shall be provided with temporary wooden bracing or dry bricks well wedged between the styles at the sill level. These shall be retained to keep the frames from warping during construction. The frame shall also be protected from damage during construction.

### **2.12.1 Door, Window, Ventilator, frame (Chowkats)**

All wooden door, window ventilator frames are of 1<sup>st</sup> class local hardwood (hollock/sunde) frames fixed in position: in contact with cement concrete or brick masonry walls with MS flat hold fast (40mm x 3mm x 250mm) and embedded in cement concrete block in proportion 1:2:4 with 2 coats of creosote oiling to the timber faces in contact with cement concrete and masonry work as directed & specified in the drawings.

### **2.12.2 Paneled Doors**

All paneled doors are made of fully paneled door shutters of 35mm thick of 1<sup>st</sup> class local wood/hollock/gamain/sundi and with BWP grade commercial plywood panels 18mm thick as directed & specified in the drawings. Panels other than one part are not permissible.

### **2.12.3 Flush doors**

All flush door shutters are 35mm thick conforming to IS 2202 (Part I) (Latest Revision), non-decorative type, core of block board construction with frame of 1<sup>st</sup> class hard wood and well matched commercial 3 ply veneering with vertical grain or cross bands and face veneer on both faces of shutters and providing lipping with 2<sup>nd</sup> class teak wood battens 25mm minimum depth on all edges of shutters.

### **2.12.4 PVC door frames**

All PVC door frames are factory made PVC door frames of size 50 x 47mm with wall thickness 5mm made out of extruded 5mm rigid PVC foam sheet metred at corner & joined with 2 nos. x 150 mm long bracket made of 15 x 15mm MS square tube. The vertical door profiles to be reinforced with 19mm x 19mm MS Square tubes of 19 gauges. EPDM rubber gasket weather seal to be provided through out the frame & to be fixed to the wall using MS screws of 65/100 mm size all as per approved Manufacturer's instructions, specifications & direction of Engineer-in-Charge.

2.12.5 All PVC factory made door shutters consists of frame made out of MS tubes of 19 gauge thickness & size of 19mm x 19mm for styles & 15mm x 15mm top & bottom rails, frame shall have a coat of steel primer of approved make and manufacture, M.S. frame covered with 5mm thick heat moulded PVC „C“ channel of size 30mm thickness, 70mm width out of which 50mm shall be flat and 20mm shall be tapered in 45 degree angle on either side for ming styles; and 5mm thick, 95mm wide PVC sheet out of which 75mm shall be flat and

20mm shall be tapered in 45degree on the inner side to form top and bottom rail and 115mm wide PVC sheet out of which 75mm shall be flat and 20mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided either side of the panel. 10mm (5mm x 2) thick, 20mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail. Paneling of 5mm thick both side PVC sheet to be fitted in the M.S. frame welded/sealed to the styles & rails with 7mm (5mm + 2mm) thick x 15mm wide PVC sheet beading on innerside, and joined together with solvent cement adhesive. An additional 5mm thick PVC strip of 20mm width is to be stuck on the interior side of the „C“ Channel using PVC solvent adhesive etc. complete as per direction of Engineer-in-Charge. Manufacturer's specification & drawing (for W.C. and Toilet door shutter).

- 2.12.6 Anodized aluminum work for doors, windows, ventilators and partition with extruded built up standard tubular and other sections of approved make conforming to IS: 733 (Latest Revision) and IS: 1285 (Latest Revision), anodized transparent or dyed to required shade according to IS: 1868 (Latest Revision) (Minimum anodic coating of grade AC15) fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc. Aluminum sections shall be smooth, rust free, straight, mitered and jointed mechanically wherever required including cleat angle, Aluminum snap leading for glazing / paneling, C.P. brass/stainless steel screws all complete as per architectural drawings and the directions of Engineer-in-Charge. For shutters of doors, windows & ventilators including providing and fixing hinges/pivots double action hydraulic floor spring of approved & manufacture IS 6315 marked for doors with stainless steel cover plate and making provision of fixing of fittings wherever required, all complete, as per Architectural drawing and direction of Engineer-in-Charge.

**2.12.7 Door, Window Clamps or Holdfasts:**

Unless otherwise specified the clamps shall be fixed to outer side of the frame with screws.

The side of the door, window frames which remains in contact with masonry shall invariably be painted with coal tar or creosote oil.

**Schedule of Fittings:**

Fittings shall be of iron, aluminum or as specified in the drawings & scope of work.

These shall be well made, reasonably smooth and free from edges, corners, flaws and other defects. Screw holes shall be countersunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be well formed.

Iron fittings shall be finished bright or black enamelled or copper oxidised. Brass fittings shall be finished Bright, Brass-oxidized or Chromium-plated (electroplated) and all aluminium fittings shall be of extruded section and surfaces screwed should be used.

Screws used for fittings shall be of the same metal and finish as the fittings. However, anodized brass screws or chromium brass screws shall be used for fixing aluminium fittings.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with screwdriver and not hammered in.

## **2.13 STEEL WORK:**

### **Mild Steel Grills:**

These should be made of the best quality material and shall be of the shape, size and pattern ordered. They shall be free from dust, burrs, blisters and cracks. Welding shall be neatly done and all slag chipped off, before primer coat is applied. Grills shall be true to shape and accurate in dimensions so that they fit exactly into the door/window frame.

Rate shall include cost of materials, cutting, fabricating, transport to site, fixing etc., complete with one coat of shop paint.

## **2.14 STEEL WINDOW/VENTILATORS:**

### **General:**

All steel casement windows and ventilators as & where shown in drawings & Scope of work shall be of approved make and quality and shall conform to IS:7452 (Latest Revision).

Putty for glazing shall be as specified in IS: 420 (Latest Revision). Hinges shall be of projecting type. Handles and peg-stays shall be of steel or as specified. Suitable legstobs provided for fixing.

Glazing clips shall be provided at a spacing not exceeding 30cms. The holes for the same will have to be drilled during fabrications by the manufacturer and not while fixing glazing.

These sections for the fixed and hinged frames shall be mitred and electrically flash but welded to form a solid and true right angle.

All windows shall be thoroughly cleaned of rust, mild scale dirt, oil etc., either by mechanical or by chemical means and be given 2 coats of primer.

All steel casement windows and ventilators etc. shall be stacked vertically at site and proper care taken that they are not warped or twisted.

### **GLAZING:**

Glass for glazing shall be as specified in the drawing and/ or specifications. All glass sheets shall be free from spots, stains, air bubbles, waviness or other defects.

All glazing shall be bedded on putty and secured by glazing clips/nails and putty of approved quality. 4mm glass shall be used, where the unsupported area of glazing is less than 1.50 sq.m. The thickness of glass shall be 5 mm, where unsupported glazing area is 1.50 sq.m or more. All glazing shall be cleared of all cement, paint and other stains, putty etc. before handing over.

### **ROLLING SHUTTERS AND GRILLS:**

#### **Rolling Shutters:**

The rolling shutters shall be of approved make and the design and shall be suitable for fixing in the positions shown in the drawing i.e., inside, outside, or below lintel or below joists. The

shutter shall be of the manually push and pull type upto 9 sq.m. Ball bearing shall be provided for easy operation where the area of the shutter is between 9 sq.m. and 12 sq.m. When the area is more than 12 sq.m, mechanical gear arrangements shall be provided. The rolling shutters shall generally conform to IS: 6248 (Latest Revision). The shutter shall be complete with door suspension, shafts, locking arrangements, pulling handles and other accessories. The slat shall not be less than 1 mm. in thickness.

#### **COLLAPSIBLE GATE/DOOR**

The Collapsible gate/door shall be of approved make and design. It shall be of single or double leaf as indicated in the drawing made out of 20 mm gate channel with jointing of 20 x 5 mm throughout the length and height of the gate, fitted with ball bearings, handles and a coat of red-oxide paint. The spacing of lattices shall be 150 mm both ways.

The rollers shall be of 40 mm dia. and fixed to alternate lattices at the bottom. The rollers shall roll over a Tee rail fixed inside a channel box. The top guide shall also be a continuous channel section. The fixed end of the shutter shall be fixed to the joints by welding the shutter to top plate insert already left in wall complete with locking arrangements and all accessories.

### **2.15 ALUMINIUM DOORS & WINDOWS AND PARTITIONS.**

#### **Materials:**

All sections shall be obtained and approved, reputed, manufacturers and shall be extruded from aluminum alloy conforming generally to IS: 733-1983 (Latest Revision) and IS: 1285-1975 (Latest Revision).

Sections shall be as per detailed drawings and generally, conform to IS: 1948-1961 (reaffirmed 2001) (Latest Revision).

All section shall be powder coated of coating thickness 50 micron in natural matt finish or such colour as specified.

### **2.16 PRE-CONSTRUCTION ANTI-TERMITES TREATMENT**

Pre-Construction anti-termites treatment with aqueous emulsion having concentration 1:20 with tricel, or its equivalent, and water. This provides emulsion containing 1% tricel (by weight) or concentrated chlorpyrifos at the bottom of foundation pits and walls on either side up to a height of 300mm from bottom of the excavation made for column, plinth beam, wall trenches etc. by applying the emulsion @ 5 (five) litres per square metre of the surface area before starting construction work (supplying of necessary tools and accessories by the contractor) as per the direction of the deptt complete.

Pre-construction anti-termite treatment with aqueous emulsion having concentration 1:20 with tricel solution, or its equivalent, and water. This provides emulsion containing 1% tricel solution (by weight) in the back fill in immediate contact with the foundation structure after completion, column, wall, etc. to a depth of 450mm and width 300mm (when required refill in 200mm thick layers) applying the emulsion @ 5 litres per square metre towards the concrete and masonry walls so as to ensure earth in contact with structure

well treated –with chemical (supplying of necessary tools and accessories by the contractor) as per direction of the deptt complete.

Pre-construction anti-termite treatment with aqueous emulsion having concentration 1:20 tricel solution, or its equivalent, and water. This provides emulsion containing 1% tricel solution (by weight) applying in the entire leveled area after plinth filling and before laying floor, tricel solution @ 5 litres per square metre of the surface to be spread with light rousing so as to ensure proper absorption by the filled-up earth (supplying of necessary tools etc. by the contractor) as per direction of the deptt complete.

Pre-construction anti-termite treatment with aqueous emulsion having concentration 1:20 tricel solution, or its equivalent, and water. This provides emulsion containing 1% tricel solution (by weight) applying in the junction of walls, column with the floor before laying floor and after operation of item no. (c) above making a channel 30mm x 30mm all over the walls and making rod holes @ 150mm apart up to ground level below and applying emulsion @ 11 litres per square metre of the vertical plinth wall surface inside the building so as to soak the soil with the emulsion up to the ground level and refill the holes and channel with the original materials obtained in making channels (supplying of necessary tools etc. by the contractor) and as per direction of the deptt complete.

Pre-construction anti-termite treatment with aqueous emulsion having concentration 1:20 tricel solution, or its equivalent, and water. This provides emulsion containing 1% tricel solution (by weight) applying the soil along the external perimeter of the building (after construction completed) to a distance close to the plinth wall as specified and as directed by the deptt up to a depth of 300mm making rod holes along the line @ 150mm apart to a depth of 300mm and applying emulsion @ 4.5 litres per running metre ensure moistening of the soil with emulsion (supplying of necessary tools by the contractor) complete as directed.

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→ **GENERAL SPECIFICATION FOR FABRICATION AND**

### **ERECTION OF STRUCTURAL & STEEL WORKS:-**

- 3.1 All structural fabrication work will be carried out by the Contractor at site of work. All workmanship and finishing shall be of the best quality and shall be conformed to best method of fabrication conforming to relevant standards and specifications. All materials will be procured by the Contractor. Such materials shall be subject to inspection and passing by the Engineer-in-charge from time to time, the Contractor providing all facilities for such inspection free of cost. Notwithstanding any inspection the Engineer-in-charge will have the liberty subsequently to inspect the materials and reject those that do not conform to the specification and no claim for compensation on this account will be entertained.
- 3.2 The contractor shall at his own expenses provide all materials required for fabrication work including oxygen acetylene, electrodes, fuel, service belts, washers, rivets etc. the steel work immediately given one shop coat of primer as per specification. Besides fabricators own marking for erection every fabricated piece shall be prominently marked sub assembly wise, as directed to enable the member to be identified isolated easily at work site. The Contractor shall also be responsible for preparation of erection marking plans. The Contractor will entirely be responsible for loss or damage of any of the items at site. The Contractor shall at his own cost rectify defects caused during handling or transportation.

### 3.3 Fabrication of Structural's:

#### 3.3.1 Welding:

**3.3.2 General:** The welding materials and procedures shall be in accordance with the requirements of latest Indian Standard Specification. The Contractor will be required to submit his proposals in respect for certain main welds for the prior approval of the Engineer-in-charge. Test plates may be required for these welds which shall be prepared and tested in accordance with relevant standard.

**3.3.3** All structural works in buildings shall be done in welded construction as per latest relevant Indian Standard Specification IS: 815 (Latest Revision), 816 (Latest Revision), 823 (Latest Revision) etc. The fabrication & erection of steel work shall be done as per latest Indian Standard Specification IS: 800 (Latest Revision).

**3.3.4 Plant & Equipment:** The equipment used shall be of sufficient capacity to suit the welding procedure laid down and be capable of depositing the particular type of electrodes to be used under the conditions of current and voltage specified by the electrode manufacturers. Efficient means shall be provided for the accurate indication of the current and in addition a pair of long testers shall be supplied by the Contractor and be available to the Engineer-in-charge. All equipment accessories and connections shall be maintained in proper working condition.

**3.3.5 Electrodes:** All electrodes shall be in accordance with the specifications mentioned in IS: 814-2004 (Latest Revision).

**3.3.6 Qualification & Testing of Welders:** The Contractor shall satisfy the Engineer-in-charge that the welding operators are suitable for the work upon which they will be employed and shall produce evidence to the effect that welders have satisfactorily completed appropriate tests. The Engineer-in-charge may call for periodic tests of the Welders and / or of the welds produced by them. Such tests shall be at the expense of the Contractor.

**3.3.7 Fusion Faces & Surrounding Surfaces:** Fusion faces and the surrounding surfaces within 50mm of welds shall be free from all mill scale and free from oil, or any substance which might affect the quality of the weld or impede the progress of welding. They shall be free from irregularities that would interfere with the deposition of the specified size of weld or be the cause of defects.

All mill scale within 50mm of welds shall be removed prior to welding either by pickling at works followed by thorough power wire brushing or by other approved methods.

If the preparation or cutting of the fusion faces is necessary the same shall be carried out by shearing, chipping, gas-cutting or flame-gouging. Where hand gas cutting or hand-gouging is employed, the blow pipe or gouging blow pipe shall be properly guided.

**3.3.8 Preparation of Joints:** The contractor shall prepare the edges with an automatically controlled flame out torch currently to the shape, size and dimensions of the V-groove, prescribed in the design and shop drawings. In case of U-groove joints, the edges shall be prepared with an automatic flame out torch in two passes following a bevel cut with gouging pass or by machining.

**3.3.9 Assembly for Welding:** Parts to be welded shall be properly assembled and held firmly in position by means of jigs and clamps prior to and during welding.

The sequence of welding shall be planned and followed that there shall be a balance of welding about the neutral axis of the fabrication. The Contractor shall employ sufficient

number of welders working at the same time in diagonal quadrants of the frame using backstep method of welding. The rate of progress of each welder shall be more or less equal and quality uniform.

The general direction of welding shall be towards the free end of the point, but in a long joint of fabrication, back-step technique shall be used to reduce distortion.

To minimize internal locked-up stresses due to welding, the vertical joints of the frame shall be welded and completed to a circular course and then the horizontal circumstantial seam welded. However, before the welding of horizontal seam started, the completed circular courses shall be aligned and adjusted for their correct axes.

Alternatively, the Contractor shall complete such course in all respect on the ground and then the pre-assembled course shall be lifted and placed in position. In such a sequence and planning the same principle of balancing of weld about the neutral axis shall be followed and the method of fabrication of each course shall be similar to fabrication of penstock pipes of transportation pipelines for industrial pipelines of bigger diameter.

**3.3.10 Accuracy of Fit up:** Parts to be fillet-welded shall be brought into as close contact as practicable and the gap due to faulty workmanship or incorrect fit up shall not exceed 1.5mm. If greater separation occurs at any position, the size of fillet weld shall be increased at such positions by the amount of the gap.

**3.3.11 Jigs and Manipulators:** Jigs and manipulators shall be used where practicable and shall be designed to facilitate welding and to ensure that all welds are easily accessible to the operators.

**3.3.12 Ends of Butt-welded Joints:** The ends of butt joints shall be welded so as to provide the full throat thickness. This may be done by the use of extension pieces. Cross-runs or other means approved by the Engineer-in-charge.

**3.3.13 Weld face and Reinforcement of Butt Welds:** The weld face shall at all places be deposited proud of the surface of the parent metal. Where a flush surface is required the surplus metal shall be dressed off.

**3.3.14 Minimum Leg Length & throat thickness in Fillet Welds:** The minimum leg length of a fillet weld as deposited shall be not less than the specified size. In no case shall a concave weld be deposited without specified permission of the Engineer-in-charge. Where permitted, the leg length shall be increased above that specified, so that the resultant throat thickness is great as would have been obtained by the deposition of a flat-faced weld of the specified leg length.

**3.3.15 Deslagging:** After making each run of welding all slag shall be thoroughly removed.

**3.3.16 Quality of Welds:** The weld metal, as deposited (including tack welds if to be incorporated) shall be free from checks, slag inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without serious under cutting or overlapping at the toes of the weld. The surfaces of the weld shall have a uniform and constant contour and regular appearance.

**3.3.17 Working Conditions:** Welding shall not be done under such weather or other conditions which might adversely affect the efficiency of the welding and where necessary effective protection or other safe guards shall be provided.

**3.3.18 Requirement on Welded Joints:** The Contractor shall ensure the following requirements in welded joints:-

Strength-equality with parent metal  
Absence of defects

Welded Joints of tanks, pipelines and apparatus operating under pressure should be hermetically sealed in working condition under specified pressure and temperature. Corrosion resistance of the weld shall not be less than that of parent metal in aggressive environment.

**3.3.19 Tolerance:** Deviations for assembly of welded joints may be permissible to the following extent.

|                                                       | Tolerances         |                 |
|-------------------------------------------------------|--------------------|-----------------|
|                                                       | Manual Arc         | Automatic       |
| A. Square butt-joints:                                |                    |                 |
| a) Gap between the ends of plates                     | +2.00mm<br>-1.00mm | +<br>-          |
| b) Stepping of one plate over the other               | 1.00mm             | 2.0 mm          |
| B. Single V-groove Joint:                             |                    |                 |
| a) Bevel angle                                        | $\pm 5^{\circ}$    | $\pm 5^{\circ}$ |
| b) Gap between two                                    | +2.00mm<br>-1.00mm | $\pm 1.00$ mm   |
| c) Stepping of one plate over the other               | 2.00mm             | 2.00mm          |
| d) Root thickness                                     | 1.00mm             | 1.00mm          |
| C. Lap Joints                                         |                    |                 |
| a) Overlap                                            | 5.00mm             | 5.00mm          |
| b) Gap between the surface                            | 2.00mm             | 1.00mm          |
| D. Tee-fillet Joints:                                 |                    |                 |
| Gap between the edge of web and surface of the flange | 2.00mm             | 2.00mm          |

### 3.4 Erection of Structural Works:

**3.4.1 Scope of Work:** Contractor shall provide all construction and transport equipments, tools, tackles, consumables, materials, labor supervision for erection including carrying out the following.

3.4.2 Transportation from site storage, handling, ramming, rigging, assembling, drilling holes, riveting, bolting, welding and satisfactory installation of all the fabricated materials in proper location according to drawings and/or as directed by the Engineer-in-Charge.

3.4.3 Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of Engineer-in-Charge. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated works on the foundation blocks.

3.4.4 Aligning, lining, leveling, drilling holes, riveting, belting, welding, securely fixing in position in accordance with drawings or as directed by the Engineer-in-Charge.

- 3.4.5 Supply of all required consumables, construction and erection materials, including but not limited to gauges, welding brazing gases and rods, electrodes and wires, bolts nuts, rivets and temporary supports etc., as required for the completion of the work.

### **3.5 Setting out:**

The Contractor shall be responsible for checking the alignment and levels of foundations correctness of foundation centres well in advance of starting erection work and shall be responsible for any consequences for non-compliance thereof. Discrepancies, if any, shall immediately be brought to the notice of the Engineer-in-Charge.

- 3.5.1 The Contractor shall assure full responsibility for the correct setting with alignment and levels shown on the drawings and plumbing of vertical members. Datum points will be fixed by the Engineer-in-Charge near the work site. Notwithstanding any assistance rendered to the Contractor by the Engineer-in-Charge, if at any time during the progress of the work any error should appear or arise therein, on being required to do so, the Contractor at his own cost shall remove and amend the work to the satisfaction of the Engineer-in-Charge.

- 3.5.2 After the Steel work has been erected, lined, leveled and aligned, the foundation bolt shall be pulled up tightly and grouting shall be done, when the ground has thoroughly cared the alignment shall be rechecked if required.

### **3.6 Assembly:**

All parts dispatched to work site as sub-assembly shall be assembled by the Contractor at the erection site. Before starting the work, the Contractor shall advise the Engineer-in-Charge fully as to the method he proposes to follow and amount and character of equipment he proposes to use which shall be subject to the approval of the Engineer. The use of method likely to produce injury by twisting bending or otherwise damaging the materials shall not be used. All defects shall be brought to the notice of the Engineer-in-Charge before carrying out rectification work.

- 3.6.1 The Contractor shall satisfy the Engineer-in-Charge about the erection method which is required to be inspected before actual erection. Erected parts shall be stable during all stages of erection and the structural elements to be erected shall be strong enough to bear erection load. The stability of structures subject to the action of wind, dead weight and erection force shall be obtained by observing specified sequence of erection of vertical and horizontal structural members by installing permanent and temporary bracings.

- 3.6.2 The Contractor shall provide adequate supervision at all stages of the work and examine each portion of the work for accuracy before fabrication or erection is commenced. He shall also provide facilities satisfactory to the Engineer-in-Charge for his inspection at any stage during erection. Irrespective of any inspection and tests made by the Engineer-in-Charge, the Contractor shall be entirely responsible for the proper execution of the contract notwithstanding any approval which may have been given by the Engineer-in-Charge of the work or of tests carried out either by the Engineer-in-Charge or the Contractor. Assemblies of structures shall as far as possible, be made, ground itself.

No riveting, permanent bolting or welding shall be done until proper alignment has been obtained.

### **PaintingafterErection:-**

- 3.6.3 Immediately before erection the whole of the priming coats of paint shall be thoroughly cleaned and dried and any loose or defective paint shall be removed as directed by the Engineer. If in opinion of the Engineer it is necessary to remove all the paint from portions of the steel work in order to yield a satisfactory job, this shall be done and the whole of these portions provided with priming coats as per specification.
- 3.6.4 After erection, any damage to the paint work shall again be made good and bolt heads etc., painted. The steel work with exception of the areas which are specified to be otherwise protected shall have finishing coats as per specification. The undercoat shall be of an approved distinct shade to the finishing coat so that it is possible to ensure that complete coverage is achieved with both coats.

### **3.7 Materials and Workmanship**

Except where otherwise stated or permitted by the Engineer-in-charge all materials shall conform to the latest Indian Standard Specifications the materials and workmanship shall be governed by IS 800-1984 (Latest Revision). Successful tenderer shall have to furnish detailed fabrication drawing and erection scheme for the Society prior to commencement of the job.

**SPECIAL CONDITIONS AND  
SPECIFICATION FOR PILING WORK**

**General Terms & conditions**

The Tenderer shall be responsible for execution of the entire pile foundation system and shall guarantee the stability of the pile foundation system against the risks of settlement up to the permissible limit or any other type of damages to the structure.

Bore-log details showing the nature of soil will be available in the Geotechnical Investigation Report which will indicate the sub-soil strata expected and are meant only as guidance to the tenderer. However, the Department does not take any responsibility for variation in strata which may be encountered while actually executing the piling work at site. Piles of required length have been recommended by soil test. The exact size and length of pile shall be determined as per actual design based on load test results.

The payment will be made for actual length of the pile executed (as per Structural RCC drawings of piling works issued along with tender papers), on the basis of length of reinforcement cage actually inserted into the bore up to cut off level, from pile tip. The variation in payment due to variation of length of Piling if any from the recommended length in geotechnical investigation report considered in the design, shall be governed by the rate quoted in the Price Bid.

The safe working load for piles shall form the basis of determining the number of piles which are to be provided for supporting various Columns etc.

Safe working load for piles based on soil parameter shall mean the total load which the pile can safely carry with a factor of safety of minimum 2.5.

Test load will mean the load applied at the head of the selected one or the group of piles for determining the Safe working load and shall be 1.5 times over the safe working load for routine load test.

Initial set shall mean the down ward movement of a pile caused by load during the first twenty-four hours after application of that load.

Progressive set shall mean the total downward movement of a pile caused under load during the test period inclusive of the initial set as defined above.

Elastic deformation shall mean the shortening of the pile within the plastic limit of materials forming the pile.

Total set shall mean the total down ward movement exhibited by the pile at the end of the test period, i.e. it shall mean the aggregate of the initial set plus progressive set plus elastic deformation.

Ultimate set shall mean the settlement remaining after the removal of the test load.

The work shall be executed as per I.S.:2911 (Part-I/Section-2)-1979 (Latest Revision) with amendments up to date, except where otherwise instructed by the Engineer-in-Charge.

Piles shall be installed as accurately as possible as per the approved design and drawings. Piles should not deviate more than 75 mm, out of the designed position as shown on the layout plan at the working level of the piling rig and maximum deviation from verticality shall not exceed 1.5% of length of pile. Piles to be cut off at a substantial depth. In case of piles deviating beyond these limits the tenderer has to drive necessary extra piles at his own cost as per drawing & direction of the Engineer-in-Charge without any liability on the part of the Society.

The reinforcement of the pile shall be carried out as per approved drawing & direction of Engineer-in-Charge and in conformity with the provision as laid down in relevant I.S. code with amendment up to date.

At least 75 mm. Length of piles shall be projected into the pile cap concrete. This however, shall not be measured for payment.

### **BORED CAST-IN-SITU PILES**

Boring operations shall be done by rotary or percussion type drilling rigs using direct mud circulation (DMC) methods to bring the cuttings out. The size of the cutting tool shall not be less than the diameter of the pile by more than 75 mm. Bentonite shall be used as drilling mud and its properties shall conform to Appendix "A" of IS:2911 (Part-I/Section-2)-1979 (Latest Revision). Tremie shall be used for placing concrete into the bore holes.

The bore hole shall be advanced up to the required founding level by rotary cutter and direct mud circulation method after installation of casing tube to the desired depth.

Bentonite slurry shall be pumped by high pressure circulating pumps into bore hole through the cutting tool and the same shall be allowed to overflow the bore. The materials which come out along with the bentonite slurry shall be passed through channels and shall be collected in sedimentation tank, where sediments settle and bentonite may be reused with the approval of the Engineer-in-Charge provided the same satisfies the requirements as per the above I.S. Code.

After the founding strata are reached the bore shall be flushed by bentonite slurry as per I.S. Code with direct mud circulation. The pumping for the flushing is done by use of mud circulation pump. During flushing, the chisel is kept resting on the founding strata to remove all the loose sediments which might have accumulated on founding strata. The direct mud circulation chisel and connecting rods are removed from the bore hole thereafter.

Reinforcement cage as per drawing and direction of Engineer-in-Charge shall be lowered.

Before concreting work is taken up the bore shall once again be flushed with bentonite slurry through tremie to ensure that the bottom of the hole is cleaned after placing the reinforcement.

The Concreting shall be done by tremie. The diameter of tremie pipe shall be minimum 200 mm. The details of tremie method of concreting shall be as per the relevant code IS:2911 (Part-I/Section-2) 1979 (Latest Revision).

The top of concrete in a pile shall be brought above the cut-off level suitably as specified in the relevant I.S. Code to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection, till mud free concrete is visualized as per satisfaction of Engineer-in-Charge or to a minimum of one metre above cut-off level.

Care should be taken to existing structure nearby so that no damage is done. If such damages occur, contractor has to make good it to the satisfaction of the Engineer-in-Chief at his own cost.

The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing of concrete & water. However, the plug should not be left in the concrete as a lump.

The tremie pipe should always penetrate well into the concrete with an adequate margin, if safety against accidental withdrawal of the pipe is urged to discharge the concrete.

The pile should be concreted wholly by tremie and the method of deposition should not be changed part way up the pile, to prevent the laitance from being entrapped within the pile.

All tremie tubes should be scrupulously cleaned after use.

#### **LARGE DIABORED CAST IN SITU PILE/CAISSON WITH SOCKETTING IN WEATHERED ROCK**

The construction method adopted must ensure safety/stability of slope.

The power and water required for the construction method shall have to be arranged by the firm.

Cleaning of the bore-holes especially in the socketting portion must be done properly to ensure development of socket friction and grouting in the socket region shall be done as per instruction of the engineer-in-Charge.

Displacement and slurry if used shall have to be complete, so as to ensure adequate end bearing.

In addition, adequate care must be taken while sinking caisson and hence proper liner material of adequate strength should be used.

The disposal of large quantities of dug up soil, water /slurry used in digging shall be done as per instruction of the Engineer-in-Charge, preferably in the close vicinity of low lying areas.

#### **MODE OF MEASUREMENT OF PILE:**

Bore Cast-In-Situ Pile – the Pile shall be measured in running metre from pile cut-off level to the founding level. No extra/empty, borings shall be considered for payment.

The rates include the cost of concrete, hire charges of tools and plants, all machineries, labour, materials, bailing out of water, breaking/cutting through and removing the

boulders or any other obstructions, if met with before reaching the required founding level etc. complete in all respects.

The Bentonite slurry should be used in proportion as specified by Engineer-in-Charge including cost thereof.

No extra shall be paid for use of Bentonite slurry or grade casing in the work.

If conditions are not satisfied from the load test, corrective measure shall be proposed by the contractor at his own cost, got approved by the Engineer-in-Charge and executed accordingly.

If load test results are found unsatisfactory the contractor shall provide new additional piles as required at his risk and cost, as per direction of Engineer-in-Charge.

Payment for test pile and testing charge shall be made if the load test results are satisfactory. For incomplete and/or unsatisfactory load test no payments shall be made.

The rate should also include the removal of slush and drilling mud from the working site after pumping from storage vat into the disposal tanker and disposed of the same beyond the compound in conformity with the direction of Secretary and cleaning, dressing the site complete in all respect.

The test piles shall be selected by the Engineer-in-Charge.

Working pile to be started after getting test result and clearance from E.I.C. and the result of the test pile to be submitted to the Department.

#### **DEFECTIVE PILES:**

In case defective piles are formed, they shall be removed or left in place as directed by the Engineer-in-Charge without affecting performance of the adjacent piles or the cap as whole, additional piles shall be provided to replace them as directed by the Engineer-in-Charge without any additional expenses to the department.

Any deviations from the designed location, alignment or load capacity of any pile, shall be noted and adequate measures should be taken well before the concreting of the pile cap and plinth beam if the deviations are beyond the permissible limit.

During chipping of the pile top, manual chipping may be permitted after three days of pile casting. Pneumatic tools for chipping shall not be used before seven days after pile casting.

After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures shall be taken as deemed fit by the Engineer-in-Charge.

#### **RECORDING OF DATA:**

A competent and qualified inspector shall be stationed at site to record necessary information during installation of piles and the data to be recorded shall include the following:-

Sequence of installation of piles in a group.

Dimensions of the pile, including the reinforcement details and concrete mix of the pile.

Depth driven or bored.

Time taken for driving/boring and for

concreting. Cut-off level/working level.

When drilling mud is used, the specific gravity of the fresh supply and contaminated mud in the hole before concreting is taken up, shall be recorded in case of first ten piles, and subsequently at an approximate interval of 10 piles or earlier, and any other important observation.

Typical data sheets for facility of recording piling data as shown in Appendix 'D' in IS: 2911 (Part-I/Section-2)-1979 (Latest Revision) should be adopted.

### **LOAD TEST:**

The initial load tests and the routine load tests shall be carried out as per IS: 2911 (Part-4)-1985.

The initial load test shall be completed and approved by Engineer-in-Charge before commencement of main piling work.

Load test can be done with kentledge load/anchor pile load. The working piles shall not be used as anchor piles for obtaining the reaction. The reaction to be made available for the test from kentledge should be 25% more than the final test load proposed to be applied.

Before any load test is carried out, the proposed equipments and accessories, the supporting structure, kentledge etc. shall be got approved by the Engineer-in-Charge. Settlement shall be recorded with minimum 2 dial gauges for single pile and 4 dial gauges of 0.01 mm sensitivity for groups, each positioned at equal distance around the piles.

The safe load for single pile for the initial test should be at least of the following:-

Two thirds of the final load at which the total displacement attains a value of 12 mm, unless otherwise required in a given case on the basis of nature and type of structure in which case, the safe load should be corresponding to the stated total displacement permissible.

50 percent of the final load at which the total displacement equals 10 percent of the pile diameter in case of uniform diameter piles and 7.5 percent of bulb diameter in case of underreamed piles.

However, routine test shall be carried for a test load of at least one and half times the working load, the maximum settlement of test loading in position being not exceeding 12 mm.

A complete record of all load tests shall be submitted by the contractor in an approved format for department's approval at no extra cost.

Rates for load tests shall be inclusive of providing kentledge making other arrangements for the test loading platforms, providing tools and plants, equipments like hydraulic jack, dial gauges etc. labor involved in carrying out the tests and removal and clearance of the site complete to the satisfaction of Engineer-in-Charge.

The load test shall be considered satisfactory if.

The safe load on the pile as revealed from the test is more than the safe bearing capacity of pile as considered by the Department in the tender.

Behavior of pile or pile group does not show any defect.

#### **PILE SHALL NOT BE ACCEPTED IN CASE OF FOLLOWING:-**

If actual cement consumption is found abnormally less than that required, theoretically for actual length of the pile on the basis of actual length of reinforcement cage. It should be minimum 80% of the theoretical requirement.

If reinforcement cage of required length as per drawings and specifications does not enter into the bore in full or minimum 80% of the full length (specified in contract schedule).

If the concrete mixer goes out of order for more than 2 hours. To avoid this, standby concrete mixer is a must.

If the deviation of location of the pile exceeds 150mm.

If the dia of reinforcement cage is reduced by more than 20% of the theoretical dia as per drawing.

To avoid this, all stirrups must be welded at least at alternate intersection to avoid slippage of stirrups causing the reduction of cage dia at Contractor's own cost.

1.5m length of pile reinforcement must be extended for adequate anchorage in pile cap above cutoff level.

#### **EXECUTION OF WORKS:**

The contractor shall be entirely and exclusively responsible for the horizontal and vertical alignment, levels, and correctness of every part of work and shall rectify effectively any erosion, imperfection therein if any observed during the execution

of pile caps, column etc. at later stage. The contractor shall rectify any defects arising out of his execution of piling work at his own cost within 15 (fifteen) days of issue of notice by the CTP Gangtok Municipal Corporation, failing which cost of rectification work shall have to be paid by him from his dues or any other resources.

The CTP Gangtok Municipal Corporation.. or his authorized representative shall furnish the contractor level benchmarks and layout drawing for piling work. The Contractor has to set out the work as per layout plan and shall provide efficient staff for the purpose and solely responsible for the accuracy of setting out, layout, levels etc.

## **TECHNICAL SPECIFICATION FOR WATER SUPPLY & SANITARY WORKS**

### **GENERAL:**

The rates are of complete items as fixed in position and overall costs - e.g. cutting of holes, chases, etc., and also for provision of fixing arrangement viz., clamps, brackets, wooden block etc. The rates shall also include restoration to original condition of all damages to walls, floor etc., during the process of fixing sanitary installations, water supply and drainage. All debris of plumbers' excavation, etc., shall be removed without any extra charge. The plumbing work/or the building work effected by the plumber work shall be left thoroughly cleaned to the satisfaction of the Engineer-in-charge.

All material should conform to the detailed specification and be of best quality and make as shown in the scope of works and as approved by the Engineer-in-charge.

All G.I. pipes (except concealed pipes and underground pipes) and brackets and fixtures and manhole covers shall be painted with 2 coats of synthetic enamel paints.

All concealed and underground G.I. pipes and specials shall be painted with 2 coats of bituminous paint.

All plumbing and sanitary fixtures, pipes and pipe fittings, trap etc., which are to be embedded into the concrete or masonry work or other building work shall be placed in position and embedded for concealed at the time of casting of concrete and during the work of construction. In case where chasing or cutting of concrete, masonry, or other structural or constructional work is unavoidable, the location of such fittings, pipe lines and traps etc., shall be chalked out at the various places and the cutting, chasing or disturbing of the construction work shall be preceded only after the due approval of the supervising authority in charge.

Galvanized iron pipes and pipe fittings shall be of medium grade quality. All cuttings, chasing and fixing work shall be completed before commencement of any plastering, tiling or finish in gwork.

### **EXTERNAL WATER SUPPLY:**

#### **7.1 Source of Water**

The source of potable water is through piped water supply by PHE dept, Govt. of Sikkim, to semi-underground water reservoir to be constructed under the scope of the present project.

#### **7.2 Water Pipe Line**

##### **7.2.1 Rising Main**

Rising main shall be of designed dia GI pipe of approved grade and specification with necessary fittings & fixtures etc. connected to the semi-underground Water Reservoir, as well as from Pump House/ Control Valves mechanism to the various overhead Reservoirs, as per detailed layout drawings.

### **7.2.2 Distribution Water Line**

The distribution water line shall be GI pipes of approved grade & specification with necessary fitting set c. of variable design diameter, and as per detailed layout drawings.

### **7.3 Semi-underground Water Reservoir**

R.C.C. semi-underground Water Reservoir of variable capacities to meet the daily requirement of water supply and will also act as Reserve Storage for Fire Fighting, as per detailed drawings.

### **7.4 Service Reservoirs**

PVC Overhead Service Reservoir of capacities 1,000 litres, 2000 litres, 5,000 litres and capacities 10,000 litres tank shall be installed at ground level for potable water supply. The tank shall be of approved make & quality.

### **7.5 Control Valves**

The Rising mains & distribution water line shall have control valve mechanism with covered enclosures as per drawing.

## **SEWERLINE, SEWAGE TREATMENT PLANT & SURFACE DRAIN**

### **8.1 Sewerline**

uPVC pipes as per IS:12818 (Latest Revision) of 150mm dia grade „A“ with solution joints have been provided for underground sewer line above sub-soil water level, along with provision of lean cement concrete 1:5:10 with 40mm nominal size stone aggregate up to haunches of S.W. pipes including bed concrete as per standard design, specification and drawing.

### **8.2 Inspection Pits**

Brick masonry inspection pits in cement mortar 1:4 of required size along with RCC/CICover as per IS Code and as per details given in the drawings have been provided.

### **8.3 Sewage/Effluent Treatment Plant of design capacity**

Sewage/Effluent Treatment Plant consisting of Bar Screen chamber, oil & Grease chamber, Equalization Tank, MBBR with Tube Settler, Dual Media Filter and Active Carbon Filter, etc. Bar Screen chamber, oil & Grease trap shall be made of RCC of M25 grade concrete and the section for the same shall be as per design and drawing. Equalization Tank, MBBR with Tube Settler shall be of MS with FRP lining on inside face and non-corrosive enamel paint on outside face.

### **8.4 Surface Drain for Storm Drainage**

Based on natural slope of the existing land profile, surface drain of design depth and cross section abutting the road network have been planned as per standard design & specification & as shown in drawings.

## **MATERIALS, WORKMANSHIP & SAMPLES:**

All the materials and workmanship are to be of the best possible description and to the entire satisfaction of the engineer-in-charge and the contractors shall immediately remove from the site any materials and /or workmanship which, in the opinion of the Engineer-in-Charge, is defective or unsuitable and shall substitute proper materials and/or workmanship forthwith.

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

The rates quoted shall be for all heights and depths.

Bidders should work out the quantities as per detailed drawings and scope of work.

### **MATERIALS:**

**General:** a) All materials shall be of best of their kind and shall conform to the latest Indian Standard specification, unless otherwise specified.

### **SANITARYWARES:**

All sanitary wares and fittings shall be of first class quality white vitreous China as manufactured by approved make.

Stainless steel sinks and draining boards shall be of best quality stainless steel of approved make.

### **SOIL PIPE-**

All soil pipes are of approved quality uPVC pipes as per IS: 12818 (Latest Revision).

### **G.I PIPES AND FITTINGS:**

All pipes shall be of galvanized iron medium quality of class B of IS 1239 (Latest Revision) of approved make otherwise specified. All fittings shall be of approved make. These pipes shall be of the diameter (nominal bore) specified. The pipes and sockets shall be cleanly finished, well galvanized. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

### **Full Way Valves:**

These shall be of gun metal country pit valve or equivalent conforming to IS: 778-1971 (Latest Revision) specification.

### **Bib Cocks/Pillar Cock/Stop Cock:**

These shall be of CP of sizes as mentioned in the drawings & Scope of works of approved make.

### **Ball Valve:**

The ball valves shall be of Pressure as specified. The ball valve shall be of gun metal for 25 mm dia, copper for 20 mm dia as specified in the drawing and scope of work.

### **DRAINAGE-uPVC PIPES:**

All pipes shall be of best salt glazed variety conforming to IS specification. The pipes shall conform to IS: 12818 (Latest Revision).

### **TESTING OF MATERIALS AND WORKS:**

The Contractor shall arrange to test materials and /or portions of works at his own cost to prove their soundness and efficiency, if after tests, any materials, work or any portion of work are considered defective or unsound by the Engineer-in-Charge, the contractor shall remove the same from the site.

### **SANITARY INSTALLATION:**

#### **Indian Type W.C.:**

The Indian Type W. C. Pans shall be of Orissa Pattern of approved sizes as mentioned in the drawing & scope of work, fitted with „P“ or „S“ trap with effective 2” seal and 2” vent as per IS:771-1963 (Latest Revision) & IS:2556 (Part II & VII) (Latest Revision).

#### **Fixing:**

The W.C. Pan shall be laid in floor sloped towards the pan in a workman like manner, care being taken not to damage the pan in the process of fixing. It shall be fixed on a base of cement concrete 1:3:6 mix. (1 cement: 3 coarse sand: 6 stone ballast 40 mm and down gauge) taking care that the cushion is uniform and even without having any hollows between the concrete and pan the joint between the W.C. pan and the trap shall be made with cement mixed with waterproofing compound and made leakproof.

#### **Flushing Cistern for Indian Type W.C.:**

The flushing of W.C. pan shall be done by low level flushing cistern in white glazed porcelain ware with all internal fittings, cistern brackets with CP flush pipe, bend as directed & specified in the drawing & scope of work.

#### **European Type W.C.:**

The Wash down pattern Horn inlet white Vitreous China pedestal type shall be approved make; these shall be fixed to floor with rawl plugs and brass screws or hung from wall as per approved design & drawing.

#### **Seat & Lid:**

These shall be of plastic hygienic seat and lid or as specified with rubber buffers, CP brass hinges and screws approved make.

#### **Flushing Cistern for EPWC:**

Unless otherwise specified, these shall be low down with internal fitting and CP brass flushing handle, CP flush bend with unions complete in all respects. Cistern shall have 15mm. (1/2”) dia. PVC overflow pipe.

#### **Urinal:**

The urinal basin shall be flat back of white vitreous China of specified size. It shall be fixed in position by using wooden plugs and screws at a height of 650 mm. from the floor level to the top lip of the urinal or as shown in the drawing. Each urinal shall have 40 mm. dia. outlet with C.P. brass hinged domed grating.

#### **Trap:**

Each basin shall have 40mm. dia. C.P. brass „P“ or „S“ trap complete with unions of approved make. This shall be further connected to 40 mm. lead of G.I. waste pipe as

specified in the drawings & scope of work, including wiped plumber joint complete with unions.

**Angle Valve:**

The cistern shall be fitted with inlet tube and angle valve of approved make complete with union unless otherwise specified in the scope of work.

The capacity of the flushing cistern and size of the flush pipe for the number of urinals shall be as follows:

-

| No. of Urinals | Capacity of Flushing Cistern | Main  | Size of distribution |
|----------------|------------------------------|-------|----------------------|
| 1.             | 5 Litres                     | -     | 15 mm                |
| 2.             | 10 Litres                    | 20mm. | 15mm.                |
| 3.             | 10 Litres                    | 25mm. | 15mm.                |
| 4.             | 15 Litres                    | 32mm. | 15mm.                |

The main and distribution pipes fittings and clamps shall be of C.P brass unless otherwise specified in the schedule of quantities; distribution pipes shall feed the urinals with C.P. brass spreaders of approved make.

**Wash Basin:**

These shall be of white vitreous China as specified in the Scope of Work and as per manufacturer's specification. These shall be supported on a pair of C.I brackets of approved design.

**Fittings:**

Each basin /sink shall have single or pair of pillar tap/special taps for the type of the sink specified and other fittings as specified, of approved make with brass waste (CP), C.P. brass angle valve with inlet connection of C.P. brass chain and rubber plug.

**Waste Connection:**

Waste pipe shall be of 1.1/2" dia. (32mm.) of P.V. of approved make complete with unions. This shall discharge into a floor trap.

**Kitchen Sinks:**

These shall be of stainless steel of specified size of pressed stainless steel of approved make and shall have 40mm CP brass traps with unions complete.

**Fixing:**

These shall be supported on C.I cantilever brackets or placed on finished counter. The joint between the sink and finished surface shall be fixed with filler to make it absolutely watertight. The draining board shall be sloped towards the sink in order to drain out all the water in the sink.

**Fitting:**

Sink shall be provided with 1/2" (15mm C.P. brass valve) mixing fitting approved make complete with swing spout.

**Waste Connection:**

The waste pipe shall be of PVC discharging up to floor trap. The rates shall include the cost of all materials and labor involved in all the operations described above.

**TOILET REQUISITES:****Mirror:**

Mirrors shall be of 5.0 mm. thick plate glass of approved make. The glass shall be uniformly silver plated at the back. Silvering shall have a uniform protective coating of red lead paint. The mirror shall have fibre glass frame of approved quality and colour. The mirror and its backings shall be fixed on the wall face to wooden cleats with C.P. brass screws and washers.

**Glass Shelf:**

The shelf shall be of glass of approved quality with edges rounded off. The size of the shelf shall be as specified. The shelf shall be supported on anodized aluminum angle frame with C.P. brass brackets and guard rails completely fixed to wooden cleats with C.P. screws and washers.

**Toilet Paper Holder:**

Toilet paper holders shall be C.P. Brass of approved make, including fixing with C.P. screws.

**uPVC Soil Waste and Vent Pipes and Fittings:**

All soil, waste and vent pipes and fittings shall be of ISI mark or similar approved uPVC pipes including bolts, nuts & other fittings as required.

**Floor Traps:**

The traps shall be of self-cleaning design. The floor trap is connected to a waste stack with bends. The other specification for these shall be the same as those for uPVC soil and vent pipes and fittings.

**Waste Connections:**

Waste from lavatories, floor traps, sinks and baths shall separately discharge over the gully trap on the ground floor and shall be separately connected to waste stack on higher storey.

Every starting manhole will have a 100 mm. (4") HCI vent terminating at 1 Metre (3 feet) above parapet of nearest buildings or as otherwise specified in the drawing.

**Anti-Syphonage Pipes:**

Anti-syphonage pipe shall be uPVC pipes with lead caulked joints. The main anti-syphonage pipes shall be 50 mm. internal diameter or as specified.

**WATER SUPPLY:****G.I. Pipes and Fittings:**

The pipes shall be of galvanized steel, welded and seamless screwed and socketed and shall conform to latest Indian Standards specifications for medium quality.

**Laying & Fixing:**

Where pipes have to be cut or re-threaded, ends shall be care-fully filled out so that no obstruction to bore is offered.

In jointing the pipes, the inside of the sockets and the screwed end of the pipe shall be rubbed over with white lead and a few turns of hemp yarn wrapped round the screwed end of the pipe which shall then be screwed home in the socket with a pipe wrench. Care must be taken that all pipes and fittings are kept at all times free from dust and dirt during fixing.

**Internal Work:**

For internal work, G.I pipes and fittings inside and outside the walls shall be fixed either visible (not in chase) by means of standard pattern holder bat clamps keeping the pipe 12 mm (1/2") clear of the wall everywhere or concealed as specified in Scope of work.

All pipes and fittings shall be fixed truly vertical and horizontal or as directed by the Engineer-in-Charge.

**External Work:**

For external work G.I pipes and fittings shall be laid in trenches. The width of the trench shall be the minimum width required for working the pipes laid underground level. They shall not be less than 60 CMS (2 feet) from the ground level, and painted with bitumen. The work of excavation and refilling shall be done in accordance with the instruction of the Engineer-in-Charge.

**Painting:**

All internal G.I pipes and fittings shall be painted with two coats of synthetic enamel paint of approved quality manufacture, colour and shade as specified under uPVC pipes and fittings. The cost of such painting shall be included in the Contractor's rates.

**Testing:**

All G.I pipes and fittings shall be tested to ensure that pipes have proper threads and that proper materials (such as white lead and hemp) have been in jointing. All leaky joints must be made leak-proof by tightening at Contractor's expense.

**Brass Water Fittings:**

All water fittings shall be of standard manufacture and shall be in all respects comply with the latest Indian Standard Specifications. The brass fittings shall be fixed in the pipe line in a workmanship like manner. Care shall be taken to see that joints between fittings and pipes are made leakproof.

**Shower Rose:**

The shower rose shall be of specified quality with flat bottom of specified diameter with uniform perforations. The inlet size shall be 15 mm. (1/2") or 20 mm (1/4") as specified. A stop cock of the requisite size shall be provided to control the inlet water supply to the shower rose.

**DRAINAGE/SEWERLINE:**

**uPVC Pipe:**

**Pipes:** All pipes must be new and perfectly sound, free from fire cracks and imperfection of glazing, cylindrical straight and of standard nominal diameter, length and depth of socket. They shall be hard burnt stoneware of dark grey colour and thoroughly salt glazed inside and outside. They should conform IS: 12818 (Latest Revision).

**Trenches For S.W Pipe Drains/Sewer Line:**

**Excavation:**

The trenches for the pipes shall be excavated to lines and levels as directed. The bed of the trench shall be truly and evenly dressed throughout from one change of grade to the next.

The gradient is to be set out by means of bending rods and should the required depth be exceeded at any point the trench shall be refilled by means of cement concrete of the specification of the bed concrete, at the contractor's own expense. The bed of the trench if in soft or made up earth shall be well watered and rammed and depressions thus formed filled with sand or other suitable materials as directed by the Engineer-in charge before laying the bed concrete.

The trench shall be kept free from water. Shoring and timbering shall be provided wherever required.

The trench width shall be the nominal diameter of the pipe plus 36 cms. (15") but it shall not be less than 52 cms. (21") in case of all kinds of soil excluding rock and not less than 92 cms. (3 feet) in case of rock.

Wherever the drain runs deeper, the width of the trench in the upper reaches may be increased as per the directions of the Engineer-in charge.

#### **Road Crossings:**

All road crossings shall be excavated half at a time, the second half being commenced, after the pipes have been laid in the first half and the trench refilled. The trench at the existing road crossings shall be filled in with mud concrete for the full depth except for the 15 cms (6") layer, which shall be filled with cement concrete 1:2:4 or as directed.

#### **Protection of Existing Services:**

All pipes, water mains, cables etc., met within the course of excavation shall be carefully protected and supported. Such mains will be hung from timbers placed across the trench. Care shall be taken not to disturb the electrical and communication cables, removal of which if necessary shall be arranged by the Engineer-in-charge.

#### **Lighting and Watch:**

The open trenches shall be provided with requisite fencing and watchman to guard against accidents. Red flags during day and red-light during night shall be provided at the ends and at intervals along the sides of the trenches.

#### **Refilling:**

Refilling in trenches for pipes shall be commenced as soon as the joints and concrete have been passed. The refilling on the top and around the drain shall be done with great care and in such a manner as will obtain the greatest amount of compactness and solidity possible. For this purpose, the earth shall be laid in regular layers of 15 cms (6") and watered and rammed at each layer. All surplus earth shall be disposed of as directed by the Engineer-in-Charge.

#### **Concreting:**

All uPVC pipes shall be laid on a bed of 15 cms. (6") thick cement concrete as specified with projection on each side of the pipe to the full width of the trench.

#### **Laying and Jointing uPVC Pipes:**

##### **Laying:**

The pipes shall be carefully laid to the levels and gradients shown on the plans and sections. Great care shall be taken to prevent sand etc., from entering the pipes. The pipes between two manholes shall be laid in a straight line without vertical or horizontal undulations.

The pipes will be laid "socket up" the gradient. The body of the pipe shall for its entire length rest on an even bed.

**Jointing:**

The adhesive solution for joints shall be applied.

**General:**

**Storm Water Drains:**

When uPVC pipes are used for storm water drainage, no concreting will be necessary. The adhesive solution for jointing will be as specified in the Scope of Work. Testing of joints also will be required.

**Precaution:**

To avoid logging of drains, both ends shall be kept plugged until the construction of manholes is completed in every respect. On completion, care shall be taken that each plug is removed and the face of the drain made smooth.

**Gully Traps:**

Each gully trap shall have a uPVC piping 15 x 15 Cms. (6" x 6") and one water tight C.C.I. cover with frame 30 x 30 Cms. (12" x 12") (inside dimensions) with machine seating faces or as specified.

**Excavation:**

The excavation for gully trap shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-Charge.

**Fixing:**

The gully trap shall be fixed on cement concrete foundation 70 Cms. (2'3") square and not less than 10 Cms. (4") thick.

The mix for the concrete will be 1:5: 10 (1 Cement: 5 Sand: 10 Stone ballast) 40 mm (1.1/2" gauge) or as specified. The jointing of gully outlet to the branch drain shall be done similar to jointing of S. W. pipes.

**Masonry Chamber:**

After fixing and testing the gully and branch drain, a brick masonry Chamber 30cm x 23 Cms (12" x 9") (inside in first class brick in cement mortar 1:5 shall be built with 11 Cms. (4.1/2") thick all round the gully trap from the top of the bed concrete up to ground level. The space between the Chamber walls and the trap is to be filled in with cement concrete of the specifications of bed concrete. The upper portion of the Chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement: 3 sand) finished with floating coat of neat cement. The corners and bottom of the Chamber shall be rounded off so as to slope towards the grating.

**C.I. Cover:**

C.I. cover with frame 30x23 Cms. (12"x9") or as specified with mechanical seating faces shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered.

smooth. The finished top of cover shall be left 15 Cms. (6") above the adjoining ground level so as to exclude the surface water from entering the gully trap.

### **MANHOLES, GULLY CHAMBER ETC.:**

**Manholes:** The size specified shall be in the internal size of the manhole. The work shall be done strictly as per drawings and specifications. The following specifications shall be adopted.

**Excavation:** The manhole shall be excavated true to dimensions and levels, shown on the plan or as directed by the Engineer-in-Charge.

**Brick Work:** The full brick work shall be with best quality brick in cement mortar 1: 6, brick masonry in arches shall be with 1<sup>st</sup> class brick in cement mortar 1:6, brick masonry round the pipe shall also be with 1<sup>st</sup> class brick in cement mortar 1:6, the joints shall be made thoroughly leak proof.

**Bed Concrete:** The manhole shall be built on a bed of 15 Cms. (6") thick cement concrete (6:3:1) with crushed stone aggregates over a layer of brick flats soling.

**Plaster:** Inside of the walls be plastered with 12 mm. (1/2") thick cement plaster 1:3 (1 cement:3 coarse sand) finished with a floating coat of neat cement.

In wet ground, 12 mm. (1/2") thick cement plaster of the above specifications shall be done on the outside surface of the walls also. This plaster shall be waterproofed with addition of 1 kilogram of „Accoproof” to 50 kilogram (1 bag) of cement with addition of any other equal and approved water proofing compound. The plastering shall be done upto 30 cms. (1 foot) above the wet soil line. Extra shall be paid for plastering the outside surface wherever directed.

**Pointing:** Pointing shall be done with 1:2 cement mortar.

**Benching:** The channels and benching shall be done in cement concrete 1:2:4 and rendered smooth with neat cement.

The following sizes of the channels shall be adopted for the benching:-

| Size of the Drain | Depth at the Centre | Depth at sides i.e. , at walls |
|-------------------|---------------------|--------------------------------|
| 100mm.(4")        | 15Cms(6")           | 25Cms(10")                     |
| 150mm.(6")        | 20Cms(8")           | 30Cms(12")                     |
| 250mm.(9")        | 28Cms(11")          | 38Cms(15")                     |
| 300mm.(12")       | 35Cms(14")          | 45Cms(18")                     |
| 400mm.(15")       | 43Cms (17")         | 53Cms (21")                    |
| 450mm.(18")       | 50Cms (20")         | 61Cms(24")                     |

### **R.C.C. Work:**

R.C.C. work for labors or lintels shall be in cement concrete 1:1½:3 with steel reinforcement as per details. Plain concrete, if used for fixing manhole covers, shall be of the above specifications.

### **Foot Rests:**

These shall be of M. S. square rod 22 mm. (7/8") or as specified and shall be painted with coal tar. These shall be embedded in masonry in cement mortar at least 23 Cms. (9") while the brick work is in progress. These shall be fixed 30 Cms. (1 foot) apart vertically and staggered laterally and shall not project more than 11 Cms. (4 1/2") from the wall.

#### **C.I. Manhole Covers:**

The C.I. covers shall be of tough homogeneous cast iron of heavy or light type as specified. The sizes specified, are the clear internal dimensions. The approximate weights of the various types of manhole covers with frames and their internal size will be as per specification in scope of work.

The frame of manhole cover shall be embedded firmly in the R.C.C slab or plain concrete as the case may be on the top of the masonry.

After the completion of the work, manhole covers shall be sealed by means of thick mortar greased. All exposed surfaces of the frames and covers shall be painted with coal tar. The cost of such painting should be included in the Contractor's rates for the manhole cover.

#### **Plain Manhole:**

90 cms. x 45 cms. (3' x 1'-6"). This type of manhole is to be provided as specified in drawing and scope of works. Due to shallowness and narrowness the manhole is provided with cover with bigger opening to facilitate cleaning and repairs. Cover of size 90 Cms. x 45 Cms. (3' x 1'-6") shall be used.

#### **Plain Manhole:**

1.2 X 0.9 M (4' x 3'). This type of manhole is constructed for main drainage work for depth less than 2.4 Meters (8").

When the manhole is built on the footpath, this shall be provided with 45 Cms. (18") internal diameter light type C.I. cover, when it is built within the width of the road under traffic, it shall be provided with 53 Cms. (21") internal diameter heavy type C.I. cover.

#### **Level of Invert:**

Sewers of unequal sectional area should not joint with level invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3rd dia. of the main above the invert of the main. The branch sewer should deliver sewage in the manhole in the direction of main flow and the junction must be made with ease so that flow in the main is not impeded.

#### **House Connections:**

No drain from house fittings e.g. gully trap or soil pipe etc., to manhole shall exceed a length of 6 Meters (20 feet) unless it is unavoidable.

#### **Drop Connections:**

In case where branch pipe sewer enters the manholes on main pipe sewer at a higher level than the main sewer, a drop connection should be provided.

C.I. Inspection bend shall be fixed in position at right angle to the drop pipe at the level of the inlet branch drain. The plain C.I. shoe at the bottom shall be fixed in the benching cement concrete 1:2:4 (1 cement: 2 sand: 4 stone ballast 3/4" gauge) so as to discharge into the channel. The joints shall be lead caulked as per specifications for the cast iron pipes for water supply.)

#### **RCC PIPE DRAINAGE/ SEWER LINE:**

##### **RCC Drainage/Sewer Line:**

RCC pipe as IS: 458 (Latest Revision) drainage shall be adopted in the case mentioned below:-

When the drain passes under a structure.

When the drain passes under a road which is subject to heavy traffic and where the covering cushion is not considered sufficient.

When the drain passes through a place where it is subjected to vibrations. In hilly places where the slopes are very steep.

When drain gullies run on the surface or above ground.

**Trenches:**

Specifications for trenches for stone ware piped drains will apply in this case.

**Pipes:**

The pipes used shall conform to the Indian Standard specifications (IS:458) for class NP3 pipes.

**Fittings:**

RCC collar, inspection chambers of brickwork with RCC manhole cover on top etc., shall conform to approved design, drawing and specification.

**Laying:**

For laying RCC pipes and fittings, specifications for RCC water mains will apply. The joints for pipes and fittings shall be cement mortar joints under water supply. The joints shall be leak proof.

**Testing:**

Testing of joints for RCC pipes shall be done by water pressure test as specified in Indian Standard code of practice.

**Masonry Chamber:**

Inspection chambers for underground shall be enclosed in masonry chambers.

**NOTE:**

In case of non-availability of any particular brand of material or equivalent as specified in the Scope of Work. Contractor could also supply any other equivalent approved brand or material or equipment conforming to the latest I.S specifications.

**Action where no Specification is specified**

In the case of any class of work for which there is no such specifications, such work shall be carried out in accordance with the Bureau of Indian Standards Specifications. In case there is no such specification in Bureau of Indian Standards, the work shall be carried out as per manufacturer's specifications, if not available then as per specifications. In case there are no such specifications as required above, the work shall be carried out in all respects in accordance with the approved drawing, design and specification.

## **SPECIAL CONDITIONS AND TECHNICAL SPECIFICATION FOR ELECTRICAL WORKS**

### **CHAPTER 1**

#### **SPECIAL CONDITIONS OF CONTRACT**

##### **1.1 General**

- 1.1.1 These Special Conditions of Contract supplement the preamble and General Instructions. These Special Conditions of Contract are at variance with General Conditions of Contract, the Provisions of these Special Conditions of Contract shall prevail.
- 1.1.2 The several documents forming the tender are to be taken as mutually complementary to one another. Detailed drawings shall be followed in preference to small scale drawings and figured dimensions in preference to scaled dimensions.
- 1.1.3 If there are varying or conflicting provisions in the documents forming part of the contract, the Engineer In Charge shall be the deciding authority with regard to the intentions of the provisions and his decisions shall be final and binding on the contractor.
- 1.1.4 The Employer reserve the right to exclude any of the Schedule items on reasons of the rates not being reasonable or subsequent change of design for evaluation of tender and deciding the contract.
- 1.1.5 The Contractor may be required to carry out any additional or alteration work other than the specified in the schedule of work / bill of quantities as and when required, by the „Employer“ within the completion period of the project.

##### **1.2 Scope of Work**

- 1.2.1 The work to be governed by this contract shall cover transportation up to destination with safe custody at site, insurance, erection, testing and commissioning of the following:

H.T. Switchgear Panel, Transformer, DG Set.  
Main L.T. Panel, Power & Lighting Distribution Board connecting cables of both incoming and outgoing feeders etc.  
H.T. and L.T. cables.  
Internal & external Electrification of buildings & Campus.

- 1.2.2 The work to be undertaken by the contractor will inter-alia include the following:

Preparation of detailed drawings of electrical wiring, cable laying, erection/fixing of various power panels, distribution wirings, electrical equipment, fitting etc.

Commissioning tests as per relevant standard specifications, code of practice, Acts and Rules.

Earthing of installations as per relevant Indian Standard Specifications.

All other earthwork and masonry works required to be done in connection with the electrical works.

### 1.3 Drawings

1.3.1 The drawings given with the tender only indicate the general scheme of requirements. Contractors shall prepare all the detailed design and working drawings and submit them to the Employer for approval.

1.3.2 The working drawings shall be furnished in triplicate furnishing physical dimensions of the equipment constructional details, disposition of busbar, terminal connection etc.

1.3.3 The electrical layout clearly indicating the electrical clearances, cable run layout with schematic diagram shall be furnished in triplicate for approval.

### 1.4 Execution of work

1.4.1 All electrical works i.e. power panels, distribution boards, equipment layout, conduits layout, electrical wiring, cable laying, telephone wiring, LAN cable wiring, earthing etc., have to be done as per approved drawings and directions given at site by the Engineer-in-Charge.

#### 1.4.2 Water and Power:

The Contractor has to arrange water and power for construction at his own cost. If the Employer at his own discretion, provides either of the above, subject to the availability, suitable charges will be levied at the Municipal rates for water supply and at Electricity Board rates for power for electrical charges, Contractors would bear the cost for providing electrical meter and meter charges as per the prevailing rate in the area and the same will be recovered from the monthly running bill. Water connection will be provided at a single point convenient to the Employer. The Contractor has to make his own arrangements for collection and distribution of water at various sites. The Contractor has to bear the charges for providing water meter and connection charges.

### 1.5 Period of Completion

1.5.1 Completion period is very important in this case. Normally no extension of time will be given. However, on account of delay if any, in the construction of building suitable extension will be considered.

### 1.6 Insurance Coverage:

1.6.1 The Contractor shall within 15 days from the date of commencement of the work insure all the works and materials with any nationalized Insurance Company at his own cost against loss or damage by fire, storm, tempest, lightning, floods, earthquake, air craft or anything dropped therefrom, aerial objects, riots, civil commotions and other such usual risks.

### 1.7 Quality of materials and works:

1.7.1 All materials used in the execution of the contract shall be of the best quality and of the class most suited for the purpose specified. Components, assemblies and equipment to be obtained from sub-contractors should be from proven sources. The work shall also conform to the following Acts, Rules and Orders:

Indian Factories  
Act Indian  
Electricity National  
Building

CodeNationalElectrical  
Code

- 1.7.2 All erection work shall be of the best quality to the entire satisfaction of the Employer. The Contractor shall ensure that the equipment and services under the scope of this contract whether manufactured or performed within the Contractor's premises or at his subordinate's premises or at the work site or at any other place are strictly in accordance with the provisions of this contract. For this purpose, the Contractor shall adopt necessary quality assurance programme to control such activities at all stages.

## **1.8 Electrical License:**

- 1.8.1 The work shall be carried out by the contractor or the contractor is allowed to engage suitable, competent electrical sub-contractor who should possess valid electrical licenses for executing similar electrical works.
- 1.8.2 It is necessary for the contractor to indicate the names of the proposed sub-contractors (electrical) along with their performance records and license details as outlined in item 1.8.1.

## **1.9 Inspection:**

- 1.9.1 The inspection officer(s) for this contract shall be nominated by the Employer and notified to the contractor.
- 1.9.2 The cost of the inspection will be on Employer's account subject to any other provisions contained hereunder or elsewhere in the contract. One week's notice must be given by the Contractor to the Inspecting Engineer to take up the inspection.
- 1.9.3 The Contractor shall provide without any extra cost of the Employer all materials, equipment, tools, labour and maintenance of every kind which the Employer's Inspecting Engineer may consider necessary for any test and examination to be made at the Contractor's or the Sub-Contractor's premises and at site and shall pay all cost attended thereon.
- 1.9.4 All the equipment and materials shall be tested / inspected by the Employer or its authorized Inspecting Engineer and approved before they are installed / used in the execution of the works covered in the contract. If the Contractor uses any equipment / materials without the prior approval of Employer, those are liable to be rejected. The exact positions of all switchboards and all runs-of-mains, sub-mains and distribution wiring to individual points including exact positions of all light fittings and switch-boards shall be first worked on the buildings and shall have to be approved by the Engineer-in-Charge before actual commencement of work.

The Contractor shall furnish, as and when demanded by the Engineer-in-Charge the T.C. and G.C. for verification of quality and make of the materials.

- 1.9.5 The Inspecting Engineer or his authorised Representatives shall have at all times access to the Contractor's premises and shall have the power to

Inspect and examine the materials and workmanship of the work at any time during the manufacture at the manufacturer's premises or in the premises of the Sub-Contractor or at the site of the erection.

Reject any part of the work submitted by the Contractor as not being in accordance with the contract.

Reject the whole of the work including equipment tendered of inspection if after the inspection of such portion as he may, in his discretion think fit he is satisfied that the same is unsatisfactory.

Mark the rejected equipment with a rejection mark so that the same may be easily identified

Re-inspect at the time of erection at site any equipment both previously inspected and approved by the inspecting Engineer at the Contractor or Sub-contractor's premises. Notwithstanding any approval given earlier, the Contractor shall make good such rejections made based on such re-inspection at site to the satisfaction of the Engineer.

The decision of the Inspecting Engineer as regards to the acceptance or rejection of equipment/work shall be final and binding to the Contractor.

**1.9.6 Consequence of Rejection**

On the equipment / assemblies being rejected by the Inspecting Officer of the Employer at destination of the Contractor shall replace such rejected equipment/assemblies of the forthwith but in any event not later than a period of 2 (two) weeks in the case of minor equipment and 4 (four) in case of a major equipment from the date of rejection. The Contractor shall bear all the costs of replacement including freight, etc., but without being entitled to any extra time on this account. The decision as to whether the equipment is to be classified as Minor or Major for the purpose of this clause shall be that of an Engineer and is not questionable.

**1.10 Installation:**

1.10.1 All works connected with and inclusive of installation and erection under this contract shall be done in accordance with the standard and established methods of installation and erection of electrical equipment and shall comply with relevant Indian Electricity Rules, National Electrical Code, BIS Codes of Specifications and Standards. The work shall also be strictly in accordance with the instructions / recommendations of the manufacturers. The equipment shall be leveled carefully before being fixed finally in position. All fragile and sensitive equipment shall be protected adequately and handled carefully during installation and erection.

**1.11 Commissioning Tests:**

1.11.1 As soon as the installations are ready for commissioning / sub-station, the Contractor shall arrange for all the tests/inspection as required by the relevant ISS and/or IER Rules and advise the Employer and others concerned. Employer shall depute their Inspecting Officer for witnessing the tests and to carry out inspection independently and also jointly with other concerned agencies where ever necessary and only after the installation passes the required tests and inspection, it should be commissioned/energized.

1.11.2 The Contractor shall take full responsibility for these tests. For site tests the Employer where possible may permit the Contractor for the purpose of testing, the use of any instruments /apparatus and electric power which the Employer can conveniently work not complying with the specifications, the Employer at their discretion ask the Contractor to pay the cost of providing the additional energy required. The Contractor shall provide all apparatus and energy, which may be required for drying out the equipment in a manner approved by the Employer. If, by reasons of the Contractor failing to comply with any of the provisions of this

clause, any of the said tests are to be repeated the Contractor shall pay all fees and expenses in connection therewith.

- 1.11.3 Visual Inspections shall include checks for satisfactory workmanship, all connections, painting, plastering, cleanliness of all fittings etc., and compliance with Indian Electricity Rules.
- 1.11.4 The ammeters, voltmeters and energy meters shall be checked for their calibration, scale, accuracy, etc. for compliance with the specified requirement.
- 1.11.5 (i) Manufacturer's test Certificates shall be furnished as evidence that type tests have been made in accordance with IS: 3231. Type test results together with appropriate drawings and records of any relevant alteration, which may have been made to any relay subsequent to the type test, shall be made available.

Certificates of compliance or routine tests shall also be furnished.

Routine tests shall be carried out at manufacturer's premises prior to commissioning in compliance with IS: 3231.

Routine tests are to be carried out on presence of Engineer-in-Charge and test certificates are to be submitted.

- 1.11.6 All cables shall be tested at manufacturer's works in compliance with relevant standards. All cables and connections after erection shall be tested as required by the Employer for:

Pressure  
Test Insulation  
Test

- 1.11.7 Earth resistance shall be measured separately for each earth electrode and when they are connected together and to the equipment recorded.

## **1.12 Warranty:**

- 1.12.1 The Contractor shall guarantee that all the equipment and the works executed under this contract shall be free from all defects and faults in materials, design, workmanship and manufacture and shall be acceptable standards for the contracted work and in full conformity to the technical specifications, drawings and other contract stipulations.
- 1.12.2 The Contractor's liability in respect of any complaint defect and/or claim shall be limited to the execution. Installation and erection of replacement parts free of charge, or the repair of defective parts only to the extent that such replacement or repairs are attributable to or arise from faulty workmanship or design or material in the manufacture of the equipment / stores, and or negligence in any manner and also in the event of failure of the equipment to perform as intended.
- 1.12.3 The contractor shall, if required, replace, repair, execute and / or install the goods or such portion thereof as is rejected by the Employer free of cost at site or at the option of the Employer the contractor shall pay to the Employer the value thereof and such other expenditure and damage as may arise by reason of the breach of the conditions therein specified.

- 1.12.4 If any defect is not rectified satisfactorily within the above mentioned 1(one) month, the Employer may proceed to do the work at Contractor's risk and cost and also without prejudice to any other rights of the Contractor under this contract.
- 1.12.5 If the Contractor so desires, the replaced parts can be taken over by him or Representative for disposal as he deems fit within a period of one month from the date of replacement of goods /parts. At the expiry of this period, no claim whatsoever shall lie on the Employer.
- 1.12.6 The Employer may, at their discretion recover the ground rent for the goods/parts which have been rejected during the warranty period for the specified period of one month, if the rejected materials are not taken over within that period of one month, by the Contractor or his Representative.
- 1.12.7 The warranty herein contained shall not apply to any material which have been repaired or altered by the Employer, or on their behalf in any without the consent of the Contractor so as to affect its strength, performance and reliability or to any defects to any part due to misuse, negligence or accidents or to items of normal wear or tear to be specifically mentioned by the Contractor in his offer and got accepted by the Employer. The decision of the Employer in regard to Contractor's liability and the amount if any payable, under this warranty, shall be final and conclusive.
- 1.13 Indemnity Bond:**
- 1.13.1 The Contractor shall sign an Indemnity Bond before starting the work from any damages, prosecution, other legal suits and claims arising out of any mishaps occurring at site due to negligence, wrong practice, bad workmanship, faulty work, violation of safety rules and regulations etc., for which the Contractor shall be solely responsible. The Indemnity Bond shall be executed in the form prescribed by the Employer.
- 1.14 Completeness of Tender:**
- All sundry fittings, assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the tender, whether such items are specifically mentioned in the tender documents or not.
- 1.15 Work to be arranged by the Department:**
- Unless and otherwise specified in the tender documents, the following work shall be arranged by the Department:
- Storage space for all equipments, components and materials for the work. Supply of material to the Contractor as stipulated in the tender documents.
- 1.16 Work to be done by the Contractor:**
- Unless and otherwise mentioned in the tender documents, the following works shall be done by the Contractor, and therefore their costs shall be deemed to be included in their tendered cost :
- Foundations for equipments and components where required, including foundation bolts.

Cutting and making good all damages caused during installation and restoring the same to their original finish.

Sealing of all floor openings provided by him for pipes and cables, from fire safety point of view, after laying of the same.

Painting at site of all exposed metal surfaces of the installation other than pre-painted items like fittings, fans, switchgear/distribution gear items, cubicle switch board etc. Damage to finished surfaces of these items while handling and erection, shall however be rectified to the satisfaction of the Engineer-in-charge.

Temporary shed if required over the storage space and locking arrangement thereof, and watch and ward of the materials and completed installation till completion of the work.

Water and power as may be required for installation.

**1.17 Storage and Custody of Materials:**

Suitable and lockable storage accommodations shall be provided by the Department free of cost to the contractor. However, their proper storage and safe custody shall be his responsibility till the final taking over the installations by the Department.

**1.18 Electric Power Supply and Water:**

Unless and otherwise specified, power supply and water supply as may be required shall be arranged by the Contractor for installation and testing of the equipments at the site of work.

**1.19 Tools for Handling and Erection:**

All tools and tackles required for handling of equipments and materials at site of work as well as for their assembly and erection and all necessary test instruments shall be responsibility of the contractor.

**1.20 Coordination with Other Agencies:**

The contractor shall co-ordinate with all other agencies involved in the building work so that the building work is not hampered due to delay in his work. Recessed conduit and other works which directly affect the progress of building work should be given priority.

**1.21 Care of Building:**

Care shall be taken by the Contractor to avoid damage to the building during execution of his part of the work. He shall be responsible for repairing all damages and restoring the same to their original finish at his cost. He shall also remove at his cost all unwanted and waste materials arising out of his work from the site.

**1.22 Structural Alterations to Buildings:**

No structural member in the building shall be damaged / altered, without prior approval from the competent authority through the Engineer-in-charge.

Structural provisions like openings, cutouts, if any, provided by the department for the work, shall be used. Where these require modifications, or where fresh provisions are required to be made, such contingent works shall be carried out by the Contractor at his cost.

All such openings in floors provided by the Departments shall be closed by the Contractor after installing the cables / conduits / rising mains etc. as the case may be, by any suitable means as approved by the Engineer-in-charge without any extra payment.

All chases required in connection with the electrical works shall be provided and filled by the Contractor at his own cost to the original architectural finish of the buildings.

### **1.23 Work in Occupied Buildings:**

When work is executed in occupied buildings, there should be minimum of inconvenience to the occupants. The work shall be programmed in consultation with the Engineer-in-charge and the occupying department. If so required, the work may have to be done even before and after office hours.

The contractor shall be responsible to abide by the regulations or restrictions set in regard to entry into and movement within the premises.

*The Contractor shall not tamper with any of the existing installations including their switching operations or connections thereto without specific approval from the Engineer-in-charge.*

## CHAPTER 2

### **General and Technical specification for electrical power distribution and wiring**

#### **2.0 Scope:**

This chapter covers the general technical requirements and measurement of the various components in Internal Electrical Installation works.

#### **2.1 Terminology:**

2.1.1 The definition of terms shall be in accordance with IS: 732-1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit, and sub main wiring, which are defined in clauses 2.2.1, 2.3.1 and 2.3.2 hereunder. Some of the commonly used terms are indicated in Appendix A.

2.1.2 The conventional signs and symbols for technical work shall be as shown in Appendix-B.

#### **2.2 Point Wiring:**

##### **2.2.1 Definition**

A point (other than a socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit.

Ceiling rose or connector (in the case of points for ceiling / exhaust fan points, pre-wired light fittings, and call bells).

Ceiling rose (in the case of pendant except stiff pendants). Backplate

(in case of stiff pendants).

Lamp holder (in case of gooseneck type wall brackets, batten holders and fittings which are not pre-wired).

*Note: In the case of call bell points, the words "from the controlling switch or MCB" shall be read as "from the ceiling rose meant for connection to bell push".*

##### **2.2.2 Scope**

Following shall be deemed to be included in point wiring.

□ Conduit/casing and capping/batten as the case may be, accessories for the same and wiring cables between the switch box and the point outlet. [See also (j) below]

□ All fixing accessories such as clips, nails, screws, plug, raw plug etc. as required.

Mechanical protection of batten wiring upto 1.5m from floor and at locations where wiring is liable to be damaged.

Metal or PVC switch boxes for control switches, regulators, socket etc., recessed or surface type, and phenolic laminated sheet covers over the same.

Outlet boxes, junction boxes, pull-through boxes etc., but excluding metal boxes if any, provided with switch boards for loose wires / conduit terminations.

Any special block required for neatly housing the connector in batten wiring system. Control switch or MCB, as specified.

3 pin or 6 pin sockets, ceiling rose or connector as required (2 pin and 5 pin socket outlet shall not be permitted).

Connection to ceiling rose, connector, socket outlet, lamp holder, switch etc.

Interconnecting wiring between points on the same circuit, in the same switch box or from another.

Protective (loop earthing) conductor from one metallic switch box to another in the distribution circuits, and for socket outlets. (The length of protective conductor run along with the circuits / sub-mains is excluded from the scope of points).

Bushed conduit or porcelain tubing where wiring cables pass through wall etc.

### **2.2.3 Measurement**

#### **2.2.3.1 Point Wiring (other than socket outlet points)**

Unless and otherwise specified, there shall be no linear measurement for point wiring for light points, fan points, exhaust fan points and call bell points. These shall be measured on unit basis by counting and classified as laid down in 2.2.3.2. [See also clause 2.4(ii)]

No separate measurement will be made for interconnections between points in the same distribution circuit and for the circuit protective (loop earthing) conductors between metallic switch boxes.

#### **2.2.3.2 Classification**

Points measured under 2.2.3.1 on unit basis shall be classified as under according to the type of building.

##### **Residential buildings:-**

Group „A“, for point wiring for type I, type II and type III residential quarters and hostels.

Group „B“, for point wiring for type IV and above type of residential quarters and barracks.

### **Nonresidential buildings:-**

Group „C“, for all types of non-residential buildings such as offices, hospitals, and laboratories, educational institutions, libraries etc.

For any other types of building, the group under which the points are to be classified shall be decided by the concerned Chief Engineer (Electrical).

#### **2.2.3.3 Point wiring for socket outlet points**

The light plug (5A/6A) point and power (15A/16A) point wiring shall be measured on linear basis, from the respective tapping point if live cable, namely, switch box, another socket outlet points or the sub distribution board as the case may be, up to the socket outlet.

He metal/PVC box with cover, switch/MCB, socket outlet and other accessories shall be measured and paid as a separate item.

Note: There shall normally be no "on the board" light plug point.

The power point outlet may be 15A/5 A or 16A/6 A six pin socket outlet, where so specified in the tender documents.

#### **2.2.3.4 Group control points wiring**

In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e. (a) from the switch to the first point outlet as one point and classified according to 2.2.3.2, and (b) for the subsequent points, the distance from outlet to the next one and so on, shall be treated as separate point(s) and classified according to 2.2.3.2.

No recovery shall be made for non-provision of more than one switch in such case.

#### **2.2.3.5 Twin control light points wiring**

A light point controlled by two numbers of two-way switches shall be measured as two points from the fitting to the switches on either side and classified according to 2.2.3.2.

No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

#### **2.2.3.6 Multiple controlled call bell points wiring**

In the case of call bell points with a single call bell outlet controlled from more than one place, the points shall be measured in parts i.e. (a) from the call bell outlet to one of the nearest ceiling roses meant for connection to bell push, treated as one point and classified according to 2.2.3.2, and (b) from that ceiling rose to the next one and so on, shall be treated as separate point(s) and classified according to 2.2.3.2.

No recovery shall be made for non-provision of more than one ceiling rose or connector for connection to call bell in such cases.

## **2.3 Circuit and Sub-main Wiring:**

### **2.3.1 Circuit wiring**

Circuit wiring shall mean the wiring from the distribution board up to the tapping point for the nearest first point of that distribution circuit, viz., up to the nearest first switch box.

### **2.3.2 Sub-main wiring**

Sub-main wiring shall mean the wiring from one main/distribution switch board to another.

### **2.3.3 Measurement of circuit and sub-main wiring**

Circuit and sub-main wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of wood batten or conduit or casing and capping as the case may be, exclusive of interconnections inside the switchboard etc. The increase on account of diversion or slackness shall not be included in the measurement.

The length of circuit wiring with two wires shall be measured from the distribution board to the first nearest switch box in the circuit irrespective of whether the neutral conductor is taken to switch box or not.

When wires of different circuits are grouped in a single conduit/casing and capping, the same shall be measured on linear basis depending on the actual number and sizes of wires run.

When circuit wires and wires of point wiring are run in the same conduit /casing and capping, circuit wiring shall be measured on linear basis depending on the actual number and sizes of wires run in the existing conduit/casing capping.

Protective (loop earthing) conductors which are run along the circuit wiring and the sub-main wiring shall be measured on linear basis and paid for separately.

## **2.4 Other Wiring Works:**

Except as specified above for point wiring, circuit wiring and sub-main wiring, other types of wiring shall be measured separately on linear basis along the run of wiring depending on the actual number and sizes of wires run.

### **Rewiring**

The scope of work of the rewiring items provided in the Schedule of Rates (Part I – Internal), 1994 includes only replacement of wires. Replacement of switches and other accessories shall be covered by the relevant and corresponding item in the Schedule.

## **2.5 System of distribution and Wiring:**

### **2.5.1 Control at the point of entry of supply**

There shall be a linked switch with fuse or circuit breaker on each live conductor of the supply mains at the point of entry.

### **2.5.2 Distribution**

The wirings shall be done on a distribution system through main and/or branch distribution boards. The system design as well as the locations of boards. The system design as well as the locations of boards shall be as specified by the Engineer-in-charge.

Main distribution board shall be controlled by a circuit breaker or linked switch with fuse. Each outgoing circuit shall be controlled by a switch with fuse, circuit breaker or only a fuse on the phase or live conductor (as in the case of a TPDB).

The branch distribution boards shall be controlled by a linked switch fuse or circuit breaker. Each outgoing circuit shall be provided with a fuse or miniature circuit breaker (MCB) of specified rating on the phase or live conductor.

Triple pole distribution boards shall not be used for final circuit distribution, unless specific approval of the Engineer-in-charge is obtained. In such special cases, the triple pole distribution boards shall be of HRC fuse type or MCB type only.

The loads of the circuits shall be divided, as far as possible evenly between the number of ways of distribution boards, leaving at least one spare circuit for future extension.

The neutral conductors (incoming and outgoing) shall be connected to a common link (multi-way connector) in the distribution board and be capable of being disconnected individually for testing purposes.

„Power“ wirings shall be kept separate and distinct from „Lighting“ wiring, from the level of circuits i.e., beyond the branch distribution boards.

Wirings shall be separate for essential loads (i.e., those through standby supply) and non-essential loads throughout.

### **2.5.3 Balancing of Circuits**

The balancing of circuits in three wire or polyphase installations shall be arranged beforehand to the satisfaction of the Engineer-in-charge.

Circuits on opposite poles of a three wire D.C. system shall be kept apart unless they are enclosed in earthed metal casing, suitably marked to indicate the risk of shock due to the voltage between the conductors contained in them.

### **2.5.4 Wiring System**

Unless and otherwise specified in the tender documents, wiring shall be done only by the “Looping system”. Phase or live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.

Where “joint box system” is specified in the tender documents, all joints in the conductors shall be made by means of approved mechanical connectors in suitable and approved junction boxes.

Lights, fans and call bells shall be wired in the „lighting“ circuits. 15A/16A socket outlets and other power outlets shall be wired in the „Power“ circuits. 5A/6A socket outlets shall be wired in the „lighting“ circuits in non-residential buildings and in the „power“ circuit in residential buildings.

The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of a linked switchgear.

#### **2.5.5 Run of Wiring**

The type of wiring shall be as specified in tender documents, namely wood batten, casing and capping, or conduit.

Surface wiring shall run, as far as possible, along the walls and ceiling so as to be easily accessible for inspection.

In no case, the open wiring shall be run above the false ceiling without the approval of Engineer-in-charge.

In all types of wiring, due considerations shall be given for neatness, good appearance and safety.

#### **2.5.6 Passing through walls or floor**

When wiring cables are to pass through a wall, these shall be taken through a protection (steel/PVC) pipe or porcelain tube of suitable size such that they pass through in a straight line without twist or cross in them on either end of such holes. The ends of metallic pipes shall be neatly bushed with porcelain, PVC or other approved material.

Where a wall pipe passes outside a building so as to be exposed to weather, the outer end shall be bell mouthed and turned downwards and properly bushed on the open end.

Protection pipe shall be provided for batten wiring passing through floors as specified in clause 3.6 of these specifications.

All floor openings for carrying any wiring shall be suitably sealed after installation. [See also clauses 1.8(iii) and 1.4(iii)].

#### **2.5.7 Joints in wiring**

No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/or protective conductors in wiring shall be permitted.

There shall be no joints in the through-runs of cables. If the length of final circuit or submain is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.

Termination of multi-stranded conductors shall be done using suitable crimping type thimbles.

## **2.6 Ratings of Outlets (to be adopted for design):**

Incandescent lamps in residential and non-residential buildings shall be rated at 60W and 100W respectively.

Ceiling fans shall be rated at 60W. Exhaust fan, fluorescent tubes, compact fluorescent tubes, HPMV lamps, HPSV lamps etc. shall be rated according to their capacity. Control gear losses shall also be considered as applicable.

5A/6A and 15A/16A socket outlet points shall be rated at 100W and 1000W respectively, unless the actual values of loads are specified.

## **2.7 Capacity of Circuits:**

“Lighting” circuit shall not have more than a total of 10 points of light, fan and socket outlets, or a total connected load of 800W, whichever is less.

“Power” circuit shall be designed with only one outlet per circuit in non-residential buildings. The circuit shall be designed based on the load. Where not specified, the load shall be taken as 1KW per outlet.

“Power” circuit in residential buildings shall be designed for not more than two outlets (15A/16A and/or 5A/6A) per circuit. The ratings for load calculation purposes shall however be taken as per the type of outlets. [See clause 2.10.1(b) for their wiring].

Load more than 1KW shall be controlled by an isolator or miniature circuit breaker.

## **2.8 Conformity to IE Act, IE Rules, and Standards:**

All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 1910 and Indian Electricity Rules, 1956 amended up to date.

The works shall also conform to relevant Indian Standard Codes of Practice (COP) for the type of work involved.

In all electrical installation works, relevant safety codes of practice shall be followed.

## **2.9 General Requirements of Components:**

### **2.9.1 Quality of materials**

All materials and equipments supplied by the contractor shall be new. They shall be of such design, size and material as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

## 2.9.2 Ratings of components

All components in a wiring installation shall be of appropriate ratings of voltage, current, and frequency, as required at the respective sections of the electrical installation in which they are used.

All conductors, switches and accessories shall be of such size as to be capable of carrying the maximum current which will normally flow through them, without their respective ratings being exceeded.

- 2.9.3a) All components shall conform to relevant Indian Standard Specification, wherever existing. Materials with ISI certification mark shall be preferred. However, for conduits, wiring cables, piano/tumblers switches and socket outlets, ISI marked materials shall only be permitted.

A broad list of relevant Indian Standards is given in Appendix D. These Indian Standards, including amendments or revisions thereof up to the date of tender acceptance, shall be applicable in the respective contracts.

## 2.9.4 Interchangeability

Similar parts of all switches, lamp holders, distribution fuse boards switchgears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.

## 2.9.5 Categorization of components

Makes of certain items of materials are categorized from time to time by the Department and included in Schedule of rates; only those makes of items under the category indicated in tender documents shall be used in the work.

For items of materials for which makes are approved by the Department, only such approved makes shall be permitted in the work.

## 2.9.6 Special risks

Special forms of construction such as flame proof enclosures shall be adopted where there is risk of fire, or explosion and where indicated in the tender documents.

## 2.10 Cables

### 2.10.1 Wiring Cables

- a) Conductors of wiring cables (other than flexible cables) shall be of aluminum or copper, as specified.

The Government of India in the Gazette notification issued vide order dated 7.5.91 of the Department of Industrial Development under the Ministry of Industry has withdrawn its earlier ban on the use of copper in the manufacture of PVC and VIR wires of domestic type. Consequently, it is left to the discretion of the technically sanctioning authority to use either aluminum or copper wiring in any building or installation. However, wiring for socket outlets in all residential buildings shall be done by using copper conductor cables only.

The smallest size of conductor for „lighting“ circuits shall have a nominal cross-sectional area of not less than 1.5 sq. mm. The minimum size of conductor for „power“ wirings shall be 4 sq. mm.

Standard aluminum conductor shall not be used in wiring cables up to and including 6 sq. mm. Size.

#### 2.10.2. Flexible cables

Conductor of flexible cables shall be of copper. The minimum cross-sectional area of conductor for flexible cables shall be 0.0006 sq. inch (14/.0076" or 14/0.193 mm).

Only 3 core flexible cables shall be used for connecting single phase appliances.

Unless the flexible cables are mechanically protected by armor, or tough rubber, or PVC sheath, these shall not be used in workshops and other places where they are liable to mechanical damage.

Flexible cable connection to bell push from ceiling roses shall be taken through steel conduit/metallic casing and capping.

### 2.11 Wiring Accessories

#### 2.11.1 Control Switches for points

Control switches (single pole switches) carrying not more than 16 A may be of tumbler or piano type, as specified, and the switch shall be "ON" when the knob is down.

Control switches of 15A/16A rating may preferably be only of tumbler type. If, however, piano type switch is used for controlling a socket outlet, combined switch cum socket shall not be permitted.

The type and current rating of switch controlling a group of points, or discharge lamps, or a single large load, shall be suitable for the respective loads and as specified in the tender documents.

Power (15A/6A) outlets shall be controlled by single pole tumbler type switches or by MCB's, where specified. Only MCB's shall be used for controlling industrial type socket outlets, and power outlets above 1 KW.

Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

#### 2.11.2 Socket outlets

Socket outlets shall be of the same type, namely, piano type or tumbler type, as their control switches. These shall be rated either for 5A/16A. Combined 5A/15A, or 6A/16A six pin socket outlet may be provided in "Power" circuits only where specified.

- b) In an earthed system of supply, socket outlets and plugs shall only be of 3 pin type; the third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.

Conductors connecting electrical appliances with socket outlets shall be of flexible twin cord with an earthing cord, which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.

- □  
□  
 □ sockets for the power outlets of rating above 1KW shall be of industrial type with associated plug top and controlling MCB.
  - □  
□  
 □ hies specified, shutter type (interlocking type) of socket shall be used.
  - □  
□  
 □ socket outlet shall not embody fuse terminal as integral part of it. But the fuse may be embodied in plug, in which case the plug shall be non-reversible and shall be so arranged and connected that the fuse is connected to phase, or live conductor, or then non-earthed conductor of the circuit.
  - □  
□  
 □ every socket outlet shall be controlled by a switch or MCB, as specified. The control switch/MCB shall be connected on the „live“ side of the line.
  - □  
□  
 □ ilet boxes for socket outlets (both 15A/16A and 5A/6A) points in residential buildings shall be of size 175mm x 100mm.
  - □  
□  
 □ A/6A and 15A/16A socket outlets shall be installed at the following positions, unless otherwise specified.
- ⇒ □ □ □ □

□

□ on-residential buildings – 23cm above floor level.

Kitchen – 23cm above working platform and away from the likely positions of stove and sink

Bathroom – No socket outlet is permitted for connecting a portable appliance thereto. MCB/IC switch may be provided above 2.1 m for fixed appliances, and at least 1 m away from shower.

Rooms in residences 23 cm above floor level, or any other / level in special cases as desired by the Engineer-in-charge.
- □  
□  
 □ nless and otherwise specified, the control switches for the 5A/6A and 15A/16A socket outlets shall be kept along with the socket outlets.

### 2.11.3 Switchbox covers

Phenolic laminated sheets of approved shade shall be used for switch box covers. These shall be of 3mm thick synthetic phenolic resin bonded laminated sheet as base material and conforming to grade P-I of IS:2036-1974.

Note: Specification for switch boxes are covered in the chapters on the various types of wiring.

### 2.11.4 Ceiling rose

A ceiling rose shall not be used on a circuit, the voltage of which normally exceeds 250V. Only one flexible cord shall be connected to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.

A ceiling rose shall not embody a fuse terminal as an integral part of it.

#### 2.11.5 Lamp holders

Lamp holders may be of batten, angle, pendant or bracket holdertypes as required. The holder shall be made of brass and shall be rigid enough to maintain shape on application of a nominal external pressure. There should be sufficient threading for fixing the base to the lamp holder part so that they do not open out during attention to the lamp or shade.

Lamp holders for use on brackets and the like shall have not less than 1.3 cm nipple, and all those for use with flexible pendant shall be provided with cord grips. All lamp holders shall be provided with shade carriers.

Where center contact Edison Screw lamp holders are used, the outer or screw contact shall be connected to the „middle wire“, or the neutral conductor of the circuit.

### 2.12 Equipments and Fittings

2.12.1 The type, rating, the required features, location of fixing etc. are indicated in the Schedules. The schedule includes all other required accessories, fasteners, small wiring etc., fixing, aligning, connecting, testing and commissioning. The materials shall be of good quality acceptable to Engineer-in-Charge and to be fixed in position as directed by him.

#### 2.12.2 Box/Rail Type Fluorescent Light Fittings.

Both single and twin tube assemblies shall be of standard fittings made out of cold-drawn sheet steel, stove enameled, the box finished in gray colour and its cover plates in white colour complete with copper chokes, starters, starter holder, tube holders, lamps and earth terminal etc.

2.12.3 Decorative Type Fluorescent Light Fittings similar to 2.12.2 with opal acrylic diffuser.

#### 2.12.4 Mirror Optics Type Fluorescent Light Fittings.

Both single and twin tube assemblies shall be of standard fittings made out of cold-drawn sheet steel, stove enameled, the box finished in gray colour and its cover plates in white colour, complete with copper chokes, starters, starter holder, tube holders“ lamps and earth terminal etc. with mirror reflector.

#### 2.12.5 Corrosive Resistant Type Fittings.

Similar to 2.12.2 with FRP body complete with copper chokes, starters, starter holder, condensers, earth terminals suitable lamp holders, lamp etc. assembled and wired neatly.

#### 2.12.6 Compact Fluorescent Type Light Fittings.

Compact fluorescent fitting with 2 x 11 Watts lamps, holders, stainless steel reflector with housing and OPEC acrylic diffuses etc.

#### 2.12.7 Bulk Head Fittings.

The fittings shall be made of pressed Aluminium body, outside finished in gray stove enamel and inside white, provided with prismatic glass, covers, rubber gaskets, BC lamp holders, earthing terminal wire nets and lamps.

#### 2.12.8 Street Light (TFL) Fittings.

The fittings shall be weather proof type fluorescent street light fittings. The fittings shall be made of Aluminium sheet and finished outside in hammer stone gray colour, stove enameled

and white inside, complete with copper wire chokes, starters, condensers, suitable lamp holders, lamps, assembled and wired neatly and provided with clear acrylic moulded cover held by spring loaded hooks against sponge rubber gaskets to make the whole unit dust, vermin and waterproof.

2.12.9 Post – Top Luminaries.

The Post – top luminaries is to be provided at Gate Pillars and in garden. Necessary pipe shall also be supplied.

2.12.10 The fans have to be suspended normally from the ceiling. These shall be single phase AC 230V, 50 Hz and of sizes indicated in the Schedule. However, if adequate vertical clearance is not available due to low ceiling wall-bracket fans will have to be provided. Fans shall include choke type / electronic type regulators with hard rubber bushes, condensers, suspension couplings, terminal blocks, suitable top and bottom canopy (covers) etc. Ceiling fans shall be of double ball-bearings type conforming to IS:374 in all respects. Fans should be supplied of approved make.

2.12.11 Exhaust Fans.

Heavy/Light duty fans are required for exhaust ventilation in buildings. The fans shall be suitable for AC, single phase, 50Hz, 230 V supply. These must be of robust construction having very low noise level. All exhaust fans shall be impeller type with ring mounting arrangements for fixing on walls. The exhaust fans shall conform to IS:3588 in all respects. Capacity and size of fans will be specified in Schedules.

2.12.12 Metal Clad Switch Socket Unit.

All the switch-socket units shall be made on non-corroding pressure-cast Aluminium alloy and these must be dust, vermin, water and rust proof. Switch-socket units shall be provided with interlocking arrangement for switch and plug HRC fuses, Neon-indicator lamps, terminal blocks and pin-top. The units shall be suitable for both flush and surface mounting. Switch socket units shall comply with IS:4160.

2.12.13 Installation of ceiling fan:

Unless otherwise specified, all ceiling fans shall be hung 2.75 M (9 ft.) above floor. The suspension rod and clamp shall be painted with approved paint without involving extra cost.

2.12.14 Installation of Fluorescent light fitting:

In case of suspension from ceiling by two rods, each fixing to the ceiling shall be capable of sustaining at least 1.1 Kg. of dead weight. The down rods and accessories shall be painted with approved paint without involving extra cost. Unless otherwise specified, these should be suspended 2.60 M (8'-6") above floors.

2.12.15 The D.Bs shall generally be installed at a height of 2.13 Mts. (7ft) from floor level.

2.12.16 All fan clamps will have to be provided from R.C. ceiling as per approved design.

2.12.17 Control switches for lights, fans, call bells, Exhaust fans etc. shall be of rating 6 Amps. 230 Volt, Piano-type flush mounted, cream colour conforming to relevant Indian Standards. Ceiling roses also shall be of 6 Amps. Rating 230 V. cream colour deluxe conforming to the relevant IS – Specification. Switches of 16 Amp capacity and associated 16A socket would also be required to provide facility of connection of power load upto 1 KW. Alternatively, Industrial type plug-socket board may be used in specific cases. Cable used for power load should be of suitable capacity.

### **2.13 Switchgear and control gear – General aspects.**

All items of switchgear and distribution boards (DBs) shall be metal clad type, except those forming part of cubicle type switchboards, in which case the board design shall be such as not to permit direct contact.

The types, ratings and/or categories of switchgear and protective gear shall be as specified in the tender Schedule of work.

RCDs (ELCBs) where specified, shall conform to the requirement of current rating, fault rating, single phase or three phase configuration and sensitivity laid down in the tender documents.

While each outgoing way of distribution board (DB) shall be of fuse, or miniature circuit breaker (MCB) as specified, and of suitable rating. On the phase conductor, the corresponding earthed neutral conductor shall be connected to a common neutral terminal block and shall be capable of being disconnected individually for testing purposes.

Independent earth terminal block.

Every distribution board (single phase as well as 3 phase) shall have an earth terminal block identical to, but independent from neutral terminal block, to enable termination of protective (loop earthing) conductors (incoming as well as outgoing) individually by screwed connection and without twisting.

Earthing terminal (1 for single phase and 2 for 3 phase) shall be provided on the metal cladding of switches and DBs for body earthing. These shall be suitably marked.

Knock out holes, with or without end plates as per standard design of manufacturers, shall be provided in the metal cladding of switches and DBs for termination of conduits/cables.

Each distribution board shall be provided with a circuit list giving details of each circuit which it controls and the current rating of the circuit, and the size of the fuse element.

### **2.14 HRC type distribution boards.**

HRC type distribution board shall be used in selected locations [See also clause 2.5.2.(iv)]. The rating shall be 16/32/63/100A per way and the number of ways shall be 4 or 8 as a TPND B as specified.

These shall be dust and vermin proof conforming to IP42, and fabricated out of sheet with stove enameled paint finish.

The DBs shall be of surface mounting type, and shall be provided with electrolytic copper busbars of suitable size.

DBs shall have phase barriers and earth terminals.

DBs shall have removable type end covers with knock-outs at the bottom and top, and shall have hinged covers with locking arrangements.

## **2.15 MCB type distribution boards (MCBDB)**

MCBDB's may be of single phase, 3 phases (horizontal type) suitable for feeding single phase loads, or 3 phases (vertical type) suitable for feeding single phase as 4 phase loads, as specified. These shall be complete with accessories, but without MCBs, which shall be specified as a separate item in the tender documents.

The current ratings and the number of ways shall be as specified. Blanking plates shall be provided to close unused ways. These shall be indicated as a separate item in the Schedule of work.

DB with integral incomer.

Where it is proposed to install the controlling MCB/MCB type isolator/both, the total number of outgoing MCBs will be reduced by one or two numbers corresponding to SP or SP&N at the incoming, since the total number of ways are fixed in MCBDBs. Bus bars in such units shall also be correspondingly shorter. The inter connections shall be done between the incomer and outgoing as part of the DB in the works.

MCBDB's shall be of surface/flush mounting pattern according to the requirement of their location, and shall be suitable to accommodate MCB's and MCB type isolators and RCD (ELCB) at incoming in single pole or multiple configuration, as required.

MCBDB's shall be dust and vermin proof conforming to IP 42, and shall be fabricated out of CRCA sheet steel, 1.6mm thick, with stove enamel paint finish.

MCBDB's shall have removable type end plates with knock-outs at the bottom and top. And shall have hinged covers with locking arrangement.

Only the knobs of the MCBs shall protrude out of the front covers through openings neatly machine made for the purpose.

The bus bars used shall

be solid electrolytic copper of appropriate sections. DIN bar(s) shall be provided

for mounting the MCB's.

## **2.16 Miniature circuit breakers (MCB's)**

„L“ series MCB's shall be used only for normal „lighting“ circuits.

„G“ series MCB's shall be invariably used for motor loads, halogen lamp fitting, sodium/mercury discharge lamps and all „power“ circuits.

Ratings (A as well as KA), number of poles, type as MCB of isolator, etc. shall be as specified in the tender documents.

## **2.17 Switchboards-application and types.**

All items of switchgear and distribution boards (DB's) shall be installed on switchboards. [See (ii) below]

Where specified by the Engineer-in-charge, only MCB DB's may be permitted to be installed directly recessed in wall without a switch board. In such cases, the metal cladding of the DB shall be suitable for recess mounting.

## **2.18 Switchboard locations:**

### **2.18.1 General aspects**

Switchboards shall be located as per drawings.

As far as practicable, the boards should be accessible from common areas like corridors, lobby areas, etc.

Switch boards shall be located only in dry situations and in well ventilated spaces. They shall not be placed in the vicinity of storage batteries and exposed to chemical fumes.

Switch boards shall not be erected above gas stoves, or sinks or within 2.5m of any washing unit in the washing rooms of laundries, or in the bath rooms, toilets or kitchens.

### **2.18.2 Main switch boards**

Main switchboards shall be situated as near as practicable to the termination of service line, and shall be easily accessible without the use of any external aid, to quickly disconnect the supply in case of emergencies.

Main switchboards shall be installed in rooms, or cupboards, or suitable enclosed space having provisions for locking arrangement to safeguard against operation by unauthorized personnel.

### **2.18.3 Distribution switchboards.**

The distribution boards shall be located as near as possible to the center of the load they are intended to control. These boards shall be fixed on suitable stanchion or wall, and shall be accessible for attention to fuses/MCBs.

Where two or more distribution boards feeding low pressure, circuits are fed from a supply at medium voltage, these distribution boards shall be:-

Fixed not less than 2 m apart; or

Arranged so that two cannot be opened at a time, namely, they are interlocked, and the metal case is marked "Danger-400V"; or

Installed in a room or enclosure accessible to only authorized persons.

## **2.19 Construction of Main L.V. Switch Board:**

### **2.19.1 Cubicle type L.T. Switch Boards, Dist Boards & Sub-Dist Boards:**

LT, AC switch boards shall be of CRCA sheet steel (min. 2mm thick) construction, floor mounted, totally enclosed conforming to IP-51 degree of protection for indoor use or IP-55 for outdoor use.

Bus bars shall be of high conductivity electrolytic grade aluminum conforming to IS:5082. Bus bars shall be located in air insulated enclosures and segregated from all other compartments of the board.

The incoming feeders of main L.T. switchboard shall have MCCB and the outgoing feeders shall be MCBs. Sub-distribution boards will comprise of Residual Circuit Breaker & Miniature Circuit Breaker for incoming and outgoing feeders respectively. Ratings of Isolators/MCCB/MCB units shall be as indicated in respective single line diagrams. Lighting Sub-distribution boards shall have MCB inlets and outlets and shall be of wall/structure mounting design for indoor use and pedestal mounting type for outdoor use.

The incomers of MDB shall have voltmeter with selector switch and also ammeter with selector switch, necessary CT's, phase healthy lamps (R, Y, B) as indicated in the single line diagrams.

All feeders shall be provided with door interlocking mechanism with defeat facility.

Terminals for power cables and gland plates for cables shall be provided in the cable alleys. All cable alleys shall have provision for cable entry from bottom. Incomers may have cable entry directly from bottoms of respective compartments.

All operating handles/knobs shall be located between 250mm-1800mm height from ground level.

Control and instrument wirings shall be with stranded copper wires of size not less than 2.5 sq. mm. for C.T. circuits and 1.5 sq. mm. for other circuits.

Indicating instruments, lamps and selector switches shall be mounted on front of switchboards.

Floor mounting Boards shall be supplied with base channel of size ISMC 75 and wall mounted boards shall have suitable lugs/brackets with fixing holes.

Lifting hooks shall be provided on each shipping section of floor-mounted switchboards.

Colour of final paint – Shadeno. 61 of IS:5.

#### 2.19.2 Bus bars:

Three phase and neutral electrolytic grade aluminum main busbars (neutral-50% of phase bus) and G earth bus shall be provided.

Rating of main horizontal buses shall be in line with nominal and short circuit ratings specified in the SLD's and vertical runs shall be so as to match loads of outgoing switch ratings in respective feeder columns. Busbars of aluminum shall be mounted on non-hygroscopic FRP insulators.

Temperature rise of busbar shall not be more than  $40^{\circ}\text{C}$  above ambient of  $45^{\circ}\text{C}$ .

Busbar shall have colored phase identification and heat-shrink type PVC sleeving.

2.19.3 Current Transformers:

Type-Bar primary type.

Insulation-Tape insulated ring type construction. Secondary-5A.

Minimum burden-

5VA Accuracy class-1.0 for measuring

Mounting-busbar side of each incoming feeder

Rated primary current-

As per feeder requirement (as shown in SLD's) Short time rating-In line with short time rating of busbars.

Polarities shall be marked on C.T.'s and on terminal blocks.

2.19.4 Moulded Case Circuit Breakers:

Triple pole moulded case circuit breakers shall conform to IS:2516. Incoming feeders shall be provided with separate neutral conductor. The MCCBs shall have minimum short circuit breaking and withstand capacity of 50KA & 50KA for 1 sec. respectively.

The MCCB shall have a manual independent closing mechanism by means of operating handles projecting outside the compartment doors. The handles shall be duly interlocked with the respective compartment door having interlock defeat facility.

The MCCB shall be provided with direct acting type adjustable overload and short circuit releases.

2.19.5 Miniature Circuit breakers:

Miniature Circuit breakers, used for sub-lighting distribution boards, shall be either single pole or triple pole as per requirements laid out in the single line diagrams. They shall have a systematic breaking capacity of 9KA rms.

The MCBs shall have knobs for manual operation. The knobs shall be protruding out through the cutouts on the front hinged doors of the respective SLDBs. The cutouts made for this purpose shall be duly gasketed to prevent entry of dust.

The distribution boards shall have proper shrouds inside the front doors such that accidental contact with live parts on opening the doors is prevented.

2.19.6 Switch and Switch Fuses:

Load break switches and switch fuses shall be AC-23 duty, triple pole with neutral air break type with independent manual quick make and quick break arrangement. All TPN switches shall have removable link in neutral. Switch-fuses and switches should withstand the fault current envisaged for the 415V system, till rupturing of respective fuses or tripping of up-stream MCCBs/ACBs as the case is.

All switches shall be interlocked with their respective compartment doors such that the doors cannot be opened when the switches are in ON position or the switches cannot be switched ON when the doors are open. However, interlock defeat

facilityshall also be provided.

#### 2.19.7 Indicating Instruments:

Size: Incomer of Main Switch Board – 144mm square and for others – 95mm square

Mounting: Flush in front of the panels

Accuracy class: 1.0

Ammeters shall be compatible with CTs of 5A secondary and read actual currents as per the SLDs.

Voltmeters and phase healthy lamp shall have protective HRC fuses.

#### 2.19.8 Earthing Terminals:

Two suitable earth terminals shall be provided on all switchboards for terminating earthing GI conductors of size 50mm x 6mm. For sub-distribution boards the earthing conductor size shall be 8 SWG wires.

#### 2.19.9 Tests:

Type Test certificates for the following tests shall be furnished: Short circuit withstand test on bus-bars, Temperature rise test on bus-bars, Verification of degree of protection.

Following Routine Tests shall be carried out (in presence of the customer's representative, if so desired):

High Pressure withstand test at 2500 volts for 1 min.,

Insulation test by 1000V megger both before and after H.F.

Test Checking of equipment ratings and physical verifications.

All the test certificates shall be furnished by the manufacturer in triplicate for customer's record. Vendor shall also furnish test certificates for major proprietary brought out items like MCBs, MCCBs, Switch fuses, Meters, CTs etc. from respective manufacturer.

#### 2.19.10 Drawing & Documents:

The manufacturer shall furnish sufficient copies of the following documents and drawings. The supply shall not be considered complete unless the same are submitted in proper time as demanded. Manufacturing shall be taken up only after approval of drawings submitted by the manufacturer.

Detailed dimension drawings and foundation plans.

Detailed circuit and wiring diagrams along with bill of equipment and accessories, mentioning the makes and ratings.

Test certificates as mentioned above, Installation and Maintenance manual.

#### 2.19.11 Performance Guarantee:

All supplies made shall be guaranteed against faulty design and or defective Material or Workmanship for a period of 12 months from the date of commissioning or 18 months from the date of delivery, whichever is earlier.

#### 2.19.12 Common requirements for all types of switchboards:

Switchboards, if unavoidable, fixed in places likely to be exposed to weather to drip, or to damp

ness, their outer casings shall be weatherproof and shall be provided with

glands or bushings or adopted to receive screwed conduits according to the manner in which the cables are run. PVC and double flanged bushess shall be fitted in the holes of the switches for entry and exit of wires.

When it is unavoidable to install in a situation where inflammable or explosive dust, vapor or gas is likely to be present, the switch boards shall be totally enclosed, or made flame proof as may be necessitated by the particular circumstances.

The various live parts, unless they are effectively screened by substantial barriers of non-hygroscopic, non-inflammable, insulating material, shall be so spaced that an arc cannot be maintained between such parts and with earth.

In every case in which switches and fuses are fitted on the same pole, these fuses shall be so arranged that the fuses are not alive when their respective switches are in the „off“ position.

No fuses, other than fuses in instrument circuit, shall be fixed on the back of, or behind a switch board panel, or frame.

Equipments which are on the front of a switch board shall be so arranged that an inadvertent personal contact with live parts (direct contact) is unlikely during the manipulation of switch gears, changing of fuses, or like operations.

The arrangement of the gear shall be such that they shall be readily accessible, and their connection to all instruments and apparatus shall be easily traceable.

Interconnections of the various mountings on the boards shall be done using PVC insulated conductors, or solid strips with PVC taping /sleeving, of appropriate sizes. Termination shall be made such that local heating is avoided.

No holes, other than the holes by means of which the panel is fixed, shall be drilled closer than 1 cm from any edge of the panel.

All the metalwork of switch boards shall be painted prior to erection with one coat of anti-rust primer. After erection, they shall be painted with two coats of appropriate enamel, or aluminium paint as required, on all sides where ever accessible.

All switch boards shall be provided with “Danger Notice Plate” conforming to relevant Indian Standards. If required in the tender specifications, a pilot lamp shall be fixed and connected through an independent single pole switch and fuse to the bus bar of the board.

## **2.20 Switch Board Installation**

Unless and otherwise specified in the tender documents, a switch board shall not be installed so that its bottom is within 1.25m above the floor, unless the front of the switch board is completely enclosed by a door, or the switch board is located in a position to which only authorized persons have access.

The switch board inside a residence shall be installed such that the operating knob/handle of the in-comer is at a height of about 2m for ease of operation at times of emergency.

- Ā □                      Ā □                      Ā □
- ll connections between pieces of apparatus or between apparatus and terminals on aboard shall beneatly arranged in a definite sequence, following the arrangement of the appar atus mounted thereon, avoiding unnecessary crossings.
- Ā □                      Ā □
- Ā □ ables shall be connected to terminal s either by crimped or soldered dlu gs, unless the terminal s are of such a form that they can be securely clamped without cutting aw ay of cable strands.
- Ā □                      Ā □                      Ā □
- ll bare conductors shall be rigidly fixed in such a manner that a clearance of at least 2.5cm is maintained between conductors of opposite polarity of phase, and betweentheconductors and any material other than insulating material.
- Ā □                      Ā □                      Ā □
- n a hinged type board, the incoming and outgoing cables shall be neatly bunched and shall be fixed in such a way that the door shall be capable of swinging through an angle of not less than 90 degrees.

## 2.22 Marking of Apparatus:

### Marking of earthed neutral conductor

On the main switchgear, where the conductors include an earthed conductor of a two-wire system, or an earthed neutral conductor of a multi-wire system, or a conductor which is to be connected thereto, an indication of a permanent nature shall be provided to identify the earthed neutral conductor. In this connection Rule 32(1) of the Indian Electricity Rules 1956 shall be referred to. The neutral conductor shall be black in colour.

### Main earthing terminal

The main earthing terminal in the main switch board shall be permanently marked as "SAFETY EARTH-DONOT REMOVE".

Where a board has more than one switchgear, each such switchgear shall be marked to indicate which section of the installation it controls. The main switchgear shall be marked as such. Where there is more than one main switchboard in the building, each such switch board shall be marked to indicate which section of the installation and building it controls.

All distribution boards shall be marked, „L“ for lighting, or, „P“ for power, and, „E“ for essential, as the case may be.

When a board is disconnected to a voltage higher than 250V, all the terminals or leads of the apparatus mounted on it shall be marked in the following colors to indicate the different poles or phases to which the apparatus or its different terminals may have been connected.

|                                      |                                                 |
|--------------------------------------|-------------------------------------------------|
| A.C.                                 | D.C.                                            |
| Three phases – Red,<br>Blue & Yellow | Three wire system<br>2 outer wires – Red & Blue |
| Neutral – Black                      | Neutral – Black                                 |

Where a four wire, three phase wiring is done, the neutral shall preferably be in one colour, and the other three wires in another colour.

All marking required under this rule shall be clear and permanent.

## 2.23 Attachment of Fittings and Accessories

### 2.23.1 Conduit wiring system:

All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders, stiff pendants, etc. shall be fixed on metal outlet boxes. The fan regulators may also be fixed on metal outlet boxes, if so directed by the Engineer-in-charge.

Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.

The switch box/regulator box shall normally be mounted with their bottom 1.25m from floor level, unless otherwise directed by the Engineer-in-charge.

## **2.24 Fixing to walls and ceiling:**

Wooden plugs for ordinary walls or ceiling shall not be used in view of the ban on use of timber in Govt. works. However, where so specified, these shall be of well-seasoned teak or other approved hard wood not less than 5cm long by 2.5cm square on the inner end, and 2cm square on the outer end. They shall be cemented into walls within 6.5mm of the surface, the remainder being finished according to the nature of the surface with plaster of lime punning.

PVC sleeves/dash fasteners should normally be used for fixing to walls or ceiling.

Plugging of walls or ceiling can be done in a better way where neatness is the first consideration. In all such case, an approved type of asbestos or fibre fixing plug (rawl or phil plug) with correct size of tools shall be used and done in a workmanlike manner.

## **2.25 Fans, Regulators and Clamps:**

### **2.25.1 Ceiling Fans**

Ceiling fans including their suspensions shall conform to relevant Indian Standards.

All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.

For wooden or steel joists and beams, the suspension shall consist of MS flat of size not less than 40mm x 6mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5cm for each flat. Where there is a space above the beam, a through-bolt of size not less than 1.5cm dia. shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of MS rod of size not less than 1.5cm dia. shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inward to hold tightly between them by means of a bolt and nut, a hook of „S“ form.

In the case of „I“ beams, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut.

For concrete roofs, a 12mm dia. MS rod in the shape of „U“ with their vertical legs bent horizontally at the top at least 19cm on either side, and bound to the top reinforcement of the roof shall be used.

In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned under sub clause (v) above cannot be used, or wherever specified, recessed type fan clamp inside a metallic box shall be used.

□ □  $\bar{A}$  □  $\bar{A}$  □  $\bar{A}$  □  
 □ anopies on top of suspension rod shall effectively hide the suspension.

□ □  $\bar{A}$  □  $\bar{A}$  □  $\bar{A}$  □  
 he leading in wire shall be of nominal cross-sectional area not less than 1.5sq.mm. and shall be protected from abrasion.

□ □  $\bar{A}$  □  $\bar{A}$  □  $\bar{A}$  □  
 □ unless otherwise specified, all ceiling fans shall be hung 2.75m above the floor.

□ □  $\bar{A}$  □  $\bar{A}$  □  $\bar{A}$  □  
 n the case of measurement of extra down rod for ceiling including wiring, the same shall be measured in units of 10cm length less 5cm shall be ignored.

□ □  $\bar{A}$  □  $\bar{A}$  □  $\bar{A}$  □  
 he wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.

#### 2.25.2 Exhaust fans

Exhaust fans shall conform to relevant Indian Standards.

Exhaust fans shall be erected at the places indicated by the Engineer-in-charge. For fixing an exhaust fan, a circular hole shall be provided in the wall to suit the size of the frame, which shall be fixed by means of lag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the hole as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction.

Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.

Installation of exhaust fans in kitchens, dark rooms and such other special locations need careful consideration; any special provisions needed shall be specified.

#### 2.25.3 Regulators

The metallic body of regulators of ceiling fans/exhaust fans shall be connected to earth by protective conductor.

### 2.26 Workmanship:

Good workmanship is an essential requirement to be complied with. The entire work of manufacture/fabrication, assembly and installations shall conform to sound engineering practice.

The work shall be carried out under the direct supervision of a first-class licensed foreman, or of a person holding a certificate of competency issued by the State Govt. for the type of work involved, employed by the contractor, who shall rectify then and there the defects pointed out by the Engineer-in-charge during the progress of work.

### 2.27 Commissioning on completion

Before the workman leaves the work finally, he must make sure that the installation is in commission, after due testing.

## **2.28 Completion Plan and Completion Certificate**

For all works completion certificate after completion of work as given in Appendix-B shall be submitted to the Engineer-in-charge.

As-built drawing to be submitted along with Completion Certificate.

## CHAPTER 3

### **PVC CONDUIT WIRING SYSTEM**

#### **3.0 Scope**

This chapter covers the detailed requirements for wiring work in PVC conduits. This chapter covers both surface and recessed types of works.

#### **3.1 Application**

Recessed conduit is suitable generally for all applications. Surface conduit work may be adopted in places like workshops, plant rooms, pump rooms, wiring above false ceiling / below false flooring, and at locations where recessed work may not be possible to be done. The type of work, viz. surface or recessed, shall be as specified in the respective works.

Flexible conduits may only be permitted for interconnections between switchgear, DBs and conduit terminations in wall.

#### **3.2 Material**

##### **3.2.1 Conduits**

All rigid conduit pipes shall be of PVC and be ISI marked. The wall thickness shall be not less than 1.6mm (16SWG) for conduits up to 32mm dia. and not less than 2mm (14SWG) for conduits above 32mm dia.

The maximum number of PVC insulated cables conforming to IS:694-1990 that can be drawn in one conduit is given size wise in Table 3.1 and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

No PVC conduit less than 20mm in diameter shall be used.

##### **3.2.2 Conduit accessories**

The conduit wiring system shall be complete in all respects, including their accessories.

All conduit accessories shall be of threaded type and under no circumstances splicing or clamp grip type accessories shall be used.

Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works.

- a) Saddles for surface conduit work on wall shall not be less than 0.55mm (24 gauges) for conduits up to 25mm dia. and not less than 0.9mm (20 gauges) for larger diameter. The corresponding width shall be 19mm & 25mm.

( ) The minimum width and the thickness of girder clips used for fixing conduits to steel joists and clamps shall be as per Table 3.2.

The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 3mm and in case of welded mild steel sheet boxes, the wall thickness shall not be less than 1.2mm (18 gauges) for boxes up to size of 20cm x 30cm, and above this size 1.6mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anti-corrosive paint before erection.

Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

A neat terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

A metal strip shall be welded/screwed to the metal box as support for types of control switches, sockets and/or fan regulators to be fixed therein.

Clear depth of the box shall not be less than 60mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if directed by Engineer-in-charge.

Except where otherwise stated, 3mm thick phenolic laminated sheet shall be fixed on the front with brass screws, or aluminum alloy/cadmium plated iron screws as approved by the Engineer-in-charge.

### **3.3 Installation:**

#### **3.3.1 Common aspects for recessed and surface conduit works.**

Conduit joints:

The conduit work of each circuit or section shall be completed before the cables are drawn in.

Conduit pipes shall be joined by means of screwed couples and screwed accessories only. Threads on conduit pipes in all cases shall be between 13mm to 19mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Fixing ends of conduit pipes shall have no sharp edges which have been affected to avoid damage to the insulation of the conductors while pulling them through such pipes.

The Engineer-in-charge, with a view to ensuring that the above provision have been carried out, may require that the separate lengths of conduit etc., after they have been prepared, shall be submitted for inspection before being fixed.

Bends in conduit:

All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than

7.5cm, or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.

No length of conduit shall have more than the equivalent of four quarter bends from outlet.

Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary, solid type fittings shall be used.

#### Outlets:

□ □  $\bar{A}\bar{A}\bar{A}$  □  $\bar{A}\bar{A}\bar{A}$  □  $\bar{A}$  □

All outlets such as switches, wall sockets etc. may be either flush mounting type, or of surface mounting type, as specified in the Additional Specifications.

□ □  $\bar{A}\bar{A}\bar{A}$  □  $\bar{A}\bar{A}\bar{A}$  □  $\bar{A}$

All switches (except piano type switches), socket outlets and fan regulators shall be fixed on metal strips which shall be screwed / welded to the box. Piano type switches and accessories shall be fixed on the phenolic laminated sheet covers in flush pattern.

#### Painting after erection:

After installation, all accessible surfaces of conduit pipes, fittings, switch and regulator boxes etc., shall be painted in compliance with the clauses under Chapter 10-“Painting”.

### 3.3.2 Additional requirements for surface conduit work.

#### Painting before erection:

The outer surface of conduit including all bends, unions, tees, junction boxes, etc. forming part of the conduit system, shall be adequately protected against rust when such system is exposed to weather, by being painted with 2 coats of red oxide paint applied before they are fixed.

#### Fixing conduit on surface:

Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one metre, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30cm from the center of such fittings.

Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps as required by the Engineer-in-charge.

In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

#### Fixing outlet boxes:

Only a portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

### 3.3.3 Additional requirements for recessed conduit

#### work Making chase:

The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.

In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

In case of exposed brick / rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

#### Fixing conduits in chase:

The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart, or by any other approved means of fixing.

#### Fixing conduits in RCC work:

The conduit pipe shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.

Location of inspection/ junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

#### Fixing inspection boxes:

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS:2667-1997.

Suitable ventilating holes shall be provided in the inspection box covers.

#### Fixing switch boxes and accessories:

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

#### Fish wire:

To facilitate subsequent drawing of wires in the conduit, a fish wire of 1.6 mm / 1.2 mm (16/18 SWG) shall be provided along with the laying of the recessed conduit.

#### Bunching of cables:

Cables carrying direct current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

Where the distribution is for single phase load only, conductors for phases shall be drawn in one conduit.

In case of three phase loads, separate conduits shall be run from the distribution board to the load points, or outlets as the case may be.

#### 3.3.4 Earthing requirements

The entire system of conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double checking at terminations.

Protective (loop earthing) conductor(s) shall be laid along the run of conduit between the metallic switch boxes and distribution boards / switch boards, terminated thereto. These conductors shall be of such size and material as specified.

The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.

Gas or water pipes shall not be used as protective conductor (earth medium).

**Table 3.1**  
**Maximum number of PVC insulated 650/1100 V grade aluminum**  
**/copper conductor cable conforming to IS:694-1990.**  
**[Clause 3.2.1(ii)]**

| Nominal Cross-sectional area of conductor in sq.cm. | 20 mm |   | 25 mm |   | 32 mm |    | 38 mm |   | 51 mm |    | 64 mm |    |
|-----------------------------------------------------|-------|---|-------|---|-------|----|-------|---|-------|----|-------|----|
|                                                     | S     | B | S     | B | S     | B  | S     | B | S     | B  | S     | B  |
| 1                                                   | 2     | 3 | 4     | 5 | 6     | 7  | 8     | 9 | 10    | 11 | 12    | 13 |
| 1.50                                                | 5     | 4 | 10    | 8 | 18    | 12 | -     | - | -     | -  | -     | -  |
| 2.50                                                | 5     | 3 | 8     | 6 | 12    | 10 | -     | - | -     | -  | -     | -  |
| 4.00                                                | 3     | 2 | 6     | 5 | 10    | 8  | -     | - | -     | -  | -     | -  |
| 6.00                                                | 2     | - | 5     | 4 | 8     | 7  | -     | - | -     | -  | -     | -  |
| 10.00                                               | -     | 2 | -     | 4 | 3     | 6  | 5     | 8 | 6     | -  | -     | -  |
| 16.00                                               | -     | - | 2     | 2 | 3     | 3  | 6     | 5 | 10    | 7  | 12    | 8  |
| 25.00                                               | -     | - | -     | - | 3     | 2  | 5     | 3 | 8     | 6  | 9     | 7  |
| 35.00                                               | -     | - | -     | - | -     | -  | 3     | 2 | 6     | 5  | 8     | 6  |
| 60.00                                               | -     | - | -     | - | -     | -  | -     | - | 5     | 3  | 6     | 5  |
| 70.00                                               | -     | - | -     | - | -     | -  | -     | - | 4     | 3  | 5     | 4  |

**Note:**

The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

The columns headed „S“ apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed „B“ apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

**Table 3.2 Girder,  
Clips or Clamps  
[Clause 3.2.2(iv)]**

| <b>Size of conduit</b> | <b>Width</b> | <b>Thickness</b> |
|------------------------|--------------|------------------|
| (i) 20mm               | 19mm         | 0.9mm (20SWG)    |
| (ii) 25mm              | 19mm         | 0.9mm (20SWG)    |
| (iii) 32mm & above     | 25mm         | 1.2mm (18SWG)    |

## CHAPTER

### 4 EARTHING

#### 4.0 Scope

This chapter covers the essential requirements of earthing system components and their installation. This shall be read with Appendix G which lays down criteria for their design. For details not covered in these Specifications, IS Code of Practice on Earthing (IS: 3043-1987) shall be referred to.

#### 4.1 Application

The electrical distribution system in the Department is with earthed neutral (i.e., neutral earthed at the transformer/generator end.) In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the sub-station, as well as in the internal/external electrical installations.

Earthing system is also required for lightning protection, computer installations and hospital operation theaters, etc. for functional reasons.

Earthing requirements are laid down in Indian Electricity Rules, 1956 as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.

Though this chapter and appendix G form part of the Specifications for Internal EI works, these requirements shall be complied with in works of earthing for other applications also.

#### 4.2 Materials

##### 4.2.1 Earth Electrodes

##### 4.2.1.1 Types

The type of earth electrode shall be any one of the following, as specified.

Pipe earth electrode.

Plate earth electrode.

Strip or conductor earth electrode.

##### 4.2.1.2 Electrode materials and dimensions

The materials and minimum sizes of earth electrode shall be as per Table 4.1.

GI pipe electrodes shall be cut tapered at the bottom, and provided with holes of 12mm dia, drilled not less than 7.5cm from other upto 2m of length from the bottom.

The length of the buried strip or conductor earth electrode shall be not less than 15m. This length shall suitably be increased if necessary, on the basis of the information available about soil resistance, so that the required earth resistance is obtained. Prior approval of the Engineer-in-charge shall be taken for any such increase in length.

#### 4.2.2 Earthing Conductor

The earthing conductor (protective conductor from earth electrode upto the main earthing terminal /earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.

The size of earthing conductor shall be specified, but this shall not be less than the following.

5mm dia (6 SWG) for GI, or 4mm dia (8 SWG) for copper wire, 25mm x 4mm in the case of GI strip, or, 20mm x 3mm in the case of copper strip.

Earthing conductor larger than the following sectional areas need not to be used, unless otherwise specified.

150sq.mm. in case of GI,  
or 100sq.mm. in case of copper.

#### 4.2.3 Earth Bus

Two copper strips, each of size 50mm x 5mm shall be provided as earth bus in a 11KV sub-station and/or diesel generating station irrespective of the capacity of the transformer / panel / generating set, etc. shall be connected to these two strips of earth bus. The two strips of the earth bus shall be bonded together.

The neutral earth leads of the transformer and/or generator alternator shall not be connected to this earth bus. They shall be connected directly to individual earth electrodes.

#### 4.2.4 Hardware Items

All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrodes, and forged tinned brass in case of copper plate electrodes.

#### 4.2.5 Protective (Earth continuity/ Loop earthing) Conductor

The material and size of protective conductor shall be as specified.

The minimum cross-sectional area of a protective conductor (not contained within a cable or flexible cord) shall be:-

2mm dia (14 SWG) in case of copper, 2.5mm dia (12 SWG) in case of GI, or, 2.24mm dia (13 SWG) in case of aluminum.

Unless otherwise specified, GI conductors should not be ordinarily used as protective conductor within any circuit, beyond a DB downstream.

### 4.3 Installation

Normally an earth electrode shall not be located closer than 1.5m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building. In such cases, electrodes may be located further away from the building, with prior approval of the Engineer-in-charge.

The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and road ways, should be avoided for locating earth electrodes.

## 4.4 Installation

### 4.4.1 Electrodes

#### 4.4.1.1 Various types of electrodes

- a) Pipe electrodes shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in Drawing.

In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-in-charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.

Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3 m below the ground level. The installation shall be carried out as shown in Drawing.

When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

- a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep. If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point. If the electrode cannot be laid in a straight length, it may be laid in a zig-zag manner with a deviation up to 45 degrees from the axis of the strip. It can also be laid in the form of an arc with curvature more than 1 m or polygon.

#### 4.4.1.2 Artificial treatment of soil

When artificial treatment of soil is to be resorted to, the same shall be specified in the schedule of work. The electrode shall be surrounded by charcoal/coke and salt as indicated in Drawing. In such cases, excavation for earth shall be increased as per the dimensions indicated in these figures.

#### 4.4.1.3 Watering arrangement

In the case of plate earth electrodes, a watering pipe 20 mm dia. medium class of pipe shall be provided and attached to the electrodes as shown in Drawing. A funnel with mesh shall be provided on the top of this pipe for watering the earth.

In the case of pipe electrodes, a 40 mm x 20 mm reducer shall be used for fixing the funnel with mesh.

The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm x 30 cm x 36 cm.

A cast iron/MS frame with MS Cover, 6 mm thick, and having locking arrangements shall be suitably embedded in the masonry enclosure.

#### 4.4.2 Earthing Conductor (Main earthing lead)

In the case of plate earth electrode, the earthing conductor shall be securely terminated onto the plate with two bolts, nuts, check-nuts and washers.

In the case of pipe earth electrode, wire type earthing conductor shall be secured as indicated in Drawing using a through bolt, nuts and washers and terminating socket.

A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized

“C” shaped strips, bolts, washers, nuts and check nuts of adequate sizes shall be used for the purpose.

The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15mm dia. GI pipe in the case of wire, and by 40mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30cm deep (to be increased to 60cm in case of road crossing and pavements). The proportion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.

The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switchboard by:

soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and Bolt, nut and washer in case of strip conductor.

In the case of substations or alterations, the termination shall be made on the earthing terminal of the neutral point on the equipment and/or the earth bus, as the case may be.

#### 4.4.3 Earth Bus and Main Earthing Terminal

In the case of substations and generating stations, two numbers copper/GI (as specified) earth bus shall be provided, duly connected to two numbers of independent electrodes, exclusively for equipment (body) earthing of substation or generating station equipments.

In all other installations, main earthing terminal shall be provided at the main switch board. This may be in the form of earth stud or single earth bar depending on the type of switch board.

Following conductors shall be terminated on to the main earthing terminal. Earth connection from electric supply company (where provided). Earthing conductor from electrode.

Protective conductors.

Equipotential bonding conductors.

#### 4.4.4 Protective (Loop earthing/earth continuity) Conductor

Earth terminal of every switch board in the distribution system shall be bonded to the earth bar/terminal of the upstream switch board by protective conductor(s).

Two protective conductors shall be provided for a switch board carrying a 3-phase switch gear thereon.

All the mountings of industrial type switchboards shall be bonded to the earth stud /earth bar using a protective conductor looping from one to another. Loop earthing of individual units will not be however necessary in the case of cubicle type switchboards.

The earth conductor in every distribution board (DB) shall be securely connected to the earth stud/earth bar of the corresponding switchboard by a protective conductor.

All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor (also called circuit protective or loop earthing conductor), looping from one box to another up to the DB.

The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are of non-metallic type, these shall be looped at the socket earth terminals, or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.

Double earthing strips in rising mains, bus trucking etc. shall be securely connected to the earth bar/earth stud at the sending end switch board. In the case of overhead busbar systems, protective conductors shall be provided in addition to feeder cable armoring connections.

#### **4.5 Earth Resistance**

The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 8 ohms.

Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, so such additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-in-charge.

#### **4.6 Marking**

Earth bars/terminals at all switchboards shall be marked permanently, either as "E" or as Symbol.

Main earthing terminal shall be marked "SAFETY EARTH-DONOT DISCONNECT".

#### **4.7 Use of Residual Current Devices (RCCB/RCBO)**

Application of RCCB/RCBO, IS:12640-1988 shall be specified in individual cases keeping in view the type, use, importance, system of earthing a nature of electrical installations to be protected by the RCCB/RCBO, requirements of the local electric supply company, etc. The sensitivity shall be 30mA, 100mA, 300mA or 500mA as specified.

**Table 4.1**  
**Materials and Sizes of Earth**  
**Electrodes [Clause 4.2.1.2(i)]**

| Type of Electrodes | Material        | Size                                       |
|--------------------|-----------------|--------------------------------------------|
| Pipe               | GI Medium Class | 40 mm dia., 4.5 m long (without any joint) |
| Plate              | i) GI           | 60 cm x 60 cm x 6 mm thick                 |
|                    | ii) Copper      | 60 cm x 60 cm x 3 mm thick                 |
| Strip              | i) GI           | 100 sq. mm. section                        |
|                    | ii) Copper      | 40 sq. mm. section                         |
| Conductor          | i) GI           | 5 mm dia (6SWG)                            |
|                    | ii) Copper      | 4 mm dia (8SWG)                            |

**Note:** Galvanisation of GI item shall conform to Class IV of IS 4736-1986.

## CHAPTER 5

### **TESTING OF INSTALLATION**

#### **5.0 Scope**

This chapter covers the details of tests to be conducted on completed internal electrical installations, before commissioning.

#### **5.1 General**

##### **5.1.1 Tests**

On completion of installation, the following tests shall be carried out:-

- |                          |                                  |
|--------------------------|----------------------------------|
| <input type="checkbox"/> | Insulation resistance test.      |
| <input type="checkbox"/> | Polarity test of switch.         |
| <input type="checkbox"/> | Earth continuity test.           |
| <input type="checkbox"/> | Earth electrode resistance test. |

##### **5.1.2 Witnessing of tests**

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Engineer-in-charge by the contractor. All test results shall be recorded and submitted to the Department.

##### **5.1.3 Test instruments**

All necessary test instruments for the tests shall be arranged by the contractor if so required by the Engineer-in-charge.

#### **5.2 Insulation Resistance**

5.2.1 The insulation resistance shall be measured by applying between earth and the whole system of conductors, or any section thereof with all fuses in place, and all switches closed, and except in earthed concentric wiring, all lamps in position, or both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure, provided it need not exceed 500 volts for medium voltage circuits. Where the supply is derived for a three wire D.C., or a polyphase A.C. system, the neutral pole of which is connected to earth shall be deemed to be through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

5.2.2 The insulation resistance shall also be measured between all conductors connected to one pole, or phase conductor of the supply, and all the conductors connected to the neutral, or to the other pole, or phase conductor of the supply with all the lamps in position and switches in "off" position, and its value shall be not less than that specified in sub-clause 6.1.3.

5.2.3 Insulation resistance in megaohms measured as above shall not be less than 12.5 megaohms for the wiring with PVC insulation cables, subject to a minimum of 1 megaohm.

5.2.4 Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 megaohm, is acceptable.

5.2.5 A preliminary and similar test may be made before the lamps etc. are installed, and in this event the insulation resistance to earth should not be less than 25 megaohms for the wiring with PVC insulation cables, subject to a minimum of 2 megaohms.

5.2.6 The term "outlet" includes every point along with every switch, except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.

5.2.7 Control rheostats, heating and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in that event the insulation resistance between the case or frame work, and all live parts of each rheostat, appliance and sign, shall not be less than specified in the relevant Indian Standard Specifications, or where there is no such specification, shall not be less than one megaohm.

### 5.3 Polarity Test of Switch

5.3.1 In a two-wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor throughout, and such conductor shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.

5.3.2 In a three wire or a four-wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled or marked for connection to one of the phase conductors of the supply.

5.3.3 The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to the earth. Glowing of test lamp to its full brilliance, when the switch is in "on" position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

### 5.4 Testing of Earth Continuity Path

The earth continuity conductor, including metal conduits and metallic envelopes of cables in all cases, shall be tested for electric continuity. The electrical resistance of the same along with the earthing lead, but excluding any added resistance, or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

### 5.5 Measurement of Earth Electrode Resistance

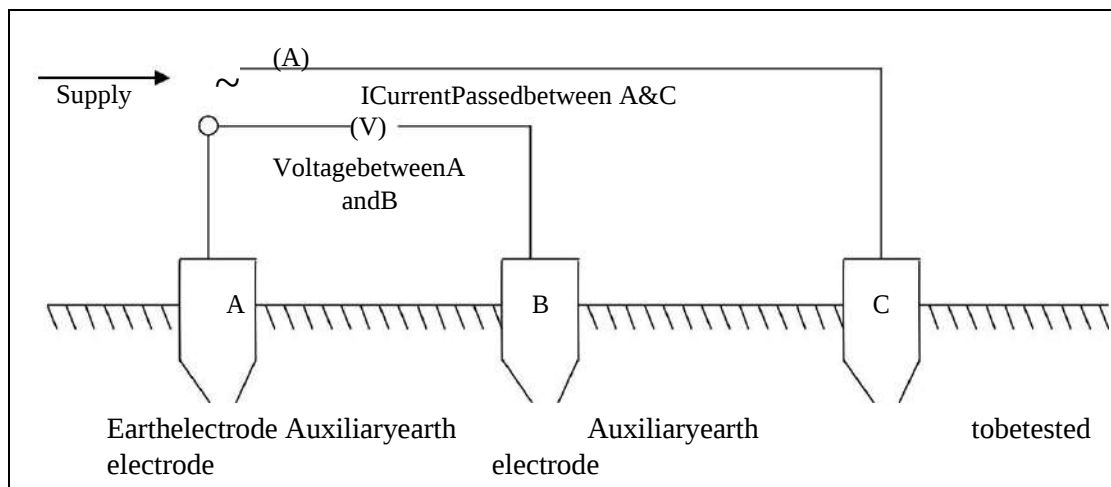
5.5.1 Two auxiliary earth electrodes, besides the test electrode, are placed at suitable distance from the test electrode „A“ to be tested and an auxiliary current electrode „C“, and the potential difference between the electrode „A“ and auxiliary potential „B“ is measured. The resistance of the test electrode „A“ is then given by

$$R = (V/I)$$

Where R = Resistance of the test electrode in ohm.

V = Reading of the voltmeter in volts.  
I = Reading of the ammeter in amps.

Refer Clause 5.5.1



5.5.2i) Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.

If the frequency of the supply of hand driven generator coincides with the frequency of stray current, there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.

5.5.3 At the time of test, the test electrodes shall be separated from the earthing system.

5.5.4 The auxiliary electrodes shall be of 13mm diameter mild steel rod driven up to 1m into the ground.

5.5.5 All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode, „C“ shall be placed at least 30m away from it, and the auxiliary potential electrode „B“ shall be placed mid-way between them.

5.5.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C up to 50m, and each time placing the electrode B midway between them.

5.5.7 On these principles, “Megger Earth Tester”, containing a direct reading ohm-meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of earth resistance of electrodes.

Appendix  
A(Clause  
2.1.1)**Termin  
ology**

This appendix indicates some of the commonly used and important terms, relevant for the internal EIW works. For complete list of terms, relevant ESS may be referred to.

**Exposed conductive part**-A conductive part of electrical equivalent, which can be touched and which is not normally live, but which may become the earth potential.

**Extraneous conductive part**-A conductive part not forming part of the electrical installation and liable to introduce a potential, generally the earth potential.

**Direct Contact** – Contact of persons or livestock with live parts which may result in electrical shock.

**Indirect Contact** – Contact of persons or livestock with exposed conductive parts made live by a fault and which may result in electric shock.

**Live Part** – A conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor.

**Touch Voltage** – the potential difference between a grounded metallic structure and a point on the earth surface separated by a distance equal to the normal maximum horizontal reach of approximately 1 meter.

**Danger** – Danger to health or danger to life or limb from shock, burn or injury from mechanical movement to persons (and livestock where present), or from fire attendant upon the use of electrical energy.

**Earth** – The conductive mass of the earth, whose electric potential at any point is conventionally taken as zero.

**Earth electrode** – A conductor or group of conductors in intimate contact with and providing an electrical connection to earth.

**Earth fault loop impedance** – The impedance of the earth fault current loop (phase to earth loop), starting and ending at the point of earth fault.

**Earth leakage current** – A current which flows to earth, or to extraneous conductive parts, in a circuit which is electrically sound.

**Earth conductor** - A protective conductor connecting the main earth terminal (or equipotential bonding conductor of an installation when there is no earth bus) to an earth electrode or to the other means of earthing.

**Equipotential bonding** – Electrical connections putting various exposed conductive parts and extraneous conductive parts at a substantially equal potential.

Note: In a building installation, equipotential bonding conductors shall interconnect the following conductive parts:

- Protective conductors
- Earth continuity conductor, and
- Risers of air-conditioning systems and heating system (if any).

Main earthing terminal – The terminal or bar which is the equipotential bonding conductor of protective conductors, and conductors for functional earthing, if any, to the means of earthing.

Protective conductor – A conductor used for some measures of protection against shock, and intended for connecting together any of the following parts:

- Exposed conductive parts,
- Extraneous conductive parts,
- The main earthing terminal,
- and
- The earthed point of the source, or an artificial neutral

Residual current – The algebraic sum of the instantaneous values of current flowing through all the live conductors of a circuit at a point of the electrical installation.

Residual current device (RCD) – A mechanical switching device, or an association of devices intended to cause the opening of the contacts when the residual current attains a given value under the specified conditions.

Residual operating current – Residual current which causes the residual current device to operate under specified conditions.

Simultaneously accessible parts – Conductors or conductive parts which can be touched simultaneously by a person or, where applicable by live-stock.

Note – In the context of protection against direct contact, a live part may be accessible with:

- Another live part, or
- An exposed conductive part,
- or An extraneous conductive part,
- or A protective conductor.

Switch linked – A switch, the contacts of which are so arranged as to make or break all the poles simultaneously, or in a definite sequence.

Switchboard – An assembly of switchgear with or without instruments, but the term does not apply to a group of local switches in a final circuit.

Note: This is as per ISS. In these Specifications, this term is used for the mounting frame in particular. With the mountings, it is termed as a switchboard panel.

Switchgear – An assembly of main and auxiliary switching apparatus for operation, regulation, protection or other control of electrical installations.

Note: For more comprehensive definitions of the terms in 2.103 to 2.106, see IS:1885 (Part 17)-1987.

Appendix  
B(Clause 2.30 & 11)

**Form of Completion Certificate**

I/We certify that the installation detailed below has been in by me/us and tested and that to the best of my/our knowledge belief it complies with Indian Electricity Rules, 1956,

Electrical installation at \_\_\_\_\_

Voltage and system of supply \_\_\_\_\_

Particulars of work:

Internal Electrical Installation

|               | No. | Total Load | Type or system of wiring |
|---------------|-----|------------|--------------------------|
| Light point   |     |            |                          |
| Fan point     |     |            |                          |
| Plug point    |     |            |                          |
| oint          |     |            |                          |
| 3 pin 5 Amp.  |     |            |                          |
| 3 pin 15 Amp. |     |            |                          |

b) Others

a) Motors:

(i)(  
ii)(i  
ii)

Other plants:

If the work involves installation of over head line and/or underground

cable (i) Type & description of overhead line

Total length and no. of spans

No. of street lights and its

direction. (i) Total length of

underground cable and its size.

(ii) No. of joints : End

joint: Tee

oint:

St.

throughjoi  
nt :

## Earthing

Description of earthing

electrodeNo.of earth electrodes  
Sizeof mainearthlead

Testresults:

Insulationresistance

i) Insulationresistanceof thewhole  
ohmssystemof conductorsto earth Meg

Insulationbetweenthe phaseconductorand neutral

BetweenPhaseRand neutral Megohms

BetweenPhaseYand neutral Megohms

BetweenPhaseBand neutral Megohms

Insulation resistance between the phase conductors in case of poly-phase  
supply.BetweenPhaseRand Phase Y  
Megohms

BetweenPhaseYand Phase B Megohms

BetweenPhaseBand Phase R Meg

ohmsPolaritytest

Polarity of non-linked single pole branch

switchesEarthcontinuitytest

Maximum resistance between any point in the earth continuity conductor  
includingmetal conduitsandmainearthinglead Ohms

Earth electrode  
resistanceResistanceofeachearthel  
ectrode

.....Ohms

.....Ohms

.....Ohms

.....Ohms

Lightning protective system

Resistance of the whole of lightning protective system to earth before any bonding is affected  
with the electrode and metal in/on the structure ..... Ohms

Signature and name of  
the Engineer-in-charge (Elec)

Signature and Name of  
Contractor

**CHAPTER**  
**6 CABLE WORK**  
**K**

**6.1 Scope:**

- 6.1.1 This Specification covers the requirements for the selection and installation of Power Cables for low, medium and high voltage applications.

**6.2 Types of Cables:**

- 6.2.1 The cables for applications for low and medium voltage supply shall be PVC insulated and PVC sheathed conforming to I.S. 1554 Part-I-1964.
- 6.2.2 The cables for applications above 1.1 KV but up to and including 11 KV supply shall be either PVC sheathed, conforming to I.S. 1554 Part-II-1970.
- 6.2.2 The cables for applications above 11 KV but up to and inclusive of 33 KV supply shall be paper insulated lead sheathed conforming to I.S. 692-1965.
- 6.2.3 The cables shall have solid/stranded aluminum conductors.
- 6.2.4 Where paper insulated cables are used, in predominantly vertical situation, these shall be of non-draining type.

**6.3 Armouring and Serving:**

- 6.3.1 Short runs of cables laid in pipes, closed masonry trenches and similar protected/secured enclosures need not be armoured. PVC cables, when armoured, shall have galvanised steel wires (flat or round) for armouring. Paper insulated cables shall have for armouring, double layer of steel tape for normal applications. Steel wire armouring is preferred. Where the cable is liable to tensile stresses in applications such as vertical runs, suspended on brackets or laid in soil where it is likely to subside.
- 6.3.2 Serving over armouring in paper insulated cable shall consist of a complete layer or layers of suitable compounded hessian materials.

**6.4 Selection of Cables:**

- 6.4.1 Cable size shall be selected considering the current carrying capacity, voltage drop, maximum short circuit duty and the period of short circuit to meet the present and future anticipated loads.
- 6.4.2 Medium voltage distributions shall be designed such that the voltage available at final outlets are generally within the limits recommended by I.S. 732-1963.
- 6.4.3 Guidance for the selection of cables shall be derived from the relevant Indian Standards such as I.S. 3961 (Part I)– 1967, I.S. 3961 (Part II)– 1967, I.S. 5819-1970, I.S. 1255-1967 etc.

- 6.4.4 While deciding cable sizes, the derating factors for type and depth of laying, grouping, ambient temperature, ground temperature, and soil resistivity shall be considered.

## **6.5 Storage and handling:**

- 6.5.1 Cable drums shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in the ground causing rot and damage to the cable drums.
- 6.5.2 It should be ensured that both ends of the cable are properly sealed to prevent ingress/absorption of moisture by the insulation.
- 6.5.3 Protection from rain and sun is preferable. Sufficient ventilation between cable drums, should be ensured during storage.
- 6.5.4 The drums shall always be rested on the flanges and not on the flat sides.
- 6.5.5 When cable drums have to be moved over short distances they should be rolled in the direction of the arrow, marked on the drum.
- 6.5.6 The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all type of PVC cables shall be taken as 12 times the overall diameter of the cable. The minimum safe bending radius for paper insulated cables shall be as given in Table I, at the end of this chapter. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.
- 6.5.7 Cable with kinks and straightened kinks or with similar apparent defects like defective armoring etc. shall not be installed.

## **6.6 Installation:**

- 6.6.1 General: The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S. 1255-1967 shall be followed.
- 6.6.2 Route: -
- 6.6.2.1 Before the cable laying work is undertaken, the route of the cable shall be decided by the Engineer-in-Charge.
- 6.6.2.2 While shortest practicable route should be preferred, cable runs shall generally follow fixed developments such as roads, foot-paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run to shorten the route length is not desirable as it would be beset with route identification and maintenance problems, besides posing difficulties during later development of open areas etc.
- 6.6.2.3 While selecting cable routes, corrosive soils, ground surrounding sewage effluent etc. shall be avoided; where this is not feasible, special precautions as decided by the Engineer-in-Charge, particularly for HV cable installations, shall be taken.
- 6.6.2.4 As far as possible, the alignment of the cable route shall be decided taking into consideration the present and future requirements of other agencies and utility services affected by it, the existence of any cable in the vicinity as may be indicated by cable

markers or cable schedules or drawings maintained for that area, possibilities of widening of roads/lanes, storm water drains etc. Cable routes shall be planned away from the drains and near the property especially in the case of MV/LV cables, subject to any special local requirements that may have to be necessarily complied with.

6.6.2.5 Whenever cables are laid along well demarcated or established roads, the LV/MV cables shall be laid farther from the kerb line than HV cables.

6.6.2.6 Cables of different voltages and also power and control cables should be kept in different trenches with adequate separation. Where available space is restricted, LV/MV cables shall be laid above HV cables.

Where cables cross one another, the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

6.6.3 Way Leave:-

6.6.3.1

It may be necessary to obtain way leave for the cable route from the appropriate authorities some of whom are listed below:-

Drainage, Public Health and Water  
Works. Telephones and Telegraphs.  
Gas Works.  
Railways.  
Director General of Civil  
Aviation. Other undertakings.  
Owners of properties.

Where necessary, joint inspection with representatives of other authorities may be arranged so that mutual interests are safeguarded. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

6.6.4 Proximity to communication cables:

6.6.4.1 Power and communication cables shall as far as possible cross at right angles. Where power cables are laid in proximity to communication cables the horizontal and vertical clearance shall not normally be less than 60 cms.

6.6.5 Railway crossing:

6.6.5.1 When the cable is laid under the Railway tracks, the cables shall be laid in spun reinforced concrete or cast iron or steel pipes at such depths as may be specified by the Railway Authorities but not less than 1m measured from the bottom of sleepers to the top of the pipe. Inside railway station limits, pipes shall be laid up to the point of the railway boundary or to a point to be decided by the Railway Authorities. Outside Railway station limits, pipes shall be laid up to a minimum distance of 3m from the center of the nearest track on either side.

6.6.6 Laying methods:

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

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

6.6.7 Laying direct in ground:

6.6.7.1 General: This method shall be adopted where the cable route is through open country, along roads/lanes etc. and where no frequent excavations are encountered and where re-excavation is easily possible without affecting other services.

6.6.7.2 Trenching:

Width of trench: The width of trench shall first be determined on the following basis (Refer figure 1).

The minimum width of trench for laying single cables shall be 35 cm.

Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter-axial spacing between the cables, except where otherwise specified, shall be at least 20 cm.

There shall be a clearance of at least 15 cm. between axis of the end cables and the sides of the trench.

Depth of Trench: The depth of trench shall be determined on the following basis (Refer figure-1).

Where cables are laid in single tier formation, the total depth of trench shall not be less than 75 cm. for cables up to 1.1 KV and 1.20 m for cables above 1.1 KV.

When more than one tier of cables is unavoidable and vertical formation of laying is adopted, depth of trench in (i) above shall tier to be formed.

Excavation of trenches:

The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvatures shall be provided complying with the requirements of clause 1.5.12.

Where gradients and changes in depth are unavoidable, these shall be gradual.

Excavation should be done by any suitable means - manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.

Adequate precautions should be taken not to damage any existing cable(s), pipes or other such installations in the proposed route during excavation. Wherever bricks, tiles or protective covers or bare cables are encountered, further excavation shall not be carried out without the approval of the Engineer-in-Charge.

Existing property exposed during trenching shall be temporarily supported or propped adequately as directed by the Engineer-in-Charge. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled in accordance with clause 1.6.7.4.

If there is any danger of a trench collapsing or endangering adjacent structures, the sides should be well shored up with timbering and/or sheeting as the excavation proceeds. Where necessary, these may even be left in place when back filling the trench.

Excavation through lawns shall be done in consultation with the staff of the department/owner concerned.

The bottom of the trench shall be level and free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8 cm in depth.

#### 6.6.7.3 Laying of cable in trench:-

At the time of issue of cable for laying, the cores shall be tested for continuity and insulation resistance (Refer clause 1.8).

The cable drum shall be properly mounted on jacks or on a cable wheel, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.

The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be paved off in one stretch. However, where this is not possible the remainder of the cable may be removed by „Flaking“ i.e. by making one long loop in the reverse direction.

- i) After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 m apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

For short runs and sizes up to 50 sq. mm of cables up to 1.1 KV grade, any other suitable method of direct handling and laying can be adopted with the prior approval of the Engineer-in-Charge.

When the cable has been properly straightened, the cores are tested for continuity and insulation resistance (Refer Clause 1.8) and the cable is then measured. The ends of all lead sheathed cables shall be sealed with solder immediately. In case of PVC cables, suitable moisture seal tapes shall be used for this purpose.

- i) Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less than 17 cms. above the base cushion of sand before the protective cover is laid.

- ii) In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 30 cms. shall be provided over the initial bed before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand

cushion of 30 cms. as stated above. The top most cable shall have a final sand covering not less than 17 cms. before the protective cover is laid.

At the time of original installation, approximately 3m of surplus cable shall be left on each end of the cable and on each side of underground joints (Straight through/Tee/Termination) and at entries and places as may be decided by the Engineer-in-Charge. The surplus cable shall be left in the form of a loop. Where there are long runs of cable length, loose cable may be left at suitable intervals as specified by the Engineer-in-Charge.

A final protection to cables shall be laid in accordance with Clause 1.6.7.3(i) to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.

Unless otherwise specified, the cables shall be protected by second class bricks of not less than 20 cm X 10cm X 10cm (nominal size) as per Building Specification or protection covers placed on top of the sand, (bricks to be laid breadth wise) for the full length of the cable to the satisfaction of the Engineer-in-Charge. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5cm. over the sides of the end cables.

#### 6.6.7.4 Backfilling:

The trenches shall be then back-filled with excavated earth free from stones or other sharp-edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30cm. Unless otherwise specified, a crown of earth not less than 50mm. in the center and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of earth however should not exceed 10 cms. so as not to be a hazard to vehicular traffic. The temporary re-instatement of roadways should be inspected at regular intervals, particularly during the wet weather, and any settlements should be made good by further filling as may be required. After the subsidence has ceased, trenches cut through roadways of other paved areas shall be restored to the same density and material as the surrounding area and repaved in accordance with the relevant Building Specifications to the satisfaction of the Engineer-in-Charge.

Where road berms or lawns have been cut or kerb stones displaced, the same shall be repaired and made good except turfing/asphalting to the satisfaction of the Engineer-in-Charge and all surplus earth of rock removed to places as specified.

#### 6.6.7.5 Route Markers:

Route markers shall be provided straight runs of the cables at locations approved by the Engineer-in-Charge and generally at intervals not exceeding 100 m. Markers shall also be provided to identify change in the direction of the cable route and also for location of every underground joint.

Route markers shall be made out of 100 mm x 100mm x 5 mm G.I./Aluminium plate, welded or bolted on to 35 mm x 35 mm x 6 mm angle iron 60 cm. long. Such plate markers shall be mounted parallel to and 0.5 m or so away from the edge of the trench. Alternatively cement concrete 1: 2: 4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm. normal size) marker 60 cm. x 60 cm. x 10 cm. in size as shown in Figure 2 shall be laid flat and centered over the cable. The concrete markers unless otherwise

instructed by the Engineer-in-Charge, shall project over the surrounding surface so as to make the cable route easily identifiable.

The word, „cable“ and other details such as voltage grading, size etc. as furnished by the Engineer-in-Charge shall be inscribed on the marker.

6.6.7.6 Single core cables:

Three single core cables forming one three phase circuit shall normally be laid in close trefoil formation and shall be bound together at intervals of approximately 1m. The relative position of the three cables shall be changed at each joint, complete transposition being affected in every three consecutive cable lengths. The joints shall be clearly marked in an approved manner to indicate the circuit and phases. The arrangement for laying a number of parallel cables shall be as detailed in clause 9.4 of L.S.1255-1967.

6.6.8 Laying in pipes/closed ducts:

6.6.8.1 In locations such as road crossing, entry to buildings, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

6.6.8.2 Stone or pipes, G.I., C.I. or spun reinforced concrete pipes shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the Building Specification or instructions of the Engineer-in-Charge as the case may be. The size of the pipe shall be decided by the Engineer-in-Charge and shall not be less than 10 cm. in diameter for a single cable and not less than 15 cm. for more than one cable. These pipes shall be laid directly in ground without any special bed except for SW pipe which shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate of 40 mm. nominal size) bed. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1m. from the ground level when laid under roads, pavement etc. When steel pipes are employed for protection of single core cables feeding A.C. load, the pipe should be large enough to contain both cables in the case of single-phase system and all cables in the case of poly-phase system.

6.6.8.3 The pipes on road crossings shall preferably be on the skew to reduce the angle of bend as the cable enters and leaves the crossing. This is particularly important for high voltage cables.

6.6.8.4 Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design.

6.6.8.5 Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothed to prevent injury to cable insulation or sheathing.

6.6.8.6 Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building ends shall be suitably sealed to avoid entry of water.

6.6.8.7 All chases and passages necessary for the laying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.

- 6.6.8.8 Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.
- 6.6.9 Laying in open ducts:
- 6.6.9.1 Open ducts with suitable removable covers shall be preferred in sub-stations, switch rooms, plant rooms, workshop etc.
- 6.6.9.2 The cable ducts should be of suitable dimensions so that the cables can be conveniently laid. If necessary, cables may be fixed with clamps on the walls of the duct or taken in troughs induct. The duct should be covered with removable slabs or chequered plates.
- 6.6.9.3 Ducts may be filled with dry sand after the cable is laid and covered as above or finished with cement plaster specially in high voltage applications.
- 6.6.9.4 Splices or joints of any type shall not be permitted inside the ducts.
- 6.6.9.5 As far as possible laying of cables with different voltage ratings in the same duct shall be avoided.
- 6.6.9.6 Where considered necessary, hooks or racks shall be provided for supporting the cables in masonry/concrete cable ducts, cable troughs. Otherwise cables shall be laid directly in the trench or trough etc. While deciding the layout of cables in such ducts, care should be exercised to ensure that unnecessary crossing of cables is avoided.
- 6.6.10 Laying on surface:
- 6.6.10.1 This method may be adopted in places like switching stations, factories, tunnels, rising main in buildings through special raceway etc. The materials used shall be as approved by Engineer-in-Charge.
- 6.6.10.2 The cables may be laid in troughs of brackets at regular intervals or directly cleared to wall/ceiling. When laid over bracket supports, the cable shall be clamped to prevent undue sag.
- 6.6.10.3 Cable clamps shall be made from materials such as mild steel, porcelain, wood, aluminum etc. In case of single core cables, the clamps shall be of non-magnetic material. A suitable non-corrosive packing shall be used for clamping unarmored cables to prevent damage to the cable sheath.
- 6.6.11 Cable identification tags: -  
Wherever more than one cable is laid/run side by side, mark the tags as approved, inscribed with cable identification details shall be permanently attached to all the cables in the manhole s/pull pits/joint pits/entry points in buildings/open ducts etc. These shall also be attached to various cables laid directly on ground at suitable intervals as decided by the Engineer-in-Charge before the trenches are filled up.

## **6.7 Jointing:**

- 6.7.1 Jointing work shall be carried out only by a licensed/experienced cable jointer.
- 6.7.2 At the preliminary stages of laying a cable, a proper jointing position should be selected in accordance with clause 1.6.6.2.
- 6.7.3 Sufficient surplus cable shall be left on each side of joints as mentioned in clause 1.6.7.3.(g).
- 6.7.4 Joints shall be staggered by 2 to 3m when two or more cables are laid together in the same trench.
- 6.7.5 A caution board indicating “CAUTION CABLE JOINTING WORK IN PROGRESS” shall be displayed to warn the public and traffic when necessary.
- 6.7.6 Jointing pits shall be of sufficient dimensions as to allow easy and comfortable working. The sides of the pit shall be well protected from loose earth falling into it. It shall also be covered by a tarpaulin to prevent dust and other foreign matter being blown on the exposed joint and jointing materials.
- 6.7.7 Sufficient ventilation shall be provided during jointing operation in order to disperse fumes given out by fluxing.
- 6.7.8 Joining materials and accessories like conductor ferrules, solder, flux, insulating and protective tapes, filling compound, jointing boxes etc. of right quality and correct sizes, conforming to relevant Indian Standards, wherever they exist, shall be used. The design of the joint box and the composition of the filling compound shall be such as to provide an effective sealing against entry of moisture in addition to affording proper electrical characteristic to joints. Where special type of splicing connector kits or epoxy resin spliced joints is specified, materials approved for such applications shall be used and instructions of the manufacturer/s supplier of such materials shall be strictly followed.
- 6.7.9 Insulation resistance of cables to be jointed shall be measured with 500 V megger up to 1.1KV grade and with 2,500/5,000 V megger for cables of higher voltage. Unless the insulation resistance values are satisfactory, jointing shall not be done.
- 6.7.10 Before jointing is commenced all safety precautions like isolation, discharging, earthing etc. shall be taken to ensure that the cable would not be inadvertently charged from live supply. Metallic armor and external metallic bonding shall be connected to earth. Where “permit to work” system is in vogue, safety procedures prescribed shall be complied with [see clauses 22 and 23 of Appendix C of General Specifications for Electrical Works (Part I- Internal) 1972].
- 6.7.11 Cores of the cables must be properly identified before jointing.
- 6.7.12 Whenever aluminum conductor is exposed to outside atmosphere, a highly tenacious oxide film is formed which makes the soldering of aluminum conductor difficult. This oxide film should be removed using appropriate type of flux.
- 6.7.13 The clamps for the armor shall be clean and tight.

6.7.14 Where a cable is to be jointed with the existing cable, these sequences should be so arranged as to avoid crossing of cores while jointing.

6.7.15 Jointing procedure:-

6.7.15.1 While it would be best to follow strictly the instructions for jointing furnished by the manufacturers/suppliers of cable and joint boxes, a brief on the jointing procedures for Paper insulated and PVC cable is given for general guidance in Appendix C.

6.7.15.2 All indoor and outdoor jointing of paper insulated cable shall be done in accordance with the provisions of Section 11 of I.S. 1255-1967.

6.7.15.3 All outdoor jointing of PVC cables shall be done using best quality of compound and jointing materials. For indoor termination of PVC cables, joints with compression type glands shall be preferred.

## **6.8 Testing:**

6.8.1 All cables before laying shall be tested with a 500 V megger for 1.1 KV grade or with a 2,500/5000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armor and insulation resistance between conductors.

6.8.2 All cables shall be subjected to above mentioned tests during laying, before covering the cables by protective covers and backfilling and also before the jointing operations.

6.8.3 After laying and jointing the cable shall be subjected to a 15 minutes pressure test. The test pressure shall be as given in Table II at the end of this chapter. D. C. pressure testing may normally be preferred to A. C. pressure testing.

6.8.4 In the absence of facilities for pressure testing in accordance with clause 1.8.3., it is sufficient to test for one minute with 1,000 V megger for cables of 1.1 KV grade and with 2,500/5,000 V megger for cables of high voltages.

## **6.9 Completion plan and completion certificate:**

6.9.1 The work shall be carried out in accordance with the drawings enclosed with the tender and also in accordance with the modifications thereto from time to time approved by the Engineer-in-Charge.

6.9.2. For all works completion certificate, after completion of work, as given in Appendix C shall be submitted to the Engineer-in-Charge. Completion plan drawn to a suitable scale in tracing cloth with ink indicating the following along with three blue print copies of the same shall also be submitted.

Layout of cable work.

Length, size, type and grade of cables.

Method of laying i.e. direct in ground, in pipes

etc. Location of each joint with jointing method followed.

Routemarker and jointmarker with respect to permanent

landmarks available at site. Name of work, job No., accepted tender reference, date of completion.

## **6.10 Telephone Cables:**

Telephone cables are polythene insulated of different no. of pairs, size 0.50mm. should be laid in underground maintaining safe distance from power cables. The protection of cables will be same as above-mentioned power cables.

**APPENDIX– C**

**COMPLETION CERTIFICATE**

(Ref.Clauses 1.9.2.and 2.11.2)

I / We certify that the installation detailed below has been installed by me / us and tested and that to the best of my/ our knowledge and belief, it complies with Indian Electricity Rules 1956.

Electrical Installation at .....

Voltage and system of supply .....

Test results in the prescribed proforma enclosed ..... Yes/No.

Signature of Supervisor

Signature of Contractor

Name and Address

Name and Address

**PROFORMA-A: CABLE LAYING (HT and MV/LT to be shown separately)**

DATE OF TEST.....  
Voltage of Megger used... ..... V

| No. | From | To | Size in Sq. mm. | Voltage grading | Total length | Result of Megger testing: insulation resistance in megaohms |                                    |                                           |                                     |                                    |                                           |
|-----|------|----|-----------------|-----------------|--------------|-------------------------------------------------------------|------------------------------------|-------------------------------------------|-------------------------------------|------------------------------------|-------------------------------------------|
|     |      |    |                 |                 |              | At the time of issue                                        |                                    |                                           | During laying and Before recovering |                                    |                                           |
|     |      |    |                 |                 |              | Conductors Phase Between                                    | neutral & Conductors Phase between | earth & neutral conductors, Phase Between | Conductors Phase Between            | neutral & Conductors Phase between | earth & neutral conductors, Phase Between |
|     |      |    |                 |                 |              |                                                             |                                    |                                           |                                     |                                    |                                           |

Signature of Supervisor

Signature of Contractor

**PROFORMA-BCABLEJOINTING:(HTandMV/LTto be shownseparately)**

DATEOFTest.....

|                                         | 1     | 2 | 3 |
|-----------------------------------------|-------|---|---|
| Number of the jointLocation             |       |   |   |
| Type of jointCompound used.Sizeof cable | I     |   |   |
|                                         | II    |   |   |
| Voltage grading Iofcables               |       |   |   |
|                                         | II    |   |   |
| Voltageofmegger used                    |       |   |   |
| InsulationResistancebeforejoining.      |       |   |   |
| Cable I a) Between                      | R&Y   |   |   |
|                                         | Y&B   |   |   |
|                                         | B&R   |   |   |
| b)Between                               | R&Y   |   |   |
|                                         | Y&N   |   |   |
|                                         | B&N   |   |   |
| c) Between                              | R&E   |   |   |
|                                         | Y&E   |   |   |
|                                         | B&E   |   |   |
|                                         | N&E   |   |   |
| Cable II a) Between                     | R&Y   |   |   |
|                                         | Y&B   |   |   |
|                                         | B&R   |   |   |
| b)Between                               | R&N   |   |   |
|                                         | Y&N   |   |   |
|                                         | B&N   |   |   |
| c) Between                              | R&E   |   |   |
|                                         | Y&E   |   |   |
|                                         | B&E   |   |   |
|                                         | N &   |   |   |
| EInsulationResistanceofJointedcable.    |       |   |   |
| a) Between                              | R & Y |   |   |
|                                         | Y &   |   |   |
|                                         | BB&   |   |   |
|                                         | R     |   |   |
| b) Between                              | R & N |   |   |
|                                         | Y &   |   |   |
|                                         | NB&   |   |   |
|                                         | N     |   |   |
| c) Between                              | R & E |   |   |
|                                         | Y &   |   |   |
|                                         | EB &  |   |   |
|                                         | EN&   |   |   |
|                                         | E     |   |   |

Signatureof Supervisor

SignatureofContractor

**PROFORMA–C:OVERHEADLINES (HTandMV/LTto be shown separately)**

DATE OF TEST.....

Voltage and System of  
Supply:AC/DC  
No. of  
phasesVolts.

Total route

lengthNo.of

spans.

Span  
length:Ma  
ximumMi  
nimum

Configuration of conductors – Vertical /

Horizontal.Typeofconductors used.

Minimumsizeofconductor.

No. of tensioned joints in

conductor.Whetherstreetlightingpro  
vided.

TypeandNo.ofstreet

lightingfittings.Sizeofcontinuousearth  
wire.

Type and size of Guard

wire.Certificates:Itiscertifiedtha

t –

Clearancesabovegroundofthelowestconductorareinaccordancewithrule77ofI.E.Rules.

Thehorizontal andverticalclearanceofoverheadlinesareinaccordancewithRules79and80 of  
I.E. Rules.

Adequateguardingarrangementhasbeenprovidedbetweensystemofdifferentvoltageerected  
on the same support.

Guardinghasbeen  
providedincaseofcrossingoftwosystemsofoverheadlinesinaccordancewith Rule 87ofI.E.  
Rules.

The metal support and metallic fittings attached thereto have been permanently and efficiently earthed as required under Rule 90 of I.E. Rules.

The stay wire has been bonded with continuous earth wire. (cl.2.5.11.2)

All the supports carrying HV lines have been provided with anti-climbing device.

14. Result of insulation resistance test-

|                                                                                                                                                                                               |                                                                                                                                               | Circuit I                                                                                       | Circuit II                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| <p> <math>\bar{A} \bar{A}</math> <math>\bar{A} \bar{A} \square \bar{A} \square</math> <math>\bar{A} \square</math> </p> <p> <math>\bar{A}</math> rate of test.                 </p>           |                                                                                                                                               |                                                                                                 |                                                                                 |
| <p> <math>\bar{A} \bar{A}</math> <math>\bar{A} \bar{A} \square \bar{A} \square</math> <math>\bar{A} \square</math> </p> <p> <math>\bar{A}</math> voltage of megger used.                 </p> |                                                                                                                                               |                                                                                                 |                                                                                 |
| c)                                                                                                                                                                                            | <p>Between phase conductors-</p> <p>i) R &amp; Y</p> <p>ii) Y &amp; B</p> <p>iii) B &amp; R</p>                                               |                                                                                                 |                                                                                 |
| d)                                                                                                                                                                                            | <p>Between conductors and neutral</p> <p>i) R &amp; N</p> <p>ii) Y &amp; N</p> <p>iii) B &amp; N</p> <p>St. Light Phase conductor &amp; N</p> |                                                                                                 |                                                                                 |
|                                                                                                                                                                                               | <p>Between conductor and earth.</p> <p>i) R &amp; E</p> <p>ii) Y &amp; E</p> <p>iii) B &amp; E</p> <p>St. Light Phase conductor &amp; E.</p>  | <p> <math>\bar{A} \square</math> <math>\bar{A} \square</math> <math>\bar{A} \square</math> </p> | <p> <math>\bar{A}</math> <math>\bar{A} \square</math> <math>\bar{A}</math> </p> |

Signature of Supervisor

Signature of Contractor

**PROFORMA–D: TESTING BEFORE COMMISSIONING: Cable & Overhead line works**  
(CLAUSE NOS.: 1.8.3 and 2.9.1)

Date of Test .....

**CABLEWORK**

Whether High Pressure Test conducted – Yes/No.

If conducted – system of supply .....

Test pressure applied ..... KV ..... minutes

Result of test – Satisfactory/Unsatisfactory.

If not conducted:-

Voltage of Megger used:

Result of Megger Testing:

Between R & Y

Y &

B &

R

Between

R & N

Y &

N &

N

Between

R & E

Y &

E &

E &

E

**OVERHEADLINE WORK (H.T.)**

Whether High Pressure Test Conducted –

Yes/No. If conducted – System of

supply .....

Test pressure applied ..... KV ..... minutes

Result of Test – Satisfactory/Unsatisfactory.

If not conducted –

Voltage of Megger Used:

Result of Megger Testing:

Between phase conductors

R & Y

Y & B

B & R

Between conductors and  
Neutral

R & N

Y & N

B &

N St.

light Ph

ase

Circuit  
I

Circuit  
II

Conductor  
&N

Between Conductors  
and earth

R & E  
Y & E

B &  
E St.  
light Ph  
ase  
Conductor  
and E  
N & E

EARTHING:

- Total number of Earth Electrodes-.....
- (ii) Earth Resistance of each Earth Electrode- (1).....  
(2).....  
(3).....etc.

Signature of Supervisor

Signature of Contractor

## **CHAPTER 7**

### **M.V. PANEL, D.B., RISING MAINS, BUS TRUNKING AND OVERHEAD BUS BAR SYSTEM**

#### **7.0 Scope:**

This covers supply/erection/testing and commissioning of the equipment suitable for 415 Volt, 3 Phase, 50 HZ 4 wire system.

#### **Requirements**

For each equipment, required IP rating and short circuit rating capacity will be specified. Governing BIS also will be specified.

All the equipment will be factory fabricated in an approved factory having modern fabrication and testing process. It shall have seven tank pre-treatment process comprising of degreasing, rinsing, de-rusting, rinsing, phosphatizing, rinsing and passivation followed by powder coat painting having a paint thickness of 60 microns or as specified. The powder paint will be subjected to oven-heated process. All panels will be provided with suitable gasket to make it dust/vermin proof.

#### **7.1 Specification of LT Cubicle Panel:**

Cubicle panel shall be floor mounted (on a base frame) totally enclosed and extensible type. The general construction shall conform to IS 8623: 93. The design shall include all provisions for safety of operating and maintenance personnel. Degree of IP protection shall be IP-42 for indoor application and IP-54 for outdoors, unless otherwise specified.

The panel shall be compartmentalized type having space and arrangement for incoming cable/ bus ducting, incoming switchgear/ switchgears, bus coupler, insulated and properly supported compartmentalized bus bars, outgoing compartmentalized switchgear, bus bars supports, joint shrouds, cable alley of suitable size for cabling routing, support and terminations, inter-connection between bus bars and switchgear with auxiliary bus bars/insulated conductors/strip setc. Also, the panel will be provided with necessary instrumentation like CTs, PTs, Ammeters, Voltmeters, phase indicating lamps, other required instruments, wiring, fuses etc.

It shall be fabricated out of CRCA sheet not less than 2.0 mm thick for load bearing members and 1.6 mm for doors of LT panels. The framework may be Angle Iron/Channel/Bolted type construction. General constructions shall employ the principle of compartmentalization and segregation of each circuit. Unless otherwise approved, incoming and bus section panels shall be separate and independent and shall not be mixed with sections required for feeders. Each section of the rear accessible type board shall have hinged access door at the rear. Operating handle of the highest unit shall be at a height not more than 1.7 mtr. Overall height of the board shall not exceed 2.3 mtr.

#### **Arrangement for Incoming/Outgoing Cable Termination**

Cable entries shall be provided either from the rear or from the front through cable alleys of suitable size. Removable gland plate to be provided for each cable entry. Cable support arrangement to be provided inside cable alleys so that cables are neatly

arranged and fixed. From each outgoing switch, insulated strip/ conductor of suitable size to be provided up to suitable terminal block, which will receive incoming/ outgoing cable termination. It is desirable that cables are not terminated directly to switchgear, but terminated through proper terminal blocks.

#### Specification of Cable Terminal Block

Terminal block of reputed make shall be used. The housing material shall be polyamide having unbreakable and fire-retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be „Din“ or „G-rail“ type. Screws shall be self captive type. No protection cover is required, and the block should be touchproof.

#### Busbars/Supports/Clearances

The bus bar system may comprise of a system of main/ auxiliary bus bars run in bus bar alleys.

For busbar material, ratings, current density, insulation, supports, busbar clearances and joints see para 7.2(iii).

#### Earthing

2 Nos. 20x3 mm copper strip for LT panel up to 400 Amp. capacity or 2 Nos. 20x5 mm copper strip for LT panel of higher capacity shall be fixed all around the panel connected to 2 Nos. earth bus copper strips connected to incoming earth conductors.

(Typical Cubicle Panel is explained in Fig. 8)

#### Commissioning

After erection, the LT panel will be commissioned after:

- Tightening of all nuts and bolts.
- Closing any left-out holes to ensure the entire panel is insect proof.
- Megger testing.
- Earthing.

#### 7.1.1 Specification of Prewired DB:

As a general practice only prewired MCB/HRC type DBs shall be used, on account of their superior technical features, compared to conventional DBs, which don't allow for proper wiring space and wiring termination. Rewirable fuse type DBs shall not be used.

Prewired DBs shall have following features:

Recess/Surface type with integral loose wire box.

Phase/neutral/earth terminal blocks for termination of incoming & outgoing wires. Din Channel for mounting MCBs.

Arrangement for mounting incomer MCB/ RCCB/ RCBO/ MCCB as required. Copper Bus bar.

Earthing terminals.

Wiring from MCBs to phase terminal block.

Interconnection between terminal block/incoming switch/busbar/neutral terminal block/earth terminal connector with specified size of FRLS pre-insulated copper conductor cable duly fitted with copper lugs/thimbles.

Terminal blocks should be suitable for termination of conductor/ cable of required size but minimum rated cross-section of the terminal blocks should be 6 sq. mm.

Terminal blocks shall be made of flame-retardant polyamide material.

Color terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth.

Prewired DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits. (This is an optional feature.)

The prewired DB shall have peelable poly layer on the cover for protection from cement, plaster, paints etc. during the construction period.

Detachable plate with knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from 1.6mm sheet steel, properly pre-treated, phosphatized with powder coated finish.

Where specified it shall be of double door construction provided with hinged cover in the front.

**Note:** Prewired DB will be factory manufactured by reputed manufacturer of MCB DBs.

7.2 Rising Mains:

### **Application**

The rising mains are essentially used in electrical distribution system in building 2 storied and above. These are only for indoor applications. For Vertical power distribution, this is a preferred method, compared to rising cable system and is more reliable and safer from point of view of fire hazard.

Tap-off arrangements shall be provided on the rising mains with tap-off boxes.

The rising main shall comprise of sheet metal enclosure, bus bars, tap-off points, tap-off boxes, end feed units, fire barriers, expansion joints, thrust pads, end covers and fixing bracket etc.

The rising main shall conform to IS 8623 and IEC 439 and shall be suitable for 415 V, 3 phase, 50 Hz supply and insulation of rising mains shall be capable of withstanding the voltage of 660-volt AC. Degree of IP protection and short circuit ratings shall be specified.

### *Enclosure*

The enclosure shall be made from sheet steel of 1.6mm thickness.

### *Bus*

#### *bars Rating*

#### *ing*

Bus bars shall be made of wrought aluminum or aluminum alloy, or electric grade copper, conforming to relevant Indian Standard, as specified. The ratings of the bus bars shall be 100A, 200A, 300A, 400A, 500A, 600A, or 800A as specified.

### *Current Density*

Bus bars shall be of sufficient cross-section so that a current density of 130A/sq.cm (800A/sq.inch) is not exceeded at nominal current rating for aluminum bus bars, and 160A/sq.cm (1000A/sq.inch) for copper bus bars. The minimum sizes of sections of bus bars are given in Table VI.

### *Cross Section of Bus Bars*

The cross section of the neutral bus bar shall be the same as that of the phase busbar for bus bars of capacities up to 200A; for higher capacities, the neutral busbar must not be less than half the cross-section of that of the phase busbar.

### *Insulation*

Each busbar shall be suitably insulated with PVC sleeves/ tapes.

The insulation of the rising mains shall be capable of withstanding the voltage of 660 V of AC.

### *Bus Bar Supports*

Bus bar support insulators shall be class F insulators made of non-hygroscopic, non-combustible, track resistant and high strength FRP/ SMC/ DMC material, and shall be of suitable size and spacing to withstand the dynamic stresses due to short circuit currents. The spacing between two insulators should be provided by the manufacturers according to the design approved by CPRI for their bus bar supports.

### *Bus Bar Clearances*

The minimum clearance to be maintained for enclosed indoor air insulated busbars for medium voltage applications shall be as follows:

#### Between

|                                       |      |
|---------------------------------------|------|
| <u>Min. Clearances</u> Phase to earth | 26mm |
| Phase to phase                        | 32mm |

**Note:** For strip connection from bus bars to switchgear, the above clearances don't apply.

- (a) Busbar joints shall be thoroughly cleaned and suitable oxidizing greases shall be applied before making the joint.

High tensile bolts, plain and spring washers shall be provided to ensure good contact at the joints.

The overlap of the busbars at the joints shall be not less than the area of the cross section of the busbars.

#### *Bus Bar Marking*

Busbars and main connections shall be marked by color or letter as per Table VII.

#### **Expansion Joint**

Expansion joint made of aluminum/copper strips shall be provided wherever necessary, to take care of expansion and contraction of the bus bars under normal operating conditions. This shall be invariably provided whenever the length of the rising main exceeds 15 m.

#### **Thrust Pads**

The bus bars shall be provided with thrust pads so that the expansion of the conductors is upwards only.

The busbar clamps and insulators shall be designed to withstand the forces due to short circuit current. They shall also permit free vertical movement of the busbars during expansion and contraction.

#### **Mounting**

Incoming cable will be connected to the rising main through an end feed unit, consisting of switch fuse unit with HRC fuse/ MCCB/ ACB of required capacity and cable end box.

Tap-off boxes at specified intervals and heights shall be provided on rising main to tap power. The box shall consist of set of HRC fuses or MCCB/ Switch fuse unit, so that power from rising main can be switched ON/OFF and provided with suitable overload/short circuit protection.

Distribution boards/ switch boards will not be mounted on rising main. Such boards will be separately erected on floor/ wall and connected to tap-off box with suitable copper conductor cable (See Fig. 10).

#### **Construction Features**

The rising mains shall be manufactured in convenient sections to facilitate easy transportation and installation. The sections shall be connected to form a vertical run at site. Each section shall be provided with suitable wall straps at convenient intervals for fixing to the wall.

The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

The front covers shall be detachable. Neoprene gaskets shall be provided between the covers and the side channels.

The enclosure shall have a degree of protection not less than IP42.

The rising main shall be designed for temperature rise not exceeding 40-degree Cover ambient temperature of 45-degree C.

Built-in fire proof barriers having 2 hr. fire rating shall be provided to restrict the spread of fire through the rising mains from one section to the adjacent section.

Necessary provisions for ventilation shall be made at suitable intervals.

These shall be complete with welded non-ferrous metallic mesh to prevent entry of vermin.

Two numbers of copper earth strips of 20 x 3 mm (for Rising Main up to 400 Amp.) and 20 x 5 mm (for Rising main above 400 Amp. and up to 800 Amp.) shall be provided along side the rising mains enclosure, and shall be bolted to each section of the rising mains.

#### *Installation of Rising Mains*

Rising mains shall be installed on walls, to which the foundation bolts shall be suitably grouted (in a shaft of adequate size for rising main and floor distribution panel). The foundation bolts shall be provided by the contractor without extra payment.

- (a) No structural member in the building shall be damaged/ altered, without prior approval from the competent authority through the Engineer-in-charge.

Structural provisions like openings, cutouts, if any, provided by the department for the work, shall be used. Where these require modifications, or where fresh provisions are required to be made, such contingent work shall be carried out by the contractor at his cost.

All such openings in floors provided by the Department shall be closed by the contractor after installing the cables/ conduits/ rising mains etc. as the case may be, by any suitable means as approved by the Engineer-in-charge without any extra payment.

All chases required in connection with the electrical work shall be provided and filled by the contractor at his own cost to the original architectural finish of the buildings.

#### *Commissioning*

Before connecting main supply after installation, pre-commissioning checks comprising megger test, checking the tightness of connections, body earth connection etc. shall be carried out and recorded.

### **7.3 Bus Trunking:**

#### **7.3.1 Application:**

These are generally provided for interconnections between the transformers of 400 KVA and above and DG sets 300 KVA and above and their switch board panels, and also for interconnections between large switch board panels where specified, thereby avoiding use of large sizes of cables for such interconnections.

### 7.3.2 Materials

#### 7.3.2.1 Enclosure

Sheet steel of minimum 2 mm thickness shall be used for fabricating the enclosure.

#### 7.3.2.2 Bus Bars and Supports

Bus bars and their supports shall comply with clause 6.2 (iii) of these specifications. The current ratings shall be as specified in individual cases.

### 7.3.3 Construction

#### 7.3.3.1 Enclosure

The enclosure shall be of bolted type, box type, welded type or any other type as per the manufacturer's standard practice, and shall be made out from sheet steel of minimum 2 mm thickness. The front cover only shall be detachable. This section of the bus duct shall be rectangular. The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

The bus trunking enclosure shall be fabricated in convenient sections for easy transportation and installation. These sections shall be connected to form horizontal and vertical runs as required at site. The enclosure shall be provided with flanged ends with drilling arrangements to suit the flanges at the switch gear and transformer terminals. All flanges shall be provided with gaskets, nuts, bolts, washers etc.

The entire bus trunking enclosure shall be designed for dust and vermin proof construction. The enclosure for outdoor installations shall be additionally in weather proof construction. The enclosure shall have a degree of protection not less than IP 42 for indoor application, and IP 54 for outdoor application in accordance with IS: 2147.

Bus trunking, if required to be installed outdoors, shall be provided with a metallic protecting canopy of adequate size above the bus trunking, fabricated as part of the enclosure.

Neoprene gasket shall be provided to satisfy the operating conditions imposed by temperature, weather etc. and durability.

Provisions for ventilation shall be made as per clause 6.2 (vii) (g) of these specifications.

Two numbers of Copper earth strips of appropriate size shall be provided alongside the bus trunking enclosure and shall be bolted with each section of the bus trunking (See Table VIII).

#### 7.3.3.2 Expansion Joint/Flexible Termination

Flexible connections shall be provided by braided or multi-leaved conductors for terminations at transformer bushing and switch gear.

Expansion joints shall be provided as per clause 6.2 (iv) of these specifications.

#### 7.3.4 Installation

Each section of the enclosure shall be suspended from the ceiling slab with suitable MS suspenders and support angles/ channels. The runs shall be neat and the route shall be as directed by the Engineer-in-charge.

The bus trunking shall be supported such that its weight does not come on the terminations.

Danger notice boards shall be provided on the bus trunking enclosure at suitable intervals in every room through which it passes.

The earthing strip shall be properly terminated to the earth bars at both ends.

Pre-commissioning checks shall be conducted.

### 7.4 Overhead Bus Bar System

#### 7.4.1 Application

The overhead bus bar system is generally used for distribution of power to a number of distributed power loads, such as motors, as in a workshop. This system has an in-built flexibility for meeting additional loads without much change in the distribution system. These specifications cover indoor application only.

#### 7.4.2 Materials

##### 7.4.2.1 Enclosure

Sheet metal used for fabrication of side channels shall be 1.6 mm thick and the top and bottom covers 1.2 mm thick.

##### 7.4.2.2 Bus Bars and Supports

The bus bars shall comply with clause 6.2 (iii) of these specifications. The bus bars shall however be rated for 200A, 300A or 400A as specified. Each bus bar shall be individually insulated by means of PVC sleeves.

The bus bar support shall comply with clause 6.2 (iii) (e) of these specifications.

#### 7.4.3 Construction

The enclosure shall be sturdy to withstand the internal and external forces resulting from the various operating conditions. The enclosure shall have a degree of protection not less than IP42 in accordance with IS 2147.

The top and bottom cover plates shall be detachable, and shall complete with gasket to make the enclosure totally dust and vermin proof.

The enclosure shall be fabricated in convenient sections for easy transportation and installation. The bus sections shall be jointed together with flanges and tie bolts. Each section of the enclosure shall be suspended from the ceiling slab with suitable and rigid MS suspenders and brackets as required. Detachable blank sheet steel

covers shall be provided for enclosing the free ends of the busbar run.

Two numbers of Copper earth strips of appropriate size shall be provided for the complete run of bus bar enclosure and shall be bolted to each section of the bus bar enclosure. Suitable provision should be made to enable earth connection to the plug-in box, when plugged in.

#### Plug-in Boxes

Each section of the bus bar enclosure shall have plug-in points spaced at intervals of approximately 600 mm for the insertion of plug-in boxes.

The plug-in boxes shall be fabricated as compact sheet steel boxes with hinged doors and shall house the fuse holders/ MCCB/ MCB. The fuse holders/ MCCB/ MCB shall be solidly connected to high conductivity copper clip-on contacts and reinforced by spring steel strips. These clip-on contacts shall plug-in directly on to the bus bars at the plug-in points.

Two earth points shall be located at the ends of the plug-in boxes. While inserting these boxes into the plug-in points, the earth points shall engage first in the special earth bushes provided on the underside of the bus bar enclosure before the main contacts are made. While withdrawing these boxes, the earth contact is maintained even after the main contacts are isolated.

The plug-in boxes after insertion into the plug-in points shall be fastened by wing nuts.

Each plug-in box shall be fitted with a brass compression gland suitable for the size of the cable specified. It should be possible to provide this gland in any position, i.e. left-hand side, right hand side or lower side of the plug-in box.

The unused plug-in points shall be blanked with detachable sheet steel covers.

#### 7.4.4 Installation

The bus sections shall be jointed together with flanges and tie bolts. Each section of the enclosure shall be suspended from the ceiling slab with suitable MS suspenders and support angles/channels as required.

Bus trunking shall be suspended at a uniform height of about 2.4 m above floor level. The layout shall be got approved from the Engineer-in-charge before erection.

The runs shall be straight, except at points of change in direction.

A connector assembly shall be supplied loose with each section of the enclosure for coupling two sections, and it shall comprise a rubber locating ring, busbar insulating tube and a connector insulating tube.

#### 7.4.5 Earthing

The Copper earth strips of the bus duct shall be connected to the earth bus/ earth terminal(s) of the switchboard controlling the bus ducts, by appropriate protective conductors, notwithstanding the connection by the armoring of the feeder cable.

#### 7.4.6 Danger NoticeBoard

Theseshallbeprovidedontheenclosureat suitableintervalsandnot exceeding5m.

7.4.7 Pre-commissioningchecksshall beconducted.

**TABLEVI**  
**Aluminum/CopperBusBarSections**

*[Clause6.2(iii)(b)]*

| <i>CurrentRatings<br/>in amps.upto</i> | <i>RecommendedRectangularCross-section</i> |                      |                                |                      |
|----------------------------------------|--------------------------------------------|----------------------|--------------------------------|----------------------|
|                                        | <i>Aluminum</i>                            |                      | <i>Copper</i>                  |                      |
|                                        | <i>No.ofStrips/<br/>Phase</i>              | <i>Sizein<br/>mm</i> | <i>No.of Strips/<br/>Phase</i> | <i>Sizein<br/>mm</i> |
| 100                                    | 1                                          | 20 x 5               | 1                              | 20x3                 |
| 200                                    | 1                                          | 30 x 5               | 1                              | 25x5                 |
| 300                                    | 1                                          | 50 x 5               | 1                              | 40x5                 |
| 400                                    | 1                                          | 50 x 6               | 1                              | 50x5                 |
| 500                                    | 1                                          | 75 x 6               | 1                              | 60x5                 |
| 600                                    | 1                                          | 80 x 6               | —                              | —                    |
| 800                                    | 1                                          | 100x6                | —                              | —                    |
| 1000                                   | 1                                          | 100 x10              | —                              | —                    |
| 1200                                   | 1                                          | 125 x10              | —                              | —                    |
| 1600                                   | 2                                          | 100 x10              | —                              | —                    |
| 2000                                   | 2                                          | 125 x10              | —                              | —                    |
| 2500                                   | 3                                          | 125 x10              | —                              | —                    |

**Note:**

In larger bus bars of sizes above 1000 amps, the sections can be accepted in otherrectangular cross-sections and numbers also, provided the total cross- sectional areaoffered is not less than the total cross-sectional area shown in the above table againsttherespective bus barrating.

With aluminum bus bars, only aluminum wire/ solid bar connections shall be made forincoming/ outgoingmountings on theswitchboards.

Withcopperbus bars,onlycopperwire/solidbarconnectionsshallbemade forincoming/ outgoingmountings on theswitchboards.

**TABLE VII**  
[Clause 7.2(iii)(g)]

**Marking for A.C. Bus Bars & Main Connections**

|       | <i>Bus Bar and Main Connections</i>                      | <i>Color</i>      | <i>Letter/Symbol</i> |
|-------|----------------------------------------------------------|-------------------|----------------------|
| (i)   | Three Phase                                              | Red, Yellow, Blue | R. Y. B.             |
|       | Two Phase                                                | Red, Blue         | R. B.                |
|       | Single Phase                                             | Red               | R                    |
| (ii)  | Neutral connection                                       | Black             | N                    |
| (iii) | Connection to earth                                      | Green             | E                    |
| (iv)  | Phase variable (such as connection to reversible motors) | Grey              | Gy.                  |

**For D.C. Bus Bars and Main Connections**

|       | <i>Bus Bar and Main Connections</i>                       | <i>Color</i> | <i>Letter/Symbol</i> |
|-------|-----------------------------------------------------------|--------------|----------------------|
| (i)   | Positive                                                  | Red          | R, or plus           |
| (ii)  | Negative                                                  | Blue         | B, or minus          |
| (iii) | Neutral connection                                        | Black        | N                    |
| (iv)  | Connection to earth                                       | Green        | E                    |
| (v)   | Equalizer                                                 | Yellow       | Y                    |
| (vi)  | Phase variable (such as connections to reversible motors) | Grey         | Gy                   |

**Note:** In the wiring diagram, positive and negative should be indicated by, + and, - respectively.

**TABLE VIII**

[Clause 7.3.  
3.1(vii)]

**A: Earth Continuity Strip for Protective Earthing of Sub-Station Equipment**

| S.No. | Type of Installation                                                                                 | Earth Electrode | Earth Strip from Earth Electrode to Earth Bus and Loop Earthing of Equipment |
|-------|------------------------------------------------------------------------------------------------------|-----------------|------------------------------------------------------------------------------|
| 1.    | Indoor sub-station with HT panel, Transformer capacity up to 1600 KVA, LT panel, Generating set.     | Copper Plate    | 25 x 5 mm Copper Strip                                                       |
| 2.    | Indoor sub-station with HT panel, Transformer capacity above 1600 KVA, LT panel, and Generating set. | Copper Plate    | 32 x 5 mm Copper Strip                                                       |
| 3.    | HT Outdoor sub-station                                                                               | Copper Plate    | 25 x 5 mm Copper Strip                                                       |
| 4.    | LT Indoor sub-station with generator                                                                 | Copper Plate    | 25 x 5 mm Copper Strip                                                       |
| 5.    | LTs with having Main LT Switch Board                                                                 | Copper Plate    | 20 x 3 mm Copper Strip                                                       |

**B: Earth Continuity Strip for Bus Trunking and Rising Main**

| S.No. | Type of Installation                                    | Material of Main Conductor | Earth Strip                   |
|-------|---------------------------------------------------------|----------------------------|-------------------------------|
| 1.    | Bus trunking up to 2500 Amp capacity                    | Copper/ Aluminum           | 2 Nos. 25 x 5 mm copper strip |
| 2.    | Bus trunking above 2500 Amp capacity                    | Copper/ Aluminum           | 2 Nos. 32 x 5 mm copper strip |
| 3.    | Bus trunking for connecting generating set and LT panel | Copper/ Aluminum           | 2 Nos. 25 x 5 mm copper strip |
| 4.    | Rising main up to 400 Amp capacity                      | Copper/ Aluminum           | 2 Nos. 20 x 3 mm copper strip |
| 5.    | Rising main above 400 Amp and up to 800 Amp capacity    | Copper/ Aluminum           | 2 Nos. 20 x 5 mm copper strip |

**C:Neutral Earthing of Transformers and Generators**

| <i>S.No.</i> | <i>Equipment</i>                       | <i>Earth Electrode</i> | <i>Earth Strip from Earth Station to Neutral</i> |
|--------------|----------------------------------------|------------------------|--------------------------------------------------|
| 1.           | Transformer of capacity upto 1600 KVA  | Copper plate           | 25 x 5 mm Copper strip                           |
| 2.           | Transformer of capacity above 1600 KVA | Copper plate           | 32 x 5 mm Copper strip                           |
| 3.           | Generating set of all capacity         | Copper plate           | 25 x 5 mm Copper strip                           |

## CHAPTER 8

### HIGH VOLTAGE PANEL

#### 8.1 SCOPE:

These specifications cover the detailed requirements for supply, installation, testing and commissioning of High Voltage Panels.

#### 8.2 TYPE OF PANELS:

- (a) Vacuum circuit breaker.

Gas filled Circuit Breaker: These breakers are new in the market and are being used for 33 KV and above in power distribution. These may be used on selective basis based on their availability, serviceability and cost.

Gas insulated compact Switchgears with Vacuum Circuit Breakers. These are recently introduced and may be used in cases of space crunches judiciously.

However, the discussions shall be limited to only Vacuum Circuit Breakers.

#### VACUUM CIRCUIT BREAKER

#### 8.3 H.V. PANEL

##### 8.3.1

The Panel board shall be of indoor type, having the incoming sectionalisation and outgoing switchgears as per IS 13118:1991 of VCB, IEC 62271-100 for Breakers and -200 for Panels/IS 3427 of switchboard. The degree of enclosure protection shall be IP-4X.

Detailed requirements shall be in accordance with the schedule of works at Appendix II.

##### 8.3.2 **Rating**

All panels assembled to form a board shall be suitable for the nominal operation voltage and rupturing capacity as specified. They should be rated as specified with a minimum of 630 Amps. and suitable for operation on 11 KV, 3 phase 50 Hz system. Type test certificate for the breaking capacity of the panel shall be supplied. A circuit breaker for a given duty in service is best selected by considering the individual rated values required by load conditions and fault condition.

### 8.3.3 Type

The HV Panel Board shall be metal clad, indoor, floor mounting, free standing type. It shall be totally enclosed dust, damp and vermin proof.

### 8.3.4 General Construction

Separately earthed compartments shall be provided for circuit breakers, bus bars, relay & instruments, CT & PT and cable boxes, fully and effectively segregating these from one another so that fault in any one compartment do not cause damage to equipment(s) in other compartment(s).

The housing shall be of bolted construction to ensure compact and rigid structure, presenting a neat and pleasing appearance. The sheet steel used should not be less than 2 mm thick.

The panels shall be bolted together to form a continuous flush front switch gear suitable for front operation of board and for extension at both ends.

### 8.3.5 General Design Aspects

The HV panel board shall be designed such that the switchgear, instruments, relays, bus bars, small wiring etc. are arranged and mounted with due consideration for the following: -

- Facility for inspection, maintenance and repairs of testing terminals and terminal boards for ease of external connection.

- Minimum noise and vibrations.

- Risk of accidental short circuits and open circuits.

- Secured and vibration proof connections for power and control circuits. Risk of accidental contact and danger to personnel due to live connections. Mountings at approachable height.

## 8.4 CIRCUIT BREAKER

### 8.4.1 General Arrangements

The circuit breaker panel shall be complete with the following:

- Racking in/Racking out mechanism. Isolating plugs and sockets.

- Mechanical inter-locks and safety shutters. Mechanical ON/OFF indicator.

- Minimum of 4 NO and 4 NC Auxiliary contacts directly operated by the circuit breaker. Additional NO & NC contacts can be provided with auxiliary contractors. Anti-

- condensation space heaters suitable for operation on 240V, 1 $\phi$  50Hz A.C. for each panel wherever specified.

- Suitable tripping arrangement.

Mechanical counter to assess the total number of operations of the breaker (if asked for specifically).

#### 8.4.2 Type

The circuit breakers shall be of horizontal/vertical isolation, horizontal draw out pattern.

#### 8.4.3 Breaker Truck

The breaker carriage shall be fabricated from steel, providing a sturdy vehicle for the circuit breaker and its operating and tripping mechanism. The carriage shall be mounted on wheels, moving on guides, designed to align correctly and allow easy movement of the circuit breaker and for removing the carriage for inspection and maintenance purposes. Vacuum interrupters shall be hermetically sealed and shall be designed for minimum contact erosion, fast recovery of dielectric strength, maintenance free vacuum interrupter, suitable for auto-reclosing. The drive mechanisms shall preferably be provided with facility for padlocking at any position namely, "Service", "Test" and "Fully Isolated". It should be possible for testing the circuit breaker for its operation without energizing the power circuit in the "Testing" position. The contacts shall be made only after the breaker is inserted into service position. Interlocking should prevent contacts from being disconnected if circuit breaker is tried to be moved from service position.

#### 8.4.4 General Features

Single break contacts are provided in sealed vacuum interrupter.

#### 8.4.5 Rating

The circuit breakers shall be continuously rated as specified with a minimum rated current of 630 Amps. with voltage rating and breaking capacity as specified.

#### 8.4.6 Operating Mechanism

The operating mechanisms shall be one of the following as specified:

Manually operated spring charged/motor wound spring charged with both mechanical and electrical release for closing. The operating mechanisms shall be trip free.

#### 8.4.7 External auxiliary supply shall be made available for charging motors & heaters operation.

### 8.5 BUSBAR SECTION

#### 8.5.1 General Requirement

The switchboard shall be **single busbar pattern** with air insulated and encapsulated busbars housed in a separate compartment, segregated from other compartments.

### **Material**

The bus bars shall be of high conductivity electrolytic copper rated as specified with a minimum rated current of 630 Amps. The bus bars shall be sized for carrying the rated and short circuit current without over-heating. Maximum bus bar temperature shall not exceed 95-degree C

## **8.6 CURRENT TRANSFORMER**

### **8.6.1 General Requirements**

Accommodation shall be provided in the circuit breaker panel to mount one set of three numbers dual core dual ratio CTs for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from the front, back or top of the panel.

### **8.6.2 Rating**

Dual core & dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amps secondary. The ratio shall normally be one of the following as specified:

- |                 |                 |
|-----------------|-----------------|
| (a) 400/200/5/5 | (b) 300/150/5/5 |
| (c) 200/100/5/5 | (d) 100/50/5/5  |

such other as required

**Note:** CT ratios shall be compatible with the loading pattern on HV side.

The CTs shall conform to relevant Indian Standards. The design and construction shall be robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5 P 10 of IS 2705-Part III-1992.

The metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705-1992 for incoming and class 1 for outgoing panels.

## **8.7 VOLTAGE TRANSFORMER**

### **8.7.1 General Requirements**

A voltage transformer of burden not less than 100 VA and of proper ratio as specified shall be provided at the incoming panel.

The accuracy class for the VT shall be class 0.5 as per IS 3156 Parts I to III for incoming and class 1 for outgoing panels.

The transformers shall be of cast epoxy resin construction. It shall be fixed/withdrawable type. HRC fuses/ MCBs shall be provided on both HV and LV sides.

## 8.8 PROTECTION AND TRIPPING ARRANGEMENT

### 8.8.1 Protection

The Relays shall be microprocessor based numerical relays with O/L, E/F and S/C protection. Tripping relay shall be used for tripping signal to the Shunt Trip Coil of Circuit Breaker operating on 24V/30V DC supply/Powerpack/110V VT supply.

**Note:** - 24V/ 30V DC shall be provided through 2 No. SMF batteries of 12/ 15 volts of minimum 26 AH capacity with a battery charger as per recommendation of the manufacturer both for protection as well as indications.

Alternatively, Power Pack converters fed through PT/230V externally could be provided with 2 Nos., 12/ 15-volt, 7 AH SMF batteries (Power pack with condenser/capacitor backup are also available which do not need batteries, these should not be used) for tripping. In cases where tripping is fed through PT, VA burden of PT shall be suitably increased (say 200 VA) as recommended by the manufacturer depending upon the number of panels and connected controls. In addition, external 24 volt / 30-volt DC supply shall be provided for indications etc. through 2 No. SMF batteries of 12/15 volts of minimum 26 AH capacity with a battery charger as per recommendation of the manufacturer.

### 8.8.2 Relays

Over current Relays shall have adjustable setting for current from 50% to 200% and earth fault from 10% to 40% or 20% to 80%. These should be of manual reset type. All relays shall have a LED indicator which will indicate operation for each function. It shall be possible to reset it only by manual operation. The number and types of relays shall be as specified.

## 8.9 SMALL WIRING

The small wiring shall be carried out with minimum 1.5 sq. mm FRLS/ HFFR insulated copper conductor cables. CT wiring shall be done with minimum 2.5 sq mm wires with color code: RYB, Gray for auxiliary DC circuits and Black for auxiliary AC circuits. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification tags shall be fitted to all wire terminals to render identification easy and to facilitate checking in accordance with IS 375. Necessary terminal blocks and cable entries shall be provided for RTD relay wiring, power supply etc.

## 8.9 METERING INSTRUMENT, PANEL ACCESSORIES (DIGITAL)

### 8.10.1 Metering

Energy metering shall be done either on the incomers or on the feeders as specified in Appendix II.

#### 8.10.2 Voltage Selection Scheme

Where a bus coupler is incorporated and only one incomer feeder (out of two available) is intended to be operated at a time, a VT Transfer Relay shall be incorporated to provide necessary potential for metering. This will be necessary when energy metering is done on individual feeders or where VT supply is used for trip circuits. Alternatively, PTs shall be provided on both the bus sections (incomers) with individual metering on each incomer.

#### 8.10.3 **Instrument Panels**

The instrument panel shall form part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the tenderer. They shall be preferably of flush mounting type at a maximum height of 1800 mm.

#### 8.10.4 **Instrumentation**

A voltmeter of class 1.5 accuracy as per IS 1248 shall be provided at each incomer panel, with selector switch. The instrument shall be calibrated for the range specified.

Energy meters of class 1.0 conforming to IS 722 (Part IX) and power factor meter of Class of accuracy of 2 shall be provided, if specified.

Ammeter of specified range of class 1.5 accuracy as per IS 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.

The panel assembly shall also take care of the following requirements: Lamp indication shall be provided to indicate ON/ OFF (by red green respectively) of switch gear.

Panel illuminating lamp.

Mechanical indication for spring charged status. If possible, an indicating lamp could be provided.

Lamp indicating tripping at fault status.

Healthy trip supply shall be indicated by clear lamp.

Separate fuses/ MCBs shall be provided for lamps, heaters, voltmeters and other instrumentation etc. on each panel.

Anti-condensation space heaters shall be provided, and shall be suitable for operation on 240 V, 1 phase, 50 Hz A.C. for each panel if specified. Where there are more than one incomer and bus sections, these shall be castle key interlocked as per interlocking scheme as specified.

#### 8.11 CABLE BOXES

Cable box shall be situated in a compartment at the rear/ side of the housing as specified.

#### 8.12 CABLE ENTRY

Provision for top (bus ducts preferred for top entry) / bottom or such other side entry shall be made as per requirement with sufficient headroom for cable termination. 3 thick removable gland plates shall be provided for cable termination.

#### 8.13 EARTHING

The earthing of the breaker body and moving portion shall be so arranged that the earthing of the non-current carrying structure to the frame earth bar is completed well before the main circuit breaker plugs enter the fixed house sockets.

The entire panel board shall have a common tinned copper earth bar of suitable section with 2 earth terminals for effectively earthing metallic portion of the panels. The frame earthing of panel shall be in accordance with Section 7 of this specifications.

#### 8.14 INSTALLATION

The installation work shall cover assembly of panels lining up, grouting the units etc. In the case of multi panels switch boards after connecting up the bus bar all joint shall be insulated with HV insulation tape or with approved insulation compound. A common earth bar shall be run preferably at the back of the switch board connecting all the sections for connecting the earth system. All protection, indications & metering connections and wirings shall be completed.

Where trip supply battery is installed the unit shall be commissioned, completing initial charging of the batteries. All relay instruments and meters shall be mounted and connected with appropriate wiring. Calibration checks of units as necessary and required by the licensee like CTs, VTs Energy Meters etc. shall be completed before pre-commission checks are undertaken.

#### 8.15 TESTING AND COMMISSIONING

Procedure for testing and commissioning of relay shall be in general accordance with good practice.

Commissioning checks and tests shall include in addition to checking of all small wiring connections, relays calibration and setting tests by secondary injection method and primary injection method. Primary injection test will be preferred for operation of relay through CTs. Before panel board is commissioned, provision of the safety namely fire extinguishers, rubber mats and danger board shall be ensured. In addition, all routine megger tests shall be performed. Checks and tests shall include following:

Operation checks and lubrication of all moving parts. Interlock function checks.

Continuity check of

wiring, fuses etc. as required. Insulation tests.

Tripping test and protection gear tests.

The complete panel shall be tested with 5000 V megger for insulation between poles and poles to earth. Insulation test of secondary of CTs and VT to earth shall be conducted using 500 V megger.

Any other tests as may be required by the Licensee / Inspector shall be conducted.

Where specified, the entire switch board shall withstand high voltage test after installation.

Any other test required by the consignee/ inspecting officer.

## CHAPTER 9

### **TRANSFORMERS**

#### 9.1 SCOPE

This section covers the detailed requirements regarding supply, installation, testing, commissioning and handing over of transformers required for the sub-station.

Conventionally oil cooled transformers were being used for electrical sub-station. However due to presence of oil for cooling of transformers, an inherent fire risk is involved in the use of oil cooled transformers.

After repeated fire accidents due to burning of oil in oil cooled transformers, I.E. Rules have been amended to provide for use of only dry type transformers where a sub-station is planned inside the main building while oil cooled transformers can continue to be used if the sub-station is located in an independent building.

There are two types of dry type transformers viz. vacuum pressure impregnated (VPI) dry type transformers and cast resin dry type transformers. This section provides for use of both the type of dry type transformers where individual capacity of transformer does not exceed 400 KVA. Only cast resin dry type transformers shall be used for higher capacity.

#### 9.2 OIL COOLED TRANSFORMERS

Oil filled transformers may be used only in sub-stations located in separate single or two storied service buildings outside the main building structure and there shall at least be 6-meter clear distance between the adjoining buildings and sub-stations such that fire tender is able to pass between the two structures. (NBC-2005 Part-8, Section 2 clause 4.2.1j).

##### 9.2.1 General Construction

The oil filled transformers shall comply with the following Indian Standards as amended up to date:

IS 2026 - Part I to V - power

transformers. IS 335 - Transformer oil.

IS 10028 (Part II & III) - Installation and Maintenance of Transformers.

IS 2099 - Bushings.

IS 2705 - Current Transformers.

IS 6600 - Guide for loading of oil immersed transformers.

### 9.2.2 Insulation Oil

Insulation oil shall conform to IS 335. Transformer oil to be supplied with initial fill of filtered oil.

### 9.2.3 General Requirements

The transformers shall be indoor or outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of IS 2026 (Part I): 1977.

### 9.2.4 Capacity and Rating

The KV Aratings for three phase transformers are given below:-

|            |            |             |             |
|------------|------------|-------------|-------------|
| <u>100</u> | <u>250</u> | <u>630</u>  | <u>1600</u> |
| 125        | 315        | 800         | & higher    |
| 160        | <u>400</u> | <u>1000</u> |             |
| 200        | 500        | <u>1250</u> |             |

Continuous ratings specified shall be irrespective of tapping position.

### **TEMPERATURE RISE**

The reference ambient temperatures assumed for the purpose of this specification are as follows :

Maximum ambient air temperature 50°C.

Maximum daily average ambient air temperature

40°C. Maximum yearly weighted average ambient temperature

32°C. Minimum yearly weighted average ambient temperature (-5°C).

The temperature rises at the above conditions and at the altitude not exceeding 1000 meters shall be as follows:

By resistance method 55°C (maximum temperature being 95°C). By thermometer 0°C.

If the site conditions indicated for a particular job is more severe than the reference ambient temperature mentioned above, the temperature rise shall be suitably scaled down such that the hot spot temperature shall not exceed the values for the reference conditions.

### 9.2.5 Tap Changing Device

Tap changing device shall be provided on H.V side, circuit type, externally hand operated with necessary indications for tap position and locking arrangement at any of the tapping positions. It shall be designed for bi-directional operation and shall be of self-positioning type and shall have the following steps:

± 2.5%                      ± 5%-7.5%-10% (if required)

**Note:** Tap changing device shall normally be off load type. However, NIT approving authority may use on load type Tap Changing Devices judiciously.

#### 9.2.6 Voltage Ratio

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11KV/433V.

#### VECTOR GROUP

In case of step down transformers, the winding connections shall conform to vector group dy. 11 unless otherwise specified.

In case of step up transformer the vector group unless otherwise specified shall be star/delta.

#### 9.2.7 Cooling

Unless otherwise specified, the transformer shall be oil immersed natural air-cooled type (ONAN).

#### 9.2.8 Accessories

The transformer shall be a single tank type with termination on bushings or cable end box as specified both on HV and MV side. The MV side shall be suitable to receive busbar trunking or MV cable inter-connections suitable for full load current of the transformer.

#### FITTINGS

The transformers shall be complete with the following fittings:

Oil conservator with oil level indicator, minimum level marking and drain plug for all transformers of capacity 50 KVA and above.

Off circuit type tap changer with position indicator and locking arrangement for all transformers.

Thermometer pocket with plug for all transformers of capacity 100 KVA and above.

100 mm dial type /stem type thermometer with metal guard Dial type thermometer may have max. temperature indicator and resetting device for all transformers of capacity 250 KVA and above.

Lifting lugs for all transformers.

Bi-directional/Unidirectional Roller to be specified.

Rating diagram and terminal marking plate for all transformers. Explosion vent for all transformers of capacity 400 KVA and above. Additional Neutral separately brought out on a bushing for earthing for

all transformers.

Earth terminals (2 Nos.) for body earthing for all transformers.

Valves for filtration, drainage and filling etc. with necessary plugs for all transformers.

Radiator assembly for all transformers.  
Silica gel breather for all transformers.  
Air release plug for all transformers.

First filling of oil to IS 335:1993 including make-up fill during installation for all transformers.

Facility to connect up Buchholz relay for all transformers of capacity 800 KVA and above.

Inspection covers  
on tank cover for access to terminal connections for all transformers.

Bushing terminations or cable box terminations as specified.

Necessary hardware, clamps, lug etc. for termination on HV/MV etc. for all transformers.

#### 9.2.9 Explosion Vent

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and of such a design to prevent gas accumulation.

#### 9.2.10 Accommodation for Auxiliary Apparatus

Where specified, such as, for restricted earth fault protection, facilities shall be provided for the mounting of a neutral current transformer.

### **RATING AND DIAGRAM PLATES**

The following plates shall be fixed to Transformer in a visible position.

A rating plate of weather proof material bearing the data specified in the appropriate clauses of IS 2026:1977.

A diagram plate showing the internal connection and also the voltage vector relationship of the several windings in accordance with IS 2026:1977 and a plan view of the transformer giving the correct physical relationship of the terminals.

#### 9.2.11 Joints and Gaskets

**All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with synthetic rubber gaskets or synthetic rubber or such other good material.**

### **GAS AND OIL ACTUATED (BUCHHOLTZ) RELAYS**

Buchholtz Relay shall be provided for transformers of capacity 800 KVA and above. The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipework shall be so arranged that all gas arising from the transformer shall pass through the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided.

All wiring connections, terminal boards, fuses and link sets connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resistant insulation and the bared ends of stranded wire shall be sealed together to prevent seepage of oil entering connection boxes used for cables or wiring.

#### **9.2.12 Cable Box**

Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated. Necessary removable links in oil approachable through inspection cover in tank cover etc. after lowering oil shall be provided for test purpose.

#### **9.2.13 Parallel Operation**

For parallel operation of transformers, the transformers shall have the same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

#### **9.2.14 Tests**

##### **9.2.14.1 TESTS AT WORKS:**

All routine and other tests prescribed by IS 2026 shall be carried out at the manufacturer's works before dispatch of the transformer in the presence of inspecting officer if required. Copies of the test certificates shall be furnished to the department. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate done on the same type/ design of the transformer shall be furnished in accordance with IS for purpose of record. If no impulse test was done in an earlier unit of the same design and capacity, one transformer will be subjected to impulse test in consultation with the Inspector at the firm's cost.

Copies of the certificates for pressure test for bushings, and type test for short circuit shall be supplied to the Department.

#### 9.2.14.1 Tests at SITE:

In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No. 10028 (Part II & III) shall be done before energization. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking:

Insulation test between HV to earth and HV to MV with 5000 volts Megger. Insulation test between MV to earth with 500 volts Megger.

Dielectric strength Test on oil.

Buchholz relay operation by simulation test when fitted.

All test results are to be recorded and reports should be submitted to the department.

#### 9.2.15 Installation and Commissioning

- 9.2.15.1 The transformer shall be installed in accordance with IS 10028 (Part II & III)-Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.
- 9.2.15.2 The transformers shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers. All parts of the transformer which are supplied loose, such as conservator, radiator banks, Buchholz relay, dial thermometer, bushing etc. shall be fitted on the transformer. Transformer oil supplied in drums shall be topped up into the transformer after duly testing/filtering up to the correct level required.
- 9.2.15.3 Wiring of devices such as Buchholz relay, dial thermometer etc. shall be carried out as per drawings. Earthing of neutral and body of the transformers shall be done in accordance with section (7) of these specifications.
- 9.2.15.4 Drying out of transformer winding will be necessary when the dielectric strength of the oil is lower than the minimum value as per IS 10028 or the transformer has not been energized within 6 months of leaving the works or where the radiator assembly is done at site. The transformer shall be dried out by one of the methods specified in IS 10028. Drying out with centrifugal or vacuum type filters will, however, be preferred. The contractor shall carry out the process of drying without interruption and shall maintain a log sheet indicating time, oil temperature and insulation resistance.
- 9.2.15.5 After complete drying out of the transformer, oil sample shall be collected by the contractor and shall be tested for dielectric strength as specified in IS 335:1993 with approved test kit.
- 9.2.15.6 All devices such as dial type thermometers, Buchholz relays and main alarm and trip contacts shall be checked for satisfactory operation.
- 9.2.15.7 All tests specified in 9.2.14 of these specifications shall be carried out by the contractor

in the presence of inspecting officer/consignee free of cost.

#### 9.2.16 Maximum Allowable Power Transformer Losses

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

Total losses for oil filled transformers should conform as per the following table:

| <i>Maximum allowable losses for oil filled distribution transformer with highest voltage for equipment 36 kV, at 50% and 100% of the load</i> |                                                    |                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|----------------------------------------------------------|
| <i>Transformer Capacity (kVA)</i>                                                                                                             | <i>Maximum Allowable losses at 50% kVA or load</i> | <i>Maximum Allowable losses at full load / Rated kVA</i> |
| 100                                                                                                                                           | 1.04%                                              | 1.80%                                                    |
| 160                                                                                                                                           | 0.96%                                              | 1.38%                                                    |
| 200                                                                                                                                           | 0.93%                                              | 1.35%                                                    |
| 250                                                                                                                                           | 0.89%                                              | 1.27%                                                    |
| 400                                                                                                                                           | 0.79%                                              | 1.12%                                                    |
| 500                                                                                                                                           | 0.75%                                              | 1.05%                                                    |
| 630                                                                                                                                           | 0.70%                                              | 0.99%                                                    |
| 1000                                                                                                                                          | 0.70%                                              | 0.98%                                                    |
| 1600                                                                                                                                          | 0.65%                                              | 0.98%                                                    |
| 2000                                                                                                                                          | 0.64%                                              | 0.98%                                                    |

## **CHAPTER 10**

### **TECHNICAL SPECIFICATION OF DG SET**

#### **10.1 SCOPE**

This section deal with unloading procedures, location, standard capacities and climatic conditions for DG set installation.

##### **10.1.1 Unloading**

###### **10.1.1.1 Gensets without Acoustic Enclosure**

**10.1.1.1.1** Genset should not be lifted from engine and alternator hooks. These are designed for lifting individual items only. Normally, provision for Genset lifting is provided on base-rails. The Genset should be unloaded from base rail by lifting with proper Genset lifting tackle or nylon sling/steel rope of suitable capacity and crane so as to ensure no damage to oil sump, air cleaner, radiator pipes etc.

**10.1.1.1.2** Genset should be covered with polyethylene or tarpaulin during installation to ensure that water does not enter inside.

**10.1.1.1.3** Spreader bar/ spacer plate of suitable size may be required to avoid damage to Genset components.

**10.1.1.2** DG set with Acoustic enclosure are provided with lifting hooks.

##### **10.1.2 Location**

###### **10.1.2.1 DG Sets with Acoustic Enclosure**

DG sets up to 1000 KVA capacity are required to be supplied with an acoustic enclosure as per CPCB norms. DG Set with acoustic enclosure shall preferably be installed outside the building (including terrace subject to structural feasibility) & location should be finalized in consultation with the Architect. However, DG set should be as near to the substation as possible i.e. as near to Essential LT Panel as possible. Associated AMF panel/ Electrical panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer standard. In case, AMF/ Electrical panel has to be installed outside the acoustic enclosure, location of room to house AMF/ Electrical panel should be decided in consultation with the Architect so that it shall be as near to the acoustic enclosure as possible. Specially, in case of connection through bus trunking, care should be taken for aesthetics.

###### **10.1.2.2 DG Sets without Acoustic Enclosure**

**10.1.2.2.1** In case of DG Sets beyond 1000 KVA capacity i.e. when DG set is supplied without an acoustic enclosure, room of appropriate size should be provided to house the DG Set. The DG set room should be as near to the substation as possible (i.e. as near to Essential LT Panel as possible). While deciding the room layout, typical 2-meters free space around Genset is recommended for proper heat dissipation and ease of service. However, to avoid hot air re-circulation, radiator cooled engines should have maximum possible space in the front. Minimum 1.5-meter free space is must. A typical Genset room is shown in Figure 1.

- 10.1.2.2.2 As far as possible, installation of DG Set should be avoided in basement. In cases where installation of D.G. Set in basement is unavoidable, due care of supply of adequate amount of air required for proper operation of D.G. Set shall be taken.

### 10.1.3 Nominal ratings of DG Sets

DG Sets are normally available in following standard capacities:  
(Ratings in KVA)

|     |      |      |     |      |     |     |     |      |      |      |
|-----|------|------|-----|------|-----|-----|-----|------|------|------|
| 7.5 | 10   | 12.5 | 15  | 17.5 | 25  | 30  | 35  | 40   | 50   | 62.5 |
| 75  | 82.5 | 110  | 125 | 140  | 200 | 225 | 250 | 320  | 350  | 380  |
| 415 | 450  | 500  | 550 | 600  | 625 | 700 | 750 | 1010 | 1250 | 1500 |

Capacity output of DG Set should be specified in tender in terms of "Prime Power Rating at 0.85 load factor" as per Clause 13.3.2 of ISO-8528 (Part-1), titled "Reciprocating internal combustion engine driven alternating current generating sets: Part-1: Application, ratings and performance" (See Appendix, "I"). However, depending upon the particular application & use, "Continuous" or "Standby" rating can be specified.

### 10.1.4 Climatic Conditions

The output of DG Set shall be specified in tender documents under actual site conditions. The tenderer has to certify that the engine & alternator meets the capacity requirement after deration as per IS/ BIS.

- 10.1.5 DG Set up to 1000 KVA capacity should be type tested for Noise and Emission norms/standards as per CPCB as per Appendix "II" and Appendix "III".

## 10.2 DIESEL ENGINE

**Scope:** This section covers engine rating, standard components of a diesel engine including exhaust piping.

### 10.2.1 Diesel Engine

#### 10.2.1.1 Engine Rating

The engine shall be of standard design of the original manufacturers. It should be 4 stroke cycles, water cooled, naturally aspirated/ turbo charged (as per manufacturer standard), diesel engine developing suitable BHP for giving a power rating as per ISO 8528- Part-1 in KVA at the load terminals of alternator at 1500 rpm at actual site conditions.

The engine shall be capable for delivering specified Prime Power rating at variable loads for PF of 0.8 lag with 10% overload available in excess of specified output for one hour in every 12 hours. The average load factor of the engine over period of 24 hours shall be 0.85 (85%) for prime power output.

The testing procedure shall be as mentioned in para 1.15.

The engine shall conform to IS:10000/ ISO 3046/ BS:649/ BS 5514 amended up to date.

10.2.1.2 Necessary certificate indicating the compliance of the above capacity requirement for the engine model so selected along with compliance of Noise and Emission norms as per latest CPCB guidelines for DG set capacity up to 1000 KVA, should be furnished from the manufacturers along with the technical bid. (Refer Appendix „II“ for noise norms and Appendix „III“ for emission norms). However above 1000 KVA DG set, manufacturers shall furnish certificate that the Engine for the DG set complies with the CPCB Emission norms.

10.2.1.3 The engines shall be fitted with following accessories subject to the design of the manufacturer:

Dynamically balanced Flywheel

Necessary flexible coupling and guard for alternator and engine (applicable only for double bearing alternator)

Air cleaner (dry/oil bath type) as per manufacturer standard,

A mechanical/ electronic governor to maintain engine speed at all conditions of load. (see Clause 9.2.1.4)

Daily fuel service tank of minimum capacity as per Table below, fabricated from M.S. sheet with inlet, outlet connections, air vent tap, drain plug and level indicator (gauge) M.S. fuel piping from tank to engine with valves, unions, reducers, flexible hose connection and floor mounting pedestals, twin fuel filters and fuel injectors. The location of the tank shall depend on standard manufacturer's design.

**Table I: Recommended Minimum Capacity of Daily Fuel Service Tank**

| S.No. | Capacity of DG set        | Minimum Fuel Tank Capacity |
|-------|---------------------------|----------------------------|
| (i)   | Upto 25 KVA               | 100 Litres                 |
| (ii)  | Above 25 to 62.5 KVA      | 120 Litres                 |
| (iii) | Above 62.5 KVA to 125 KVA | 225 Litres                 |
| (iv)  | Above 125 KVA to 200 KVA  | 285 Litres                 |
| (v)   | Above 200 KVA to 380 KVA  | 500 Litres                 |
| (vi)  | Above 380 KVA to 500 KVA  | 700 Litres                 |
| (vii) | Above 500 KVA to 750 KVA  | 900 Litres                 |

Dry exhaust manifold with suitable exhaust residential grade silencer to reduce the noise level.

Suitable self-starter for 12V/24V DC.

Battery charging alternator unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads and terminals.

Necessary gear driven oil pump for lubricating oil, priming of engine bearing as well as fuel systems as per manufacturer recommendations.

Naturally aspirated/ turbo charger (as per manufacturer standard) Lubrication oil cooler

Lubrication oil filters with replaceable elements

Crankcase heater as per manufacturer recommendations

Fuel injection: Engine should have suitable fuel injection system in order to achieve low fuel consumption

Fuel control solenoid

Fuel pump with engine speed adjustment

Engine Control Panel: fitted and having digital display for following:

- |                                  |                                  |
|----------------------------------|----------------------------------|
| (a) Start/stop key switch.       | (f) Battery charging indication  |
| (b) Lube oil pressure indication | (g) Low lube oil trip indication |
| (c) Water temp. indication       | (h) High water temp. indication  |
| (d) RPM indication               | (i) Overspeed indication.        |

Engine hours indications

All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch any moving part.

Radiator/ Heat Exchanger System/ Remote Radiator (delete whichever is not applicable)

Any other item not included/ specified but is a standard design of the manufacturer

#### **10.2.1.4 Governor**

Mechanical governor of class A2 for up to and including 200 KVA capacity and Electronic governor of class A1 for capacity above 200 KVA, as per ISO 3046/BS5514 with actuator shall be provided as per standard design of manufacturer. Governor shall be a self-contained unit capable of monitoring speed.

#### **10.2.1.5 Frequency Variation**

The engine speed shall be so maintained that frequency variation at constant load including no load shall remain within a band of 1% of rated frequency.

#### **10.2.1.6 Fuel System**

It shall be fed through engine driven fuel pump. A replaceable element of fuel filter shall be suitably located to permit easy servicing. The daily service tank shall be complete with necessary supports, gauges, connecting pipe work etc. In case of Top Mounted tanks, non-return valves are must in fuel supply and return line of specified value. Pipe sealant should be used for sealing for all connections. No Teflon tape to be used. If piping length is more than 10 meters, detail engineering is required in consultation with OEM/Manufacturers.

#### **10.2.1.7 Lubricating Oil System**

It shall be so designed that when the engine starts after a long shut down lubrication failure does not occur. Necessary priming pump for the lube oil circuit as per recommendation of manufacturer shall be installed, to keep bearings primed. This pump shall be normally automatically operative on AC/ DC supply available with the set.

#### **10.2.1.8 Starting System**

This shall comprise of necessary set of heavy-duty batteries 12V/ 24V DC (as per manufacturer standard), and suitable starter motors, axial type gear to match with the

toothed ring on the flywheel. A timer in the control panel to protect the starter motor from excessive voltage on cranking run shall be suitably integrated with the engine protection system and shall be included within the scope of the work. Battery capacity shall be suitable for meeting the needs of starting system (as three attempts starting), as well as the requirements of control panel, indications and auxiliaries such as priming pump as applicable etc. The scope shall cover all cabling, terminals, including initial charging etc. The system shall be capable of starting the DG set within 20-30 sec., even in winter condition with an ambient temperature down to 0°C.

#### **10.2.1.9 Battery Charger**

The battery charger shall be suitable to charge required numbers of batteries at 12V/24 volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter & voltmeter etc. Connections between the battery charger & batteries shall be provided with suitable copper leads with lugs etc.

#### **10.2.1.10 Piping Work**

All pipelines and fittings and accessories requirement inside the room/enclosure and outside for exhaust piping shall be provided by the contractor. This shall include necessary flexible pieces in the exhaust, fuel, lub. oil and water lines as are necessary in view of the vibration isolation requirement in the installation. Piping of adequate size shall be used for lub. oil of the material as per manufacturer standard. However, only M.S. pipes for the exhaust shall be used. For fuel lines within the acoustic enclosure, PVC braided pipe as per manufacturer recommendations can be used. However, for fuel lines outside the acoustic enclosure only MS pipe be used.

The pipe work shall be inclusive of all fittings and accessories required such as bends, reducers, elbows, flanges, flexible connections, necessary hardware etc. The installation shall cover clamps, supports, hangers etc. as are necessary for completing the work. However, the work shall be sectionalized with flanged connections as are necessary for easy isolation for purposes for maintenance of unit as approved by Engineer-in-charge.

#### **10.2.1.11 Common Bed Plate**

Engine and alternator shall be directly coupled or coupled by means of flex plate/flexible coupling as per manufacturer standard design and both unit shall be mounted on a common bed plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The bed plate shall be suitable for installation on suitable anti-vibration mounting system.

#### **10.2.1.12 Exhaust System: (wherever applicable)**

**10.2.1.12.1 Exhaust Piping:** All M.S. Pipes for exhaust lines shall be conforming to relevant IS. The run forming part of factory assembly on the engine flexible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work includes necessary cladding of exhaust pipe work using 50 mm thick Loosely bound resin

3

(LBR) mattress/mineral wool/Rockwool, density not less than 120 kg/m<sup>3</sup> and aluminum cladding (0.6 mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbocharger / exhaust piping. The exhaust pipe shall be \*run along the existing wall of the building duly clamped/\*supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer-in-charge.

#### 10.2.1.12.2(a) Exhaust systems should create minimum backpressure.

Number of bends should be kept minimum and smooth bends should be used to minimize backpressure.

Pipesleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.

Exhaust piping inside the Acoustic Enclosure/Generator room should be lagged with asbestos rope along with aluminum sheet cladding / insulated as per clause 2.2.1.12.1 to avoid heating to the room.

Exhaust flexible shall have its free length when it is installed. For bigger engines, 2 flexible bellows can be used.

For engines up to 500 KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.

„Schedule B“ MS pipes and long bend/elbow should be used.

The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.

When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.

When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

**10.2.1.12.3 Optimum Silencer Location:** Location of the silencer in exhaust system has very definite influence on both reduction of noise and backpressure imposed on the system. The preferred silencer locations are given in the Table below, where L is length of the total exhaust system measured from exhaust manifold in meters. Please note that locating the silencer as per optimum silencer location is not mandatory. For high rise buildings, suitable arrangements may have to be provided in consultation with an acoustic engineer.

| <i>Optimum Location of Silencer (In meters)</i> |                                                  |                                                    |
|-------------------------------------------------|--------------------------------------------------|----------------------------------------------------|
|                                                 | <i>In-line Engine</i>                            | <i>„V“ Engine</i>                                  |
| Best                                            | $2L/5$                                           | $(4L - 1.5)/5$                                     |
| Second best                                     | $4L/5$                                           | $(2L - 4.5)/5$                                     |
| Worst Location of Silencer                      | $L/5$ or $3L/5$ or at tail end of Exhaust piping | $(3L - 10)/5$ or at the tail end of Exhaust piping |

10.2.1.12.4 *Exhaust Stack Height*: In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:-

a) For DG set up to 1000 KVA:-

$$H = h + 0.2 \times \sqrt{KVA}$$

Where H = height of exhaust stack, h = height of building

b) For DG set above 1000 KVA: -

30m High or 3m above the building height, whichever is higher.

10.2.1.12.5 Care should be taken to ensure that no carbon particles emitted due to exhaust leakage enter and deposit on alternator windings and on open connections.

10.2.1.12.5 Support to Exhaust Piping: Exhaust piping should be supported in such manner that load of exhaust piping is not exerted on turbocharger.

#### 10.2.1.13 Air System

It is preferable to provide vacuum indicator with all engines to indicate choked filter. Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM/ manufacturer recommendation for the particular model of the engine. Gensets should be supplied with medium duty/ heavy duty air cleaners (specify one only). (Heavy duty air cleaner should be used for installations in dusty or polluted surroundings.)

#### 10.2.1.14 Cooling System

10.2.1.14.1 System should be designed for ambient temperature of 40 DegC.

10.2.1.14.2 Water softening/ demineralizing plant should be used, if raw water quality is not acceptable.

10.2.1.14.3 Coolant should be used mixed with additive (in suitable proportion) as per recommendation of OEM/ Manufacturer for various engine models.

10.2.1.14.4 Radiator fan flow should be free from any obstruction.

10.2.1.14.5

For radiator cooled DG Set, proper room ventilation should be planned at the time of construction of DG room.

10.2.1.14.6 Remote Radiator can be used in case of basement installation where fresh air may not be available. The proper location of remote radiator is very essential for the successful and efficient operation of remote radiator. In this the cooling media is ambient air. So, in order to obtain maximum efficiency from remote radiator, it is necessary to get fresh air in its surrounding. The horizontal distance of remote radiator from engine should not exceed 10 Meter.

10.2.1.14.7 For the dusty or polluted surroundings (as radiator gets clogged) and/ or bigger capacity Gensets (say 1000 KVA and above), installation of Cooling System with Heat Exchanger system may be used.

10.2.1.14.8 Optional items as under may be included as per site requirement at the discretion of Technical Sanctioning authority:

## Cooling

SystemRemoteR

adiator

JacketWater Heater

CrankcaseOilHeater

Aftercoolerjacketturbobochargerelectricalpreheatsystems.

## FuelSystem

Fuel Water

SeparatorAuxiliaryF

uel Pump

## ExhaustSystem

Industrial Grade

MufflerResidential Grade

MufflerCriticalGradeMuffler

SuperCriticalGradeMuffler

## Start System

Battery Warmer

PlateBatteryCharger

|                          |   |   |   |
|--------------------------|---|---|---|
| AutomaticFloatEqualizing | Å | Å | Å |
| rickle                   | Å | Å | Å |

## 10.3 ALTERNATOR

**Scope:** This section covers technical requirement of the alternator.

### 10.3.1 Synchronous Alternator

Self excited, screen protected, self regulated, brush less alternator, Horizontal foot mounted in Single/Double bearing construction (specify one only) suitable for the following:

|                                             |   |                                    |
|---------------------------------------------|---|------------------------------------|
| Rated PF.                                   | : | 0.8(lag)                           |
| Rated voltage                               | : | 415 volts                          |
| Rated frequency                             | : | 50 Hz                              |
| No. of Phases                               | : | 3                                  |
| Enclosure                                   | : | SPDP                               |
| Degree of protection                        | : | IP-23                              |
| Ventilation                                 | : | Self ventilated air-cooled         |
| Ambient Temperature                         | : | 40° C Maximum                      |
| Insulation Class                            | : | F/H                                |
| Temperature Rise                            | : | Within class F/H limits at rated   |
| load Voltage Regulation                     | : | +/-1%                              |
| Voltage variation                           | : | +/-5%                              |
| Overload duration/capacity: continuous use. | : | 10% for one hour every 12 hours of |

|                                             |                                                                                                       |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Frequency variation                         | : As defined by the Engine Governor (+/-1%)                                                           |
| Excitation                                  | : Self/ separately excited (Self excitation upto 750 KVA and separately excited system above 750 KVA) |
| Type of AVR                                 | : Electronic                                                                                          |
| Type of Bearing and lubrication arrangement | : Anti-friction bearings with Grease                                                                  |
| Standard                                    | : IS 4722 & IEC:34 as amended upto date.                                                              |

10.3.2 Alternator should be able to deliver output rating at actual site conditions.

10.3.3 The alternator above 500 KVA capacity shall be fitted with suitable Nos. Resistance Temperature Device (RTD) & Bearing Temperature Device (BTD) along with space heaters. The terminal of space heaters will be wired to terminal box and the temperature scanner shall be provided in control panel for scaling the winding and bearing temperature.

#### 10.3.4 Excitation

The alternator shall be brushless type and shall be self/separately excited, self-regulated having static excitation facility. The exciter unit be mounted on the control panel or on the alternator assembly. The rectifiers shall be suitable for operation at high ambient temperature at site.

#### 10.3.5 Automatic Voltage Regulators (AVR)

In order to maintain output terminal voltage constant within the regulation limits i.e. +/- 1%, Automatic voltage regulator unit shall be provided as per standard practice of manufacturer.

#### 10.3.6 Fault tripping

In the event of any fault e.g. over voltage/ high bearing temperature/ high winding temperature or an external fault, the AVR shall remove the excitation voltage to the alternator. An emergency trip shall also be provided.

#### 10.3.7 Standards

The alternator shall be in accordance with the following standards as are applicable.

IS:4722/ BS2613:1970. The performance of rotating electrical machine.

IS:4889/ BS269 rules for method of declaring efficiency of electrical machine.

#### 10.3.8 Performance

Voltage dip shall not exceed 20% of the rated voltage for any step load or transient load as per ISO 8528 (Part-1). The windings shall not develop hot spot exceeding safe limits due to imbalance of 20% between any two phases from no load to full load.

The generator shall preferably be capable of withstanding a current equal to 1.5 times the rated current for a period of not more than 15 seconds as required vide clause 14.1.1 of IS 4722:1992.

The performance characteristics of the alternator shall be as below: Efficiency at full load 0.8 P.F.

Upto 25 KVA – not less than 82%

Above 25 KVA and up to 62.5 KVA – not less than

86% Above 62.5 KVA & up to 250 KVA – not less than

90% Above 250 KVA – not less than 93.5%

|     |                         |                                             |
|-----|-------------------------|---------------------------------------------|
| (b) | Total distortion factor | Less than 3%                                |
| (c) | (i) 10% overload        | One hour in every 12 hrs of continuous use. |
|     | (ii) 50% overload       | 15 seconds.                                 |

### 10.3.9 Terminal Boxes

Terminal boxes shall be suitable for U.G. cables/ Bus Trunking. The terminal box shall be suitable to withstand the mechanical and thermal stresses developed due to any short circuit at the terminals.

### 10.3.10 Earth Terminals

2 Nos. earth terminals on opposite side with vibration proof connections, non-ferrous hardware etc. with galvanized plate and passivated washer of minimum size 12 mm dia. holes shall be provided.

### 10.3.11 Space Heaters

Alternators of capacity more than 500 KVA shall be provided with suitable space heater to maintain the winding temperature automatically such that it does not absorb moisture during long idle periods. The heater terminals shall be brought to a separate terminal box suitable for 230 V AC supply and a permanent caution notice shall be displayed.

## 10.4 MANUAL/AMF PANEL, BATTERIES AND ELECTRICAL SYSTEM

**Scope:** This section covers technical and functional requirements of Manual/AMF Panel, Battery/Electrical System.

### 10.4.1 Location of Panel

#### 10.4.1.1 DG Set with Acoustic Enclosure

Associated AMF panel/Manual panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer's standard. In case, AMF/Manual panel has to be installed outside the acoustic panel, location of room to house AMF/Manual panel should be decided in consultation with the Architect as near to the acoustic enclosure as possible. In case of connection through bus trunking, care should be taken for aesthetics vis-à-vis surrounding.

#### 10.4.1.2 DG Set without Acoustic Enclosure

In case of DG Set is supplied without acoustic enclosure, Manual/AMF electrical control panel should be located inside the sub-station building.

### 10.4.2 Type of Control Panel

Control panel shall be either manual type or AMF type as per the requirement of work to be decided by NIT approving authority.

#### 10.4.2.1 Manual Control Panel

The control panel shall be fabricated out of 1.6 mm sheet steel, totally enclosed, dust, damp and vermin proof wall mounted/ free standing floor mounted type with IP-53 degree of protection & front operated.

The Standard control panel shall consist the following

instruments: Composite meter for digital display of:

Voltage

Current

Power factor (for 15 KVA and  
above) Frequency (for 15 KVA &  
above) Energy Meter (for 15  
KVA & above)

HRC fuses of suitable rating.

One MCB of suitable rating for DG sets up to 45 KVA rating  
or Switch Disconnector Fuse Unit (SDFU) for higher ratings.

Push button-switch or ON/OFF Switch for ON and OFF operation

Pilot lamps one No. in case of single-phase DG sets and 3 numbers in  
case of three phase DG sets.

Battery charger complete with voltage regulator, Voltmeter and Ammeter  
for charging the battery from external mains. This will be in addition to the  
battery charging alternator or dynamo fitted on the engine.

Instrument fuses.

All the components in the control panel shall be properly mounted, duly wired  
and labeled. Suitable terminals are to be provided for panel incoming and outgoing connections.

#### 10.4.2.2 AMF Control Panel

10.4.2.2.1 *General Features*: The control panel shall be fabricated out of 1.6 mm thick sheet steel, totally enclosed, dust, damp and vermin proof free standing floor mounted type & front operated. It shall be made into sections such that as far as feasible, there is no mixing of control, power, DC & AC functions in the same section and they are sufficiently segregated except where their bunching is necessary. Hinged doors shall be provided preferably double leaf for access for routine inspection from the rear. There is no objection to have single leaf hinged door in the front, all indication lamps, instruments meter etc. shall be flushed in the front. The degree of protection required will be IP-42 conforming to IS 2147.

10.4.2.2.2 *Terminal Blocks and Wiring*: Terminal blocks of robust type and generally not less than 15 Amps capacity, 250/500 V grade for DC up to 100 V and 660/ 1100 volts grade for AC and rest of the junction shall be employed in such a manner so that they

are freely accessible for maintenance. All control and small wiring from unit to unit inside the panel shall also be done with not less than 2.5 sqmm copper conductor PVC insulated and 660/ 1100 volts grade. Suitable color coding can be adopted. Wiring system shall be neatly formed and run preferably, function wise and as far as feasible segregated voltage wise. All ends shall be identified with ferrules at the ends.

10.4.2.2.3 *Labeling*: All internal components shall be provided with suitable identification labels suitably engraved. Labels shall be fixed on buttons, indication lamps etc.

10.4.2.2.4 *Painting*: The entire panel shall be given primer coat after proper treatment and powder coating with 7 tanks process before assembly of various items.

10.4.2.2.5 *Equipment requirements*: The control cubical shall incorporate into assembly general equipment and systems as under:

Control system equipments and components such as relays, contactors, timers, etc. both for automatic operation on main failure and as well as for manual operation.

Equipment and components necessary for testing generating set's healthiness with test mode and with load on mains.

Necessary instruments and accessories such as voltmeter, power factor meter, KW meter, KWH meter, Ammeter, Frequency meter etc. in one energy analyzer unit with selector switch to obtain the reading of desired parameters.

Necessary indication lamps, fuses, terminal blocks, push buttons, control switches etc. as required.

Necessary engine/ generating set shut down devices due to faults

/abnormalities. Necessary visual audio alarm indication and annunciation facility as specified. Necessary battery charger.

Necessary excitation control and voltage regulating equipment. (Alternatively provided on the Alternator itself).

Necessary overhead bus trunking terminations all internal wiring, connections etc. as required.

Breakers as specified in the schedule of work.

10.4.2.2.6 *System Operation*:

The above-mentioned facilities provided shall afford the following operational requirements.

#### **10.4.2.6.1 Auto Mode:**

A line voltage monitor shall monitor supply voltage on each phase. When the mains supply voltage fails completely or falls below set value (variable between 80 to 95% of the normal value) on any phase, the monitor module shall initiate start-up of diesel engine. To avoid initiation due to momentary disturbance, a time delay adjustment between 0 to 5 seconds shall be incorporated in start-up initiation.

A three-attempt starting facility shall be provided 6 seconds ON, 5 seconds OFF, 6 seconds ON, 5 seconds OFF, 6 seconds ON, if at the end of the third attempt, the engine does not start, it shall be locked out of start, a master timer shall be provided for this function. Suitable adjustment timers be incorporated which will make it feasible to vary independently ON-OFF setting periods from 1-10 seconds. If alternator does not build up voltage after the first or second start as may be, further starting attempt will not be made until the starting facility is reset.

Once the alternator has built up voltage, the alternator circuit breaker shall closely connect the load to the alternator. The load is now supplied by the alternator.

When the main supply is restored and is healthy as sensed by the line voltage monitor setting, both for undervoltage and unbalance, the system shall be monitored by a suitable timer which can be set between 1 minute to 10 minutes for the load to be transferred automatically to main supply.

The diesel alternator set reverts to standby for next operation as per (a), (b) and above.

#### 10.4.2.6.2 *Manual Mode:*

In a manual mode, it shall be feasible to start-up the generator set by the operator on pressing the start push button.

Three attempt starting facility shall be operative for the start-up function.

Alternator circuit breakers close and trip operation shall also be through operator only by pressing the appropriate button on the panel and closure shall be feasible only after alternator has built up full voltage. If the load is already on „mains“, pressure on „close“ button shall be ineffective.

Engine shutdown, otherwise due to faults, shall be manual by pressing a „stop“ button.

#### 10.4.2.6.3 *Test Mode:*

When under „test“ mode pressing of „test“ button shall complete the start up sequence simulation and start the engine. The simulation will be that of mains failure. Sequence 2.4.2.2.6.1(a) and (b) shall be completed.

Engine shall build up voltage but the set shall not take load by closing of alternator circuit breaker. When the load is on the mains, monitoring of performance for voltage/frequency etc. shall be feasible without supply to load.

If during test mode, the power supply has failed, the load shall automatically get transferred to alternator.

Bringing the mode selector to auto position shall shut down the set as per sequence of 2.4.2.2.6.1(d) provided main supply is ON. If the mains supply is not available at that time, the alternator shall take load as in (c) above.

#### 10.4.2.2.7 *Engine shut down and alternator protection equipment:*

Following shut down and protection systems shall be integrated in the control panel.

##### *(a) Engine:*

Low lubricating oil pressure shut down. This shall be inoperative during startup and acceleration period.

High coolant (water) temp. shut

down. Engine over speed shut down.

*Alternator Protection:* Following protection arrangement shall be

made: Over load

Short circuit

Earth  
fault  
Overvoltage

#### 10.4.2.2.8 *Monitoring and Metering Facilities:*

- (a) Necessary energy analyzer unit for visual monitoring of mains, alternator and load voltage, current, frequency, KWH, power factor, etc.

A set of visual monitoring lamp indication

for: Load on set

Load on mains

Set on test (Alternator on operation duty, Alternator on standby duty).

Set of lamps for engine shut down for over speed, low lub. oil pressure and high coolant water temperature, overload trip of alternator, earth

fault trip of alternator, engine lockout and failure to start etc. All these indications shall have an audio and visual alarm. When operator accepts the alarm, the hooter will be silenced and the fault indication will become steady until reset by operating a reset button.

#### 10.4.2.2.9 *Operating Devices:*

A set of operation devices shall be incorporated in the front of panel as under:

Master Engine Control Switch: This shall cut off in „OFF“ position DC control to the entire panel, thus preventing start-up of engine due to any cause. However, battery charger, lamp test button for testing the healthiness of indication lamps, DC volt meter / ammeter etc. shall be operative. It shall be feasible to lock the switch in OFF position for maintenance and shutdown purposes.

Operation selector switch OFF/AUTO/MANUAL/TEST position.

Energy analyzer unit for display of various electrical parameters like voltage, current, frequency, KW, power factor, etc.

A set of push buttons as specified.

Relays, contactors, timers, circuit breakers as required.

Necessary battery charger with boost/ trickle selector, DC voltmeter and DC ammeter.

#### 10.4.2.2.10 *Compatibility with „Building Management System“ (BMS):*

PLC compatibility and required nos. of Input/ Output terminals points should be provided in the AMF control panel.

### **10.4.3 Battery/Electrical System**

10.4.3.1 Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging centre. Initial charging should be done for 72-80 hours.

10.4.3.2 Batteries should be placed on stands and relatively at cool place.

10.4.3.3 Battery capacity and copper cable sizes for various engine capacity are recommended

as indicated in the table below. Cable sizes shown are for maximum length of 2m. If

length is more, cable size should be selected in such a way that voltage drop does not exceed 2V. However, capacity as recommended by manufacturer may be taken.

| <i>DG Set Capacity</i>       | <i>Battery</i> | <i>Cable Size<br/>(Material<br/>Copper)</i> | <i>Electrical<br/>System</i> |
|------------------------------|----------------|---------------------------------------------|------------------------------|
| Above 500 KVA                | 360            | 70                                          | 24                           |
| Above 125 KVA upto 500 KVA   | 180            | 70                                          | 12                           |
| Above 82.5 KVA upto 125 KVA  | 180            | 50                                          | 12                           |
| Above 62.5 KVA upto 82.5 KVA | 150            | 50                                          | 12                           |
| Above 25 KVA upto 62.5 KVA   | 120            | 50                                          | 12                           |
| Up to 25 KVA                 | 88             | 35                                          | 12                           |

10.4.3.4 For AMF applications, a static battery charger working on main supply is recommended to keep the batteries charged at all times.

10.4.3.5 1.5 sq. mm copper wire should be used for wiring between junction box and Control Panel.

#### **10.4.4 Cabling**

10.4.4.1 Power cabling between alternator and control panel and changeover switch to mains should be done with recommended cable sizes.

10.4.3.2 Typical cable sizes for 415V application are provided in Appendix VI.

10.4.3.3 As far as possible, for DG Set of capacity 750 KVA & above connection between alternator to AMF panel & AMF Panel to Essential panel shall be through bus-trunking. For exposed/outdoor bus-trunking protection requirement should be IP-55.

10.4.3.4 If LT panel is part of tender of the DG Set jobs of 500 KVA & above, LT Panels specified, should be one of the reputed brands.

10.4.3.5 Overheating due to loose thimbling/undersize cables causes most of electrical failures, hence correct size of cable and thimbles should always be used, if cable is specified.

10.4.3.6 While terminating cables, avoid any tension on the bolts/busbars (if cable is specified). While terminating R, Y & B phase notations should be maintained in the alternator and control panel for easy maintenance.

10.4.3.7 Crimped cables should be connected to alternator and control panel through cable glands, if cable is specified.

10.4.3.8 Multi-core copper cables should be used for inter connecting the engine controls with the switchgear and other equipment.

10.4.3.9 For AMF application, multicore 1.5 sq. mm flexible stranded copper cable for control cabling should be used.

10.4.3.10 It is recommended to support output cables on separate structure on ground so that weight of cables should not fall on alternator/base rail.

10.4.3.11 External wirings, when provided for remote voltage/excitation monitoring/droop CT etc. shall be screened sheathed type. Maximum length of such wiring shall not exceed 5 meters.

#### 10.4.3.12 Alternator Termination Links

10.4.3.12.1 For proper terminations between links and switchgear terminals, the contact area must be adequate. The following situations should also be avoided as they lead to creation of heat sources at the point of termination:

Point contact arising out of improper position of links with switchgear terminals [Figure 2(i)].

Gaps between busbars / links and terminals being remedied by connecting bolt/stud [Figure 2(ii)]. In such cases the bolt will carry the load current. Normally these bolts / studs are made of MS and hence are not designed to carry currents.

10.4.3.12.2 Adequate clearance between busbars / links at terminals should be maintained (IS 4232 may be referred to for guidelines).

Figure 2(iii) indicates the quality of different configurations.

10.4.3.12.3 Improper termination will lead to local heat generation which may lead to failure.

### 10.5 FOUNDATION

**Scope:** This section covers details of foundations for DG set with or without acoustic enclosures.

#### 10.5.1 Genset with Acoustic Enclosure

For DG Sets installed inside the DG Set Room - A PCC foundation (1:2:4, M-20 grade) of approximate depth 150 mm above the finished Genset Room Floor level is required so as to provide leveled surface for placement of the acoustic enclosure. The length and breadth of foundation should be at least 250 mm more on all sides than the size of the enclosure. Genset should be mounted on AVM "s" inside the enclosure.

For DG Sets installed outside in open area - A PCC (1:2:4, M-20 grade) foundation of weight 2.5 times the operating weight of the Genset with enclosure as recommended by the Genset manufacturer OEM/OEA, whichever is higher, is required to be provided and is included in scope of work for SITC of Genset. 300 mm of this foundation height should be above the ground level. The length and breadth of foundation should be at least 250 mm more on all sides than the size of enclosure. Genset should be mounted on AVM "s" inside the enclosure.

Design of the foundation as recommended by the OEM shall be submitted by the contractor before execution of work along with the drawings as mentioned in section 1.19.

### 10.5.2 Genset without Acoustic Enclosure

**10.5.2.1** Gensets should not be installed on loose sand or clay.

**10.5.2.2** Foundation should be designed considering safe bearing capacity of soil. Vibration isolators (AVMs) should be provided to reduce vibration transmission to the surrounding structure.

**10.5.2.3** Depths of PCC (Plain Cement Concrete) for typical soil condition have been shown in the table below. However, structural engineers should be consulted to verify the data depending upon soil condition.

| <i>DG Set Capacity (KVA)</i> | <i>Typical Depth of PCC Foundation (For soil bearing capacity 5000 kg/sqm)</i> |
|------------------------------|--------------------------------------------------------------------------------|
| 750-2000                     | 600 mm                                                                         |
| 625                          | 400 mm                                                                         |
| 320-500                      | 400 mm                                                                         |
| 200-320                      | 400 mm                                                                         |
| 82.5-200                     | 400 mm                                                                         |
| Up to 82.5                   | 200 mm                                                                         |

**10.5.2.4** Foundation level should be checked diagonally as well as across the length for even flatness. The foundations should be within  $\pm 0.5^\circ$  (angle) of any horizontal plane.

## 10.6 ACOUSTIC ENCLOSURE

**Scope:** This section covers technical requirements of the acoustic enclosures.

**10.6.1** As per CPCB norms, restriction has been imposed for new DG sets up to 1000 KVA for noise level (see Appendix „II“). Therefore, in terms of these norms, acoustic enclosure should be type tested at the climatic conditions specified in para 9.1.4 through one of the authorized laboratories.

### 10.6.2 Installation

**10.6.2.1** Acoustic enclosures are supplied with built-in Anti Vibration Mountings (AVMs). As such, Genset can be installed directly on the leveled surface.

**10.6.2.2** Exhaust piping outlet should not be turned towards window / ventilator of home or occupied building. Provision of rain cap should be ensured.

**10.6.2.3** The acoustic enclosure placement should be such that there is no restriction in front of air inlet and outlet from canopy.

### 10.6.3 Service Accessibility

**10.6.3.1** Genset / Engine control panel should be visible from outside the enclosure.

**10.6.3.2** Routine / periodical check on engine / alternator (filter replacement and tappet setting etc.) should be possible without dismantling acoustic enclosure.

**10.6.3.3** For major repairs / overhaul, it may be required to dismantle the acoustic enclosure.

10.6.3.4 Sufficient spaces should be available around the Genset for inspection and service.

#### **10.6.4 General Design Guidelines**

10.6.4.1 To avoid re-circulation of hot air, durable sealing between radiator and canopy is must.

10.6.4.2 Ventilation fans are must for the Gensets cooled by heat-exchanger/cooling towers system.

10.6.4.3 Exhaust piping inside the enclosure must be lagged (except bellow).

10.6.4.4 Temperature rise inside the enclosure should not be more than 5°C for maximum ambient above 40°C and it should be below 10°C for ambient below 40°C.

10.6.4.5 There should be provision for oil, coolant drain and fill. Fuel tank should have provision for cleaning.

10.6.4.6 The enclosure should be designed to meet the total air requirement for the D.G. Set at full load at site conditions as recommended by the engine manufacturer.

#### **10.6.5 Specifications for Acoustic Enclosure**

10.6.5.1 The acoustic enclosure shall be designed and manufactured conforming to relevant standards suitable for outdoor installation exposed to weather conditions, and to limit overall noise level to 75 dB (A) at a distance of 1 mtr. from the enclosure as per CPCB norms under free field conditions.

10.6.5.2 The construction should be such that it prevents entry of rain water splashing into the enclosure and allows free & quick flow of rain water to the ground in the event of heavy rain. The detailed construction shall conform to the details as under:

10.6.5.3 The enclosure shall be fabricated out of the CRC A sheet of thickness not less than 1.6 mm on the outside cover with inside cover having not less than 0.6 mm thick perforated powder coated CRC A sheet.

10.6.5.4 The hinged doors shall be made from not less than 16 SWG (1.6 mm) thick CRC A sheet and will be made airtight with neoprene rubber gasket and heavy-duty locks.

10.6.5.5 All sheet metal parts should be processed through 7-tank process.

10.6.5.6 The enclosure should be powder coated.

10.6.5.7 The enclosure should accommodate the daily service fuel tank of the D.G. Set to make the system compact. There should be provision of fuel gauge, which should show the level of the fuel even when the DG Set is not running. The gauge should be calibrated. The fuel tank should be filled from the outside as in automobiles and should be with a lockable cap.

10.6.5.8 The batteries should be accommodated in the enclosure in battery rack.

10.6.5.9 The canopy should be provided with high enclosure temperature safety device.

10.6.5.10 The acoustic lining should be made up of high-quality insulation material i.e. rock wool/ glass/ mineral wool/ PU foam of appropriate thickness & density for sound absorption as per standard design of manufacturers to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber

cloth and would be supported by perforated M. S. Sheet duly powder coated / GI sheet/aluminum sheet.

- 10.6.5.11 The enclosure shall be provided with suitable size & No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose. Sufficient space will be provided inside the enclosure on all sides of the D.G. set for inspection, easy maintenance & repairs.
- 10.6.5.12 The canopy should be as compact as possible with good aesthetic look.
- 10.6.5.13 The complete enclosure shall be of modular construction.
- 10.6.5.14 The forced ventilation shall be as per manufacturer design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G. sets.
- 10.6.5.15 The acoustic enclosure should be suitable for cable connection/connection through bus-trunking. Such arrangements on acoustic enclosure should be water proof & dust-proof conforming to IP-65 protection.
- 10.6.5.16 The inside of enclosure should be provided with at least two nos. 28W-T5 fluorescent tube light luminaire controlled by a 5A switch for adequate lighting during servicing etc. of the DG Set. The power supply to this luminaire should be from the load side of the AMF Panel so that it can remain energized under all condition

## CHAPTER 11

### STREET LIGHT POLES, OUTDOOR TYPE FEEDER PILLAR BOX ETC.

#### 11.1 Street Light Poles:

Poles used for area lighting should be of size 410 SP-17 of IS: 2713. The length of the pole shall be 8.5 meters of which the bottom 5.0 meters shall be of 114.3 mm dia., next 1.75 meters 88.9 mm dia and the rest 1.75 m 76.1 mm dia. Poles shall be fabricated from ERW pipe swaged and welded at joints with an overlap of 250 mm and 250 mm for the lower and upper joints respectively. The minimum wall thickness at the bottom, middle and upper section shall be 4.5 mm, 4.05 mm and 3.25 mm respectively. The poles shall have a combined cap-cum-arm bracket of 40 NB steel pipe of 1.0-meter length for direct entry into the luminaries. The bracket shall be at an angle of 30° to the horizontal. Also, shall be provided with rigid C.I. pole base suiting the bottom section of the poles with fixing bolts and holes for grounding into foundations. Planting depth of the pole is 1.25 M. A hole of diameter 25 mm shall be provided on the pole at a height of 2.0 meter from bottom for cable entry. All poles shall be painted inside and outside by bituminous anti-corrosive paint. Each pole shall have a 200 mm x 300 mm x 100 mm deep duly painted weather proof sheet steel junction box rigidly clamped to the pole. The sheet steel thickness shall be minimum 2 mm. Each junction box shall have a 15 Amp rewire able fuse cutout and a heavy duty 4-way 15 Amp terminal.

The poles shall have a 800 mm x 800 mm square x 1500 mm deep PCC foundation below ground level and 450 mm x 450 mm square x 750 mm high PCC base above ground level. The face of the junction box with its hinged cover shall remain open within the base. The base of the pole shall be finished with cement plaster and the entire pole finished with two coats of aluminum paint of good quality.

The pole shall be erected properly with cement concrete foundation as per Specifications. Necessary curing of the concrete shall be done as per relevant procedures. 2 nos. 32 mm dia PVC conduit pipe with gland and bends shall be provided in the foundation for cables entry into terminal box. Electrical connection between the terminal box and the light fixtures shall be made by means of 2.5 mm single core PVC insulated copper cable of 1100 V grade.

#### 11.2 Outdoor type Feeder Pillar Box (for Campus lighting/Buildings services)

Outdoor type Feeder Pillar Box of 3 Ph 4 Wire, along with TPN Switch fuse unit with HRC fuses is required to distribute both single phase and three phase power supply to different consuming points / Campus lighting poles or fittings. It should be made of 12 SWG, CRCA sheet steel and interior of the box should be accessible from both front and back side with 2 leaf doors. The bottom plate of the pillar box shall have suitable opening for entry of cables and MS flat of adequate section is to be provided inside the box along with the width for clamping of cables. The feeder pillar box shall be mounted on plinths of suitable size and height not less than local flood level. The plinth shall be built on a cement concrete base of 20 mm thick cast in situ at a depth of 150 mm from ground level and necessary G.I. pipe shall be provided in the plinth for cable entry. Suitable arrangements shall also be made for satisfactory fixing of the pillar box by foundation bolts. A suitable insulating board such as Bakelite shall be provided as separator.

### 11.3 Street Lighting Fixtures

The fixtures shall be suitable for LED/ fluorescent / mercury / vapor / sodium vapor / metalhalide lamp as specified and shall be made of cast / sheet aluminum epoxy enameled housing, anodized aluminum reflector and non-yellowing type acrylic cover.

The fixture shall be totally enclosed type suitable for outdoor installation having enclosure equivalent to IP43 as per IS 2147.

The fixture shall have light distribution same as that of semi-cut off type as specified.

The fixture shall be provided with side entry for the supporting pipe. The cable shall be taken inside through the supporting pipe of 25 mm dia.

The clamping arrangement for the supporting pipe shall be designed to suit the weight of the fixture and wind load for mounting height up to 16 M as specified in the relevant Indian Standard Specification. The clamping arrangement shall provide wide range flexibility in the use of supporting pipe by the purchaser.

Unless otherwise specified, fixture for use with mercury/sodium vapor lamp shall be provided with arrangement of adjusting the position of lamp holder to have a cut off or semi-cut off light distribution.

## LIST OF STANDARDS

The following list records those standards which are acceptable as „good practice“ and „accepted standards“ in the fulfillment of the requirements of the Code. The latest version of a standard shall be adopted at the time of the enforcement of the Code. The standards listed may be used by the Authority as a guide in conformance with the requirements of the referred clauses in the Code.

In the following list, the number appearing in the first column parentheses indicates the number of the reference in this part/section.

- IS: 8270 (Part 1)-1976 Guide for preparation of diagrams, charts and tables for electrotechnology: Part I Definitions and classification-
- IS: 2032 Graphical symbols used in electrotechnology:
- IS: 2032 (Part II)-1962: Part II Kind of current distribution system and method of connection
- IS: 2032 (Part III)-1962: Part III Circuits and variability
- IS: 2032 (Part IV)-1964: Part IV Rotating machines and transformers
- IS: 2032 (Part V)-1965: Part V Generating stations and substations
- IS: 2032 (Part VI)-1965: Part VI Motor Starters.
- IS: 2032 (Part VII)-1974: Part VII Switchgear and auxiliaries (first revision)
- IS: 2032 (Part VIII)-1965: Part VIII Semiconductor devices
- IS: 7752 (Part I)-1975 Guide for improvement of power factor in consumers' installations: Part I Low and medium supply voltage
- IS: 5216-1969 Guide for safety procedures and practices in electrical work
- IS: 10118 (Part II)-1982 Code of practice for selection, installation and maintenance of switchgear and control gear: Part II Selection
- IS: 1646-1982 Code of practice for fire safety of buildings (general): Electrical installations (first revision)
- IS: 1255-1967 Code of practice for installation and maintenance of paper insulated power cables (upto and including 33 KV) (first revision)
- IS: 2148-1968 Specification for flame proof enclosures of electrical apparatus (first revision)
- IS: 375-1963 Specification for marking and arrangement for switchgear bus-bars main connections and auxiliary wiring (revised)
- IS: 1777-1978 Specification for industrial lighting fittings with metal reflectors (first revision)
- IS: 1947-1980 Specification for floor lights (first revision)
- IS: 2206 Specification for flame-proof electric lighting fittings: IS: 2206 (Part I)-1962: Part I Well-glass and bulk head type
- IS: 2206 (Part II)-1976: Part II Fittings using glass tubes
- IS: 3287-1965 Specification for industrial lighting fittings with plastic reflectors
- IS: 3528-1966 Specification for water-proof electrical lighting fittings
- IS: 3553-1966 Specification for water-tight electric lighting fittings
- IS: 4012-1967 Specification for dust-proof electric lighting fittings
- IS: 4013-1967 Specification for dust-tight electric lighting fittings
- IS: 5077-1969 Specification for decorative lighting outfits
- IS: 3106-1966 Code of practice for selection, installation and maintenance of fuses (voltage not exceeding 650 volts)
- IS: 3961 Recommended current ratings for cables:
- IS: 3961 (Part I)-1967: Part I Paper-insulated lead-sheathed cable
- IS: 3961 (Part II)-1961: Part II PVC-insulated and PVC-sheathed heavy-duty cables
- IS: 3961 (Part III)-1968: Part III Rubber insulated cable
- IS: 3961 (Part IV)-1968: Part IV Polyethylene insulated cable
- IS: 3961 (Part V)-1968: Part V PVC-insulated light duty cables

IS: 2086-1963 Specification for carries and bases using in rewirable type electric fuses up to 650volts(revised)

IS: 9224 (Part II)-1979 Low voltage fuses: Part II Supplementary requirements for fuse withhighbreakingcapacityforindustrialapplication

IS:2672-1966Codeof practiceforlighting

IS: 732 (Part II)-1983 Code of practice for electrical wiring installations: Part II Design andconstruction(second revision)

IS:7733-1975CodeofpracticeforelectricalwiringinstallationsinhospitalsIS:4648-1968 Guideforelectricalayoutinresidentialbuildings

IS:900-1965Codeof practiceforinstallationandmaintenanceofinductionmotors(revised) IS:3072-1975Codeofpracticeforinstallationandmaintenanceofswitchgear(firstrevision)IS:1653-1972Specificationforrigidsteelconduitsforelectrical wiring(secondrevision)

IS: 2509-1973 Specification for rigid non-metallic conduits for electrical installations (firstrevision)

IS:2412-1974Specificationforlinkclipsforelectricalwiring(firstrevision)

IS: 3419-1976 Specification for fittings for rigid non-metallic conduits (first revision)IS:9537 Conduitfor electricalinstallations:

IS: 9537 (Part I)-1980: Part I General requirementsIS:9537(PartII)-1981: PartIIRigidsteel conduits.

IS: 2667-1976 Specification for fittings for rigid steel conduits for electrical wiring (firstrevision)

IS:5133(PartII)-1969Boxesforenclosuresofelectricalaccessories: PartIIBoxesmadeofinsulatedmaterials

IS:1913(Part I)-1978General andsafetyrequirementsforluminaries:PartITubularfluorescentlamps (secondrevision)

IS:1258-1979Specificationforbayonetlampholders(secondrevision)

IS:418-1978Specificationfortungstenfilamentgeneralserviceelectricclamps(thirdrevision)IS:1534(Part I)-1977 Specificationforballastsforfluorescent lamps: Part I Forswitchstart circuits(secondrevision)

IS: 1569-1963 Specification for capacitors for electric discharge lamps (fluorescent andmercuryvapour)

IS: 2183-1973 Schedule for high pressure mercury vapor lamps (first revision)IS: 2215-1968 Specification for starters for fluorescent lamps (second revision)IS:2418Specificationfortubularfluorescentlampsforgenerallightingservice:IS:2418 (PartI)-1977: PartIRequirementsandtests(firstrevision)

IS: 2418 (Part II)-1977: Part II Standard lamp data sheets (first revision)IS:2418 (PartIII)-1977:Part IIIDimensions DimensionsofG-5andG-13bi-pincaps(first revision)

IS: 2418 (Part IV)-1977: Part IV Go and no go gauges for G-5 and G-13 bipin caps (firstrevision)

IS: 3323-1980 Specification for bi-pin lamp holders and tubular fluorescent lamps (firstrevision)

IS: 3324-1965 Specification for holders and starters for tubular fluorescent lampsIS: 374-1979 Specification for electric ceiling type fans and regulators (third revision)IS:3043-1966 Code ofpractice for earthing

IS: 8623 (Part I)-1977 Factory-built assemblies of switchgear and control gear for voltage uptoandincluding1000V ACand 1200VDC: PartIGeneralrequirements

IS: 10028 (Part II)-1981 Code of practice for selection, installation and maintenance oftransformers: PartIIInstallation

IS: 2309-1969 Code of practice for the protection of buildings and allied structures againstlighting(firstrevision).

## TECHNICAL SPECIFICATIONS FOR PASSENGER LIFT

## SCOPE OF WORK

- ☐ heworkcoveredbythecontractshallincludethesupply,installation,testing&commissioning of  
Standard gearless lift with stainless steel hairline finish, 1.0 metre persecond speed lift  
(Gearless machine above the hoist way in Machine room at the top), asdetailedin theenclosed  
specificationand ScheduleofItems anddrawings.

The tenderer shall assume full responsibility for the details of design, equipment selection, erection and commissioning of the lifts. The installation shall comply with all the safety codes and local rules.

Excluded from the scope of work of the Lift Contractor

The following items of work are excluded from the scope of work of the Lift Contractors.

RClearfinished hoistwayasshown inthedrawing.

RMachineRoomincludingfloor slab,andtheliftpit.

### ℛLightingandventilation oftheMachineRoom.

⌘ Electric Power supply with MCCB/MCBs/ELCB and 2 nos. earth connections in eachmachineroom.

℞Architravesforlift entrances.

℞ Hoisting hooks/beams in machine room

ceiling. Included within the Scope of Work of the Lift

Contractor

All other works pertaining to the lift installation including supplying fixing and painting of machine supporting beams, bearing plates, buffer support channels, hoist way steel door frames with supporting channels/angles at each landing, fascia plates, landing sills, metal counterweight guards, guides and brackets, pit ladder and other steel items and all foundations, pedestals and soles etc. required to make the installation complete and acceptable to the Lift Authority shall be within the scope of works of the lift contractor and the cost of the same shall be included in the tender price. Scaffolding for the lift erection and posts for supporting the door and cutting of walls, floors, ceilings, steel reinforcements or partitions together with any repairs made necessary including grouting of all bolts, sills, steel members, indicator and button boxes etc. in position, and making good the damages including wiring and providing light points and socket outlet points in the hoistway at alternative floors and lift pit to satisfy the lift rules and local regulations shall be the responsibility of the lift contractor.

## RULES&REGULATIONS

The complete installation covered by the specifications shall conform to the current edition of American Standard Safety Code for Elevators by the American Society of Mechanical Engineers, B.S. Code of Practice for Electric Lifts, I.S. 1860-1968 or latest Local Lift Rules & Act as amended

up to date. All electrical installation shall comply with in all respect with the requirements of IndianElectricityAct1910,IndianElectricityRules1956andalsowiththeprovisionofI.S.732-1963code of Practice for electrical wiring installation. All codes referred to herein mean the latest inforce.It is the soleresponsibilityoftheliftsuptliertoobtainthe necessaryprovisionalandfinal



approval and licenses for regular use of the lift from the authority required for the installation.

## **POWER SUPPLY**

Necessary construction power supply including electric wiring required till the completion of erection of the equipment shall have to be arranged for by the contractor at his own cost. However, the Employer may assist the contractor in obtaining such connection. The temporary wiring carried out for this temporary supply will be in conformity with the requirements of the local electric supply Authority undertakings. The necessary connection charges for temporary supply as well as consumption charges if provided/ arranged by employer will have to be borne by the tenderer.

### **Permanent Electric Supply to the lift Machine Room**

The Employer will arrange to provide electric supply for the lift in the lift machine room when the lift installation will be ready. The electric supply will be terminated to a Breaker of adequate capacity with earthing in the lift machine room. The Employer will also provide one 32A TPN SFU for permanent supply to the fan & light of the lift car including light for lift well located in a group. Any wiring onward from this unit shall have to be carried out by the tenderer at his cost with necessary isolation device at the appropriate points. Any earthing required for the equipment shall also have to be provided by the tenderer at his cost from the earthing terminals provided by the Employer in the lift machine room.

Adequate nos. of light points and power outlet points with necessary local control switches shall be provided for the lift well(s) and pit(s) and car by the lift contractor including making necessary wirings and earthing from the SFU unit provided by the Employer in the lift machine room.

## **ABBREVIATION**

Wherever the following abbreviations occur they shall be interpreted to read as follows:

|                         |                                                                                                             |
|-------------------------|-------------------------------------------------------------------------------------------------------------|
| B.S.S                   | British Standard Specification.                                                                             |
| I.S.S                   | Indian Standard Specification.                                                                              |
| I.E.E.<br>of regulation | Regulation for the Electrical Equipment of Building issued by the Institution Electrical Engineers, London. |
| I.E. Rules              | Indian Electricity Rules in force at the time of installation.                                              |
| A.C                     | Alternating Current                                                                                         |
| K.W                     | Kilo Watts                                                                                                  |
| B.H.P.                  | Brake Horse Power                                                                                           |
| M.P.S.                  | Meter Per Second                                                                                            |
| F.P.M.                  | Foot Per                                                                                                    |
| Minute KG               | Kilogram                                                                                                    |
| Lbs.                    | Pounds                                                                                                      |

## **AMBIENT TEMPERATURE AND HUMIDITY CONDITION**

All lifts with associated equipment shall be suitable for continuous use in an ambient temperature of 45 degrees centigrade and relative humidity of 100%, both not occurring simultaneously.

## **CONTRACT DRAWINGS**

The successful tenderer shall be required to submit within 30 days from the date of receipt of the letter of intent the following drawings for the approval of the Architects/Owner.

General layout arrangement drawing in plan and elevation.

Plan, Cross sectional elevation and end view of the machinery wherever applicable including their weight, and various force reactions acting on the floors, walls foundations.

Drawing showing details of locations of fixtures for guides in the lift

shaft. Foundation drawing of all plants including weight of the foundation.

Schematic control Circuit Drawings.

On completion of the work, a complete set "As Built" of drawing in triplicate shall be handed over to the Owner/Employer for their record. Schematic wiring diagrams are also to be handed over to the Owner/Employer in triplicate at the time of handing over. Further a copy of the detailed wiring diagram shall be framed and installed in the machinery room by the contractor.

## **TECHNICAL PARTICULARS**

Tenderer shall furnish Technical particulars of the equipment offered in the proforma as attached so as to enable a critical technical analysis of their tender offer.

## **COMPLETION TESTS**

### **Load Test**

A contract load test under the supervision of the local authorities and in presence of the Employer's representative shall be carried out in accordance with guidance of the IS specification and local lift regulations before the lift is put into commission. During the test the brakes, limit switches, buffers and car safety devices shall be caused to function with the contract load in the lift. The lift shall be tested for accuracy of levels at all loads in either direction and for smooth vibration less travel. The lift shall be accepted upon satisfactory completion of the contract load test and after the same are certified by the appropriate local authorities/Lift Inspector and Employer representative.

### **Other Completion Tests**

Insulation resistance tests to earth of the entire electrical equipment and wiring installation are to be carried out by means of a constant pressure 500 volts testing megger set and the test result shall not be less than 1 megohm.

Result of continuity test of the conduit installation and any other metal work to earth shall not be more than one ohm.

The temperature of motors and associated control equipment shall be checked after a continuous run of at least one-hour duration to ensure that temperature rises are within the limit. Test for speed shall be carried out and the speed shall not vary more than 10% of the specified speed under any condition of load either ascending or descending.

## FEES&LICENSES

The Lift Contractor shall submit requisite application forms with necessary fees to the State LiftInspector/Authority for permission to erect and for operation after getting the requisite forms (to befurnished by him) duly filled in and signed by the Owner. He will also liaison with the lift inspectorand arrange for the provisional approval, inspection and issue of the license by the Lift Inspector forregularuseofthelifts.

The lift supplier will bring all his tools and tackles, testing apparatus at the time of inspection of Government Inspector/ Authority and he will be solely responsible for getting the lift installation approved/ passed by the lift inspector/ Authority.

Statutory fees paid by the Supplier will be reimbursed by the Owner/Employer on submission of money receipts in the name of the Owner/Employer.

## MAINTENANCE

The contractor shall undertake inspection and maintenance of the equipment installed under this contract for a period of 1 year from the date of acceptance of the complete installation. The maintenance during the above period shall be free of cost to the Employer and shall cover weekly inspection of the equipment, carrying on necessary adjustment, oiling, and greasing and replacement of parts, if necessary and attending to the breakdown calls immediately.

## GUARANTEE

The lift installation shall be guaranteed for a period of 1 year from the date of handing over against defective materials and workmanship. During the guarantee period the contractor shall rectify, repair or replace defective parts and components free of cost to the Employer.

## TRAINING OF OWNER'S PERSONNEL

The contractor shall associate with him during the erection and maintenance period, the maintenancestaff of the Employer to familiarize them with the operation and maintenance of the machineryequipment.

## SPECIFICATION FOR LIFT

**Machinery:** Shall be worm gearless traction type located directly above lift well for the passenger lift. This shall be complete with Permanent Magnet Synchronous Motor, electromagnetic brake, shaft, sheaves, all mounted on a single bed plate. The worm and worm wheels speed reducing gear shall be mounted in an oil tight casing with the worm under slung. The worm shaft shall be machined from a high tensile steel forging and the rim of worm wheel be cast from special bronze mixture. The worm wheel rim and the rope sheaves shall be bolted to the same steel spider to eliminate keys. The worm shall be connected to the driving motor through solid couplings. Motor shall be specially designed for lift service with high starting torque, low starting current and low noise level. The machine will be provided with dust proof bearing having large bearing surface and equipped with suitable means for lubrication.

## Ropes and Sheaves

□  $\bar{A} \square \bar{A} \square$   
 $\bar{A} \square$ istingropesshallbemulti-strand steel Size andnumber  
ofropesshallbeto

ensure a factor of safety of not less than 12 as per Lift Rules 1958. Compensating device for the weight of the main rope shall be provided, if required.

Each rope shall be free from joints and length shall be such that at least one turn remains on winding drum with the car or counter weight at the end of its travel and clearance. Means shall be provided to equalize the load on individual suspension ropes, the contractor shall furnish certificate of ropes from the rope manufacturer issued by competent authority.

Deflector and overhead sheave shall be of 30 ton ferromolybdenum casting or steel, with grease lubricated bearing supported on structural steel beams, sheave shall be provided with grooves to maintain constant traction and positioned as to obtain proper loading of car and counter weight ropes.

If two to one roping is employed to ensure safety a guard shall be provided on the top of the car as per I.S. 1860-1968.

**Brake:** Brake to be of electrically released spring applied type and should be designed to ensure positive cushioned stop under variable load. Dynamic slow down to be used and the brake to be applied when lift was nearly stopped thereby assuring smooth stop and longevity of the brake lining. The brake shall have Ferrodo Lining.

It shall be possible to release the brake manually so as to move the lift car in short stops. For this purpose suitable brake release equipment shall be supplied/to be provided on the lift controller.

**Automatic Rescue Device:** This will enable to move the lift car to the nearest lower landing in case of lift stoppage in between landings due to any reason. The electronic controller along with necessary dry maintenance free batteries with battery charger shall be installed in the Lift Machine Room which will continuously monitor the normal power supply into the main lift controller and activate the rescue operation within a few seconds of a power failure. It will bring the lift car to the nearest lower floor and open the doors automatically. Thereafter, the lift car shall remain parked there until normal power supply resumes.

**Guides & Fastening:** Heavy duty steel tee guides as per IS 4666-1968 shall be provided for car and counter weight, the guide surface being machined and polished. These shall be continuous through the entire length of lift well and shall withstand without any deformation the action of safety gear with a fully loaded car. The ends of the guides shall be tongued and grooved to provide smooth joints and connected with steel joint plates. The guide rails shall be securely fastened to Brackets or supported by approved heavy rail clamps. Guide brackets or supports shall be bolted or welded to the steel inserts provided in the hoistway.

Guide rail lubricators shall be provided in the car. The lubricators shall be able to evenly distribute the oil over the guide rails at adjustable feed rates.

#### **Lift Car:**

**Size:** To be quoted by the tenderer, according to the specified capacity and to be accommodated in the available lift well (approximate size has been mentioned in lift detail).

**Car Frames :** The car frame shall be made of structural steel of rigid for passenger lift construction to withstand without permanent deformation the operation of safety gear. Car shall be so mounted on the frame that minimum of vibration and noise are transmitted to the passengers inside.

**Car Platform:** The car platform shall be of framed construction and shall be mounted on rubber isolating pads supported on the car frame. The flooring of the passenger car shall be provided with 3 mm thick PVC tile over M.S plate (not less than 5 mm thick) and are to be supplied & fixed by the manufacturer.

**Car Body:** The lift car enclosure shall have side front and ceiling of stainless steel hairline finish for 8 passenger lift. The enclosure including the door shall withstand deformation against a thrust of 35 kg applied normally at any point as per I.S. 4666-1968. Ventilation openings shall also be as per above I.S.

**Car Roof:** The roof shall be constructed to withstand the weight of 2 men. Access trap of ample dimension shall be provided in the roof of the car to provide for emergency exit.

**Car Fixtures:** Besides car operation panel and signals as specified elsewhere the following shall be provided:

300 mm (12") sweep low noise ceiling fan, recess mounted in ceiling, with grills.

Direct/Indirect Fluorescent light.

Battery operated automatic emergency light with rechargeable Dry maintenance free battery (2 hours capacity) and battery charger.

One slave unit for intercom.

**Car Operation Panel:** Flush type car operation panel having the following fixtures, shall be provided in the car as specified elsewhere.

Car Call Button corresponding to landing

call. Auto/Attendant Key switch.

Alarm Bell switch for battery operated alarm bell situated in ground floor. Door open and close button.

Non-Stop Button.

Up and down button

Emergency stop button.

Independent switch for independent control of car.

)

ON/OFF switch for fan control.

**vii) Car and Hoistway Entrance, Door Operation and Interlocks:** Both the car and hoistway entrances should be provided with centre opening automatic power operated hairline finish stainless steel doors for passenger lifts. All the Lift doors having minimum entrance opening 800 mm wide x 2000 mm high for lifts to be provided with retractable Infrared movement sensing devices with high speed door operator, sheave type top point shangers

and tracks. Suitable posts for supporting the doors for entrance are to be provided by contractor. Clear opening as mentioned shall be offered by the contractor.

Door operation shall be positive acting and powered by AC motor rigidly connected to door. Operation shall simultaneously open the car and hoist way door and maintain the door fully opened or closed at each floor stop. Door operator shall be suitable for attendant/automatic operation and shall be provided with hydraulic cushion for smooth stop.

Retractable safety shoes are to be provided on each side. Each safety shoe will extend to the full height/length of the door and project beyond the front edge of the car door. When the car door is in its open position, the safety shoe will retreat thus assuring a substantially clear opening.

Should there be a movement of a person or object while the door is closing, the car and hoist way doors will return to the open position. The doors will remain open until the expiration of pre-determined interval and then close automatically.

Reversal of the doors may also be accomplished by pressing the door "open" button in the car operating panel.

The following interlocks for the door shall be provided -

Car shall not move until the hoist way door is mechanically locked in the closed position.

Hoist way door cannot be opened from the landing side unless the car is on that particular floor.

Car shall not move while the car door is open.

## **Signal Etc.**

### **For Passenger Lift**

Digital car position indicator in car enclosure having mirrored polished stainless steel facia for Passenger lifts and having easy to read digital position indicator and illuminated up and down arrows.

Hall Button with tell-tale lights at each landing with stainless steel facia for Passenger lift.

Digital Car Position Indicator in all floors having stainless steel facia for Passenger lift and easy to read digital position indicator.

**Fireman's Switch:** Fireman switch with glass to break for access shall be provided in lift lobby at ground floor as per requirement for firefighting. 1 No. for passenger lift.

**Battery Operated Alarm Bell:** Situated at a convenient location in the Fire Control Room (40 M approx. away from Lift lobby) in ground floor with associated cabling & accessories. One safety switch shall be provided in the each lift pit for operating the alarm bell from lift pit by the maintenance personnel during emergency.

**Intercom System:** One master at Ground floor (40 M away from Lift Lobby) at ground floor and the other in the Lift Machine Room with one slave in car and all associated cabling and accessories.

Additional 2 pairs of cables (2 pair 0.61 mm twin twisted telephone cable) shall be provided for each lift and shall be terminated to a suitable terminal box in the Ground floor for connecting the same with the building Public Address System and EPABX extension.

**Leveling:** The lift shall be incorporated with suitable floor leveling devices. Leveling accuracy  $\pm 9.0\text{mm}$  shall be achieved.

**Counter Weight:** Counter weight shall consist of cast iron weights housed in a rigid structural Steel frame work for passenger lift. Counter weight shall be equal to the weight of the car and 40% of the contract load or any other percent to promote smooth and economical operation.

**Lift Pit:** A metal counter weight guard to the required height shall be provided at the bottom of the hoist way in the lift pit. The top of the screen shall be not less than 2800 mm high from the bottom of the lift pit as per requirement of IS.

In lift pit, a ladder, a light point with switch and a 5A switch socket outlet shall be provided for each lift shaft.

**Spring Buffers:** For car and counter weight shall be fixed in the pit. These shall have a long stroke and be so designed that they will stop the car and counter weight from governor tripping speed at an average rate of retardation not exceeding gravity.

Blocking and supports if found necessary for the buffers shall be supplied by the lift contractor.

**Governor & Safety Devices :** A mechanical safety device for stopping the lift in the event of slackening or fracture of any rope or failure of electricity and protecting the car from falling or exceeding admissible speed as per relevant Clause of B.S. 2655 and I.S. 4666-1968 actuated by a speed governor shall be mounted under the car platform and securely bolted to the frame.

The governor shall be located in the lift machine room and driven by governor rope suitably connected to the car and mounted on its own pulleys. The governor rope shall not be less than 8 mm dia. and shall be of steel in accordance with IS: 4666-1968 and IS: 2365-1963.

The operation of Governor on over speed shall open a switch disconnecting the power from the lift and shall trip the safety mechanism which shall instantaneously engage the guide with sufficient force to stop the car from governor tripping speed, with full load in the car and bring the car to a smooth stop with an average rate of retardation within the limits in the code of practice for various loads.

The governor shall be accurately adjusted to operate at tripping speed specified in the code of practice and sealed. The Governor jaws shall grip the rope in minimum time after the governor reaches tripping speed. The governor rope gripping devices shall be so designed that no appreciable damage or deformation to the rope results from the stopping action of the device. The pressure of the two jaws on the guide shall be equalized.

Governor tripping speed shall be within 100% to 125% of rated speed. Safety gears of the following types shall be used (a) Gradual Wedge Clamp type (b) Flexible guide Clamp type. The maximum stopping distances of lift cars with the contract load in the lift car and the minimum stopping distance with the attendant only in the lift car shall be as follows:

|                        | <u>Maximum</u> | <u>Minimum</u> |
|------------------------|----------------|----------------|
| GradualWedgeClamptype  | 2.13mtrs       | 0.46mtrs       |
| FlexibleGuideClamptype | 0.53mtrs       | 0.15mtrs       |

**Reverse Phase Relay:** Shall be provided on the controller to protect the lift equipment against phasereversal, lowvoltage and phasefailure.

**Terminal Limit Switches and Ultimate Terminal Switches:** Terminal switches shall stop the car automatically at terminal floors within the top and bottom permissible over travel. They shall act independently of the operating devices, the ultimate limit switches and the buffers. They shall be in accordance with clause 23 of IS 4666-1968.

Ultimate terminal switches shall be provided in accordance with the statutory requirements and standing practices. When provided these shall arrange to stop the car automatically within top and bottom clearances independently of the normal terminal switches but with the buffers operative, by disconnecting the motor from the supply and bring the brakes into operation in case of overrun.

In the event of these switches operating due to over travel it shall be possible to operate lift only after manually resetting the back-up limit switches, for the purpose, which shall be installed in an accessible location for easy manual resetting.

**Controller:** Controller for the machine shall be designed to give the required operation as specified and shall be securely mounted on substantial self-supporting steel frame designed for floor mounting.

To prevent access of lizards, vermin etc. the controller shall preferably be enclosed and hinged doors shall be provided.

The switches handling power circuit shall be equipped with contacts designed to prevent sticking due to fusing. The acceleration and speed control of lift shall be controlled by adjustable time relays.

All wiring shall be neatly, numbered, grouped and cleared. All leads except for control indicator circuits shall be provided with soldered lugs or suitable clamps and washers. Control & Indicator wires shall be brought to accessible clamps and washers or soldered terminals or studs. The wiring on the back of the panel shall be of the flame resisting type.

The controller shall automatically limit the current to that required for the specified requirements and shall prevent the electrical equipment from overload or excess current.

The controller shall be arranged to cut off the power apply the brake and bring the car to rest upon failure of power or operation of any electrical safety devices. Tropical insulation shall be provided throughout.

The Control Panel shall be equipped with three (3) spare set of volt free NO/NC changeover contacts for BMS interfacing for passenger lift only.

**Auxiliary Switches :** For use of maintenance personnel, the following switches shall be provided on top of lift car-

Emergency stop switch.

Maintenance switch - The controlling circuit shall be so arranged that in the event of the operation of this switch the car speed shall be within 0.85 mtrs/sec and car movements shall be possible only on application of continuous pressure on a button. It shall be positioned to prevent inadvertent operation.

**Trailing Cables:** All multi core trailing cables employed for the car shall satisfy the requirements of IS 4287-1967. Trailing cables for lighting, fan and signal circuits shall be separate. Length shall be adequate to prevent any strain due to movement of the car.

**Lighting for Hoist way/Lift Well:** Suitable lights points shall be provided in the lift well. One socket outlet shall be provided in the lift well for use of maintenance personnel at a level slightly above the ground floor landing. All the points shall be group controlled from lift machine room. Wires shall be carried out in surface conduit, by the lift contractor.

**Wiring:** Except for the travelling cables, all wirings shall be carried out with PVC insulated „FR“, copper wires, drawn into steel conduit. PVC wire shall be 1100 volts

grade.

Conduit shall be heavy gauge welded and shall comply with I.S. specification. 16 SWG conduits shall be run on the surface and all accessories used shall be of the inspection type with screwed ends. Travelling cables shall be Tough Rubber sheathed and shall comply with IS specification. They shall originate in the half way boxes in the lift well and shall terminate at the car distribution box. They shall be so hung that the correct size of loop is obtained.

All the above wirings shall be carried out by the lift contractor.

**Earthing:** The Owner/Employer shall provide in the lift machine room one earth bar consisting of galvanized iron flat 25mm x 6mm. The Employer will also provide two earth leads from the extremities of the earth bar to the Earthing system on Earth stations in the ground floor.

The lift contractor shall 'Earth' each item of apparatus and plants supplied by him by means of two separate and distinct earth wires, each not less than half of the largest current carrying conductor subject to a minimum no. 8 SWG hard drawn bare copper wire. The earth wires shall be bolted to the earth bus, through sweating sockets. All contact faces and sweating sockets shall be tinned.

**Operation:** Automatic Group supervisory control for Passenger Lifts where more than one lift is there with Full collective/selective operation with and without attendant control with self-leveling device. The isolated single lift shall simplex with full collective/selective control.

**Variable Voltage Variable Frequency Speed Control Equipment with two way self leveling device :**

|                                                             |                                          |
|-------------------------------------------------------------|------------------------------------------|
| Variable Voltage Motor Directly coupled with gear equipment | box (for 1.0 MPS speed)/gear             |
| with variable voltage variable                              | less drive, Microprocessor based control |
| frequency with micro leveling.                              |                                          |

For Variable Voltage Variable frequency:

Each lift will include one static convertor (Silicon Controlled Rectifier) controlling set of compact design. The unit will be of self supported and self ventilated type and the rotating element will have a single continuous steel shaft. The Static

Convertor (Silicon controlled rectifier) unit will be of high efficiency and low power consumption and will have sufficient capacity to handle the drive mechanism without overheating the peak load elevator service.

Protective device with HRC fuses and over load relays is to be supplied to protect the driving motor and the static convertor against overloads short circuit, Proper Phase Sequence (R/Y/B), phase failure etc. Necessary HRC control fuses shall be provided for control circuit protection. The elevator motor and the static convertor (Silicon Controlled Rectifier) unit shall be protected against overload and short circuit.

The static convertor and the controllers shall be provided with suitable voltage regulator to take care of the voltage fluctuations occurring in the system from 360 to 450V, A.C.

## **ERECTION AND COMMISSIONING**

Erection of equipment shall be carried out in a workmanlike manner without causing any hindrance to the work of the other contractors.

All rotating equipments shall be mounted on suitable rubber/spring isolation mounts to minimize transmission of noise and vibrations.

Entire installation shall conform to the requirements of the local Lift Inspector/ is the sole responsibility of Lift Supplier to obtain approval for necessary license for operation of the lift. Authority and the layout and equipment and

Work Programmed for Supply, Installation, Testing & Commissioning of Passenger Lift.

- 16.1 The intending tenderer on acceptance of tender, has to submit necessary work programmed giving following details:

Date of Submission of Drawings for Approval. Date of delivery of Lift materials at site.

Date of submission of Form-A, obtaining provisional approval of drawings from the Lift Inspector.

Date of commencement of work at site.

Date of Civil works and allied works for erection of lifts by Contractor. Date of Installation of lifts.

Date of submission of Form-B, Inspection and final approval of the lift for regular use of lifts. (viii) Date of commissioning and handing over of lifts.

## **Technical Data**

The intending Tenderer has to furnish following technical data along with tender documents:

17.1

Manufacturer 17.2

Capacity in

kgs 17.3 Speed: MP

S

17.4TractionMotor

□

type

$\bar{A}$  □

$\bar{A}$  □

$\bar{A}$

- Rating and Basic  
(H.P.)Voltage(V)  
Speed  
(RPM)InsulationClass  
Maximum Starting Torque  
(kg.m)Maximum Starting Torque (% of  
F.L.T.)StartingCurrent  
Full LoadCurrent
- 17.5 Ropes/Belts
  - Number and  
SizeRoping  
RatioFactorof  
Safety  
MaterialSpecification
- 17.6 GuideRail Sizeandweightper metre
- 17.7 ForcesonGuideRail(onApplicationof SafetyDevice)
- 17.8 Car
  - Construction  
DetailsFloor Finish  
CarEnclosureFinish  
ThicknessofStainlesssteelsheet ofCar  
EnclosureIlluminationandVentilation  
DeadWeightofCar(kg)  
ClearOpeningfor CarEntrance
- 17.9Buffer
  - Type  
Nos  
Reactionofeach(kg)
- 17.10 CounterWeight
  - MaterialWei  
ghtinkg
- 17.11 Sheaves–MaterialSpecification
- 17.12 Car &Hoist wayDoor–Construction
- 17.13 GovernorTrip(%rated speed)
- 17.14 Controller–TypeofEnclosure
- 17.15 MotorGeneratorSet  
(VariableSpeedD.C.)–Ifrequired
  - Type (Common shaft or  
coupled)Input (Kw)  
Output  
(Kw)Speed(R  
PM)  
Motor Insulation  
ClassGenerator Insulation  
ClassRatingBasis

TempRiseover45DegreeAmbient

Noiselevel(DB)  
Reaction of foundation  
(kg)MotorstartingCurrent  
MotorCurrentwhentractractionmotorstarts

- 17.16 Auto Rescue Device batteries & battery  
chargerType  
No. and capacityofeach Battery
- 17.17 IsthemachinerymountedonacommonMSbaseFrame
- 17.18 Details of EmergencyPowerSupplyProvided
- 17.19 ProvidedAuxiliaryswitchesforMaintenancePersonnel asperspecificationinyouroffer.

## **SPECIAL CONDITIONS FOR LIFT INSTALLATION**

### **General Requirement**

The lift installations shall generally be carried out in conformity with the requirements of the Indian Electricity Act, 1910 as amended up to date, Lift & Escalator Act, 1955, Lift Rules, 1958 and the Indian Electricity Rules, 1956 framed thereunder, the relevant regulations of the Electric Supply Authority concerned, and also with the specifications laid down in the Indian Standards I.S. 1860-1061 Code of practice for Electric Lift and I.S. 732-1963 Code of Practice (revised) for Electrical Wiring Installations (System voltage not exceeding 650 volts). The wirings shall also be according to the specifications of Local Authority and as per N.E.C.

Electrical Installation for lift installation work shall be carried out only by Contractor/Contractors holding valid contractors' license issued by the concerned State Government as applicable to the voltage grade and nature of electrical installation work in accordance with Rule 45 of Indian Electricity Rules, 1956 with its latest amendments. The work shall also be carried out under the direct supervision of a person holding a certificate of competency and by a person holding permit issued or recognized by the concerned State Government.

### **Materials**

All materials, fittings, appliances, used in electrical installations, shall conform to Indian Standard Specifications wherever these exist. Materials to be used shall be got approved by Owner/Architects/Engineer-in-Charge prior to actual use.

### **Eligibility, License, Supervision**

Only Contractor having valid contractors' license, issued by the concerned State Government, for doing the category of work as per tender shall be eligible for award of contract. A xerox copy of such license shall be enclosed with the contract offer.

All work shall be carried out under direct supervision of Licensed Electrical Supervisor and Tradesman, certified by Electrical Authority for the requisite part.

The Contractor shall ensure that all the above statutory licenses are renewed before they lapse, during tenure of this work.

Owners shall have the right to call for verification of all licenses as and when felt necessary by them or their authorized representative.

The licensed supervisor shall be available at site at all reasonable hours to receive instruction from the Owner/Architects/Engineer.

### **Wires & Cables**

All wires and cables to be used in electrical wiring shall have ISI marking on it. If the suppliers indicate that ISI marking on wires/cables is not possible because of manufacturing process, the cables/wires shall be accepted with the submission of test certificate and copy of license issued by B.I.S.

### **Conduits**

PVC conduits to be used in wiring shall conform to relevant IS in all respects and shall be FR-ISI marked.

### **Testing, Test Certificate**

6.1 The contractor shall have to submit G.A and Schematic Control/Circuit drawing(s) in triplicate and have these approved by the Owner/Architects before undertaking the work.

6.2 The Contractor shall have to furnish manufacturer's test certificate, type test certificate if asked by the Architect for particular material/materials brought at site for incorporation in work.

6.3 The Contractor shall have to carry out insulation tests, conductivity tests, and any other tests required as per specification and furnish test certificates to the same in quadruplicate.

6.4 The contractor will have to submit manufacturer's test certificate/ISI certificate for conduits, cables, copper wires, etc. if required by Owner/Architects.

#### Installation, Testing & Commissioning, Electrical Inspection etc.

7.1 The Owner will apply for provisional and final clearance of this installation. However, all necessary forms required by Inspecting Authority are to be collected/arranged and to be properly filled up by the Contractor and submitted to Authority after due endorsement by the Owner along with necessary fees, if required. Owner will reimburse the statutory fees paid by the Contractor on his behalf of Owner, on production of the official money receipt of the Inspecting Authority/Authority.

7.2 The Contractor has to take all initiative/responsibility towards provisional and final approval of the lift installation and permission for regular use of the lifts and get the installation passed by the Lift Inspector/Local Authority in all respects including any variations, alterations, and modifications after inspection of Inspector/Authority, if any for permanent and use of the lift. All the above are in the Contractor's scope of work.

7.3 The Contractor shall submit to the Lift Inspector/Authority, the necessary Test Forms, G.A, Elevation and Control Schematic Drawings. Single Line Diagram, etc. as required, for approval and regular use of lifts without delay.

#### Handing Over/Taking over

The assets will be taken over from the contractor within about one month after the issue of License by the Lift Inspector and after rectification of all defects pointed out by the Lift Inspector and Owner/Architect. The contractor shall be responsible for the installation and its maintenance in all its aspect and respects until the installation is taken over by the Owner or his authorized representative. In case the handing over/taking over is delayed, extra financial implications for providing security etc. by the contractor shall be considered separately on the merit of the case.

#### Drawing

The successful tenderer shall be required to submit within 30 days from the Letter of Intent/Work Order the following drawings for approval of the Architect/Owner:-

General Layout Arrangement drawing in plan and elevation.

Plan, Cross-sectional Elevation and End View of the installation with details of machinery including their weight and various focus relations activity on the floors, walls, foundations. Drawings showing details of location of fixtures for guide in the lift shaft.

Foundation Drawing of all plants including weight of the foundation.

On completion of work, the contractor shall submit "As Built" copies of all the above drawings alongwith one set of reproducible transparency in triplicate for each lift along with their final bill. Thecontractor shall have to submit the operation and maintenance check list/maintenance manual intriplicate for each lift along with the final bill. One set of the "As Built" drawings are to properlyframedand displayed in theMachineroomforeachlift.

## **SPECIAL CONDITION AND TECHNICAL SPECIFICATION FOR CENTRAL A.C. SYSTEM**

### **SPECIAL CONDITIONS**

#### **1.01.00 GENERAL:**

- 1.01.01 The Special Conditions are intended to amplify the General Condition of Contract and shall be read in conjunction with the same. Wherever conflicting, the more stringent shall apply. Wherever the General Condition of Contract is not included in the tender, the Special Conditions will be applicable to the HVAC Contract/Work Order.

#### **1.02.0 SCOPE OF WORK:**

- 1.02.01 The scope of work to be carried out is illustrated in this technical specification, and all other conditions included by the department in the Tender document. The contractor shall carry out and complete the said work under this contract in every respect in conformity with contract document and with the direction of and to the satisfaction of the department. The contractor shall furnish all labour, material and equipment as required for completion of the work and specified otherwise, transportation, all tools, tackles, scaffolding and staging and all other incidentals necessary for supply, installation, testing, commissioning of the Refrigeration system as described in the specification and as per design & drawing to be approved by the department.

#### **1.03.00 SITE VISIT:**

- 1.03.01 Before tendering the Bidders must visit site and fully satisfy himself with the site condition, building/structural details or any other information, he may require. No extra charge made in consequence of any misunderstanding or incorrect information on any of these points or on ground of insufficient description shall be allowed.

#### **1.04.00 CO-ORDINATION OF SPACE & WORK:**

- 1.04.01 The contractor before preparing the working drawings shall examine the site and all the architectural, structural, electrical, plumbing and false ceiling drawings & prepare shop drawings based on co-ordination of spaces shown on them.
- 1.04.02 The contractor shall co-ordinate his work with other agencies working at site so as not to cause interference with the progress of other's work and he will co-operate with other agencies for smooth and speedy progress of work and timely completion of project.

#### **1.05.00 WORKING DRAWINGS, DIAGRAM & SCHEDULES:**

- 1.05.01 The contractor shall prepare all necessary working drawings, diagrams and schedules as may be required.
- 1.05.02 All drawings shall be fully comprehensive and shall coordinate the manufacturers' data in respect of individual items of equipment to present as a whole the complete information for the interconnection of groups or group of such items.
- 1.05.03 All Drawings, Diagrams and Schedules called for in this clause shall be submitted to the department for approval. Before commencing the work, the Contractor shall obtain approval in writing from the department and subsequently supply up to five copies of each drawing for distribution.

- 1.05.04 Approval by the department of the Drawing shall not relieve the contractor of any part of his obligation to meet all requirements of the contract or of the correctness of his drawings. The contractor shall be responsible for and pay for all alterations of the work due to discrepancies or omission in the drawings or other particulars supplied by him, whether such drawings has been approved by the department or not.

**1.06.00 RECORD DRAWINGS AND O & M MANUAL:**

- 1.06.01 The contractor shall submit "as installed" record drawings of the whole work and two draft copies of O & M Manual.
- 1.06.02 Final taking over of the plant will be considered only after receipt of the full sets of O & M Manual and "as installed" record drawings.

**1.07.00 SETTING OUT THE WORK:**

- 1.07.01 The position of the points and equipment as indicated in the tender drawings may require slight variation to suit site conditions. The exact positions of the points and equipment must be checked and shown on detailed working drawings for submission for approval to the Engineer before the installation is commenced.
- 1.07.02 Should any points or equipment shown on the drawings be omitted from schedules or vice versa, the contractor shall assume that these points are to be installed. Any discrepancies of this nature shall be immediately brought to the notice of the Engineer at the time of tender.

**1.08.00 SAMPLES & LITERATURE:**

- 1.08.01 Samples manufacturers' drawings, catalogues, pamphlets and other documents will be submitted by the contractor in duplicate. Before taking up the work the samples of material, samples of fabricated duct pieces or samples installation of false ceiling or any other work of similar kind will have to be approved by the department. All samples shall be supplied free of cost.
- 1.08.02 Tenderers' offers shall include manufacturers' printed literature for all the main items. The literature must include the performance chart.

**1.09.00 GUARANTEES:**

- 1.09.01 The Contractor shall guarantee that all equipment and entire installation shall be free from any defects due to defective material and bad workmanship and that the equipment shall operate satisfactorily and that the performance and the efficiency of the equipment and the system shall not be less than the guaranteed values. The guarantee shall be valid for a period of twelve months from the date of taking over or of the installation and any part/component found defective shall be replaced free of all costs by the contractor. The services of the contractors' personnel if requisitioned during this period for such work shall be made available free of any cost to the department.

**2.01.00 TESTING:**

- 2.01.01 All routine tests and experiments which may be necessary to determine that the equipment, material and workmanship to be used comply with the specification and one of adequate capacity for its full rate of duty, shall be informed at the place of manufacture or fabrication or on the site or at all or any independent testing organization and test certificate furnished at contractor's

expense. The representative of the department and the Engineer shall be at liberty to be present and to participate in the tests.

2.01.02 The contractor shall provide free of cost such assistance, instruments, machines, labour, supervision and material as are normally required for examining, measuring and testing any works and the quality, weight or performance of any equipment/material used. The contractor shall also provide oil and other consumables required for the test without any additional cost.

2.01.03 All samples shall be supplied by the contractor at his own cost.

2.01.04 The entire cost of any test shall be borne by the contractor.

2.01.05 If the tests fail to demonstrate satisfactory nature of the installation or part thereof, then the contractor shall at his own expense carry out such alteration or replacement as are required to the department's complete satisfaction. The department shall be at liberty to call for further test when such alteration has been made.

#### **2.02.00 COMPLETION PERIOD:**

2.02.01 The entire works will be completed within 36 months from the date of receipt of the formal work order.

#### **2.03.00 CLEANING OF WORKSITES:**

2.03.01 The contractor shall properly clean the work as it progresses and shall promptly remove all rubbish and debris from the site from time to time as is necessary and as directed.

#### **2.04.00 CLEARING OF THE SITE ON COMPLETION:**

2.04.01 Two weeks after the completion of work the site must be cleared up and should be handed over in ship-shape condition to the satisfaction of Architect/Engineer. Up to this date, the contractor is liable for all accidents, damages and thefts which might occur on the site. Work destroyed or damaged before it was finally taken over by the department either through act or negligence of the contractor or his workmen, servants, agents, sub-contractors will be rebuilt by the contractor at his own expense.

#### **2.05.00 SAFETY CODE:**

2.05.01 The Contractor at his own cost arrange for the safety provision stipulated by the Government or local authorities in respect of all labour directly or indirectly employed for the performance of the works and shall provide all facilities in connection therewith.

2.05.02 The Contractor shall take adequate precautions against fire and make adequate fire fighting arrangement as stipulated by Government or Local authorities and shall be responsible for fire consequences.

#### **2.06.00 SECURITY AT SITE:**

2.06.01 Safety and security of all plant, machineries, tools and tackles and material at site shall be sole responsibility of the contractor. The contractor shall take all necessary precautions to prevent wastage, damage or theft or loss whatsoever to the plant, machineries, tools and tackles, material etc.

2.06.02 The Contractor shall also protect the department's property from injury arising in connection with his contract and shall indemnify the department against any possible damage to the building, roads or member of the public in course of the execution of the work.

#### **2.07.00 STORAGE FACILITY:**

- 2.07.01 Plant Room/AHU Room/Packaged Unit Room, if ready can be used for storage of equipment/material brought to site by the contractors. Watch and ward of the same will be contractors' responsibility.

**2.08.00 SCHEDULE OF WORK:**

- 2.08.01 Before finalization of the contract, the successful Bidders shall submit a Completion schedule in the form of a bar chart. The progress and the completion of work shall be in accordance with the bar chart and will form a part of the contract.

**2.09.00 SUBCONTRACTORS:**

- 2.09.01 The total responsibility of the work including implementation of the specification shall be owned by the contractor.

**2.10.00 EXCLUSIONS & VARIATIONS:**

- 2.10.01 Any comment on technical or commercial conditions or any exclusions shall be made clause-wise and no comment on any clause of this tender shall be deemed to be accepted by the bidder.
- 2.10.02 Any printed condition and any condition contrary to the conditions stipulated in this tender, in the offers submitted by the bidder, shall be excluded from the contract.

**2.11.00 INSURANCE:**

- 2.11.01 All equipment and material supplied by the contractor shall be covered by a comprehensive Insurance policy against all risks during transit, storage, erection at site, testing, commissioning, trial run till the HVAC plant is taken over by the department. The contractor shall assume liability for accident to their own and their sub-contractor's workmen during the period of erection, testing, commissioning and trial run of the HVAC plant.
- 2.11.02 The comprehensive all risk insurance policy shall also cover the risk of injury or death to persons other than those engaged / employed by the contractor or damage to material or property including damage to building and on account of execution of work.

**2.12.00 MEASUREMENT:**

- 2.12.01 All measurements shall be as per the relevant latest I.S. Code or as described in this specification.

**2.13.00 INDIAN STANDARD:**

- 2.13.01 A reference made to any Indian Standard specification in this document, shall imply reference to latest revision to that standard, including such revision/ amendments as may be issued by the ISI during the currency of the Contract.

## **DETAILS OF WORK**

### **1.01.00 SCOPE OF WORK:**

1.01.01 The Contractors' scope of work covers design, manufacture, supply, installation, testing and commissioning of a centralized chilled/hot water type A.C. system for air conditioning different areas.

### **1.02.00 THE A.C. SPACE:**

1.02.01 The area to be air conditioned inside the building.

### **1.03.00 SCHEDULE OF REQUIREMENT:**

1.03.01 The requirements of the A.C. System are given in the specification, Scope of Work and the tender drawings are required to be worked out by the Contractor, while designing the HVAC system.

### **1.04.00 DESIGN CRITERIA:**

#### **1.04.01 Ambient Design Conditions:**

The Ambient Design Conditions may be taken as under-

|        |   |                                         |
|--------|---|-----------------------------------------|
| Summer | - | 26.67° C (80°F) DB & 23.33° C (74°F) WB |
| Winter | - | 04.44° C (40°F) DB & 03.89° C (39°F) WB |

#### **1.04.02 Indoor Design Conditions-**

|        |   |                                                |
|--------|---|------------------------------------------------|
| Summer | - | 22.22° ± 1° C (72 ° ± 2° F) DB & RH around 55% |
|        | - | 21.00° ± 1° C (70 ° ± 2° F) DB & RH around 55% |

#### **1.04.03 Internal Loads-**

The internal loads taken into consideration in the Heat Load Estimate are to be specified.

#### **1.04.04 Ventilation-**

The ventilation rate in respective areas will be as per the recommendation/ASHRAE and shall be specified.

#### **1.04.05 Roof Insulation-**

The exposed roof of all the A. C. areas shall be provided with under-deck insulation using 50 mm thick fire-retarding quality EP of specified density to avoid condensation during peak winter.

#### 1.04.06 Electric Supply–

The electrical equipments shall be suitable for operation on  $400 \pm 10\%$  volts, 3-phase, 4-wire, 50Hz, A.C. supply. The FCUs shall be suitable for operation on  $230 \pm 10\%$  volts, 1-phase, 50Hz A.C. supply.

#### 1.04.07 Water Supply:

Required quantity of clean, soft and filtered water will be available at site for make-up purpose in the chilled water circulation system.

### 1.05.00 COOLING LOAD:

1.05.01 Estimated cooling and heating loads for respective areas/zones are to be indicated by the tenderer in the form of Annexures.

### 1.06.00 PROPOSED A.C. SYSTEM:

- 1.06.01 Air conditioned with circulation of chilled water/hot water to be produced in a centralized chilled/hot water plant which will be located in a “Chiller Yard”.
- 1.06.02 There will be two or three water chilling units each of about 50% capacity or 33.33% capacity. Each water chilling Unit shall be with two or three “Rotary Screw type Compressors” and “Air cooled type Condenser”.
- 1.06.03 The air-cooled Water Chilling Units shall be designed to work as “Heat Pump” during winter operation to produce Hot water that will be circulated through the heat transfer coils inside AHUs & FCUs for heating respective Zones / departments.
- 1.06.04 The “Chiller Yard” will have one pump room for housing all the chilled water/hot water circulating Pumps.
- 1.06.05 Respective Air Handling Units (including the fresh air treatment AHU for supplying treated fresh air to the Delux & VIP cabins) shall be provided with Pan-humidifiers for adding moisture to the conditioned space during winter for maintaining specified RH.
- 1.06.06 Respective AHUs shall also be provided with electric strip heaters of required capacities for keeping RH within limit during monsoon operation. The reheating system shall be complete with Tubular, mineral filled, finned air heating element; two/three stage humidistats, necessary contactors, safety air stats and other items/controls as per requirement.
- 1.06.07 There will be three Primary chilled/hot water circulation pumps (2 Nos. Duty + 1 No. as 50% stand-by).
- 1.06.08 There will be two secondary chilled/hot water circulation pumps (1 No. Duty + 1 No. as 100% stand-by). Each pump shall be provided with variable frequency drive to regulate their speed to match the requirement of flow. There will be one logic controller complete with remote sensor/transmitter for the duty & stand-by pump.
- 1.06.09 The secondary chilled water circulation pumps, driving motors, programmable variable speed logic controller, adjustable frequency drive and remote sensor/transmitter etc. shall be procured

from one source only.

Before finalization of the contract, the performance curve of the pump at different speeds (i.e. from 20 % to 100% in steps of 10%) shall be furnished.

- 1.06.10 Respective AHU rooms shall be provided with pivot / shutter type fire dampers on the supply and return air passage and shall be fixed/ supported on the masonry walls. The fire dampers shall have minimum 90 minutes fire holding capacity and the contractors shall furnish necessary test certificate to that effect. Micro switch shall be provided to switch off the blower motor with the actuation of the Fire Damper. All control cabling interlocking the micro-switch with the blower-motor shall be within the scope of the contractor.
- 1.06.11 Additional points shall be provided in the starters of AHU fan-motors to interlock the same with the fire/smoke detectors in the respective zones.
- 1.06.12 The supply air ducts up to at least 6.50 mtrs. from canvas connection (at the outlet of respective AHUs) shall be provided with acoustics lining using 10mm thick "arm sound super silencer" from Armacell or of equivalent product. Mode of fixing and the adhesive shall be as per the recommendation of the manufacturer
- 1.06.13 Microvee filters having filtering capacity down to five microns with 99.9 % efficiency shall be provided at the outlet of the AHUs.
- 1.06.14 Grills and diffusers shall be of extruded aluminum section finished with powder coating. The colour shall be approved by the department before ordering. The grills/diffusers shall be of approved make only.
- 1.06.15 Respective AHUs shall be provided with 2-Way dynamic temperature control valves with actuator, linkage, proportionate thermostat completes with all other accessories as required. HVAC contractor shall carry out all control cabling to the modulating valves. The control valves shall be provided with facility for field adjustment to set maximum flow rate through the coil. The proportionate thermostat shall be of reputed make.
- 1.06.16 Respective FCUs shall be provided with ON/OFF 2-way valve with self balancing stainless-steel cartridge. The valve shall be complete with snap acting thermostat of reputed make.
- 1.06.17 The on/off operation of the respective AHUs and the chilled water circulation pumps shall be from BMS at a later date and as such necessary provision shall be incorporated in the respective starter/switchgear for making these connections. Necessary points shall also be provided in the starter/switchgears for indicating on/off/trip status of respective AHUs and pumps in the BMS. The HVAC contractor shall include these costs in their rates.
- 1.06.18 The tentative routing of the chilled water piping between equipment in the A. C. Plant Room and respective AHUs shall be indicated by the tenderer.
- 1.06.19 Piping drawings near respective equipment shall include all the accessories as specified in the drawings and in the technical specifications

- 1.06.20 Additional provision shall be provided in the piping near AHUs and pumps and also inside AHUs for fixing necessary sensing elements/transducers for future connection to BMS or PC to indicate the following  
Temperature and pressure at coil-in and coil-out. Temperature of air at the canvas, return air and filter. Pressure at the inlet and outlet of the pumps.
- 1.06.21 The minimum supply air quantity to any area shall be @ 1.5 cfm per sq.ft. The designed dehumidified air quantity shall be passing through the coil and the balance air quantity shall be by-passed
- 1.06.22 The bidders shall indicate the cost of interfaces which may be required for connecting the water chilling units to PC including the cost of software.
- 1.06.23 A portion of the Basement area used for car parking shall be provided with positive ventilation using axial flow type exhaust fans, installed along the eastern wall.
- 1.07.00 CODES & STANDARDS:**
- 1.07.01 The equipment, material and the work covered by this specification, unless otherwise specified, shall conform to the latest edition of the standards and codes including all addenda.

## **TECHNICAL SPECIFICATIONS OF CENTRAL A.C. PLANT WITH CHILLED WATER SYSTEM**

### **WATER CHILLING UNITS (WITH SCREW TYPE COMPRESSOR –**

#### **AIR COOLED): 2.00.00 SCOPE:**

2.00.01 The scope of this section comprises supply, installation, testing and commissioning of water chilling/Heat Pump units with screw type compressors conforming to these specifications and in accordance with the requirement of the "Schedule of Quantities".

2.00.02 The water chilling/Heat Pump packages shall comprise of single/multiple screw type hermetic /open type compressors, air - cooled condenser, shell and tube DX/flooded type cooler, driving motor, driving assembly, motor starter, Refrigerant piping, Refrigerant, oil, mounting frame, microprocessor controls, gauges etc. The Chiller unit shall be completely factory assembled, charged and tested with full operating refrigerant HFC -134a and oil charged.

#### **2.01.00 COMPRESSOR:**

2.01.01 The Rotary Screw compressor shall be open/hermetic type complete with discharge shut-off valve, suction service valve, suction and discharge check valves, suction filter, internal muffler etc.  
The part load capacity control shall be with hydraulically actuated slide valve system. The compressors shall be equipped with integral oil separation system; oil sump and filter. Oil heaters shall be provided to maintain oil temperature during shut-down.

2.01.02 The vibrations shall not exceed 15 microns and the noise level shall be less than 85 DB.

2.01.03 The capacity reduction shall be down to 10% of the full load output.

2.01.04 The compressor motor shall be suitable for operation on 415V  $\pm$  10% volts, 3-Phase, 4-wire, 50 $\pm$ 3 Hz. A.C. supply.

2.01.05 The compressor shall be equipped with unloaded starting device.

2.01.06 The compressor shall be suitable for operation with HFC-134a refrigerant and shall give specified output against 130° F saturated condensing temperature and 35° F saturated suction temperature.

#### **2.02.00 AIR-COOLED CONDENSER:**

2.02.01 The condenser coils shall be constructed with internally enhanced seamless copper tubes arranged in a staggered row pattern and mechanically expanded in to rippled aluminium fins with full fin collars. The fins shall have full drawn collars to completely cover the copper tube for protection against atmospheric corrosion and provide excellent heat transfer. An integral subcooler circuit for sufficient subcooling shall be provided for effective elimination of liquid flashing and increase unit efficiency.

2.02.02 Multiple direct drive propeller fans shall be provided to operate in formed bell-shaped orifices at low tip speeds for maximum static efficiency and minimum noise and vibration. Each fan shall be protected by a heavy gauge closed meshed fan guard and shall be positioned within the unit cabinet for maximum protection.

2.02.03 Each condenser fan shall be driven by a heavy-duty, 3-phase motor with permanently lubricated ball bearings and inherent overload protection from short circuiting.

### **2.03.00 EVAPORATOR:**

- 2.03.01 Evaporator shall be cleanable shell and tube type with seamless copper tubes mechanically expanded into heavy steel tube sheets.
- 2.03.02 Evaporator may be DX/flooded type. The flooded evaporator shall be with integrally finned copper tube. Removable type water heads shall be provided for tube cleaning. vents and drain plugs are to be provided in each head.
- 2.03.03 Flooded evaporator shall be provided with oil recovery system.
- 2.03.04 In case of multiple compressor units the evaporator will have independent refrigerant circuit for respective compressors.
- 2.03.05 Water chilling unit shall be equipped with flash economizer cycle and modulating refrigerant expansion devices. DX coolers shall be provided with Electronic Expansion Valves.
- 2.03.06 Evaporator shall be insulated with minimum 25mm thick closed-cell polyurethane.
- 2.03.07 Heat transfer area shall be designed for a fouling factor of  $0.0005 \text{ ft}^2 \cdot \text{hr} \cdot ^\circ\text{F} / \text{BTU}$
- 2.03.08 Evaporator shall be tested to a test pressure of 200 psig on shell side and 300 psig on tube side. Necessary test certificate shall be submitted. The design and fabrication of evaporator shall conform to ASME code for unfired pressure vessel.

### **2.04.00 MOUNTING FRAME:**

- 2.04.01 The compressor, driving motor, condenser and evaporator, the control panel and other accessories shall be mounted on a frame of heavy structural steel to make it a compact water chilling package. All equipments shall be rigidly bolted / fixed to the mounting frame.
- 2.04.02 Mounting frames shall be with polyester-powder paint finish electrostatically applied and oven baked before assembly.
- 2.04.03 The water chilling unit shall be placed on spring mounting to be located at the loading points.

### **2.05.00 REFRIGERANT PIPING:**

- 2.05.01 Refrigerant piping shall be with refrigerant grade seamless copper pipes.
- 2.05.02 Each refrigerant circuit shall include one compressor, oil separator, replaceable core filter drier, combined moisture indicator and sight glass, discharge and liquid shut-off valves, expansion valve, refrigerant economizer etc.

### **2.06.00 REFRIGERANT, OIL & OIL & ANOTHER CONSUMABLE:**

- 2.06.01 Water chilling unit shall be complete with required quantity of Refrigerant HFC-134a, lubricating oil, and other consumables during commissioning, testing and trial run till the plant is handed over in satisfactory working condition.

### **2.07.00 CONTROL BOX, POWER & CONTROL WIRING:**

- 2.07.01 The control Box shall be fabricated with minimum 2 mm thick sheet steel with polyester paint finish both inside and outside. The box shall be provided with hinged access door and the

control box shall include 3-Phase power supply terminal with individual circuit breakers on multiple

compressor units, control circuit transformer complete with power and control wiring, fuses for control circuit and other features and accessories as required.

- 2.07.02 The water chilling unit shall be factory wired so that only field electrical connection to the unit shall be to a single point 3-phase power terminal.

**2.08.00 CHILLER PERFORMANCE TESTS:**

- 2.08.01 The performance testing shall be in accordance with ARI standard 550/590-98 and necessary test certificates shall be furnished.

## FAN COIL

### UNITS 3.01.00 SCOPE:

3.01.01 Scope of this section comprises the supply, erection, testing and commissioning of Horizontal Fan-Coil units conforming to this specification and in accordance with the requirement of the Schedule of Quantities.

### 3.02.00 TYPE:

3.02.01 The fan-coil units shall be furred-in type comprising cabinet, cooling coil, fan, fan-deck, drain-pipe, fan-motor, air-vent, duct collar etc. The fan-coil unit shall be suspended from the ceiling and shall be concealed above the false ceiling.

### 3.03.00 CAPACITY:

3.03.01 The minimum capacity of the fan-coil units shall be 1.0 TR, 1.5 TR and 2.0 TR with 8°F temperature rise of chilled water at the specified indoor design condition.

### 3.04.00 CABINET:

3.04.01 The panels of the Base-Units shall be fabricated with 18 G. GI sheet. The horizontal unit height shall not exceed 11 inches. The horizontal unit shall include four rubber grommets for mounting isolation.

### 3.05.00 COILS:

3.05.01 The coils shall be of minimum 3-row deep (1-Row for heating) staggered, seamless copper tube with ripple aluminium plate fins. The spacing between the fins shall be 2 mm. The copper tube shall be of minimum 10 mm OD and wall thickness of minimum 0.5 mm. Water inlet and outlet connection shall be provided with SAE flare nuts for connection to the control valves. A vent connection shall be provided for quick removal of air from the coil. A suitable drain connection shall also be provided for draining the coil.

3.05.02 The coil shall be tested at 350 psig minimum air pressure underwater.

3.05.03 Coil shall be provided with left or right-hand connections.

### 3.06.00 FAN:

3.06.01 The fan impellers shall be with forward curved blades and driven by extended motor shafts. The fan scroll shall be fabricated with 20 G. GI sheets. Impeller shall be of aluminium and statically and dynamically balanced.

3.06.02 The fan shall deliver rated cfm at the maximum motor speed and the **noise level** shall not exceed **NC 35**. The air quantity at the maximum speed of 1.0 TR, 1.5 TR and 2.0 TR fan-coil units shall be 500 cfm, 700 cfm and 1000 cfm respectively.

3.06.03 The fan deck shall be designed for easy removal.

### 3.07.00 FAN MOTOR:

3.07.01 The fan motor shall be designed for 3-speed with permanent split capacitor and built in overload protection. The motor shall be rated for 1/12<sup>th</sup> HP, 1/10<sup>th</sup> HP and 1/10<sup>th</sup> HP for 1.0 TR, 1.5 TR and 2.0 TR fan-coil units respectively and suitable for 200-240 Volts, 1-Phase, 50 Hz A.C. supply.

### **3.08.00 PRIMARY DRAIN PAN:**

3.08.01 The drain-pan shall be fabricated with 16 G galvanised steel, insulated (with 25 mm expanded polystyrene) and pitched for positive drainage with the unit level. The pan shall project under the entire length and width of the coil, including the headers and return bends and extend beyond to catch the condensate from chilled water valves and fittings. A second layer of 22 G GI shall be provided to make the drain pan double skin construction with insulation sandwiched in between.

3.08.02 The drain pan shall have adequate size and depth to prevent dripping of condensate water from the unit, controls and valves. Two drain connections shall be provided at opposite ends.

3.08.03 Air vent connection from the unit shall be directly connected to the drain pan.

### **3.09.00 FILTERS:**

3.09.01 The filters shall be cleanable type with synthetic filtering media.

### **3.10.00 DUCT COLLARS:**

3.10.01 Duct collars shall be provided between the horizontal fan coil units and the supply air grills with flexible connection in between.

### **3.11.00 VALVE PACKAGE:**

3.11.01 Each fan coil unit shall be provided with following valves: -  
One combination stop and balancing valve.  
One combination Shut-off ball valve and Y-strainer.  
One three-way motorised by-pass/two-way motorised valve, as specified.

3.11.02 The fan coil units shall be provided with 3-way motorised by-pass or two-way motorised valves as specified.

### **3.12.00 THERMOSTAT AND 3-SPEED SWITCH:**

3.12.01 The thermostat shall be snap acting type suitable for 220 V, 1-Phase line. The thermostat shall be suitable for cooling or cooling and heating operation as specified with 4°F differential.

3.12.02 The thermostat shall be complete with 3-speed switch for operating the fan-motor at low, medium and high speed.

### **3.13.0 TESTING:**

Factory test certificate giving pressure testing of coil, power consumption of fan motor, performance rating, quantity of air delivery (CFM) at different speeds and noise level shall be submitted before supplying the equipment. On completion of installation, the FCUs shall be tested for their design performance and the test results shall match with the approved factory test certificates.

## **AIR HANDLING UNITS:**

### **4.1.00 Scope:**

- 4.1.01 Scope of this section comprises the supply, installation, testing and commissioning of the AIR HANDLING UNITS conforming to the specification and in accordance with the requirement of the schedule of quantities.

### **4.2.00 Type:**

- 4.2.01 Single Skin Air Handling Units shall be draw-through type. The Unit shall be of sectionalised construction comprising Blower Section, Coil Section, Bypass Damper Section and Filter Section.

### **4.3.00 Capacity:**

- 4.3.01 Minimum capacity of the AHU shall be as specified in the tender document or as per design. The design parameters shall be as described in the section "Detail of Work".

### **4.4.00 Casing Structure:**

- 4.4.01 Single skin Air Handling Units shall be made out of minimum 2 mm thick anti-corrosive hollow profiles (with round corners) of Extruded Special Aluminium Alloy filled with PUF insulation with joineries and detachable panels. The panels shall be made out of minimum 1.25 mm thick Pre-Plasticized GI sheets with internal surface covered with minimum 12 mm thick fire retarding quality closed cell cross linked foam insulation for attenuation of noise. The condensate from cooling coils to be collected below the coil in a sufficiently large SS-304 stainless steel Drain Pan (minimum 18 G thick) insulated with minimum 16 mm thick closed cell cross linked foam insulation glued in one piece to the underside and four vertical faces. The drain pan shall be sloped towards a drain socket with about 25 mm gradient. The fan-motor assembly shall be placed inside the Fan-Section on a mounting frame made out of Extruded Aluminium Box Channels with suitable vibration isolators. Access doors with locking arrangement and ensuring adequate structural stability to the panel and to the main frame shall be provided in the fan chamber for easy approach to all equipment. One 150 mm round inspection window with sight glass shall be provided in the fan section access door. Access door shall be provided with limit switch to cut off fan power supply, in case of opening the door. Suitable cable entry BOX with earthing provisions shall be provided in the fan chamber.

### **4.5.00 Blower:**

- 4.5.01 DIDW Centrifugal fan shall be provided. The fan wheels shall be forward curved, multi-blade type enclosed in housing and mounted on a common shaft. The fan housing shall be made from die-formed side sheets with stream lined inlets and guide vanes to ensure smooth air flow into the impeller wheel. The fan wheels and the housing shall be fabricated from heavy gauge sheet. All wheels shall be statically and dynamically balanced and shall run on large diameter, precision ground solid steel shafting in heavy duty, self-aligning grease lubricated deep grooved ball bearing Plummer blocks. The bearings shall be suitable for 20,000-hour operation. The bearings shall be mounted externally for easy servicing. The Blower shall be designed for lowest operating noise level.

### **4.6.00 Cooling Coil:**

Cooling coil shall be constructed from light annealed seamless copper tubes brazed into solid drawn copper headers with corrugated aluminium plate fins bonded to copper tubes and assembled in zinc coated steel casing fabricated with minimum 16 G Sheets. The flow and return headers shall be arranged to ensure equal flow of water through all tubes and shall be fabricated

out of 2 -1/8" OD copper pipes of 16 G thick. Purge and drain connection shall be provided on the headers. The tubes shall be mechanically expanded to ensure tight fin bond. The return bond shall be die-formed and brazed to the tubes and shall have at least one size thicker tube wall than the standard straight tubes. The tube shall be of 3/8", 1/2" or 5/8" OD seamless copper tubes and shall have 12 to 14 aluminium fin per inch. Complete coil including the headers shall be tested with 325 psig compressed air under water for chilled water coils and with Nitrogen at 400 psig for DX coils. Necessary Test Certificates shall be furnished. One mist-arrestor fabricated with minimum 22 G aluminium sheet mounted on suitable frame shall be provided immediately after the coil to arrest the condensate carry over to fan chamber.

#### **4.7.00 Damper Section:**

##### **4.7.01**

AHU shall be provided with Bypass Damper. Dampers shall be of interlocking and opposed blade louver type. Blades shall be made out of G.I. sheets not less than 1.6 mm thick. Dampers shall be equipped with bush bearings of brass/gun metal.

#### **4.8.00 Filter Section:**

The Filter section shall be of heavy gauge construction with echelon arrangement of filters. Slides and end cap shall be provided to permit filter access at either left or right side. The filter elements shall be of synthetic non-woven media supported by three layers of HDPE mesh on both sides with reinforcing layer of aluminium expanded mesh in between, stitched together in diamond pattern and enclosed in a 2" wide M.S. frame of 22G GI sheet. Filter face shall be corrugated up to minimum 2" for maximum surface area. The filtering capacity shall be down to 10 microns with minimum 90 % efficiency.

#### **4.9.00 Blower Motor:**

4.9.01 Blower Motor shall be TEFC type with IP-55 protection, four pole Squirrel Cage Induction Motors suitable for operation on  $415 \pm 10\%$  volts, 3-phase, 50 Hz A.C. supply with class B insulation and guaranteed for continuous operation at name plate rating. The motor shall be operated by DOL or S/D starter with overload release, undervoltage and SPP protection. The motor shall be adequately sized to prevent overload.

4.9.02 The Blower Motor shall be complete with variable pitch diameter pulley. The drive assembly shall be completed with Blower pulley, Oil resistant type V-belts, Belt guard, etc. The Motor shall be mounted on an adjustable base. The pulleys shall be provided with taper lock.

4.9.03 The Blower-Motor assembly shall be mounted on a galvanised steel base frame which will be placed on spring mounting inside the fan chamber to ensure complete isolation of vibration produced by blower-motor from the main structure of the AHU. Fire retarding quality flexible connection shall be provided between blower outlet and the unit outlet. A second set of similar flexible connection shall be provided between AHU outlet and the ducts. All openings/outlets provided on the unit shall be with suitable collars and flanges for connecting flexible connections.

#### **4.10.00 Sound Level:**

4.10.01 Maximum sound pressure level measured at a distance of 1 Mtr from the AHU shall not exceed 50 DB.

#### **4.11.00 Double Skin AHU:**

4.11.01 For 100 % fresh air application Double Skin AHU shall be used with 50 mm thick PUF Insulation in between the double skin. All joints shall be properly isolated and other precaution shall be

taken to prevent condensation on the outer surface and the frame of the AHUs.  
Other constructional details shall be same as single skin AHUs.

**4.12.00 Installation:**

- 4.12.01 The AHUs shall be mounted on ribbed neoprene vibration isolation pads cut to 6" x 6" size in double layer. Minimum 22 Gauge G.I. sheets shall be provided between AHU-base and ribbed neoprene pads.

**4.13.00 Painting:**

- 4.13.01 The panels shall be made out of minimum 1.25 mm thick Pre-Plasticized GI sheets and the panels are fixed to a frame of hollow profiles (with round corners) of Extruded Special Aluminium Alloy. Wherever M.S. support will be used, its surface will be factory finished with powder coating over zinc-chromate primer. Any surface marred during Transport or installation shall be given fresh coat of powder coating. In case of panels with Pre-Plasticised GI sheet, any surface marred during transport or installation shall be replaced with a new panel.

**4.14.00 Testing:**

- 4.14.01 The Units shall be tested for their design performance. The test results shall be taken by the contractor as per section "Test Reading" and the computed results shall conform to the specified capacities and quoted ratings.
- 4.14.02 The Contractor shall provide all instrument and services needed for testing the capacity and power consumption.

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>(D)</b>     | <b>PUMP WITH VARIABLE FREQUENCY DRIVE:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>5.01.00</b> | <b>SCOPE:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 5.01.01        | The scope of this section comprises supply, installation, testing and commissioning of chilled water circulating pump set with Variable Frequency Drive conforming to this specification and in accordance with the requirement of "Schedule of Quantities"                                                                                                                                                                                                                                              |
| <b>5.02.00</b> | <b>CONSTRUCTIONAL FEATURE:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5.02.01        | The constructional feature of the pump shall be horizontal spindle type, single stage, volute casing with end suction and top centre line discharge. Back pull-out design will enable to remove the rotor assembly without disturbing the pump lines. The support feet shall be integrally cast with the volute casing. The dimensions shall correspond to DIN-24255.                                                                                                                                    |
| <b>5.03.00</b> | <b>SHAFT:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 5.03.01        | The shaft shall be of accurately ground stainless steel supported with two grease lubricated deep ball bearing.                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>5.04.00</b> | <b>IMPELLER:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 5.04.01        | The impeller shall be enclosed type with double curved blade having smooth surface. The pump will be dynamically balanced and the impellers will be hydraulically balanced to compensate for axial thrust. The impellers shall be of bronze construction.                                                                                                                                                                                                                                                |
| <b>5.05.00</b> | <b>CASING:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5.05.01        | The casing shall be of cast iron, high efficiency volute type. The suction and discharge nozzles and the supporting feet are cast integral with the casing. The casing test pressure shall be 16 bars.                                                                                                                                                                                                                                                                                                   |
| <b>5.06.00</b> | <b>SHAFT SEAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 5.06.01        | The shaft seal shall be unbalanced mechanical seal conforming to DIN 24960.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>5.07.00</b> | <b>FLANGES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5.07.01        | The flanged dimensions shall be as per EN-1092-2.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>5.08.00</b> | <b>SPEED:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 5.08.01        | The pump shall be selected for 1450 rpm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>5.09.00</b> | <b>MOTOR:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 5.09.01        | The pump shall be directly coupled to a SPDP type 4-pole Sq. cage induction motor suitable for operation on $400 \pm 10\%$ volts, 3-phase, 50 Hz, A.C. Power supply. The stator winding shall be insulated with Class F insulation and impregnated to exclude moisture. Motor shall be provided with Terminal Box suitable for conduit/flexible conduit connection. The motors shall conform to IS-325. The motor shall have IP-55 degree of protection and shall have minimum three earthing terminals. |
| 5.09.02        | The pump-motor shall have at least 10% in excess of maximum BHP of the pump plus the transmission losses.                                                                                                                                                                                                                                                                                                                                                                                                |

- 5.10.00 BASEPLATE:**
- 5.10.01 The pump and motor shall be mounted on a single base-plate and directly coupled through a flexible coupling. The couplings shall be protected by a guard mounted on a common base.
- 5.10.02 A drip pan of adequate size and minimum 50mm deep fabricated out of minimum 2 mm thick M.S. sheet with drain connection shall be provided below the pump to collect any dripping water through the pump gland/shaft seal.
- 5.11.00 PUMP ALIGNMENT:**
- 5.11.01 The pump shall be factory aligned by the manufacturers. Prior to testing, the pump alignment shall be verified for each pump with a dial indicator within 0.05mm.
- 5.12.00 VARIABLE FREQUENCY DRIVE:**
- 5.12.01 There will be one common VFD for multiple pumps plus one as standby. It will comprise of pump logic controller, differential pressure transmitter and safety/display feature.
- 5.12.02 The pump logic controller will be suitable for closed loop operation and bear the label of CE as well as UL.
- 5.12.03 The PLC will have two parts- pump management unit for monitoring function and pump functional unit for operating functions. The controllers shall be programmed to safeguard against pump flow surges, hunting, system overpressure, motor overload, end of curve and NPSHR above NPSHA.
- 5.12.04 The controllers shall also safeguard against the following-  
 Low suction pressure cut-out for protection against insufficient suction pressure. High system pressure cut-out for protection against high system pressure.  
 Automatic switching off the pump when the system demand is very low to cause a no-flow condition.
- 5.12.05 The PLC shall receive minimum three analog inputs- two from sensors/transmitter and third one for a flow sensor to serve as a criterion for end of curve protection algorithm.
- 5.12.06 The LCD display characters and green/red indicating lights shall be provided for operating and fault conditions. The system shall give history of last ten faults.
- 5.12.07 The PLC shall be provided with automatic auto-VFD by-pass.
- 5.12.08 The PLC shall be provided with facilities for connecting it with the BAS at a later date.
- 5.13.00 INSTALLATION:**
- 5.13.01 The pump-motor assembly shall be mounted on a concrete foundation projecting at least 15 cms above finished floor level. The foundation base shall be set on about 6 to 8 mm thick cross-ribbed neoprene vibration isolation pads of minimum two layers. Spacer bars shall be provided between pump and motor coupling to facilitate removal of pump-impeller without disturbing motor.
- 5.13.02 For upper floor installation, the pump bases shall be mounted on an inertia base, resting on springs support for eliminating vibration to the building structure.

**5.14.00      TESTING:**

5.14.01      The performance of the pumps at site shall be computed from the pump-curves furnished by the manufacturer. The performance curve and power consumption with operating points clearly indicated on the curves shall be submitted and the same will be verified at the time of commissioning and testing.

**5.15.00      PAINTING:**

5.15.01      The pump motor assembly shall be factory painted with approved finish. Any surface marred during transport or installation shall be cleaned off with approved cleaning agent, then given a coat of primer red oxide and finally finished with two coats of finishing paint to match with the adjoining shop painted surface. If the patch up paintings shall not match the shop finish, entire surface will then be given a fresh coat of painting.

## EXHAUST FANS

### **:7.01.00SCOPE:**

7.01.01 The scope of this section comprises the supply, erection, testing and commissioning of propeller type exhaust fans conforming to the specifications and in accordance with the Bill of Quantities .

7.01.02 Make and Type:

The propeller fans shall be Asthom, Crompton or approved equal make, direct-drive, Ring or Diaphragm mounted with three or four blades.

### **7.02.01 Mounting Plate:**

The mounting plate shall be fabricated out of 12 to 16 gauge (depending on the fan size) sheet steel with streamlined venture inlet. The Orifice ring shall be correctly formed to provide easy passage of air without turbulence.

7.02.02 Fan Blades:

The fan blades shall be of Aluminium or steel rigidly fixed to fan hub of heavy welded steel construction. The fan blades shall be designed for low air turbulence and low noise. The blades and hub assembly shall be statistically and dynamically balanced.

7.03.03 Fan Shaft:

The shaft shall be of steel, turned, ground and polished and shall be sized to operate well below the 1<sup>st</sup> critical speed.

### **7.03.01 Fan Motor:**

The fan motor shall be totally enclosed suitable for operation on 415  $\pm$  10% volts, 3-Phase, 50 Hz, A.C. supply or 220  $\pm$  10% volts, single-phase, 50 Hz, A.C. Supply and shall be of permanent split Capacitor type. The motor shall be provided with prelubricated sleeve or ball bearing designed for quiet operation. The rpm of the motor shall be selected for lowest possible noise level by the fan. The motors shall be suitable for both vertical and horizontal operation.

### **7.04.01 Ancillary Fittings:**

The propeller fans shall be provided with following ancillary fittings as indicated in the Bill of Quantities.

Gravity operated louvers shutters comprising aluminium of light construction. The air velocity through the louvers shutters shall be within 255 M/min to 455 M/min.

Fan speed regulators with attractive hammer tone painted sheet metal body and rotary switch for speed control shall be provided.

Wire guards from heavy gauge wire rods with all joints and crossings welded to protect both motor and impeller side of the fans.

In case the fan is used for supply or make-up purpose, the air intake side shall be provided with inlet cowl.

**7.05.01 Performance:**

The noise level, capacity ratings, power consumption at the operating points shall be submitted and verified at the time of testing and commissioning of the plant.

**7.07.01 Testing:**

7.07.02 The units shall be tested for their design performance. The test results shall be taken by the contractor and the test readings shall conform to the specified capacities and quoted ratings.

7.07.03 The contractor shall be provided all instrument and services needed for testing the capacity and power consumption.

**7.07.01 IS Specification:**

7.07.02 The propeller types shall conform to IS-2312 and 3588.

## SHEETMETALWORK

### 8.00.00 Scope:

8.00.01 Supply and installation of all sheet metal work shall be as per the specification described below.

### 8.01.00 Material:

8.01.01 All Duct shall be fabricated out of best quality Galvanised steel sheets or Aluminium sheets. The Galvanised steel sheets shall conform to IS-277-1992 (or latest edition). Sheets used shall be produced by hot dip process and galvanising shall be Class-VI, light coating of Zinc of around 200 gms/m<sup>2</sup>. The Aluminium sheets shall be of Grade SIC or NS3 as specified in IS 737-1955 (or latest edition). The sheets should be clean, smooth and straight and free from any water marks. GP sheets shall be soft and annealed and of lock forming quality and it will not crack on bending or hammering. Weight of GP sheets shall not be less than 5.32, 6.66 & 8.22 kg/ m<sup>2</sup> for 24 G, 22 G & 20 G respectively.

8.01.02 The thickness of the sheets shall be as given below:

| Maximum size of Duct in mm |     |       | Thickness of sheets in mm |           |
|----------------------------|-----|-------|---------------------------|-----------|
|                            |     |       | G.S.S.                    | Aluminium |
| Upto                       | 750 |       | 0.63                      | 0.80      |
| 751                        | to  | 1500  | 0.80                      | 1.00      |
| 1501                       | to  | 2250  | 1.00                      | 1.50      |
| 2251                       | &   | Above | 1.25                      | 1.80      |

8.01.03 Fabrication of the duct shall be carried out as per recommendation of ASHRAE and IS-655 1963 (latest edition). All the transverse joints, connections, bracings, seams etc. shall be in accordance with the following Tables:

8.01.04

| Maximum Size in mm | Thickness of Bracing Sheets (G. S.) mm | Transverse Joints                                                                |  |                                        |
|--------------------|----------------------------------------|----------------------------------------------------------------------------------|--|----------------------------------------|
| Upto 300           | 0.63 (24G)                             | 25mm Pocket/S-Slip on 2.5M Centres                                               |  | Cross-break.                           |
| 301 to 600         | 0.63 (24G)                             | -do -                                                                            |  | Cross-break                            |
| 601 to 750         | 0.63 (24G)                             | -do -                                                                            |  | 25x25x3mm angles at 1.2M from joints   |
| 751 to 1000        | 0.80 (22G)                             | 25x25x4mm angle connection on 2.5m centres                                       |  | -do-                                   |
| 1001 to 1500       | 0.80 (22G)                             | 40x40x6mm angle connection on 2.5M centres                                       |  | 40x40x3mm angle at 1.2M from joints    |
| 1501 to 2250       | 1.00 (20G)                             | 40x40x6mm angle connection on 1-meter maximum centre with 35x3mm bar reinforcing |  | 40x40x3mm angle at 60cm from joints    |
| 2251 to above*     | 1.15 (18G)                             | 50x50x6mm angle connection at 1m maximum centres with 35x3 bar reinforcing       |  | 40x40x3mm angles at 60cm. From joints. |

Ducts 2251 and larger require special field study for hanging and supporting. All Transverse joints and Bracing are with M.S. angles.

Girth angles and companion flanges shall be suitably mitred and welded at corners and riveted to the duct sheets of 75mm centres. Flange joints shall be made with 9.5mm G.I. bolts and nuts at 150mm centres and shall be provided with 33x5 mm good quality **Neoprene Rubber Gaskets**.

### 8.01.05 Duct Supports:

Duct Supports shall be as per the following details:

| Duct Sizes            | Duct Supports                                      | Location of Supports     |
|-----------------------|----------------------------------------------------|--------------------------|
| Upto 1250 mm          | 40x40x3mm M.S. Angle with 8mm dia tie rod          | At the transverse Joints |
| Over 1250 to 2250mm   | 40x40x6mm M.S. Angle with minimum 10mm dia tie rod | -do-                     |
| Over 2251mm to 2250mm | 50x50x6mm M.S. Angle with minimum 10mm dia tie rod | -do-                     |

NOTE: The tie rods to be supported from the Expansion bolts fixed to the R.C.C. ceiling. The supporting capacity of the expansion bolt shall be checked before fixing it in position. Upto 1250

duct size, one Expansion bolt support per tie rod may be provided. Above 1250 mm size duct size per support, minimum two Expansion bolts should be used to fix a cleat to the roof Slab from which the tie rod shall be supported (Refer to the details in the Drawings). Minimum thickness of the supporting **cleat** shall be **6 mm thick**. Only Electric Drills shall be used for fixing the expansion bolts to the R.C.C. Slabs.

All supporting members like Angles, rods, cleats etc. shall be cleaned and two coats of red oxide primer shall be applied before fixing in position.

Ducts above 600 mm and above shall be reinforced between the joints. Where Drive slips are used, the angles shall be reverted to the duct about 50mm from the slips.

Simple elbow, transformation sections and straight ducts shall be formed with Pittsburgh corner seams; complicated fittings such as double compounded elbows shall be constructed with double seam corners.

All joints and seams shall be rendered airtight.

Dimension of Duct Sections shown are inside dimensions of bare ducts. Where ducts are required to be lined or insulated on inner surface, their dimensions have to be enlarged, so that the cross-section area is not reduced as compared to those shown in the Drawings.

**8.02.00** Elbows & Vanes: Standard radius elbows with a R/D ratio not less than 1.25 shall be used as far as possible. Turning vanes shall be provided at required spacing such that the aspect ratio of each individual elbow formed by the vane shall not be more than five. Where space restriction does not permit standard radius elbow, square elbows with equally spaced double thickness vanes at 5cm. Centres may be used.

### 8.03.00 Transformation:

**8.03.01** Duct transformation shall be made with a side slope of 1 is to 7. Where space restriction does not permit, the slope may be brought down to 1 is to 4. If the duct cross section area needs to be reduced, a maximum reduction of 10% of the original area may be allowed.

### 8.04.00 Dampers:

**8.04.01** Dampers shall be provided in duct/branch ducts, whether or not indicating in the drawing for proper volume control and balancing of the system. The Dampers shall be robust construction and tight fitting.

**8.04.02** Air Volume Control Dampers shall be multi-blade type with opposed blade air foil construction. Blade width shall be 250mm maximum and the Damper size shall be 1200mm x 1200mm, mounted in a 50mm channel frame. Blades should be connected to a suitable linkage for gang

operation and the operating mechanism shall consist of links, levers and locking quadrants as required for proper control and setting at a desired position with a clearly visible damper position indicator, showing closed or open position. Dampers larger than 1200mm in width shall be furnished in multiple sections. The Dampers shall be enclosed in GI sheet, one size heavier than the corresponding ducts. PVC bush shall be used for pivoting the damper blades.

8.04.03 Splitter Dampers shall consist of double thickness airfoil blades suitably hinged at the downstream edge. The link rod shall be terminated outside the duct (and insulation) with airtight hub and locking knob. The Dampers shall be fabricated of G.S. sheets of two gauges heavier than the duct in which it is to be installed.

8.04.04 Dampers and Splitter Dampers shall be provided as shown in the Drawings.

#### **8.05.00 Fire Dampers:**

8.05.01 Rectangular pivot type or curtain type Fire Dampers shall be provided at the locations indicated in the drawings. The Fire Dampers should be best quality available from the indigenous sources. In normal condition the blade/curtain of the fire damper shall be held in open position, providing maximum air passage and at the same time do not produce vibration, noise and chatter due to the passage of air.

8.05.02 The blade/curtain shall hold the Damper in open position by the fusible link. Once the link opens, the blade/shutter will close the passage automatically and instantly by the stored energy and then hold it tight by the Locking Arrangement, without use of springs, weights or other Devices which may be subject to failure.

8.05.03 Suitable limit switch shall be provided at the bottom frame of the Fire Damper within the duct, which will be operated by the thrust from the closing of the Damper. The closing of the limit switch will cut off the power supply to the Blower Motor of the AHUs. The Blade linkage and Hinges or any other mechanisms, which may give way under heat or air pressure, shall not be used in the fire Damper.

8.05.04 The Fire Damper shall be mounted as per the manufacturer's recommendation. Necessary access door shall be provided in the duct for attending to the Fire Dampers as per manufacturer's recommendations.

8.05.05 Minimum a dozen (or the quantity recommended by the manufacturer) of spare Fusible links will be supplied by the HVAC contractor to the owner at the time of handing over of the plant. The prices should include the cost of these spare Fusible links.

8.05.06 The Fire Dampers shall be of type tested by CBRI – Roorkee for 90 minutes fire rating as per UL-555-1995. The fusible link shall be rated to fuse at 74°C (165°F) as per UL rating. In case, closing operation shall be with Spring, only SS strip type springs shall be used.

#### **8.06.00 Air Turning Vanes:**

8.06.01 Air turning vanes shall be provided in all the outlet collars for grills/Diffusers and the non-split branch take-offs to streamline and equalise the Air flow. The turning vanes shall be fabricated out of 0.8mm G.I. sheet and equally spaced on side runners and shall be riveted/bolted to duct sheets.

#### **8.07.00 Grills/Registers/Diffusers:**

All Grills/Diffusers/Registers shall be supplied all in accordance with the duties, sizes and locations shown in the approved Drawings.

8.07.01 Supply & Return Air Grills/Registers-

The Supply and Return Air grills/diffusers shall be of extruded aluminium sections and finished with powder coating of approved colour. The grills and diffusers shall be of "Dynacraft", "Caryair" or approved equivalent make.

- 8.07.02 The Diffusers can be of Square, Rectangular or linear (Strip line) design, slotted linear (Modulinear) design. The grills/Registers can be of double deflection rectangular type or fixed bar linear (Aeroline) design as specified in the drawings or in the schedule of quantities.
- 8.07.03 Grills and Diffusers shall be of robust and rattle free construction. The bars in double deflection diffusers shall be adjustable type to deflect air through 0° to 100° in horizontal arc and upto 30° deflection up or down.
- 8.07.04 Slotted diffusers shall be provided with control vanes for directional change of air pattern through 180°
- 8.07.05 Grills and diffusers shall provide **concealed fixing arrangement** and screws shall not be fixed on the flanges.
- 8.07.06 Inner core of square/rectangular diffusers and the fixed bar type linear grill shall be removable type. Continuous linear grills and diffuser sections shall be butt with hairline joints.
- 8.07.07 In case of continuous grills or diffusers, at least 9" space on both sides of the supply air portions shall be blanked off from inside to prevent short-circuiting of S. Air to R Air passage.  
Bid holding the fixed bars in linear grill shall be painted white.
- 8.07.08 Supply and Return air Grills and diffusers shall be provided with volume control dampers. The VCDs inside the grills/diffusers shall be key-operated from the front face and shall be painted black.
- 8.07.09 Grills and diffusers shall be selected to provide required throw and air velocity in the room and a sound level below NC30.
- 8.07.10 All the VCDs, blank-off sheets and wherever any shinings surface is visible behind Return Air grill shall be painted with two coats of black synthetic enamel paints.
- 8.07.11 Grills and diffusers shall be provided with spongy rubber gaskets between flanges and wall or ceiling/bulkhead.
- 8.07.12 Samples of Grills/Registers/Diffusers shall be approved by the Architect/Engineer before procurement.

#### **8.08.0 Installation:**

- 8.08.01 Installation of ducts shall conform to IS:655-1963 (or latest Edition).
- 8.08.02 HVAC contractor shall provide and neatly erect all the sheet metal work as shown in the approved Drawing.
- 8.08.03 Where ducting has to avoid building structural members piping, electrical conduits, cables, light fixture etc. (Whether or not shown in the Drawings) ducts shall be transformed, divided or shifted to one side, as approved by the Architects.

- 8.08.04 Duct shall be supported from the main ceilings. In case, the duct shall be supported from the ceiling hangers or rest on the suspended ceilings.
- 8.08.05 All ducts and plenum boxes shall be adequately supported and braced with M.S. Section of adequate size to keep the duct true to shape and to prevent sagging, vibration or breathing. All joints should be made airtight and all interior surfaces shall be smooth.
- 8.08.06 Access Panels:  
400mm x 400mm rigid access panels, stud bolted with airtight rubber gasket shall be provided adjacent to all Dampers/Fire Dampers, plenum boxes/heaters and should be provided with necessary access from the suspended ceiling.
- 8.08.07 In places where sheet metal ducts or sleeve terminate in woodwork or masonry opening, tight joints shall be made by means of closely fitted heavy flanged collars and seal gaskets.
- 8.08.08 Air Handling unit shall be connected to Duct work by inserting an air inlet and outlet double canvassing sleeve. Each sleeve shall be of minimum 100mm long, securely bonded and bolted to duct and the AHUs. The canvassing sleeve should be held rigidly to the connecting Ductwork in line with the AHU inlet/outlet.
- 8.08.09 Canvassing sleeve will be of 15-ounce, flame and mildew resistant type with a 75mm to 100mm length Zip stitched to the canvas.
- 8.09.00 Insulation:**
- 8.09.01 Necessary thermal and Acoustical Insulation will be provided in the Duct work as specified in the Section-INSULATION. Wherever, it will be difficult to fix insulation on the top surface of the duct after installation, insulation slab should be fixed on the top surface, before the duct is erected.
- 8.10.00 Testing:**
- 8.10.01 On completion of the installation, the entire Duct system shall be tested for Air Leakage. Any leakage detected shall be set right immediately. For clean room application, additional smoke test is mandatory. Capped Air-flow connections shall be provided as necessary for testing and balancing the air Distribution.
- 8.10.02 The AHU in the air distribution system shall be operated for 24-hours for driving away the dust and other unwanted materials inside the duct.
- 8.10.02 On commissioning of the plant the entire air distribution system shall be balanced using approved Anemometer to supply the required air quantities to various rooms/region to maintain the specified inside condition. All Dampers after adjustment shall be set and locked in position. The readings of Air Quantities and static pressure after final balancing of the system, through each register, grills and Diffusers shall be recorded and submitted to the Architect/Engineer for approval. All recording instruments shall be provided by the contractor. All air and static pressure measurements shall be done through probe type meters.
- 8.11.00 Measurement of Duct Work:**
- Unless otherwise specified, measurement for ducting for the project shall be on the basis of centre line measurement described here below:
- 8.11.01 Duct Work:  
The Duct work shall be measured on the basis of external surface over or end ducts, without insulation. The external surface area shall be calculated by measuring the perimeter, comprising

overall width and depth, including corner joints, in the centre of each section, multiplied with overall length from flange face to flange face and then adding up areas of all Duct Sections.

For tapered rectangular ducts, the average width and depths shall be considered for perimeter and the length of tapered duct section shall be the centre line distance between the flanges of duct section.

For special pieces like Tees, Bends, Collars, Reducers/Transformation pieces, the measurements shall be identical to that described above, using the length along the centre line.

The unit rate for duct work quoted by the contractor shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers, expansion bolts, angles, flats with double nuts for supports/bracings, felt strips between ducts and support, vibration isolator where specified or required, inspection chamber/access panel, splitter Damper with quadrant and level for position indication, turning vanes, straightening vanes and all other accessories required to complete the duct installation as per this specification. These accessories shall not be measured separately and paid for.

#### 8.11.02 Measurement of Accessories:

The special items like Registers, grill, Diffusers, Dampers etc. shall be measured by the cross-sectional area perpendicular to air flow as identified here below:

Grills and Registers - Area by multiplying width and height, excluding the flanges. The volume control Dampers, gaskets and other fixing accessories shall form a part of the unit rate. Linear grills shall be measured by linear measurement only, with O.B.D. Diffusers Cross sectional area for air flow at the neck/collar on branch duct. Neither the bell mouth or the discharge face area nor the flange will be measured.

Linear Diffuser - shall be measured by the linear measurement only and not by the cross-sectional area and shall exclude flanges for mounting the linear Diffusers. The supply air plenum for Linear Diffusers shall be measured with the ductwork.

Fire Dampers - Shall be measured by the cross-sectional area perpendicular to the direction of airflow. The rates quoted shall include necessary collars and flanges for mounting, inspection door, fusible links, shutters/curtain, limit-switch and other accessories, which may be required. No allowance shall be payable, for extension of cross-section outside the air stream.

## PIPING9.0

### 0.00SCOPE:

9.00.01 Extent and scope of this section covers supply, erection and testing of entire piping complete with valves and fittings for condenser water/chilled water/make-up & drain water and hot water and balancing the respective fluid flow in the different sections of the Air Conditioning system as per the specification described in this section.

### 9.01.0 PIPESIZES:

9.01.01 The tender drawings depict only the general layout and arrangement of the piping and they are not intended for use as working drawings. The A.C. contractor shall prepare his own shop drawings and obtain approval before the piping work is started.

### 9.02.00 CONDENSER AND CHILLED WATER PIPING:

9.02.01 All pipe work shall be as set out in the table below:

| Pipe Size         | Material                                                          | Joints & fittings                                                                      | Sealing material                                                              | I.S.S. standard                                      |
|-------------------|-------------------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------|
| Upto 50 mm NB     | G.I. Pipe Medium Class OR M.S. Pipe Heavy Class (Where specified) | a) Screwed Fittings<br>b) Unions<br>c) Screwed flanges<br>d) Welded joints for MS pipe | a) Teflon tape<br>b) Teflon tap<br>c) 3mm, 3-ply non-hardening rubber gaskets | I.S.-1239(part – I&II)-(1968 & 1969)<br>IS-3589:1956 |
| 65mm to 150mm NB  | M.S. Pipe Heavy class                                             | a) Welded<br>b) Slip-on flanges                                                        | 3mm, 3-ply non-hardening rubber gaskets                                       | -do-                                                 |
| 200mm to 400mm NB | M.S. Pipe – thickness as specified                                | -do-                                                                                   | -do-                                                                          | I.S.-3589:1956                                       |

9.02.02 Pipe Threads:

All pipe threads shall be conforming to IS-554:1955 and flanges to IS-1536: 1960. The screwed joints shall be made using PTFE tape or with fine quality long stranded hemp and an approved jointing compound.

9.02.03 Pipe shall be black steel unless otherwise stated. The pipes shall be new and of TATA BST or approved standard manufacturer. The pipes shall be cleaned thoroughly and given a primary coat of red oxide paint or equivalent before being installed.

9.02.04 All new pipe fittings shall be used. The fitting shall be "R" brand or approved equal and shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of weldable type. All flanges will be from standard manufacturer conforming to IS-1536:1967 or as required. The flanges shall be of forged steel. All flanges shall include bolts, nuts, washers etc. as required.

9.02.05 For all sweep connections from mains, long radius branch bend & fittings shall be preferred to square Tee-welds. Where square Tee-off connections shall be used, it shall be through equal or reducing tees. For smaller tee-off, ferrules welded to the main pipes shall be used. Drilling and tapping of the wall of the main pipe shall not be permitted.

9.02.06 All equipment and valve connections or connections to any other mating pipes shall be through unions / screwed flanges upto 50mm dia and welded flanges for larger dia or as required for mating connections.

### 9.03.00 WELDED JOINTS:

- 9.03.01 All welded joints shall be executed by first-class welders working under skilled supervision and shall strictly conform to Indian standard code of procedure for manual metal arc welding of mild steel IS-823: 1964. During welding process proper attention shall be given to correct alignment of pipes and fittings. All welding pipe work shall be bevelled for butt welding. "Flame cut" entries into pipe work may be used but the cut edges must be filed/grind smooth and all burr and cuttings removed from the bore of pipe prior to the fitting being welded to the pipe.
- 9.03.02 No welded joints shall be left partly completed. It shall be completed within the same working day.

### 9.04.00 VALVES AND STRAINERS:

- 9.04.01 **Gate and Globe valve**, shall be provided where indicated in the drawings, conforming to the following specification:-

| Size         | Construction                                                                | Ends           |
|--------------|-----------------------------------------------------------------------------|----------------|
| 15mm to 50mm | Gun Metal                                                                   | Screwed female |
| 65mm & over  | a) Cast iron body<br>b) Bronze or Gun metal for spindle, valve seat Nut etc | flanged        |

The valves shall be of heavy duty and of Leader or Kirloskar make. The valves shall conform to IS-780: 1969 and IS-778:1964 and flanges to IS- 1536:1967 or as required. Valves shall have non-rising spindle unless otherwise specified and shall be suitable for 21 kg/cm<sup>2</sup> test pressure. Tail piece shall be used where required.

- 9.04.02 The **Butterfly valves** shall provide bubble tight shut off in both flow direction, resilient seated, wafer type and designed to fit between wide variety of mating flanges without gaskets. The body shall be of single piece wafer design cast out of graded cast iron to IS – 210 Gr FG 220. The Disc shall be of SG Iron to IS- 1865 SG 400/12 and designed for an aerodynamic profile to give higher Cv values. The surfaces shall be nylon coated. These seatings shall be made of Black Nitrile rubber for general service operation. The Shaft shall be of stainless steel AISI-431/AISI-410. For Shaft seal, Nitrile Rubber „O“ Rings and primary & secondary seals shall be provided. Valves up to 200mm NB shall be with hand lever with locking arrangement for every 10° rotation. To open or close the valve fully, only a quarter turn will be required. Valves above 200 mm NB shall be of gear operated type. The Butterfly valves shall conform to BS – 5155 and shall be rated for PN16/PN10 as specified.
- 9.04.03 Wafer type **Check Valves** with Pressure Class PN-16 shall be used in the water lines. The body and Disc shall be of SG Iron and the sealing Rings shall be of Nitrile Rubber. The Check valves shall be suitable for use both horizontal as well as horizontal pipelines.
- 9.04.04 **Balancing Valves** – The body and the bonnet shall be of one piece cast out of graded Cast Iron or Ductile Iron. Disc and other internals shall be of either Gun Metal or S.S. The seats will be made of Nitrile Rubber. The balancing valves shall be provided with necessary ports for connection to Mercury manometer to measure the pressure drop across the valve. Valves shall have proper scale and locking arrangement to permit precise pressure regulation. Valves shall be tested to IS – 778 and shall be rated to PN-16. Valves up to 50mm NB shall be with screwed ends and above 50mm NB shall be with Flanged ends.
- 9.04.05 **Strainers** shall be Pot type or Y-type with C.I. or fabricated steel bodies designed to the test pressure specified for the gate valves. However, Y-type strainers will be preferred to Pot-Strainers. The strainers shall be provided with easily removable cover and brass screen. The screens shall be of not less than 0.6mm thick brass sheet, having perforations of 3mm dia to provide a minimum net free area of 4 times the cross-section area of piping connected to the strainer. The strainers shall be provided with flanges or threaded socket according to the pipe

size. On both sides of the strainer equal size gate valves or butterfly valves shall be provided so that strainers may be cleaned without completely draining the system. The design of the strainer shall be such that removal, replacement and cleaning of the screen can be carried out without disconnection of the main pipe. The strainers shall be fixed on the suction side of the pump and on the inlet side of any heat exchanger. 3/8" drain valve shall be provided on the removable cover for draining out the water before opening the strainer.

#### **9.05.00 PIPING INSTALLATION**

9.05.01 Tender drawings indicate schematic layout with size and routing of the pipes. Routing of pipe and the pipe sizes may, however, be altered to suit the site conditions. Within three weeks of the award of the contract, the A.C. contractor shall prepare the detailed working drawings, showing height of run, distance from wall, location of valves, fittings, Air vents, drain points, support etc.

9.05.02 All pipe work shall be adequately supported in such a manner as to permit free movement due to expansion, contraction, vibration or other changes in the system. Supports shall be arranged as near as possible to joints and change of direction. Vertical rising pipes particularly in shafts shall be adequately supported at the base to withstand the total weight of the riser. Under no circumstance shall branches from vertical rising pipes be the means of supports for the vertical pipe work. Riser passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with 12mm thick rubber pad or any resilient material.

9.05.03 Purpose made brackets/pipe racks shall be provided for supporting pipes. Hangers for horizontal pipe work (or pipe racks) at high level shall be with M.S. angle or channel sections suitable for securing to the roof structure. For pipe rack support, each hanger shall be provided with two metallic expansion bolts. Piping shall be fabricated of steel made in halves and secured by bolts or screws. The contractor shall be responsible for the structural efficiency of all brackets, supports and hangers.

For guidance refer to ASHRAE piping standards sketches.

9.05.04 All hangers and supporting brackets shall be painted with two coats of red oxide and finished coat of black enamel paint. Where pipes and clamps are of dissimilar material, a gasket shall be inserted in between. Ribbed neoprene pads of about 8 mm thick shall be placed between the pipes and the supporting bracket & clamps. All clamps, plates, bolts, nuts, washers etc must essentially be made of galvanized or hot dipped galvanized variety only.

9.05.05 Supports carrying chilled water pipe work shall be sized to fit over the insulation with "High density polyurethane blocks" (about 160 KG/M<sup>3</sup> density) inserts to grip the pipe. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. Semi circular pipe sleeve fabricated with 1.8 mm G.I. sheet metal shall be placed between insulation and the clamp, saddle or support extending about 150mm on both sides.

9.05.06 Maximum spacing of pipe support shall be as under.

| Nominal pipe diammm | Maximum spacing meter |
|---------------------|-----------------------|
| Up to 15mm          | 1.55                  |
| 19 to 25mm          | 2.00                  |
| 32 to 150mm         | 2.50                  |
| Above 150mm         | 9.00                  |

Pipe hangers shall be fixed on walls and ceilings by means of metallic expansion bolts of reputed make. Spring support may be provided, wherever specified.

9.05.07 All pipe work shall be plumb in the vertical and levelled to the turn of a bubble in the horizontal except where wall or floor finishes deviate from vertical or horizontal in which case pipe work shall be parallel to the surface to present a neat appearance. All pipe work shall be erected such

that it may be vented or drained satisfactorily. All low points in the system shall have drain cocks fitted and high points shall have automatic air vent/purge cock as specified.

- 9.05.08 Air vents shall be of double float type, with GM/CI body, vulcanite balls, rubber seats etc. Air vents shall be fixed with an equal size gate valves of rising spindle and the vents shall be of sizes as specified below:-

| Mains         | Air vents. |
|---------------|------------|
| Upto 100mm    | 25mm       |
| 100 to 300 mm | 38mm       |
| Above 300mm   | 50mm       |

Discharge from the air vent shall be piped through an equal sized G.I. pipe to the nearest drain or floor waste.

- 9.05.09 No joints shall be formed in the thickness of wall, floor slabs or roof slab. No pipe work shall be chased into floor slabs, roof slabs or walls. Pipes of 50mm larger diameters shall be provided, wherever pipes pass through walls and the annular space be filled with felt/fibre glass and finished with retaining rings and bituminous compound.

- 9.05.10 Opening required in the floor slabs for taking various pipes are indicated on the drawing. The HVAC contractor shall carefully examine the cut-outs provided and shall intimate the locations where cut-outs shown do not match the requirements.

- 9.05.11 Pipe work shall be installed with minimum disturbance to other work on the site. A programme of work shall be prepared in consultation with the Engineer.

- 9.05.12 All pipes using screwed fittings shall be accurately cut to the required sizes and threaded in accordance with I.S.-554:1955 and burrs removed before fixing.

- 9.05.13 Immediately after installation of pipes, the open ends of all piping shall be blocked to avoid entrance of foreign matters into the pipes. Wherever reducers are to be provided in horizontal runs, eccentric reducers shall be used. In the vertical runs, concentric reducers may be used.

- 9.05.14 Drains shall be provided at all low points and shall be of following sizes:-

| Mains      | Drain |
|------------|-------|
| Upto 300mm | 25mm  |
| Over 300mm | 38mm  |

Drain piping shall be provided with Ball valve of equal size. Drain piping shall be piped through equal size G.I. pipe to the nearest drain or floor waste. Piping shall be pitched toward the drain point.

- 9.05.15 Flanged inspection pieces of 1 M long with bolted flanges at both ends shall be provided at every 30 metres centres or less to facilitate future inspection and cleaning of all welded pipes.

- 9.05.16 All buried pipes shall be cleaned and coated with Zinc chromate primer or reputed make and bitumen paint and then wrapped with three layers of fibre glass tissue - each layer laid in bitumen.

- 9.05.17 Insulated buried pipes shall be cleaned, de-rusted and then given a coat of epoxy primer. Insulation, shall be applied as detailed in the section "INSULATION" wrapped with G.I. wire and covered with polyethylene sheet duly sealed. Over this chicken wire netting of 24 G shall be provided and two coats (each of 7mm thick) of cement sand plaster (1:4) shall be applied. Wherever indicated in the "Bill of Quantities"/drawings, buried insulated pipes shall be further weather proofed using a coat of bituminous compound of approved make over the plastered surface wrapping on a layer of RP tissue and one layer of roofing tar felt with minimum 75mm

overlap, set and sealed with adhesive and held in position by 16-gauge T.I. wire tied at 30 cm interval.

#### **9.06.0 PRESSURE GAUGES:**

9.06.01 "Bourden Tube" type pressure gauges of appropriate range with at least 100mm dia dial shall be installed at the following locations:

Supply and return of all condensers and chillers. All pumps-at suction and delivery

Chilled water-cooling coil/heat exchangers-inlet and outlets.

The pressure gauges shall be connected to the pipes by SS/brass U-tubes of 12mm dia through shut-off cocks, required for gauge protection during testing. The gauges shall be calibrated before installation. The pressure gauges shall conform to 18-3624.

9.06.02 Wherever specified, only pressure test points may be provided.

#### **9.07.0 THERMOMETER:**

9.07.01 Direct reading 225mm long industrial thermometers having reading mercury shall be provided at the inlet and outlet of all heat exchangers (chilled water-cooling coils, chillers and condensers) to read entering and leaving temperature of water. The thermometers shall be installed in separate wells. Thermometers shall be of appropriate range (0.50°C or 30°F to 120°F) and shall be calibrated before installation. Thermometers for insulated piping shall be installed in extended neck to avoid any damage or deformation of insulation.

9.07.02 Wherever specified, only brass thermo-well shall be provided.

#### **9.08.0 FLOW SWITCHES:**

9.08.01 Flow switch shall be provided at the water line outlet of condensers and chillers. The flow switch shall prevent the compressor from starting unless water flow is established in condenser cooling system and chilled water lines.

#### **9.09.0 EXPANSION TANK:**

9.09.01 1000/500 litres capacity (as specified) Expansion tank made of HDPE and completely insulated and provided with overflow, drain, make-up connection, vent pipe, ball valves and float valve etc, shall be provided at the indicated location in the layout drawing. The bottom of the tanks shall be at least 60 cms above the highest point of the chilled water system. The base of the HDPE tank shall rest on a fully horizontal base.

#### **9.10.0 INSULATION:**

9.10.01 Chilled water piping, condensate drain piping etc. shall be insulated as per the specification enumerated under the specification "Insulation".

9.10.02 Pipe insulation shall not be carried out till the satisfactory completion of pressure testing.

#### **9.11.0 VIBRATION ELIMINATION:**

9.11.01 Piping installations shall be carried out with vibration elimination fittings/springs wherever required.

#### **9.12.0 PENETRATION OF STRUCTURE:**

9.12.01

For all penetrating pipes and tubes (through walls & floors), tightly pack the annular space

between construction and penetrating element to full  
depth with 25mm thick pipe section of

Expanded polystyrene and seal both sides with non-hardening, resilient, non-shading sealant. Over the EP a22 GGI sleeve shall be provided.

#### **9.13.00 TESTING:**

- 9.13.01 Piping shall be flashed and cleaned thoroughly after completion of installation. Piping shall be tested to hydrostatic test pressure at least two and half times the maximum working pressure for a period of 24 hours. However, minimum test pressure shall be 10 Kg/cm<sup>2</sup>. The defects in joints and leaks observed during the test shall be rectified to the entire satisfaction of the Employer's representative/consultants and the piping shall again be subjected to pressure test.
- 9.13.02 The testing of piping shall be conducted in presence of Employer's representative. The contractor shall intimate the employer's representative well in advance of his intention to test a section or sections of piping all testing shall be witnessed by the employer's representative. The test readings shall be jointly recorded by the HVAC contractor and the client's site representative.
- 9.13.03 The system may be tested in sections and such sections shall be securely isolated.
- 9.13.04 The contractor shall be responsible for proper and noiseless circulation of water through all coils and other heat exchangers in the respective systems. If proper circulation of water is not achieved due to air-lock or any defect, the HVAC contractor shall rectify the defects. He shall bear all expenses for carrying out the above rectifications including tearing up and making good of floors and walls as may be required.

#### **9.14.0 BALANCING:**

- 9.14.01 After the completion of installation and testing of piping, all the piping system shall be adjusted and balanced to deliver the water quantities as specified/as required/as directed.
- 9.14.02 The instrument/equipment required for adjusting and balancing the water system shall be accurately calibrated before taking any measurement. Calibrated orifices and portable flow meters shall be used to adjust and balance the water flow.
- 9.14.03 Automatic control valves and 3-way diverting valves, if provided in the system shall be set for full flow conditions during the balancing of the system. All regulating valves provided in the system. All regulating valves provided in the system for adjusting the water flow, shall be permanently marked after balancing is completed, so that they can be restored to their correct positions, if disturbed.
- 9.14.04 The contractor shall furnish a certified balancing report to the consultant for evaluation and approval.

#### **9.15.00 PAINTING:**

- 9.15.01 After successful completion of installation, testing and insulation all piping shall be given two coats of approved synthetic enamel paint (over insulated or un-insulated pipe surface) as per the colour coding to be specified by the consultant.
- 9.15.02 The direction of flow of fluid in the supply and return pipes shall be prominently marked in white arrows.

## **ELECTRICAL INSTALLATION**

### **10.01.00 Scope:**

- 10.01.01 Scope of this section comprises of the supply, erection, testing and commissioning of electrical switchgear and wiring installation.

### **10.02.00 General:**

- 10.02.01 Work shall be carried out in accordance with the specifications, local rules I.E. Act 1910 as amended up to date and rules issued thereunder, regulations of the Local Fire Insurance Association and Indian standards Code of Practice No. IS: 732-1963 and General Specifications for Electrical work (Internal) - 1977. For items of work not covered by any of the above regulations, wiring rules in the 13th edition of the institution of Electrical Engineer London, shall apply. Definition of terms shall be as in the I.E.E., Rules.

### **10.03.00 Wiring System:**

- 10.03.01 Wiring shall be carried out with PVC insulated, PIC sheathed and armoured cables. Wiring shall be suitable for a 3-phase, 50 cycles, 4 wire supply with 415 Volts between phases and 230 Volts between phase and neutral. The voltage and frequency of supply shall be subject to variations permissible under the Indian Electricity Act and Rules.

### **10.04.00 Material:**

- 10.04.01 All materials shall be of the best quality complying with the appropriate IS/BS specification. Material used shall be subject to the approval of the consultants and samples of the same shall be furnished wherever required. All switchgear shall be suitable for a system short circuit capacity of 35 M.V.A. at 415 Volts.
- 10.04.02 Isolators/HRC switch fuse units shall be of the heavy-duty pattern with a quick make and break movement. The MCCBs the isolators/HRC fuse-switch units shall be able to carry rated current continuously without excessive temperature rise or softening of welding of contacts. Provisions shall be made for the incoming and outgoing conduits or cable entries as required.
- 10.04.03 Control panel shall be constructed of high quality 2mm thick sheet steel stiffened and reinforced by a sturdy angle frame work. Care shall be taken to ensure that it is termite and vermin proof. The housing shall be of sectionalised construction. The rear section shall accommodate outgoing power cables / control cable and interlocking cables. Middle section shall contain 4 strips of aluminium bus bars and the front section would be for accommodating fuse-switch units along with HRC fuses, MCCB/MCB, star/delta or DOL Starter, indication lamps, interlocking/indication contactors and on and off push buttons. The front portion shall be divided into as many sections as per requirements of No. of feeders from particular switchboard. All these portions shall be used for accommodating accessories of the equipment as detailed above. Individual compartment shall be provided with plastic black anodised screwed name plate.
- 10.04.04 The bus bars and connections shall consist of hard-drawn high conductivity aluminium strip with PVC sleeves of appropriate phase colour. The bus bars shall be mounted edgewise on insulated bases which will permit sufficient movement for compensation of temperature stresses and also to withstand the electro-magnetic forces produced during short-circuits. The neutral bus bar shall be rated for 60% of the phase rating.
- 10.04.05 The sheet steel work shall undergo a process of degreasing, through cleaning and painting with high corrosion resistant primer. The panel shall then be baked in an oven. Finishing treatment shall be by application of synthetic enamel paint of approved shade.

#### **10.05.00 CablesLaying:**

- 10.05.01 Cables shall be laid generally in accordance with Indian standard Code of Practice.
- 10.05.02 Cables shall be laid in trenches or buried or carried on walls or overhead cable trays as stated in the schedule or indicated in the drawings or approved by Consultants. Where more than one cable will be running, proper spacings shall be provided to minimise the loss in current carrying capacity. Cable racks and trays shall be provided wherever specified in bill of Quantities.
- 10.05.03 Cables shall be suitably supported with angle iron clamps mounted on M.S. brackets/supports when taken along the walls. This distance between supports shall not be more than 1.0 meter.
- 10.05.04 Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bends of the cables when installed shall be sufficiently large to ensure that no undue stress is caused on the insulation/conductor.
- 10.05.05 Where cables pass through pipes, wooden bushes shall be provided at the ends. When cables made to pass through floors or walls, the holes for the cable shall be sealed in a manner approved by the Consultants.
- 10.05.06 With each cable, two nos. of earth conductors of sizes specified under sub-head "Earthing" shall be provided.

#### **10.06.00 Equipment Wiring:**

- 10.06.01 Final connections to the equipment shall be through flexible wiring particularly for equipment mounted on guide rails and which are liable to be moved.

#### **10.07.00 Wire/Cable Sizes:**

- 10.07.01 For all single phase/3-phase wiring, 650/1100 volts grade PVC insulated aluminium conductor wires shall be used. All power cabling shall be with PVCA cables. The PVC wires and cables, if used, shall be taken through M.S. conduits and final connections to the equipment shall be through M.S. flexible conduits rigidly clamped at both ends. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification.
- 10.07.02 The minimum size of control wiring shall be 1.5 sq. mm. PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels. Multi strand PVCA cable with 1.5 copper conductor can also be used for control wiring.
- 10.07.03 Power cabling shall be of PVCA cables with Aluminium conductor and shall be of following sizes:
- |       |                                                       |                                                  |
|-------|-------------------------------------------------------|--------------------------------------------------|
| (i)   | Up to 5 HP motors/2 KW heaters                        | 3x4 sq. mm. cables.                              |
| (ii)  | From 6 HP to 10 HP motors and 3 KW to 7.5 KW heaters. | 3x6 sq. mm. cables OR<br>2 Nos. 3x4 sq. mm cable |
| (iii) | From 12.5 HP to 15 HP motors.<br>(S/D Starter)        | 2 Nos. 3x10 sq. mm. cable                        |
| (iv)  | From 20 HP to 25 HP motors                            | 2 Nos. 3x16 sq. mm. cables.                      |

|        |                                                              |                              |
|--------|--------------------------------------------------------------|------------------------------|
| (v)    | (S/D Starter)<br>From 40 HP to 50 HP motors<br>(S/D Starter) | 2 Nos. 3x25 sq. mm. cables.  |
| (vi)   | 75 HP motors<br>(S/D Starter)                                | 2 No. 3x50 sq. mm. cables.   |
| (vii)  | 100 HP Motor<br>(S/D Starter)                                | 1 No. 3x70 sq. mm. cables.   |
| (viii) | 200 HP motor<br>(S/D Starter)                                | 1 No. 3x185 sq. mm. cables.  |
| (ix)   | 300 HP motor<br>(S/D Starter)                                | 2 Nos. 3x300 sq. mm. cables. |
| (x)    | 400 HP motor<br>(S/D Starter)                                | 2 Nos. 3x500 sq. mm. cables. |

10.07.04 All the switches, contactors, push buttons stations, indicating lamps shall be distinctly marked with a small description of the service installed. Circuit wiring diagram of control panel shall be fixed to the cover of control panel for verification. The following capacity contactors and overload relays shall be fixed to the cover of control panel for verification. The following capacity contactors and overload relays shall be provided for different capacity motors:

| Sl. No | Rating of Motors | Type of Starters | Contactor current capacity | Overload Relay Range |
|--------|------------------|------------------|----------------------------|----------------------|
| 1.     | 5 HPMotors       | DOL              | 16amps                     | 6-10amps             |
| 2.     | 7.5 HPMotors     | DOL              | 16amps                     | 9-14amps             |
| 3.     | 10 HPMotors      | StarDelta        | 12/16/16amps*              | 10-16amps            |
| 4.     | 12.5 HPMotors    | StarDelta        | 12/25/25amps*              | 10-16amps            |
| 5.     | 15 HPMotors      | StarDelta        | 16/32/32amps*              | 10-16amps            |
| 6.     | 20 HPMotors      | StarDelta        | 25/32/32amps*              | 13-23amps            |
| 7.     | 25 HPMotors      | StarDelta        | 25/40/40amps*              | 20-32amps            |
| 8.     | 40 HPMotors      | StarDelta        | 40/70/70amps*              | 28-42amps            |
| 9.     | 50 HPMotors      | StarDelta        | 40/70/70amps*              | 28-42amps            |
| 10.    | 75 HPMotors      | StarDelta        | 70/110/110amps*            | 45- 70 amps          |
| 11.    | 100 HPMotors     | StarDelta        | 110/200/200amps*           | C.T. Operated Relay  |
| 12.    | 125 HPMotors     | StarDelta        | 110/200/200amps*           | C.T. Operated Relay  |
| 13.    | 150 HPMotors     | StarDelta        | 200/250/250amps*           | C.T. Operated Relay  |
| 14.    | 200 HPMotor      | StarDelta        | 200/300/300amps*           | C.T. Operated Relay  |

#### Star/Line/Delta

#### 10.08.00 Earthing:

10.08.01 Earthing shall be as per IS:3043-1987 in all respects. The earth station shall consist of GI pipe and accessories as per IS: 3043 (Fig. 14 & 15). The connection between earth plate and main earth bar shall be by means of 3 Nos. 3/8" brass bolts and nuts. These bolts shall be fixed at least 4" apart. The earthing station shall be preferably located in a grassy lawn/near flower beds/near water tap. The earth stations shall be kept at least 2 metre away from the foundation of the building or outer face of the building. The distance between earth stations, shall be at least 5 meters. The resistance of the earth electrodes as measured with approved earth testing equipment shall not be greater than 0.5 ohms. In case of Rocky soil, it may be relaxed up to 0.8 ohms.

10.08.02

Earthings shall be galvanised iron strips/wires, or copper strips/wires as mentioned in schedule of quantities.

10.08.03 G.I. Earthing:

The main panel shall be connected to the main earthing system of the building by means of 2 Nos. 25mm x 6mm G.I. strips. All single-phase metal clad switches and control panels shall be earthed with minimum 3 mm diameter G.I. conductor wire. All 3-phase motors and equipments shall be earthed with two numbers distinct and independent G.I. wire/tapes as follows:

|                                                                                                                      |                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Motors upto and including 10 H.P. Motors 12.5 HP to 40 HP capacity. Motors 50 to 75 HP capacity. Motors above 75 HP. | 2 Nos. 4 mm dia G.I. wires. 2 Nos. 6mm dia G.I. wires. 2 Nos. 25mm x 3mm G. I. strips. 2 Nos. 25mm x 6mm G.I. strips. |
|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|

All switches shall be earthed with two numbers distinct and independent G.I. wires/tapes as follows:

- |                                                                             |                              |
|-----------------------------------------------------------------------------|------------------------------|
| (a) 3-Phase switches and control panels upto 60 amps rating.                | 2 Nos. 6mm dia G.I. wires.   |
| (b) 3-Phase switches and control panels 60 amp to 100 amps rating.          | 2 Nos. 8mm dia G.I. wires.   |
| (c) 3-Phase switches, control panels, bus ducts, 200 amps rating and above. | 2 Nos. 25mm x 6mm G.I. tapes |

#### 10.08.04 Copper Earthing:

The main panel shall be connected to the main earthing system of the building by means of 2 Nos. 25mm x 3mm copper tapes. All single-phase metal clad switches and control panels shall be earthed with minimum 2 mm diameter copper conductor wire. All 3 Phase motors and equipments shall be earthed with two numbers distinct and independent copper wires/tapes as follows:

|                                                                                                                      |                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Motors upto and including 10 H.P. Motors 12.5 HP to 40 HP capacity. Motors 50 to 75 HP capacity. Motors above 75 HP. | 2 Nos. 3 mm dia copper wires. 2 Nos. 4 mm dia copper wires. 2 Nos. 6 mm copper strips. 2 Nos. 25mm x 3 mm copper strips. |
|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|

All switches shall be earthed with two numbers distinct and independent copper wires/tapes as follows:

- |                                                                             |                               |
|-----------------------------------------------------------------------------|-------------------------------|
| (a) 3-Phase switches and control panels upto 60 amps rating.                | 2 Nos. 3mm dia copper wires.  |
| (b) 3-Phase switches and control panels 60 amp to 100 amps rating.          | 2 Nos. 4mm dia copper wires.  |
| (c) 3-Phase switches, control panels, bus ducts, 200 amps rating and above. | 2 Nos. 6mm x 6mm copper tapes |

The earthing connections shall be taped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be riveted with and brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance and properly tinned.

#### 10.09.00 Control/indication/interlocking wiring:

- 10.09.01 The control/indication/interlocking wiring shall be done with 1.5 Sq. mm PVC insulated and PVC sheathed armoured copper conductor cables of multicore as per requirement. All the machines as detailed in the drawing shall be remote controlled at the main panel board through push

buttons(ON/OFFButtons).Allthemachinesshallhavered/greenlampindicatorstoallowtheworking/off positionofindividual machines.Anelectricalinterlockingshall beprovidedfor

safe running of refrigeration machines i.e. the refrigeration machine shall only start after C.T. fans, condenser water pumps and chilled water pumps have started working. Control wiring for individual fan coil units shall be done with 2.5 Sq. mm copper conductor single core cables drawn in recessed conduit.

#### **10.10.00 Completion Drawings:**

10.10.01 Four sets of completion drawings giving single line diagram run of cables location along with detail panels, indication/interlocking circuits cable with sizes within the building/underground cables showing the location of straight through joint boxes, location of main earthing station shall be furnished within one month from the date of completion of the work.

#### **10.11.00 Testing:**

10.11.01 Before the commissioning of the plant and equipment the entire installation shall be tested in accordance with Code of practice IS 732-1963 (Revised') and the test report furnished by the qualified and authorised person. The electrical installation shall be got passed from local electrical inspector and a certificate from the electrical inspector shall be submitted. All tests shall be carried out in the presence of the owner/employers' representatives.

#### **10.12.00 Painting:**

10.12.01 All the switchgear panels, frame work, conduit etc. shall be painted with two coats of high corrosion resistant primer and the finishing treatment shall be by application of synthetic enamel paint of approved make and shade.

## MOTORS AND MOTOR CONTROL CENTRES:

### 11.01.00 General:

- 11.01.01 These specifications cover all types of motors used for driving pumps, blowers in the air handling units, compressors and other equipment in the HVAC system. The installation of motors and Motor Control Centres shall be carried out strictly in accordance with the specification as detailed in this section.

### 11.02.00 Motors

- 11.02.01 Rating: The ratings of the motors shall be as indicated in schedule of equipment and selected on the basis of ambient temperature and allowable maximum temperature rise as specified.
- 11.02.02 Standards: All motors shall comply with IS: 325, IEC 34-Part I or BS: 2313 in respect of general requirements and performance. Motors shall also conform to IS: 1231, IEC 72.1 for foot-mounted motors and IS: 2223 and IEC 72.2 for flange-mounted motors.
- 11.02.03 In general all the motors above 1 hp shall be 3-Phase unless otherwise specified, Motors of 1 hp or below shall be either 3-Phase or single Phase as required.
- 11.02.04 Motors shall run at all loads without appreciable noise or hum. Motors shall be one of the following designs as specified.  
Squirrel  
cage, Wound  
Rotor Totally enclosed  
Totally enclosed, fan cooled.
- 11.02.05 Windings of motors shall be class 'F' insulated and fully tropicalised. The insulating materials used shall not be liable for action of fungi or microbes. The insulations shall afford adequate protection against conductive dust.
- 11.02.06 Motors shall be rated for continuous duty as defined in IS: 325. All motors shall have suitable torque characteristics as required by the duty of driven equipment. Motors shall be suitable for operation on 415 Volts, 3-Phase, 50 - HZ, AC Supply (and 230 Volts single phase, 50 HZ AC supply for single phase motor).
- 11.02.07 Motors shall be provided with a combination of ball and roller bearings. The roller bearings shall be fitted on the driving end and the ball bearings shall be fitted on the free end. Bearings shall have ample capacity to deal with any axial thrust. The bearings shall be of standard cartridge type which effectively seals off dust and moisture. Suitable grease nipples shall be provided for re-greasing the bearing.
- 11.02.08 Motors shall be provided with a cable box to suit aluminium conductor, PVC insulated, PVC sheathed and steel armoured cable.
- 11.02.09 Motors shall be designed to operate successfully under the following conditions of voltage and frequency variation.

Where the voltage variation does not exceed 10% above or below normal. Where the frequency variation does not exceed 5% above or below normal.

Where the sum of voltage and frequency variation does not exceed 10% (provided the frequency does not exceed 5% above or below normal.)

11.02.10 Slip-ring motors shall be drip-proof construction. The degree of protection of the motor enclosure shall be IP-23 as per IS: 4691. The terminal boxes shall conform to degree of protection IP-55 as per IS: 4691. The slip-rings shall preferably be of phosphor-bronze on an insulated cast iron hub. The slip-rings shall be carried on an extension of the shaft at the non-driving end of the machine. Clearance between the rings shall be sufficient and adequate to allow flashover and to facilitate clearing. Brushes shall be of proper grade to give contact resistance. The slip-rings and brushes shall be easily accessible. A rigidly built fan secured to the shaft and shaped to give efficient airflow and adequate ventilation with quiet operation shall be provided.

11.02.11 Motors, except fractional horse power motors of 1/8 hp and below, shall be provided with running over current protection generally by means of a bi-metallic thermal overload protective device incorporated in the starter panel. Motors larger than 100 hp shall be provided with full thermal protection with a thermostat detector in the starter winding, measuring unit, tripping relay, and necessary wiring. The motor windings shall be provided with anti-condensation heater of 220V,

50Hz, 1-Phase.

G02.12 Motors starting current shall not exceed the following value.

Slip ring Motors : 150% of full load current.

Sq. Cage Motors : 60% of full load current.

Type of Motor

Starting Method

Squirrel Cage

Direct-on line

Motor Squirrel Cage

Star/Delta Starters.

Motor Wound rotor (slip-ring)

Rotor-resistance Starters

### 11.03.00 Motor Starters:

11.03.01 Motor starters shall be manufactured in accordance with IS-1882 or BS: 587. The starters shall be totally enclosed in metal clad, dust and vermin proof construction. Unless otherwise specified, all starters shall be direct on line, star/delta, auto transformer or stator-rotor pattern as required. All starters shall be of continuous rating and shall be of automatic contactor type. All starters shall be suitable for 415 Volts, 3-Phase, 50Hz, A.C. Supply.

11.03.02 Contactor shall have the number of poles as required for appropriate duty. The making capacity of the contactor shall be as per category A-4 conforming to BS: 775. All the contacts shall be solid silver or silver faced and all the contactors and starter equipment shall be designed for not less than 40 operations per hour.

11.03.03 Means shall be inherent in the starter for automatically disconnecting the starter from electricity supply in the event of interruption of supply. However, the contactor and associated under voltage relay shall be suitable for voltages down to 75% of the normal supply voltage.

11.03.04 Unless otherwise specified, all starters shall have integral Start/Stop push buttons. Start push buttons shall be coloured green and shall be shrouded to prevent inadvertent operation. Stop push buttons shall have mushroom heads and shall be coloured red. All push button operated contactors shall be provided with a hold-on/running contact.

11.03.05 All remote-control circuit connected to starters shall operate at 230 Volts or lower Voltage. Motor starters shall be provided with thermal overload relay with adjustable settings, on each phase for three phase Rotor. The motors of 100 hp and above shall be provided with current transformer operated thermal overload relays. The thermal over-load relays shall have thermal characteristics suitable for the associated motor, its starting characteristics and suitably compensated for ambient air temperature variations. Single Phase preventers shall be provided for all the three phase motors.

- 11.03.06 Green, Red, amber indicating lamps shall be installed on each feeder panel of starter to indicate open and close conditions of the contactors and fault conditions of motor as detected by the thermal overload relay.
- 11.03.07 Terminal blocks with integral insulating barriers shall be provided for each starter.
- 11.03.08 All the starters shall be provided with a schematic diagram on a durable material fixed permanently within each lid or cover.
- 11.03.09 Starters shall be provided with sufficient extra N/o and N/c contacts for interlocks, indicating lamps, etc.
- 11.03.10 Automatic Star/Delta starters shall be provided with adjustable timers.
- 11.03.11 Starters for wound rotor motors shall be rotor resistance type and shall be oil immersed, metal clad construction with combination of drum type rotor resistance stator and starter switch. Rotor starters shall be used for starting only. The stator switch shall be of heavy duty, with trip free mechanism. The tripping mechanism shall not reset until the starter handle is in OFF position.
- 11.04.00 Installation of Motors:**
- 10.04.01 Installation of the motors shall be in accordance with IS: 900. Motors shall be mounted on a common foundation with the driven machine or equipment coupled through a flexible coupling or through belt drive. The drive arrangement shall be provided with a safety guard.
- 10.04.02 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 with nuts and bolts to facilitate belt installation and subsequent belt tensioning.
- 10.04.03 Motors shall be wired as per the detailed specification and drawings. All motor frames shall be earthed with 2 Nos. copper earthing conductors of size not less than 8 SWG. Schedule of wiring cables and earthing conductors has been shown on the relevant drawings.
- 10.04.04 Motors shall be tested in accordance with the relevant Indian Standard/British Standard Specifications and test certificates shall be furnished in triplicate. Motors shall be tested at site after erection for insulation resistance.
- 10.04.01 All the motors, starters and frames shall be painted with two coats of synthetic enamel paint.
- 11.05.00 Motor Control Centres:**
- 11.05.01 General:
- Motor control centres shall be provided and installed wherever specified for controlling motors. Motor control centres shall comprise circuit breakers, switch fuses, starters, control and indicating equipment as specified. The motor control centres shall be totally enclosed, metal clad, flush front and back, cubicle pattern suitable for front and rear access. The motor control centres shall conform to IS: 8623.
- 11.05.02 Construction:
- Motor control centres shall be free standing type with basic structure being fabricated out of 14-gauge steel with reinforcing channels welded in place. All the doors shall be 14-gauge steel. The enclosure of motor control centres shall be in accordance with NEMA type 1 or 12 as specified. The motor control centres shall have a busbar chamber at the top or bottom and feeder

compartments of modular dimensions in vertical section. Vertical bus bars connected to the main bus bars shall be located behind each vertical feeder compartments. Individual compartments shall be of adjustable type and shall be convertible designs such that ratings of feeder control units can be changed if required. Circuit Breaker and switch handles and starter push button shall be mounted on the devices and not on the doors. Suitable screw and rawl device shall be provided on each compartment door for locking the doors in position. On the right-hand side of each vertical feeder/control compartment, a vertical wireways shall be provided with separate doors. Cable alley door shall be bolted type or otherwise as specified.

#### 11.05.03 Bus Bars:

All bus bars shall be suitable for 415 volts, 3-Phase, 4 wire, 50 HZ, A.C. Supply. Main and vertical bus bars shall be made of high conductivity aluminium. The thermal short circuit capacity of horizontal bars shall not be less than 45 KA rms, and that of vertical bus shall not be less than 37 KA rms. Bus bars shall be supported and braced at regular interval by non-hygroscopic, non-combustible, track resistant and high strength type polyester fibre glass moulded insulators. Separate support shall be provided for each phase and neutral. All bus bars shall be insulated with heat shrinkable sleeve of hard, smooth plastic insulation of high dielectric strength to provide non-ageing and non-tracking protection and shall hold good for temperature 0° C to 90° C. The bus bars shall be colour coded with coloured bands at regular intervals. The bus bars shall be adequately supported and braced to withstand stresses due to short circuit current.

#### 11.05.04 Earthing:

Entire motor control centre shall be provided with copper earth bus running throughout the length of the panel. In addition, a vertical earth bus shall also be provided in each vertical section to facilitate earthing of various feeder/control compartments trolleys. Feeder compartment trolley shall be provided with an earth pin which makes first and breaks after the main plug in contacts. Motor control centre shall be provided with 2 Nos earthing bolts for connection to the local earth grid.

#### 11.05.05 Unit Compartments:

Each compartment in a vertical section shall be provided with screw arrangement for jacking of the feeder trolleys. The trolleys shall be available in various modular dimensions. The movement of the feeder trolley shall be controlled by the screw jacking arrangement. The feeder/control equipment shall be mounted on the vertical wall of the trolley and all the components of feeder/control equipment shall be easily accessible from the front. Plug-in copper contacts of trolley shall be provided with a locking arrangement such that the movement of the trolley can prevent in both fully plugged-in and isolated position. It shall be possible to clamp the trolleys to the motor control centre structure when in fully plugged-in position by a screw. All the equipment mounted in the compartment trolleys shall be marked with proper designation as per the drawings. Each feeder/control unit compartment shall be provided with an independent door. Unit doors shall be fastened to the stationary structure by a removable hinge. Unit doors shall be held closed by a slotted, knurled quarter fastener. Suitable padlocking arrangement shall also be provided. All units' door shall be provided with rubber gaskets.

#### 11.05.06 Interlocking Arrangement:

Motor control centre shall be provided with the following safety interlocks.

All the switches/breakers shall be interlocked with door so that the unit cannot be closed unless the unit door is closed. This interlock shall also prevent opening the unit door unless the switch/breaker is in OFF position.

All the switches/breaker handles can be locked in ON-OFF position.

An integral operating handle shall be provided for each switch/breaker. The position of the breaker/switch shall be indicated by the operating handle.

A suitable de-interlocking device shall be provided for deliberate inspection of feeder switch/breaker without having to switch off the feeder.

11.05.07 Feeder/ Control Equipment:

Feeder and Control equipment shall be provided as per the drawings and schedule of quantities.

Switch fuses:

All the switch fuses shall conform to IS: 4064, IS: 4047 or BS: 3185.

Air Circuit Breakers:

All air circuit breakers shall conform to IS: 2516 or BS: 3659.

Moulded case circuit breakers:

All moulded case circuit breakers shall conform to BS: 3871.

Starters:

All starters shall be as specified herein before.

Current Transformers:

All CTs shall be as per specification.

Indicating Lamps:

Suitable Red, ON "Green, OFF" indicating lamps shall be provided on each feeder/starter compartments.

Ammeters:

Ammeters of suitable range as specified shall be provided for each feeder/starter compartments.

11.05.08 Wiring:

All control and auxiliary wiring shall be carried out with copper conductor, PVC insulated wires. Wiring shall be properly colour coded and laid out neatly in bunches and firmly fastened to the sides in the trolley. The terminations for conductors shall be done by crimping lugs on to the conductor ends. Suitable printed PVC ferrules shall be provided for easy identification of wires. Power wiring from the unit switches/circuit breakers to the starters shall be carried out using copper conductor PVC insulated wires of adequate current ratings suitable for the equipment.

The wiring shall be colour coded using red, yellow, blue and black for 3 phases and neutral respectively. All terminations shall be carried out by crimping lugs on to the conductor ends. The lugs shall be fastened to the equipment using suitable washers and screws. All the wiring shall be neatly bunched and fastened to the sides of the trolley. Wiring selection for power shall be done considering the effects of temperature rise, bunching. All conductors shall be provided with printed PVC ferrules for easy identification.

11.05.09 Terminals:

Suitable fixed or plug and socket type terminals shall be provided for each compartment of MCC for terminating the power cables. The terminals shall be of adequate rating to suit aluminium conductor, PVC insulated, PVC sheathed armoured cables. All the terminals shall be suitably numbered as per the wiring diagram.

11.05.10 Enclosure and Surface Treatment:

Motor control centres shall be of dust and vermin proof construction suitable for indoor installation. All doors shall have rubber gaskets. Adequate protection shall be provided so that ingress of dust and vermin, moisture encountered in indoor installations shall not in any amount be

sufficient to interfere with the satisfactory operation of the enclosed equipment. Sheet metal components and accessories of motor control centres shall be given a rigorous anti-rust treatment comprising of degreasing, phosphating before the primer paint are applied. The sheet metal shall then be stove enamelled with enamel paint to the approved finish. The interior of the motor control centres shall be painted to an off-white shade.

11.05.11 Name Plate:

Motor control centres as well as their individual compartments shall be provided plastic black anodised screwed name plates.

Diagram:

Each compartment of MCC shall be provided with a circuit diagram of its components and wiring and fixed on to the inner-surface of door or lid.

11.05.12 Danger Plate:

A standard danger plate indicating the voltage grade shall be provided on the motor control centre.

11.05.13 Testing:

The panels shall be tested after fabrication, assembling and wiring.

Wiring shall be tested with 1000 Volt megger to ensure adequate insulation resistance.

H.T. test shall be carried out with 2.5 KV rms for one minute to check the insulation of busbars.

Suitable injection tests shall be performed to check the corrections of calibration of meters, instruments and relays (if any).

11.05.14 Installation:

Motor control centres shall be installed at the locations shown on the drawings. All motor control centres shall be provided with an integral base channel frame for grouting the motor control centres to the floor. The MCCs shall be supplied with required number of anchor bolts.

The contractor shall supply foundation drawings for the motor control centres. The motor control centres shall be installed on the concrete foundations and fixed to the floor by means of foundation bolts. Wherever RCC foundation is not feasible/provided, robust steel channels with tapped holes shall be embedded in the floor for installing the control centres. The required cables shall be brought and terminated at the motor control centres, using cable glands, lugs and sockets. All the cables shall be properly arranged and led through the cable alley. The various power and control cables shall be clamped firmly on to the sides of the cable alley.

The tightness of all main and auxiliary busbar connections shall be checked. All wiring terminations and bus bar joints shall be tightened wherever necessary before energising the motor control centres.

NOTE:

The above specification is for withdrawable type MCC. However, the offer of the contractor shall be in line with specifications furnished in bill of quantities unless specifically called for in B.O.C., M.C.C.'s shall not be of withdrawable trolley type. However, wherever ACBs are used

they shall be of withdrawable type and switch units need not be of withdrawable type. The tenderers shall clearly state the type of MCC they have offered.

11.05.15 Calculation for Busbar Sizing:

The contractor, before manufacturing shall furnish calculations establishing adequacy of bus bar sizes for specified current rating, short circuit current and temperature rise consideration at specified ambient temperature. The busbars and jumper shall be of high conductivity aluminium alloy of 63401WP and sized as per IS-5082.

**11.06.00 Moulded Case Circuit Breakers:**

11.06.01 The MCCB shall conform to IEC-947 / IS 13947 with rated duty short circuit breaking capacity ICs 40 KA. MCCBs shall be provided with rotary type door mounted handles. MCCBs shall be current limiting type with tripping time less than 10 ms.

11.06.02 MCCBs shall be provided with "load" and "line" interchangeable terminals for ease of termination and maintenance. MCCBs shall have minimum electrical life of 8000 operations (close-open). The MCCBs used for motor protection shall have an electrical life of minimum 100,000 (close-open).

11.06.03 The MCCB shall be quick make, quick break, independent Manual, current limiting type with trip free features and shall be provided with adjustable type tripping device with inverse time characteristics for overload protection and instantaneous characteristics for short circuit current. It shall be possible to adjust the continuous current settings over wide range with the help of setting plug.

11.06.04 The operating mechanism shall operate irrespective of the speed and force with which the operating lever is moved. During trip, the moving contact shall open even if the operating lever is held closed.

11.06.05 The breaker shall ensure that the operating lever reflects the position of the moving contact positively. The position of operating lever shall be marked „I“ for breaker closed and „O“ for breaker open and intermediate (Yellow) for breaker tripped.

# TECHNICAL SPECIFICATION, DESIGN PARAMETER & SPECIAL CONDITION OF CONTRACT FOR HVAC SYSTEM (VRF)

## VARIABLE REFRIGERANT FLOW (VRF)

### General

The scope of this section comprises the design, supply, erection, testing and commissioning of inverter technology based VRV/VRF type system of air conditioning summer cooling and winter heating conforming to these specifications and in accordance with the requirements of Design and Drawing. The prices quoted shall include all the equipment ancillary material as specified and all such items whatsoever and which may be required to fulfill the intent and purpose as laid down in the specification and the approved drawings. The contractor shall calculate equipment capacity based upon design parameters specified for the system design & verify all the quantities and sizes of refrigerant pipe, fitting/cables, control cable, pipes, insulation, indoor units, outdoor units etc. before placing the order to avoid any shortfall or surplus. The tenderer shall also include all necessary civil work/MS frame work for installation of outdoor and indoor units in VRV/VRF based air-condition system. This shall include R-410A & its charging for proper & specified functioning of air-conditioning system.

Civil work/MS frame work for indoor and outdoor units related to VRV/VRF equipments, all cuttings should be properly finished as existing surrounding. The installation of outdoor unit on the terrace of building should be checked up structurally & their mounting should be structurally safe of the outdoor unit to ensure in such a way that after installation

Cutting of walls and  
floors/ceiling. Making holes.  
Sleeves. Foundation.  
Foundation.

The scope in the tender schedule also covers detailed designing of complete air-conditioning system based on inverter technology based VRV/VRF air-conditioners with air-cooled outdoor unit's system capable of cooling as per individual or season requirement suitable for operation on 415V, 3 phase, 50Hz AC electric supply.

The outdoor units shall have cooling mode, consisting of one/multiple outdoor unit with single circuit of refrigerant piping and multiple indoor units of various types. Each indoor unit should have capability to cool as per seasonal weather changes. This shall also include complete capacity calculation for indoor and outdoor units complete with AUTOCAD drawing, designing & layout of following.

- Outdoor units.
- Indoor units.
- Refrigerant piping and insulation.
- IV) Condensate drains water piping and insulation & disposal. Power & Control Cables between Outdoor units & Indoor units.
- VI) Building Management system for HVAC

While designing the system care should be taken to select outdoor units of suitable capacity based on design data provided & to economize on available floor area for installation of outdoor units as well as optimum utilization of outdoor units. The indoor units should be designed based upon the heat load calculations for individual rooms/ areas to be air-conditioned and over capacities should be avoided. The designing of HVAC PC based BMS (Building Management System) so that complete system shall be monitored & controlled from one location for optimum utilization of system & for keeping monthly as well as continuous log of important parameters/ events of

complete air-conditioning system. The design should also specifically take care of disposal of condensate drain water so that there is no leakage of condensate water inside the room as well in the route of condensate water pipe line. The layout of refrigerant piping is to be designed in such away so that it should not disturb the aesthetic of the building / room, inadvertent damage in the route of pipes should not occur in failure & optimum length of pipeline for efficient air-conditioning. After completion of the work four set of „as erected/commissioned drawing“ of activities listed above shall be submitted.

## **Design Data**

The work of air-conditioning (with R410A based refrigerant) and indoor units as specified in BOQ of this document is required to be carried out at site. The specified design parameters are only tentative in nature; however, all efforts shall be made to achieve the following specified design parameters and *if at any design stage need for higher capacity outdoor Unit or Indoor Units is required, necessary approval shall be accorded based on design analysis and discussions on the subject from the Consultant.*

**The tenderer shall quote only those makes for which he has satisfactorily executed the job and shall also furnish certificate to the effect that the such equipment has performed satisfactorily under outdoor weather conditions at least for a period of one year from its commissioning. The performance certificate from the end users shall also be enclosed with the tender documents.**

The project of air-conditioning is required to be executed in time bound and professional manner. The equipments involved in air-conditioning are complex in nature comprising of instrumentation, controls and building management system. The job, therefore calls for highest order of technical expertise and also requirement of experience of air-conditioning installation with proven performance. The tenderer, shall, therefore obtain, before quoting/the consent of OEM and furnish the same along with the bid document. This consent shall also cover aspects of desired assistance in the field design, development, testing, execution, completion & maintenance/ maintenance spares of the air-conditioning system.

Notwithstanding the technical details as specified in the tender, the manufacturers may offer/indicate systems and necessary design & features applicable for the offered products at the tendering stage.

## **OUTDOOR UNIT**

For testing and evaluation consideration, JIS B8616 or equivalent standard shall be applicable.

The outdoor unit shall be factory assembled, weatherproof casing (Material of construction of casing shall be vendor's standard design), constructed from heavy gauge GI sheets steel panels and coated with baked enamel finish. The outdoor unit shall be completely factory wired, tested with all necessary controls & filled with first charge of refrigerant before delivering at site.

The inverter technology based VRV/VRF equipment should be capable so that refrigerant piping between indoor units and outdoor unit shall be extendable up to 100m with maximum height difference between outdoor & indoor unit of 50m & level difference between two indoor unit maximum up to 15m. However, such long pipeline and head difference may not be applicable for this project.

The minimum acceptable value of Coefficient of Performance (COP) of the offered system, in conformance with JIS B8616 or equivalent, shall be not less than 4.0 at 50% rated load

with 32 deg C outdoor and 22 deg C wet bulb conditions for 48 HP or equivalent nearest size outdoor unit as per OEM standard catalogue. In case, tests have been done to work out COP from other than JIS B 8616, the standards along with necessary test procedure shall be furnished along with the tender.

The above COP values, as indicated in (iii) above are required to be furnished, in original, by the tenderer directly from the original equipment manufacturer (OEM) with OEM's seal and signatures on all the documents pertaining to the backup information for example cooling capacity at capacity indexes varying from 130% to 30% (in steps of 10%) for outdoor temperature (deg C DB) varying from 20 to 32 deg. and indoor temperature (deg C WB) varying between 24 deg. C duly indicating the total cooling capacity and power input in kW. The data shall be preferably in steps of 2°C. The final testing, shall be carried out as per required standards to verify the values as furnished by OEM.

The tenderers may please note that above guaranteed figures may be checked by the client, at any stage of the work, through its nominated inspection agency either at OEM's works or duly certified laboratory in accordance with JIS B 8616 or equivalent standard.

During the above inspection/testing, if the results are found exceeding i.e. 1.5% than quoted in clause (a) above, a penalty of 5% of the contract value or higher shall be imposed besides.

The outdoor unit shall be factory tested and filled with first charge of refrigerant R-410A before delivering at site.

It should also be provided with duty cycling for inverter scroll compressors capable of changing the rotating speed of compressor by inverter controller to follow variation in cooling and heating loads & switching starting sequence for better stability and prolonging equipment life. Outdoor units above 5 HP may have minimum 2 compressors and shall be able to function with one of the compressors in failed condition.

The compressors installed in the outdoor units shall be preferably equipped with at least one inverter compressor up to 12 HP, two inverter compressors up to 24 HP, three inverter up to 36 HP and 4 inverter compressors beyond 36 HP so that operation is not disturbed on failure of any of the compressor.

The outdoor unit shall be suitable for mix match connection of all types of indoor units.

It should be provided with duty cycling for switching the starting sequence of multiple outdoor units.

The outdoor unit shall be modular in design and should be allowed for side-by-side installation.

The unit shall be provided with its own microprocessor control panel with provision for integration with the Building Management System for air-conditioning system.

- xi. The outdoor unit should have anticorrosion paint free plate for easy mounting of unit.

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

The outdoor unit should be fitted with low noise level and should not be more than 67 dbat normal operation when measured at 1.5m distance from ground level.

The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss.

The outdoor units are connected to multiple indoor units of various types as such the combined operating loads of indoor units may touch 120 to 125% of the nominal capacity. The outdoor unit shall be able to perform at the combined loads demands as indicated above.

In case of trouble occurs in an indoor unit(s), the continuous operation of system should be possible.

The unit shall be designed in such a way that cleaning of drain Pan should be easy & inspection/replacement of compressor should be easy.

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

### **Compressor**

The compressor in inverter-based system shall be highly efficient. The system should respond efficiently in accordance to the variation in cooling or heating load requirement.

The inverters shall preferably be IGBT type for efficient & quiet operation.

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

Oil heater shall be provided in the compressor casing or as per manufacturer standard equipments.

### **Oil Recovery system**

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

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

### **Refrigerant Circuit**

The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valve at condenser end.

The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

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

### **Heat Exchanger**

The heat exchangers shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil. The aluminum fins shall be covered by anti-corrosion resin film.

The units should be with by-pass/e-pass heat exchanger to optimize the path of heat exchanger and for better arranged for vertical discharge. Each fan shall have a safety guard.

### **Safety Devices**

All necessary safety devices shall be provided to ensure safe operation of the system. Following safety devices shall be part of outdoor unit, high pressure switch, fuse, fan drive overload protector, fusible plug, crankcase heater over load relay, overload protection for inverter.

The outdoor roof mounted units shall be provided in such a fashion that these do not affect the overall aesthetics and ambience of the Stadium. If required, these units shall be suitably camouflaged to give a good aesthetic look. These provisions, however, shall be discussed, if required, at a later date and the prices for the same shall be worked out separately as extra item.

Noise levels for outdoor units shall not be more than 67 db (measured at point 1 meter in front of the unit at a height of 1 meter).

### **INDOOR UNITS**

General:

All indoor units as specified under this item shall have, in general, noise levels less than 46 dB. For critical application noise levels below these limits may, however, be specified during design stage.

Each Unit shall have electronic control refrigerant flow rate respond to load variation of the room.

The address of the indoor unit shall be set automatically in case of individual and group control.

In case of centralized control system, it shall be possible to set the address of individual indoor unit through a liquid crystal remote controller.

The fan shall be high static, dual suction, aerodynamically designed turbo, multi-blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having support from housing.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21 kg/sq. cm or as per OEM standard air pressure underwater.

Indoor unit shall have cleanable type filter to an integrally moulded/moulded plastic frame. The filter shall be slide in and neatly insertable type. It shall be possible to clean the filter either with compressed air or water.

Each unit shall have computerized PID control for maintaining designed room temperature. Each unit shall be provided with microprocessor thermostat for cooling.

Each ductable unit shall have with corded remote controller and each high wall & cassette type indoor unit shall be with corded remote controller as standard features. The remote controller shall memorize the latest malfunction code for easy maintenance. The controllers shall have self-diagnostic features for each and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap (for high wall unit) individually as per requirement.

The unit shall be high wall mounted type. The unit shall include pre-filters, fan section and DX-coil section. The housing of the unit shall be powder coated/heat treated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type.

#### **Highwall Indoor type unit**

The unit shall be high wall mounted type. The unit shall include pre-filters, fan section and DX-coil section. The housing of the unit shall be powder coated/heat treated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo type.

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

#### **Ceiling Mounted Type Indoor Unit**

The unit shall be ceiling mounted type. The unit shall include synthetic non-woven type filter, fan section and DX-coil section. The housing of the unit shall be powder coated/heat treated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners.

Unit shall have an external attractive panel for supply and return air. Unit shall have supply air grilles and return air grille.

Low gas detection system and sound level shall be as OEM standard.

All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view.

#### **Ductable type Indoor unit**

The unit shall be ductable type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated / heat treated galvanized steel. The unit shall have high static fan for ductable arrangement and it should also have suitable arrangement for drain water.

The ductable unit shall be used as recirculation unit as well as fresh air units.

#### **Building Management System for Air-conditioning System**

Air-conditioning network shall have capability of monitoring minimum 200 indoor units. The system shall have capability of monitoring the overall system through a central computer with one unit as stand-by. The system shall have the capabilities such that detailed settings can be programmed for each indoor unit/whole building/group/remote control group. The system shall be conventional PC based system P-4 or higher version with a minimum speed 2 GHz, CPU Intel motherboard with 256 MB DDR2 RAM, Hard disk storage 160 GB or more and 19" flat TFT monitor with CD/DVD R/W drive. The make of PC's are HP/Compaq, HCL, IBM. The system should be supplied with suitable capacity online UPS of 120 minutes standby capacity.

The same BMS should control the temperature, humidity of the Central system and shall accord ON, OFF, Trip of all AHU fans, return air fans, Heat wheel etc.

### **Control System Components:**

The above computers shall be capable of data input/ output from intelligent units with bus running between central control systems and indoor units/ other associated air-conditioning systems installed in the building. The minimum system configurations shall be as under:-

Minimum 200 indoor units with intelligent processors sufficient to handle above system as interface between the main PC and individual equipment controls.

Ethernet TCP/IP / 10 base/T communication.

Intelligent processor units shall have minimum 18 input ports with two digital output ports and shall have standalone capability for a period of minimum 48 hours.

### **Management**

The software system capable of recoding operational history management generation of reports in graphic and table from daily, weekly and monthly and operation in eco mode shall be provided. The above management system shall be complete in all respects to enable these functions.

The software should be easily installable using just CD. The software should be user friendly & run on Windows 2000 & Windows XP Professional/ Home with latest version/ updates so that it can easily run on any PC. It shall have the capability to calculate electricity billed/charged for multiple indoor units connected, schedule monitoring & control, error display with audible alarm & text, operating record of indoor units with accumulated operating time of outdoor unit.

### **Controls:**

The PC system mentioned above shall be capable of individual system control/group control with automatic cool, power failure/release control temperature control and timer etc. The unit shall also be capable of monitoring through graphic user interface operation fault indication, set point indication and any other parameters as may be deemed required.

The system shall be fully compatible with the VRF inverter-based equipment/ system proposed to be installed against this contract.

All the system designs related to this control system hardware software and control wiring/interfaces shall be included in the scope of work and detailed designing etc. shall be provided before commencement of installation of the system.

### **Centralized Type Remote Controller**

A multifunctional compact centralized controller shall be provided with the system. These controllers shall be capable of controlling all the indoor and outdoor units and should be capable of integration with the PC based Building Management System of HVAC.

It shall be able to control the indoor units with the following

functions: Starting / stopping of Air-conditioners as zone or group or

individual unit. Temperature setting for each indoor unit or zone.

Switching between temperature control modes, switching of fan speed and direction of air flow, enabling/disabling of individual remote controller operation.

Monitoring of operation status such as operation mode and temperature setting of individual indoor units, maintenance information and trouble shooting information.

Display of air conditioner operation history.

Daily management automation through yearly schedule function with possible various schedules.

### **Y-joint/Ref. net separation**

Supply & installation of the Y-joint/ref.-net separation refrigeration pipe joints and headers in the appropriate orientation to enable correct distribution of refrigerant. The distribution joints should be factory insulated with pre-formed section of Expanded polystyrene/Equivalent.

### **Refrigerant piping**

Refrigerant piping for the air-conditioning system shall be up to 19.05 mm dia. of soft seamless copper tubes & for above 19.05 mm dia the pipe material shall be of hard seamless copper tubes with pipe material being hard drawn copper pipe. Forged copper fittings shall be used for the refrigerant piping. The refrigerant piping arrangement shall be in accordance with good engineering practice as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuit except y-joint/separation tubes. Before jointing any copper pipe or fittings, its internal shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.

After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specified by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to a vacuum of not less than 700 mm Hg and held for 24 hours.

The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit the thickness of copper piping shall not be less than 18 SWG for pipes up to 19.05 mm and 16 SWG for larger dia.

The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter. All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fastener, brackets and supports which shall be fixed to the building/structure by means of inserts or expansion shields or anchor fasteners of adequate size and number to support the load imposed thereon.

The refrigerant piping should be laid in core cut in the floor in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner by making appropriate boxing arrangement matching with the interior of the room. All associated minor Civil Engineering works (like chasing on wall, ceiling & re-plastering and repainting etc.) related with the above items are included in the scope of work. The above scope does not include false ceiling wherever required.

To protect Nitrile rubber insulation of outdoor installed copper piping from degradation due to ultra violet rays and atmospheric condition, it shall be covered with polyshield coating of at least two coats of resin and hardener (polybond make or equivalent). Fibreglass tapes shall be helically wound with adequate overlap & coated with two coats of resin with hardener to give smooth & plain finish.

Entire liquid and suction refrigerant pipelines including all fittings, valves and strainer bodies etc. shall be insulated with 19mm/ 13mm thick elastomeric Nitrile rubber.

### **CODES & STANDARDS**

Design, manufacturer, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below.

|         |                                            |
|---------|--------------------------------------------|
| IS- 655 | -Specification of metal air ducts          |
| IS- 277 | -Specification for G.I. Sheets.            |
| IS-659  | -Safety code for Air-conditioning          |
| IS-660  | -Safety code for Mechanical Refrigeration. |
| IS-3253 | - Phase induction Motors.                  |
| IS-210  | -For Grey Iron Casting.                    |
| IS-226  | - Structural Steel.                        |

Standard codes for testing Centrifugal and Axial Flow Fans AMCA Bulletin No.210.

## TECHNICAL SPECIFICATIONS OF SPLIT/PRECISION AIR CONDITIONERS

### 1.0 SPLIT TYPE AIR CONDITIONERS

#### 1.1 Technical Specification

The Air conditioning machine shall be with "High Wall" type indoor unit, outdoor condensing unit, Reciprocator compressor, Auto Swing/Sweep, 4-way Air Deflection System, necessary refrigerant piping & electrical wiring between outdoor and indoor units through PVC flexible conduit, refrigerant R-22, microprocessor control, Wireless Remote Control with (Operation Display, Start-stop, Operation Mode Selection, "ON" Timer, "OFF" Timer, Time Setting, Air Circulation, Timer, "SET", Timer, "CANCEL", Room Temperature Checking, Vertical Airflow Direction Control, Room Temperature Setting, Indoor Fan Speed Selector, Jet Cool) electronic thermostat, high purity filter, time delay feature, oscillating louver, 3-speed cooling, condensate drain piping Frost-proof Evaporator Pipe

### 2.0 PRECISION AIR CONDITIONERS

#### 2.1 Technical Specification

The Air conditioning machine shall be with "High Wall" type indoor unit, outdoor condensing unit, reciprocating compressor, Auto Swing/Sweep,

4-way Air Deflection System,  
necessary refrigerant piping & electrical wiring between outdoor and indoor units  
through PVC flexible conduit,  
refrigerant R-22,

microprocessor control,  
 Wireless Remote Control with (Operation Display, Start-stop, Operation Mode Selection,  
 „ON“ Timer, „OFF“ Timer, Time Setting, Air Circulation, Timer, „SET“, Timer, „CANCEL“, Room  
 Temperature Checking, Vertical Airflow Direction Control, Room  
 Temperature Setting, Indoor Fan Speed Selector, Jet Cool)  
 electronic  
 thermostat, high purity  
 filter, time delay  
 feature, oscillating lou  
 ver,  
 3-speed cooling, condensate  
 drain piping Frost-proof  
 Evaporator Pipe Heater  
 Humidifier

## 2.2 Voltage Stabilizer:

Servo Controlled Voltage Stability AC, single phase without output sensed, active time delayed, manual  
 start/resettable high & low voltage trip facilities.

Rating: 1.0kva, AC Single

Phase Input Range: 170 V to

270V Output Range: 230V

±1%

Output Wave Form: The output wave form is a true replica of the  
 input. Correction Rate: 35V/sec for each phase

Effect of Load P.F.: None

Metering: continuous monitoring of input/output voltage.

Input indications: high and low voltage indicators (with audible alarm). Control:

Automatic / Manual

Protection: Circuit Breaker

Ambient Temperature: up to 45°C

max Nature of Cooling: Air cooled

Type of Motor: A.C. Step Synchronous Motors.

## **SPECIAL CONDITIONS AND TECHNICAL SPECIFICATIONS FOR FIRE PROTECTION & FIRST AID FIRE FIGHTING APPLIANCES**

### **1.0 Instructions to Tenderers**

#### **1.1**

Before filling up, the complete Tender Specifications should be read properly and the tenderers shall visit the site and make themselves thoroughly acquainted with the nature and requirements of the work, facilities for access of materials, mode of transport and storage and removal of spoils and rubbish.

#### **1.2 During submission of lump-sum offer, attention should be paid on the following points:-**

1.2.1 While filling the data sheet, enclose with the scope of work i.e. Vol III of the Tender document, the name of manufacturers should be specified properly based on the list of recommended manufacturers enclosed with the Tender document.

1.2.2 Moreover, writing like "Best available make" will not be accepted without the submission of satisfactory test report.

1.2.3 For imported equipment or material, if offered, no import assistance can be provided by the client.

#### **1.2.4**

Tenderers should furnish along with the offer, the schedule of recommended spares for trouble-free operation of the system(s) for three years.

1.2.5 Submission of tender will be the conclusive evidence as to the fact that the tenderer has fully satisfied themselves as to the nature and scope of the work to be done, site conditions and all other factors, affecting the performance of the contract and the cost thereof.

1.2.6 The entire job shall be executed by Bidder based on the guidelines furnished in the scope of work, specifications, various codes/standards, bidder's experience and good engineering practice. Items and quantities, which have been furnished in the scope of work, specification, are tentative and indicative only. During quoting, the Bidder must take into consideration of any additional items necessary for satisfactory operation of the system(s), for which no additional payment will be granted beyond the lump-sum amount quoted for the entire system.

1.2.7 The layout of control cabling for Fire Alarm System should be made at site in close coordination with the Engineer-in-Charge or his authorized representative.

### **2.0 Type of Fire Protection, Detection System & Design Philosophy**

2.1 The system covered under this specification shall be designed, manufactured & tested for proven, reliable & trouble-free performance. It shall be capable to identify the fire and would continuously monitor the ambient condition of the protected area through Analogue Addressable Fire Detection & Alarm System. The type of protection and detection system to be provided are.

2.1.1 Yard Hydrant with Wet Riser

2.1.2 Sprinkler System

2.1.3 Analogue Addressable Fire Detection & Alarm System

## **2.2 Yard Hydrant with Wet Riser**

- 2.2.1 A well designed and well laid hydrant service is the backbone of the entire fire fighting system as it fights fires of serious proportions in all classes of risks and continues to be in full operation even if part of affected building and/or structures have collapsed and also keeps cool the adjoining properties, thereby minimizing the exposure hazards.
- 2.2.2 Wet Hydrant system shall essentially consist of Fire Water Pumps, Piping, Isolation Valves, Hydrant Valves, Hose with Coupling, Branch Pipe with Nozzle, Hose reel etc
- 2.2.3 Underground piping shall be laid around the complex with a minimum distance of 2 M from the face of the building. Yard Hydrant shall be installed on the underground piping. Four nos. risers shall be provided along with the staircase. One no. landing valve and one no. hose reel shall be installed at each floor from each riser. Hose boxes to be mounted near each hydrant / landing valve. Each hose box shall consist of two nos. hose with coupling & one no. branch pipe with nozzle & one no. spanner. Isolation valves in underground piping network shall be provided inside valve chamber covered with C.I. cover.
- 2.2.4 Pumping system shall be connected to the ring main piping. Pumping system shall consist of one no. electric motor driven fire pump, one no. diesel engine driven standby pump, one no. jockey pump, and one no. composite control panel etc.
- 2.2.5 In case of fire outbreak, hose pipes fitted with branch pipe and nozzle are to be connected to the hydrant valves/landing valve and then hydrant valves/ landing valves are to be opened, and the pressurized water jet is to be directed towards the seat of fire for extinguishment.

## **2.3 Operation Philosophy**

### **2.3.1 Pumping Systems**

- 2.3.1.1 This is a combined system consisting of Fire Hydrant & Sprinkler System. Normally pipeline upto the Hydrant valve/ sprinkler head shall be kept pressurized at a pressure of 7.0 Kg/cm<sup>2</sup> by the jockey pump. To take care of minor leakages from the system jockey pump shall start & stop automatically so that system pressure is maintained.
- 2.3.1.2 In the event of fire outbreak, the jockey pump would come into operation automatically but since the water demand would be more, the jockey pump would not be able to meet the demand and pressure would fall further, resulting in bringing the main electric motor driven fire pump into operation automatically ensuring a steady supply of water to the system.
- 2.3.1.3 If electric motor driven pump fails to start, or if the line pressure further goes down due to further higher demand, the standby diesel engine driven pump shall come in operation automatically. However, the pump shall be stopped manually only after ascertaining that the fire is extinguished.
- 2.3.1.4 Provision of manual starting of the Pump shall also be provided.

## **2.4 Automatic Sprinkler System**

- 2.4.1 The most important principle of successful fire extinction is to attack an outbreak immediately which means, any device, which can detect an outbreak of fire automatically and then helps to extinguish it with a minimum fire loss. Automatic sprinkler system using water as an extinguishing medium has been universally adopted for this purpose. It also raises an alarm to alert people nearby.

- 2.4.2 Automatic Sprinkler System shall essentially consist of underground & above ground piping, Installation Control Valves (ICV), stop valves, sprinkler heads etc. Water in the pipeline shall be pressurized at all times. In case of fire, fragile bulb provided on the sprinkler shall collapse at a pre-determined temperature, thus allowing water to discharge on the seat of fire. Sprinkler heads shall be provided in such a way that each sprinkler should cover the floor area.

## **2.5 Analogue Addressable Fire Detection and Alarm System**

- 2.5.1 There shall be one no. Fire Alarm Control Panels with work station to be installed in the control room. The system shall comprise of Analogue Addressable Multi criteria detectors (heat + opt), Heat detectors, which would continuously monitor the ambient condition of the protected area. Detectors are installed in the areas where chances of fire occurrence may happen. All the detectors in each floor are to be wired up and directly hooked up with the Fire Alarm Control Panel. All the detectors are provided with a built-in LED, which will glow steadily in case of detecting a fire. In the event of fire outbreak respective sensor would sense smoke/heat and register an audio-visual annunciation in the Fire Alarm control panel identifying location of fire. In the event of fire outbreak or an emergency in any floor, person identifying the same will operate a manual call point.
- 2.5.2 The panel logic shall be such that when any Detector or MCP (Manual Call Point) is operated, immediately sounders in the fire floor will raise an alarm. All sounder shall be provided with strobe.
- 2.5.3 The panel also will register an audio-visual alarm for the respective floor.

## **2.6 Public Address & Talk Back System**

- 2.6.1 Adequate no. of Speakers are installed in each floor duly hooked up with a 250 W Amplifier and emergency Battery backup for alerting the inmates of the building in case of emergency.
- 2.6.2 Also talk back system is provided in each floor duly hooked up with the master set.
- 2.6.3 Both the PA & talk back system are controlled from the central control point located in the Electrical Sub-station building.

## **2.7 Fire Extinguishers & Safety Signage**

- 2.7.1 Different type of Fire Extinguishers shall be provided.
- 2.7.2 EXIT signs are to be displayed prominently in all floors at the exits to assist evacuation, in case of emergency.
- 2.7.3 Fire Order Notice Boards are to be displayed at the main entrance & other prominent locations of the buildings.

## **3.0 Intent of Specification**

- 3.1 It is not the intent to specify completely herein, all details of design and construction of the equipment/system. However, the equipment/system shall conform, in all respect, to high standard of engineering, design and workmanship in all respect and be capable of performing continuous commercial operation in a manner acceptable to the department, who interpret the meaning of drawing and specification and shall have the right to reject any work or materials, which in their judgment is not in full accordance herewith.

3.2 This specification is intended to cover the design, engineering, manufacture, test and inspection at works, properly packed for transportation, delivery to site, storage, erection, testing, commissioning, performance demonstration at site and handing over to the department the Fire Hydrant system with Wet riser, Automatic Sprinkler system for the building & Fire Detection Alarm system with Public Address & Talk Back facilities.

3.3 The entire system shall be engineered by Bidder based on the guidelines furnished in the specification, various codes/standards, bidder's experience and also good engineering practice. Item and quantities, which have been furnished in the specification and scope of work, are tentative and indicative only. During quoting, the Bidder shall vet the above scope of work and may furnish additional items necessary for satisfactory operation of the system, and the cost of which must be included in the overall lump-sum quoted price of the Bidder.

#### **4.0 System Description**

4.1 The Fire Protection and Fire Alarm System should be in line with the drawings indicated under list of tender drawing, furnished herewith. The complete work should also comply with the system description, technical specification/ data etc. as furnished hereinafter and the quantities shown in the scope of work is for the guidance of the tender. The relevant drawings and detailed specification etc. as contained in the tender documents shall form the basis of execution & lumpsum payment and not the schedule of quantities which is given only for guidance. Any additional equipment, material, service which are not specifically mentioned but required to make the system complete operational and acceptable to the Dept./ Local authority shall be deemed to be included in the scope and be furnished without any extra cost to Department.

4.2 Manufacture or Procure, Supply, Delivery to site, Storage, Installation, Testing, Commissioning, Performance, Demonstration at site and handing over to purchaser the complete fire protection and fire alarm system for the instant work.

4.3 Supply of all the equipments/materials should be completed in all respects i.e. all necessary accessories like initial packing/gasket/lubricant/fuel, special tools, first charge of refill, commissioning spare, etc as may be needed for proper installation and operation, irrespective of whether specifically mentioned in the technical specification or not.

4.4 Furnishing of all necessary documents as may be needed during the course of complete execution of the job viz. construction drawing as may be required for the Fire Protection System & Fire Alarm System including as erected drawings, operation/maintenance manual, manufacturer's test certificate, dimensioned drawing indicating part number, material specification etc.

4.5 In the interest of standardization, department reserves the right of selecting a particular manufacturer of fire protection equipment/component and the Tenderer/ Contractor should supply the same of the particular make, if so required.

4.6 Providing anti-corrosive treatment for buried piping and painting for above ground piping/equipment including supply of auxiliary steel members as necessary along with associated civil work related to above/underground piping and cabling such as excavation, backfilling, construction of brick masonry chamber with manhole cover for under-ground valve, chipping off foundation for pump/other equipments & grouting, opening in brick wall for routing of pipe/cable and sealing the opening.

4.7 Assistance to department in getting necessary approval from local fire service authority i.e. final N.O.C. The assistance shall include arranging, participating in discussion with the said fire service and as per

the prevailing norms, after completion of all the fire protection and fire alarm

system work the Director of local fire services shall be approached for inspection and testing of the same. More precisely, the complete responsibility of getting the Final N.O.C. shall be with the contractor.

## **5.0 Services outside the scope of Fire Protection & Fire Alarm System work but included in the scope of Civil & electrical Work of Lumpsum Tender/Contract**

- 5.1 Civil work associated with construction of pump house, water reservoir, equipment foundation, floor/wall inserts, all puddle pipes, pipe trench, cable trench, providing and laying of R.C.C pipe under roads as may be needed for the instant job.
- 5.2 Power Supply for all electrical equipment as detailed in specification

## **6.0 System Description**

- 6.1 The complete Fire Protection and Fire Alarm System will comprise the following:-

- 6.1.1 Fire Protection by Portable Extinguisher.
- 6.1.2 Fire Protection by Yard Hydrant, Wet Riser, Automatic Sprinkler & First Aid Hose Reel System.
- 6.1.3 Electronically operated Intelligent Fire Alarm & Detection System, comprising of Addressable Break glass Type Manual call Point and Addressable Multi-Criteria Detectors (i.e. combined Smoke & Heat Sensing type) & Addressable Rate of Rise cum fixed temperature Heat Detectors.
- 6.1.4 Safety Signage.

### **6.2 Portable Extinguisher**

- 6.2.1 All floors or area of the complete equipped with portable extinguishers of different type, complying with norms of IS: 2190.
- 6.2.2 5 kgs. capacity Dry Powder, 9 ltrs. capacity Foam and 4.5 kgs. capacity Carbon-di-Oxide type extinguisher & G.I. Fire Buckets with Sand will be kept and distributed on each floor in such a way that during the emergency/fire hazard on any portion of the floor, it should not require to travel long distance for the person to collect the extinguisher. Moreover, all the extinguishers will be installed in the locations which will have easy access/ approach.

### **6.3 Yard hydrant, Wet Riser, Automatic Sprinkler & Hose reel**

- 6.3.1 Fire Fighting of the complete complex by using manual equipments to employ water on the fire hazard will essentially consist of a reliable water distribution system and a net work of under ground/ above ground piping on which necessary valves/equipments will be installed. The enclosed drawings speak for the same. The System water requirements will be fed by the fire water pump house which in turn will remain

connected with an underground reservoir, where a reserve of 1,00,000 ltr of water will be available always or as design consideration. Normally the U/G reservoir will remain filled with clear water. The reservoir will have necessary connections for water filling/replenishment under the arrangement of the Department.

- 6.3.2 One number electric motor driven fire water pump of capacity 900 lpm at 30 mtr. Head or as design consideration will be installed in the fire water pump house, to cater to the water demand for fire fighting system. All the pumps will have auto-manual starting arrangements and will remain interlocked that in any case of any fire hazard or routine testing of the system, when any yard hydrant/landing valve/hose reel is opened manually to spray water or in any case of automatic operation of sprinkler system, then there will be a drop of water pressure in the water header causing auto start of electric motor driven fire pump and auto stopping of jockey pumps. The Fire Pump and the Sprinkler Pumps will be inter-locked with the Jockey Pumps in such a way, so that at any point of time the Jockey Pump will not operate in conjunction with either of the said Pumps. Stoppage of fire pumps will be manual only.
- 6.3.3 The delivery header of fire water pumping system will be connected with underground /aboveground piping network and ultimately with Yard Hydrant or wet riser or hose reel or sprinkler system. The top of each riser will also be provided with one air release/ safety valve arrangement. Necessary fire fighting accessories viz. branch pipe with nozzle and 63 mm hose with coupling of standard length will be kept ready, housed in glass fronted cabinet near each Landing Valve and Yard Hydrant Valve.
- 6.3.4 Fire service inlet will also be connected with the piping network suitably guided by isolation and Non-return Valves in such a way that through the said inlet pressurized water from fire tender can directly feed the fire fighting network of complete complex.

#### **6.4 Analogue Addressable Fire Alarm System**

- 6.4.1 The system shall comprise of one no. Fire Alarm Control Panel duly hooked up with Analogue Addressable Multi- Criteria detectors (heat + opt), heat detectors, which would continuously monitor the ambient condition of the protected area. Detectors are installed in the areas where chances of fire occurrences may happen. All the detectors in each floor are to be wired up & hooked up with the Fire Alarm Control Panel. All the detectors are provided with built-in LED, which will glow steady in case of detecting a fire. In the event of fire outbreak, respective sensor would sense smoke/heat and register an audio-visual annunciation in the Fire Alarm Control Panel identifying location of fire. In the event of fire outbreak on an emergency in any floor, person identifying the same will operate manual call point.
- 6.4.2 The panel logic shall be such that when any detector or Manual Call point is operated, immediately sounders in the floor under fire, will raise an alarm. All sounders shall be provided with strobe.

#### **6.5 Public Address & Talk Back System**

- 6.5.1 Public Address System will be provided in the building to make the inmates aware from the Central Control Room, in case of any eventuality.
- 6.5.2 Talk Back System will also be incorporated, so that the Central Control Room can direct the persons in the floor to take necessary measures in case of Fire.

#### **6.6 Safety Signage**

#### 6.6.1

The complete equipment with evenly distributed "EXIT" Board and Fire Order Notice Board as per the requirement of Fire Services.

### 7.0 Scope of Services

7.1 The equipment and items to be furnished under the scope of this specification are outlined hereinafter. Any additional equipment, material, service which are not specifically mentioned but required to make the system complete operational and acceptable to the Department / Local authority shall be deemed to be included in the scope and be furnished without any extra cost to Department.

7.1.1 Design, supply, transportation to site, erection, testing and commissioning of Yard Hydrant with Wet Riser System, Automatic Sprinkler System & Analogue Addressable Fire Detection Alarm System with Public Address & Talk Back facility.

7.1.2 All erection and maintenance tools and tackles, furnishing complete calculation of scheme/layout of erection and construction drawing, as may be required for the Fire Protection System and Fire Alarm System.

7.1.3 Minor civil work such as alignment of pump and motor, grouting of foundation bolts, excavation and back filling in case of buried piping.

7.1.4 Initial supply of lubricant grease, diesel oil for trial run testing and commissioning.

7.1.5 Final painting of equipment and structure

7.1.6 Training of Department's Operation and Maintenance staff during testing and commissioning period.

7.1.7 Submission of final "ASERECTED" drawing after installation.

7.1.8 All bolts, foundation bolts, nuts, gaskets, packing, pipe hangers, support/ thrust block etc as needed for complete erection and commissioning to be provided.

7.1.9 All paints and materials for anti-corrosive treatment on pipes/equipments/structures.

7.1.10 Various test reports, test certificates, erection manuals, operation and maintenance manual of equipment.

7.1.11 Supply of steel sections and plates wherever necessary.

7.1.12 All supports including the supply of all auxiliary steel members as necessary for above ground piping.

### 8.0 Project Information and Design Basis

8.1 Project : Proposed Medical College at Sichey, Gangtok, Sikkim

8.2 Design Basis : National Building Code (NBC) of India 2005, Part 4, Amendment No. 3, IS: 2189 and IS: 3844

8.3 Fire protection &



Envisaged : Asper Sl. No (C) (a)3 under Table 23 of NBC 2505 Part 4.

## 9.0 Justification of System Envisaged

Ref. Sl. No (C)(a) 3 under Table 23 of NBC 2505 Part 4.

### Codes and Standards

All the systems and equipments within the scope of this tender shall be reputed proven make, designed and manufactured in accordance with the stipulations of latest version of Indian Codes or recommendation of local Fire Authority/T.A.C/ F.O.C /N.F.P.A

When an equipment is offered conforming to standards other than those listed below, it shall be supported by satisfactory test report by competent authority.

IS:1646: Code of practice for fire safety of building (general), Electrical

Installations IS:1648:

Code of Practice for fire safety of buildings (general), Fire Fighting Equipments and its Maintenance

IS:3034: Code of Practice for Fire Safety of Industrial Buildings, Electrical Generating and Distributing Stations

IS:884: First Aid Hose Reel for Fire Fighting (For Fixed Installations)

IS:2171: Portable Fire Extinguisher, Dry Powder Type

IS:2175: Heat Sensitive Fire Detector

IS:2878: Portable Fire Extinguisher, CO<sub>2</sub> Type

IS:1239: Part – I: Mild Steel Tubes

Part –

II: Mild Steel Tubulars and other wrought steel pipe fittings IS:778:

Gun metal gate, globe and check valves for general purposes

IS:14846: Sluice valves for water- works purpose (50 to 1200mm

size) IS:5312: Swing Check type Reflux (Non-Return) Valves

IS:10204: Portable Fire Extinguisher, Foam Type

IS:2190: Code of practice for selection, installation and maintenance of portable First-Aid Fire Appliances

IS:1520: Horizontal Centrifugal Pumps for clear, cold and fresh

water. IS:5290: Landing valves (internal hydrant)

IS:8423: Controlled Percolating Hose for Fire Fighting

IS:903: Fire Hose delivery Couplings, Branch Pipe, Nozzles and Nozzle Spanner

IS:2062: Structural Steel (Fusion/Welding Quality)

IS:325: Three Phase Induction Motor

IS:2871: BranchPipe,UniversalforFire Fightingpurposes  
IS:732: Codeofpracticeforelectricalwiringinstallations

- IS:2217: Recommendations for providing first aid fire fighting arrangements in public buildings
- IS:3844: Code of practice for installation and maintenance of internal fire hydrants & hose-reel on premises.
- IS:2189: Code of practice for selection, installation and maintenance of Automatic Fire Detection and Alarm System
- IS:636: Non-percolating flexible fire fighting delivery hose.
- NBC: National Building Code 2005, Part 4.

## **TECHNICAL SPECIFICATION**

### **1.0 Portable Fire Extinguisher**

- 1.1 All the portable extinguishers shall be of free-standing type and shall be capable of discharging freely and completely in upright position.
- 1.2 Each extinguisher shall have the instructions for operating the extinguisher on its body itself and shall be supplied with initial charge with accessories as required.
- 1.3 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns and shall be painted with durable enamel paint of fire red colour conforming to relevant Indian standards.
- 1.4 All portable type fire extinguishing equipments shall conform to relevant IS or NFPA standard 10.
- 1.5 Foam type extinguishers shall comprise of suitable thickness sheet steel body coated with leaded tin alloy internally and externally (by electrolytic disposition process), inner receptacle of lead coated brass, polished gun metal fittings with a locked handle. It shall conform to IS: 10204.
- 1.6 Carbon-di-Oxide extinguishers shall comprise of high-pressure steel cylinder body wheel type valve, braided reinforced hose, non-conducting horns and accessories, wheeled trolley or mounting clamp, etc. It shall conform to IS: 2878.
- 1.7 Dry chemical extinguishers shall comprise of suitable thickness sheet steel body coated with leaded tin alloy internally and externally (by electrolytic disposition process), an inner container, carbon-di-oxide gas cartridge, a plunger rod for carbon-di-oxide release, a high-pressure hose, a nozzle, a nozzle holder, wall mounting brackets and other accessories. It shall conform to IS: 2171. The powder shall conform to IS: 4861 or IS: 4308.
- 1.8 Any other kind of portable fire appliances provided shall conform to NFPA standard 10 and of approved make.

### **2.0 Fire Water Pump**

- 2.1 The pump shall be of horizontal centrifugal type and designed for continuous operation at its best efficiency point. The pump shall have continuously rising head characteristic from operating point towards shut-off. The drive unit of the pump shall be suitably rated, so that the same can take the load of full open condition. The pump set along with its drive unit shall run smoothly without undue noise and vibration. Parts of pump like impeller, shaft sleeve, wearing rings etc. shall be of non-corrosive metal.
- 2.0 Under certain conditions there may be occasions when fluid flow through the pump would be reversed as in case of loss of power to the pump drive. The pump shall be so designed that the impellers and other accessories are not damaged under such conditions of flow reversal.

### **3.0 Electric Motor**

- 3.1 Notwithstanding anything stated in this specification, the motor has to satisfy the requirement of the mechanical system during normal and abnormal conditions.
- 3.2 All induction motors shall be of squirrel cage type and shall conform to the latest

applicable Indian Standard (IS: 325) & IEC.

3.3 The motor shall be suitable for continuous duty in the specified ambient temperature and the enclosure shall be dust proof as per IS: 4691 and equivalent to IP-22 (for motor above 15 KW) or IP-54 (for Motor 15 KW & below).

3.4 The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IS: 325.

#### **4.0 Pump Starting Panel**

4.1 The panel shall be of free-standing floor/ wall mounting consoles as required and out of CRCA sheet steel. Suitable terminal blocks shall be provided for termination of external cable/wires. The Panel feature shall be able to match the system description or philosophy for water-based fire protection system.

4.2 The panel shall be suitable to accept electric feeding of 415 Volt, 3 Phase, 50 HZ AC supply. The panels shall have the visual indication for power supply and of pump status.

4.3 The Diesel engine operated Standby Fire Pump shall have control through timers in three different time sequence, to activate the self to start the engine, as per system logic.

4.4 The starting interlock of the pump motor and Diesel Engine shall meet the system philosophy. The starter for Fire Pump shall be of Star-Delta type and that of Jockey Pump shall be of D.O.L. type.

#### **5.0 Hydrant/Landing Valve**

5.1 The G.M. Hydrant Valve should conform to IS: 5290 type „A“ and should be suitable for indoor or outdoor installation. The hydrant valve must be complete in all respects i.e. with blank cap and chain. It should have flanged inlet suitable for 80 mm Nb and oblique type female instantaneous coupling outlet of 63 mm size to receive male coupling as per IS: 903.

#### **6.0 Branch Pipe with Nozzle**

6.1 The G. M Branch Pipe with Nozzle should conform to IS: 903. The branch pipe should have male inlet connection of 63 mm size at one end and another end should be threaded with a nozzle of 18/20 mm bore.

#### **7.0 Hose with Coupling**

7.1 63 mm size-controlled percolation hose should conform to IS: 8423/ IS: 636 and of 15 M long. Both the end of the hose should be properly riveted and copper wire bound with pair of male & female G.M. Hose Coupling as per IS: 903.

#### **8.0 Fire Service Inlet (4-Way)**

8.1 Fire Service Inlet connection should generally conform to IS: 904 and complete with four 63 mm dia instantaneous type gun metal inlets with built in check valves and 150 mm Nb connection for installation with the fire main.

#### **9.0 Swinging Hose Reel**

- 9.1 First aid fire fighting swinging Hose Reel should conform to IS: 884 and complete with reputed make 20 mm dia rubber hose of 30 M long with GM shut off nozzle. It should be wall mounting type and should be complete in all respects i.e. with swivel joint, nozzle etc.

## **10.0 Piping**

- 10.1 Mild Steel Black Pipe should be as per IS: 1239 & IS-3589, medium and heavy grade. The complete piping system should withstand hydraulic test pressure equal to 1.5 times of maximum working pressure.
- 10.2 Piping to be laid over ground shall be supported properly on wall/ column/ beam/ floor to suit site condition. Piping to be buried under ground shall be provided with protection of the outer surface, against soil corrosion by using anticorrosion tape.
- 10.3 Outer surface of over ground pipes shall be thoroughly cleaned of mill scale, rust etc by wire brush, there after, one coat of red lead primer shall be applied. Finally, two coats of synthetic enamel paint of approved colour shall be applied.

## **11.0 Sluice Valve**

- 11.1 Valves 40 mm and below shall be heavy pattern gun metal valves with cast iron wheel tested to 16 Kg./cm<sup>2</sup> pressure. Valves shall be Leader or equivalent make.
- 11.2 Sluice Valves 50 mm and above shall be cast iron double flanged with non-rising spindle. Sluice valves below ground shall be provided with suitable valve chamber. Sluice valves in exposed locations i.e. pump house etc. shall be provided with cast iron wheels. Sluice valves shall be of approved make and conform to IS: 1484 PN: 1.6 and tested to 16 kg./cm<sup>2</sup> pressure.

## **12.0 Non-Return Valve**

- 12.1 Non-return valves shall be swing check type. Valves will have a permanent "ARROW" in inscription on its body to indicate direction of flow of water. These valves shall generally conform to IS: 5312.

## **13.0 Battery and Battery Charger**

- 13.1 Battery charger will be located inside the main fire alarm panel but the lead acid type batteries will be placed in wooden box, outside the panel. Battery shall preferably be Exide make and sealed maintenance free type (SMF)
- 13.2 Battery and Battery Charger unit for Diesel Engine Starter should be housed in proper housing separately, near the engine, whereas the Battery for Fire Alarm Control Panel should be preferably placed within the panel.
- 13.3 All Batteries should be of sealed Maintenance free type of required capacity.

## **14.0 Fire Alarm Control Panel**

- 14.1 The panel shall contain a Microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipments.

Analogue addressable Smoke, Heat, MCPs, Repeater Panels and other panels in the network.

Addressable Modules

Panel Modules including initiating circuits and notification appliances circuits Printers

Annunciations and another system-controlled device

#### 14.2 Basic Performance Requirement of the Main Fire Alarm Control Panel

Supervise and monitor all intelligent detectors and modules connected to the system for normal, trouble and alarm condition.

Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.

Detect and activate any initiating device and location of the alarm condition. Operate all notification appliances and auxiliary devices, as programmed.

Visually and audibly announce any trouble, supervisory, security or alarm condition on operator's terminals, panel display and annunciators

### 15.0 Programmable Electronic Sounders

15.1 Electronic Sounders shall operate on 24 VDC nominal

15.2 Electronic sounders shall be fielding programmable without the use of special tools at a sound level of at least 90 dBA measured at 10 feet from the device

15.3 Shall be flush or surface mounted as shown on plans

15.4 Shall operate on 25/70 VRMS with field selectable output taps from 0.5 to 2.0 w

15.5 Frequency responses shall be a minimum of 400 Hz to 4000 Hz

### 16.0 Strobe Lights

Strobe light shall meet the requirements of the ADA, UL, Standard 1971, be fully synchronized and shall meet the following criteria:

16.1 Shall operate on 24 VDC nominal

16.2 The maximum pulse duration shall be 2/10 of one second

16.3 Unless otherwise specified in specification the intensity shall be a minimum of 75 candelas

16.4 The Flash rate shall be a minimum of 1 Hz and a maximum of 3 Hz

16.5 The appliance shall be placed 80 inches (2,030 mm) above the highest floor level within the space, or 6 inches (152 mm) below the ceiling, whichever is the lower.

## **17.0 Addressable Pull Box (Manual Station)**

- 17.1 Addressable pull boxes shall, on command from the control panel, send the data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after a true emergency operation, they cannot be restored to normal use except by the use of a small key.
- 17.2 All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
- 17.3 Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the station.

## **18.0 Intelligent Multi-Criteria Detector (Thermal+Photo Electric Type)**

- 18.1 The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photo electric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
- 18.2 The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, ward, laundry, kitchen etc) and then have the ability to automatically change the settings as the environment changes (as walls are moved or as the occupancy changes).
- 18.3 The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomenon.

## **19.0 Addressable Control Module**

- 19.1 Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24VDC powered polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.
- 19.2 The control module NAC shall be wired as per NFPA 72 with up to 1 amp. of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as dry contact (Form- C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary relay or NAC may be energized at the same time on the same pair of wires.
- 19.3 Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.
- 19.4 The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30VDC.

## **20.0 RemoteResponseIndicator**

- 20.1 These shall be connected with the detectors which are normally visible or remains inside cubicles with door closed. These should be actuated simultaneous with the actuation of detector(s) and by this indicator the actuated detector(s) locations shall be pinpointed.
- 20.2 These indicators should generally be mounted in easily visible points near the room, housing the detector(s). The indicators shall be of dual LED type and of any manufacturer, acceptable by local fire brigade authority.

## **21.0 DieselEngine**

- 21.1 Engines after correction for altitude and ambient temperature shall have bare engine horsepower rating equivalent to the higher of the following two values:-

20% in excess of the maximum brake horsepower required to drive the pump at its duty point  
The brake horsepower required to drive the pump at 150% of its rated discharge

# TECHNICAL SPECIFICATION OF PUBLIC ADDRESS & REINFORCEMENT SOUND SYSTEM

## 1.0 SPECIFICATION

### 1.1 CHANNEL AMPLIFIERS:

Channel amplifiers should have following features & specification:

Zone ON / OFF facility. Output levels of each zone can be set independently to desired levels and the zones can be switched ON/OFF without disturbing the volume setting.

Stereo music input.

Line input & output one each zone for connecting to a mixer and booster amplifier respectively.

Speaker & driver unit selector switch for each zone. Bass boost defeated at driver unit position for safer operation of driver unit.

Resettable circuit breaker for protection against overload and short circuit. Instant transfer to DC power if AC power fails.

Bar graph display option.

- |                          |                                                        |
|--------------------------|--------------------------------------------------------|
| H. Power Output          | : 750W + 750W Max., 500W + 500W R.M.S. at 10% THD      |
|                          | i. 450W + 450W R.M.S. at 5% THD, 415W + 415W R.M.S. at |
|                          | ii. 2% THD                                             |
| I. Output Regulation     | : $\leq 2$ dB, no load to full load at 1KHz            |
| J. Signal to Noise Ratio | : 60dB                                                 |
| K. Outputs               | : Line 1V/1K $\Omega$                                  |
| L. Power Supply          | : AC: 220-240V, 50Hz, DC: 16A                          |

### 1.2 CENTRAL AMPLIFIERS:

Central amplifiers should have following features & specification: Extremely

clear and intelligible sound

Headphone output with volume control

Automatic Mic OFF function in delegate units. Delegate unit microphone can be set to automatically turn OFF

Three unbalanced MIC inputs with one aux. input for various user's application.

E. Power Supply : AC:220-240V,50Hz,DC: 24V

F. Power Output :50WR.M.S.output to drive external reinforcement speaker.

### 1.3 SPEAKERS:

All speakers shall be wall/Ceiling mounted.

Each speaker shall have its own accessible exterior volume control mounted on the enclosure.

C. Rated Voltage :70/100V

D. Power taps : 4/8/16W

### 1.4 REMOTE PAGING MIC CONTROL:

Remote paging MIC control should have following features & specification: Several modes (all zones & individual zones)

Capable of cascading (series connection with RJ45) up to 16 microphones (or as required) Operation number input Keys with LED display.

D. Input : MIC: 600 $\Omega$ ,10mV,unbalanced,Line: 10K $\Omega$ ,775mV,  
unbalanced

E. Output : Balanced

F. Frequency response : MIC:100Hz~15KHz;Line:30Hz~18KHz.

G. S/N Ratio : MIC input:60dB Line input:80dB

H. Power Supply :DC24V

I. Communication Protocol :RS422

Communication Input & speed: RJ45,Speed: 4800bps.

### 1.5 PAGING SELECTOR CONTROL UNIT:

Paging selector control unit should have following features & specification:

10Zonepagingselector/controller(orasperdesign)Zonal

pagingfacility

2channelamplifierinputswhenpagingannouncement ismade

Twocolorzone statusLEDto indicatemusic orpagingstatusofeach zone.

E. Input :MIC1,2:600 $\Omega$ ,5mV,unbalanced,Line1,2:10K $\Omega$ ,775mV,  
unbalanced

F. Frequencyresponse :MIC:100Hz~15KHz;Line:30Hz~18KHz.

G. S/NRatio : MICinput:60dBLineinput:80dB

H. Power Supply : AC230V, 50Hz,

I. CommunicationProtocol :RS422

CommunicationInput &speed: RJ45,Speed:4800bps

#### **1.6 DELEGATESUNIT:**

Delegateunitshouldhavebuilt-inloudspeakerandhigh-qualityelectretcondensermicrophone on flexible gooseneck. Microphone shall be equipped with a ring LED indicator to show which MIC is ON. Each unit shall have a headphone output with volume control & TALK switch.

Delegateunit shall haverecessedvolumecontrol.

#### **1.7 CHAIRMANUNIT:**

Chairman unit shall have non-lockable priority switch which interrupts the meeting and mutes the microphones. Each unit shall have recessed volume control.

#### **1.8 MICROPHONES**

The microphones shall satisfy the following minimum performance characteristics:

On axis frequency response not to vary by more than +6dB, -10dB over the frequency range 100 to 10000Hz, relative to 1KHz.

Sensitivity not to less than 1.0mV/Pa (-77dBref. 1V/uBar) at 1KHz.

Distortion to be less than 0.5% at 1KHz at 30Pa sound pressure level input.

Front to-back discrimination ratio to be greater than 15dB for unidirectional

microphones. Balanced, low output impedance in the range 200 to 600 $\Omega$  at 1000Hz.

## **SPEAKER CABLES**

The loudspeaker cable shall be flexible pair of tinned, annealed copper conductors, PVC insulated, and white or grey PVC sheath. For surface wiring, the cable shall be a parallel pair. For conduit run, the cables shall be twisted pair. The cables shall satisfy the following minimum characteristics:

at least 19 strands per conductor

strand diameter not to be less than 0.21 mm nominal

outer diameter not to be greater than 8 mm, insulation thickness

not to be less than 0.5 mm

Cable shall be terminated on a terminal strip before being cabled to the amplifier with no splices between outlets and junction boxes.

Outlets and junction boxes shall be readily accessible.

Speakers/transformers and wires shall be connected using the 70 / 100-volt system in a distributed fashion.

Documentation of wiring routes and connections shall be provided to the Engineer-in-charge.

## **POWER SUPPLY CABLE:**

Power cables shall be three-core PVC insulated, not armored with copper conductors of not less than 2.5 sq. mm to BS 6004 and BS 6346 and complete with an overall protection sheath of PVC.

## **CONNECTOR & ACCESSORIES:**

All audio connectors for wall panels, mixer inputs, microphones etc. shall be Cannon XLR type

Each indoor loudspeaker shall be terminated through a 2A three-pin plug and socket complying with BS 546 to facilitate easy removal of the loudspeaker. Locally made plug and socket of equivalent standard is also acceptable. The Contractor shall be responsible for properly mounting the socket baseplate onto any existing adaptable box. Outdoor speakers shall be terminated through cap retaining ring.

A sheet metal box with stainless steel cover shall be required to house one Cannon XLR male or female socket

## INSTALLATION

Devices shall be seismically secured. Shelf-mounted amplifiers shall have earthquake grips securing the units to the shelf. Ceiling speaker assemblies (top hats, bridges) shall be secured with approved safety wiring to the structure above.

Amplifiers shall be mounted on a shelf (as per detailed drawing) with a 1-inch (25 mm) security lip around its perimeter and shall be located in the communications closet, 1200mm or 48 inches above the floor.

Where a wall mount amplifier is used, follow a standard installation procedure (or as per detail drawing), with accessibility to maintain the equipment.

# TECHNICAL SPECIFICATIONS FOR IP CCTV SURVEILLANCE SYSTEM, DATA NETWORKING, TELEPHONE & ACCESS CONTROL SYSTEM

## SUVELIANCESYSTEM:

## IPVideoSystemOverview:

- directional Audio.
- Video and alarm management software under one single front end and should be open platform with support to renowned IP camera brands.
- System should allow to be used as a distributed or central architecture with support to any number of cameras and any number of clients that may be added in future.
- System Guarantees Bandwidth & Frame rate control.
- Provides Broadcast quality Video across IP network including Internet. Provides multiple failover and network resilience.
- Provides real time recording at 25fps with no frame loss.
- Provides PTZ Camera Controls & Binary INPUT/OUTPUT controls. Supports Multiple IP Video Streams.
- Secured recording for evidence purposes and user authentication to protect data integrity.
- Video Stream bitrate selectable from 32 to 4096 kbps or better
- All the IP cameras shall have SD card slot for recording in SD card when network is down/fail

## IPFixedDomeCamera(IndoorType)

Cameramusthave1/3",1.3MPprogressivescanCMOS  
 Color Resolution 540 TV Lines or better for sharp pick up of live  
 video.Minimum Sensitivity of Day: 0.5 Lux; Day/Night: 0.5 lux color /  
 0.05 luxWhiteBalanceMode: Auto;Fluorescent;Indoor; Outdoor  
 Varifocal /Auto Iris DC drive lens options of 3.8 – 9.5mm or 9 –  
 22mmShutter Speeds 1/60 to 1/10,000 (NTSC), 1/50 to 1/10,000 (PAL)  
 or AutoOperating voltage: Power over Ethernet (802.3AF); 12V/24V  
 AC/DC.The hardware architecture must incorporate multiple processors  
 to ensurebest video quality and other functions even at maximum  
 processor load.The IP Camera must have H.264 video compression  
 standards, by justupgrading the firmware over the network without  
 dismantling the camera.The IPCameramustrunLinuxOperatingsystemfor  
 reliability.  
 Thecameramusthaveabuiltinfirewall.  
 Support network protocol 802.3 and IETF Standards 10/100 Base-T  
 Ethernet,RTP/RTCP,TCP,UDP,ICMP,SNMP,HTTP,FTP,TELNET,MULTIC  
 AST,ARPand IGMP  
 Shouldsupportandallowconfigurationofthefollowingvideoresolutions

352X240(CIF)  
704 X 480 (D1)

# VideoOperationCodecManagement,RecordingandProcessingSoftware(VOCMRPS)

VOCMRPS will be a highly scalable, enterprise level software solution. It must offer a complete Video Surveillance solution that will be scalable from one to hundreds of cameras that can be added as and when required. It should allow for seamless integration of third party security infrastructure where possible. The system MUST be capable of working on latest Windows OS and Windows Server platforms. Should support client - server architecture.

The software must not have operator seat based licensing. It must allow for any number of user seats/installations on the IP video network to be added for future scalability at no management software cost or licensing cost.

- iii. The manufacturer supplied management software pack should be on open platform/ standard media player.

The system shall allow operation with/without a PC keyboard or mouse with touch screen PC monitors. Once system configured, virtual matrix functions can be carried out using CCTV keyboards and should have capability to configure with TV.

The VOCMRPS shall provide the following:

- Automatic search of components of proposed system on the network.

- The system should allow for live view, playback and system configuration of the IP video system.

- The system should allow for creation of multiple users and user groups and assign tasks to each.

- Drag & Drop functions for most functions on the system and also for setup of connection between cameras and monitors and also support to create custom layout by grouping of cameras from different server/ locations into groups for more efficient monitoring.

- It shall be possible to display video and audio bit rates; frame rate and resolutions on each video pane as overlays.

- The live view must be capable of highlighting motion as green rectangle overlays and displaying real-time alarm information overlaid on the live video feed.

- It shall be possible to listen to audio from individual codec (cameras) or Receivers.

- Audio must be simultaneously transmitted from the Operator to allow a two-way conversation.

- It must be possible to establish bi-directional audio connection on alarm. The user should also be able to disable listen when speaking to prevent feedback through the microphone.

- ⌘ System setup for pre-defined surveillance tasks to be invoked at pre-defined times in the day.
- ⌘ Programming of automatic recording events on NVR, maybe based on events such as alarms and video analysis.
- ⌘ Remote maintenance of IP Video components.
- ⌘ Offline construction of site, tree and addition of devices.
- ⌘ It shall be possible to show text on screen display (OSD) when video is displayed on a Receiver/Decoder.
- ⌘ The location of the OSD must be configurable on the screen.
- ⌘ The system should provide Video Lockout facility where a super-user can prevent all other users from viewing live video and divert recorded video to another Networked Video Recorder. The super-user shall also be able to release the video lockout and restore the system to its original state. It should also support software watchdog for advance detection of problem & recovery at server.

- The VOC MRPS shall allow the following:

Live display of cameras

Live display of camera sequences, salvos and guard tours

Retrieval of archived Video using normal playback, thumbnails (motion, even for time based)

Instant Replay of Live Video

Use of site maps and Google

map Configuration of system settings

gs

- For each camera setup bitrate, framerate, and resolution shall be set independent of other cameras in the system.
- The system must allow application of sorting and searching filters on bookmarks for faster retrieval and access to incidents in recorded footage

Should be installable on a Linux/Windows PC.

The NVR should have no limitations on the kind of storage to be used (RAID, NAS, etc.). The NVR must be capable of recording 50 cameras simultaneously (or as required). The NVR must be providing for a disk management system which will automatically reapear old recording to overwrite with new ones when max disk usage is reached. The storage on a minimum Disk of 8TB

## **ONLINE UPS (RATING AS PER DESIGN CALCULATION) WITH BATTERY BACKUP FOR 30 MINUTES:**

### **Input:**

Nominal AC Input Voltage: 1 Phase 230V AC + Neutral + Earth , 50

Hz Line low/ High transfer: + 15%

Frequency range: + 5%

### **Output**

Voltage: 220VAC/230VAC/240VAC

Voltage Regulation: +

1% Frequency: 50 Hz +/-

0.1% Output waveform: Pure sine wave

Harmonic distortion: <2% (linear load)/5% nonlinear load Power factor

or: 0.7 to unity

Crest factor: 3:1

Inverter overload capacity: 110% 15min./125% 10min./150% 1min./>150% 1sec.

Efficiency (AC – DC):

90% Bypass: Static bypass

### **Display**

Standard: 2 line x 20 characters, Backlight LCD

AC input voltage, AC input frequency, Battery voltage, AC output voltage, AC output frequency, AC output load%, Temperature

UPS status (Mains fail, Individual phase fail, Battery low, DC high, Overload with shutdown time, Output low, output high, Over temperature, UPS bypass)

**(f) UTP CAT-6 CABLE:**

It should have the following features & specification:

23 AWG Annealed bare solid copper, CAT-6 UTP Cable, Channel optimized to 350 MHz

Meets EIA/TIA 568-B.2-1 Category 6 specifications, Passed UL 444 test and meets CM and CMR ratings

Worst Case Cable Skew: 45 nsec/100 meters

Characteristic Impedance: 100 (+/- 3) Ohms 500 MHz, Tested till 700

MHz Conductor Annealed copper wire Diameter 0.52 mm (nominal)

Insulation High Density polyethylene, Diameter 0.94 mm (nominal) support for Fast Ethernet and Gigabit Ethernet IEEE 802.3/5/12, Voice, ISDN, ATM 155 & 622 Mbps and Broadband.

**ACCESS CONTROL SYSTEM:**

**Software**

The software shall support at least 4000 holiday dates and have an automatic holiday rescheduling feature.

The software shall have the ability to perform scheduled automatic database maintenance and backup tasks at user selected intervals and ability to configure the amount of history stored in the active database.

The software shall have the ability to produce the following report types: system and alarm event reports, user reports, hardware configuration settings, access level reports, employee time & attendance reports.

The reports shall be available in Adobe PDF and MS Excel formats.

Report filters must be convenient and user friendly: allow operator preview user photos, content of access levels, hardware settings and time zone configuration.

The software shall support an unlimited number of building floor plans.

Floor plan viewing interface shall have convenient zoom in/out controls by mouse wheel.

The software shall allow operator to conveniently edit floor plans by “dragging and dropping” hardware devices to selected plan areas.

The software shall allow assigning custom icons to each floor plan in order to help operators identify floor plans quickly. The software shall have a wide selection of default icons as well.

The software shall support “full-screen” mode that would take up 100% of the monitor area and prevent operators from starting or accessing any other programs.

All configuration and user changes shall be sent to controller immediately. The software shall display the progress in percent as the changes are being downloaded. The downloading shall be done in background and not affect the normal use of the software in anyway.

The floor plans shall display real-time status of system hardware and allow operators to immediately see the effects caused by configuration changes.

Dynamic search function shall be present in all windows of the program: search results shall be narrowed automatically as a key phrase is being entered. I.e. after entering characters “xy” the program shall locate and display all records containing these characters, and after typing in more characters shall refresh the results automatically.

The software shall use an industry standard database engine released not earlier than 2005 and currently supported by the manufacturer.

The software shall have the ability to automatically display photos and additional information about users as they enter/exit through doors.

The software shall be available in the official language(s) of the country where it is being installed. If such language is not included in the standard installation, the software shall support user friendly translation method: simply replacing program text directly in the software (“on the fly”), without the need of sending any files to the manufacturer for compiling.

The software shall have a modern interface, attractively designed and convenient to use.

The software shall be adapted for operators who have not received any special training related to management of integrated security systems. Graphical user interface shall be intuitive. Introducing the system to a new operator shall not take more than 1 hour.

In order to reduce the amount of work done by an operator, the software shall incorporate an option to copy objects: users, doors, floor plans, time schedules, access levels and holidays.

The software shall facilitate integration with other systems of the building.

The software shall have the ability to transfer entry and exit events to HR systems with the purpose of work time calculation.

The software shall store information and provide reports about visitors and appointments.

## **Hardware**

The hardware shall support open architecture. Communication protocols shall be available to system integrators and software development companies in order to protect end-users from being constrained to a single brand of hardware or software.

The hardware shall support all industry standard readers that output information in Wiegand or Clock/Data formats (up to 128 bits).

There shall be at least 2 types of controllers: (a) for one door with an entry reader and an exit button and (b) for one door with two readers (entry and exit) or for two separated doors with entry readers and exit button.

There shall be an IP-reader available. The IP-reader shall integrate a contactless card reader and controller in a single body, designed for surface mounting on a wall or a door frame eliminating the need for enclosures.

Each controller and IP-reader shall have a standard RJ-45 network port for communication with software and other controllers.

Controller and IP-readers shall support standard Ethernet 10/100 Base T network and TCP/IP communication protocol.

Systems using Ethernet converters, adapters, or terminal servers that enable network connectivity for legacy controllers by tunneling RS-232/485 serial data over Ethernet shall not be acceptable.

Single-door controller and IP-reader shall have at least 32 Mb SDRAM operating memory and 8 MB Flash memory for database and events. Two-door controller shall have an option for expanding Flash memory to 32 MB.

All controllers and IP-readers shall use a 32 Bit 100 Mhz RISC processor (or better) in order to enable fast execution of advanced functions.

Controllers and IP-readers shall use Linux operating system and accept firmware upgrades via network.

All system parameters including card numbers, PINs, access levels, time schedules, holidays and operations modes shall be stored in controller and IP-reader memory and not affected in case of a power loss.

Single-door controller and IP-reader shall have enough memory to store at least 40,000 users. Two-door controllers shall have enough memory to store at least 250,000 users.

In case communication with the host PC is interrupted, the controller and IP-reader must have enough memory to store at least 5000 latest events (FIFO buffer).

Operation of controller and IP-reader shall be completely independent of the PC or "Master controller". Should the PC or the communication link fail, the users should not be affected in any way and all functions should continue working.

IP-

readers shall have the following inputs and outputs:

Exit button input

Door contact

input Auxiliary alarm

input

Tamper sensor and tamper input

Inputs for monitoring AC power and backup battery state. There should be an option to reconfigure these inputs to function as general purpose inputs.

Relay for controlling an electric

lock. General purpose auxiliary output rel

ay.

One-

door controllers shall have the following inputs and outputs: Po

wer output for the reader

Outputs for controlling LEDs and beeper

of the reader Wiegand or Clock/Data input

Exit button

input Door contact

input Auxiliary alarm

input Tamper input

Inputs for monitoring AC power and backup battery state. There

should be an option to reconfigure these inputs to function as general purpose inputs.

Relay for controlling an electric

lock. General purpose auxiliary output rel

ay.

Two-door controller shall have the following inputs and

outputs: Power output for two readers

Outputs for controlling LEDs and beeper of the readers Two

Wiegand or Clock/Data inputs

Two exit button

inputs Two door contact

inputs Two auxiliary alarm in

puts Tamper input

Inputs for monitoring AC power and backup battery state. There

should be an option to reconfigure these inputs to function as general purpose inputs.

Two relays for controlling an electric

lock. Two general purpose auxiliary output rela

ys.

Relays of controllers and IP-readers should support two modes of operation: (a)

drycontact and (b) powered mode, whereas power to the lock is provided via relaycontacts this way simplifying wiring and eliminating the need for an additional powersupply.

Controllers and IP-readers shall have an RS-232/485 communication port that wouldactasabackupcommunicationchannelincasethenetworkconnectionwasinterrupted.

|                          |                                                                              |  |
|--------------------------|------------------------------------------------------------------------------|--|
| <input type="checkbox"/> | 支持5,000指纹模板存储容量                                                              |  |
| <input type="checkbox"/> | -to-many verification in less than 1 second (with the database of 3000users) |  |
| <input type="checkbox"/> | -to-manyverificationwiththedatabaseof9000users.                              |  |
| <input type="checkbox"/> | 支持100,000eventstorage                                                        |  |
| <input type="checkbox"/> | 内置-inUSB,RS-232/485,LANandWLANcommunicationports                             |  |
| <input type="checkbox"/> | 可选择operationmodes:fingerprint,fingerprint+card,fingerprint+PIN.              |  |
| <input type="checkbox"/> | 支持door-phonefunction                                                         |  |
| <input type="checkbox"/> | 支持microphone,speakerand2.5“QVGAcolorLCD                                      |  |
| <input type="checkbox"/> | 支持2MBflashmemory                                                             |  |
| <input type="checkbox"/> | 支持doorcontactandexitbuttoninputs                                             |  |
| <input type="checkbox"/> | 支持lockcontrolrelay                                                           |  |

powersupplies, redundant hot swappable fan trays, SD card slot, physical stackabilitywith stackingbandwidth ofat least 480Gbps.

Switching capacity at least: 960 Gbps, Maximum forwarding rate: 714 Mbps. At least 128K MAC address table size.

Layer-2 Features: IEEE 802.1D, 802.1s, 802.1w, Jumbo frame up to 12000 bytes, 802.1AX, ERPS, Port based & flow based one-to-one & many-to-one mirroring, IGMP snooping v1v2&v3, MLD snooping v1&v2, 802.1Q, 802.1v, Q-in-Q, GVRP (at least 4000 dynamic VLANs), MAC based VLAN, private VLAN, subnet based VLAN.

Layer-3 Features: static routing, policy based routing, route redistribution, ECMP, WCMP, RIPv1v2, RIPv6, OSPFv2v3, BGP, at least 16K entries support in hardware routing table, IPv4 & IPv6 support. IGMPv1v2cv3, PIM-SM, PIM-DM, PIM-SSM, PIM Sparse-Dense mode, DVMRPv3, MLDv1v2, MPLS, VPLS, IPv6 tunneling, VRRP, L3VPN, VRF-Lite, MP-BGP, 802.1Qbb, 802.1Qaz, 802.1Qau.

Security Features: Port security (at least 12K MAC address per port), binding of IP address & MAC address with port, ARP spoofing prevention, traffic segmentation, SSLv3, SSH, DoS & BPDU attack prevention, Guest VLAN, Web based & MAC based access control, 802.1X, dynamic VLAN assignment, ARP inspection, ACL based on IP address, MAC address, TCP & UDP port number, 802.1p priority, IPv6 traffic class, DSCP. time based ACL. Protection of the CPU from protocol control packet attack.

QoS Features: 8 queues per port, strict priority, WRR, weighted deficit round robin, port based & flow based bandwidth control with minimum granularity of 8 Kbps, trTCM, srTCM, WRED, CIR.

Management Features: Console port, 10/100/1000 Base T out of band management port, Web based GUI, CLI, SNMPv1v2cv3, telnet, TFTP & FTP, DHCP server, client & relay, syslog, LLDP, LLDP-MED, trace route, DNS resolver, DNS relay, SMTP, SNMP trap, SNTP, debug command, RMONv1v2, remote copy protocol, support for multiple configuration & firmware.

## **ACCESS SWITCH:**

Access switch should have following features & specification:

L2

Managed switch having 24x 10/100/1000 Base T ports, 2x 1 G SFP slots & 2x 10 G SFP+ slots.

Switching Capacity should be at least 92 Gbps

Packet Forwarding Rate should be at least 68 Mpps for 64-byte packet size

The switch should have non-blocking architecture & wire-speed performance under fully loaded condition from first day

The switch should have smart fan with sensor IC that provides different fanspeed based on different temperature. Power consumption should be less than 25 watt

support for 10G port based physical  
stacking with at least 6 units per stack & stacking bandwidth of 40Gbps

Support for virtual stacking with at least 32 units per stack & stacking bandwidth of 20Gbps. Stacking cable should be included.

MAC Address Table size: At least 16000, support at least 512 static MAC

Flow Control: IEEE 802.3x in full duplex, back pressure in half duplex  
& HoL blocking prevention  
Jumbo Frame Support (At least 9Kbytes)

IGMP v1 v2 snooping with at least 512 IGMP snooping groups, Per VLAN IGMP Snooping, host-based IGMP snooping fast leave, IGMP snooping querier.

MLD snooping with at least 512 MLD snooping groups, Per VLAN MLD Snooping, host based MLD fast leave, MLD snooping querier.

IEEE 802.1D STP, 802.1w RSTP, 802.1s MSTP with at least 16 MSTP instances, Root guard equivalent feature.

The switch should be able to avoid the loop occurring in a single port connected to an unmanaged switch/hub by shutting down the corresponding port or corresponding VLAN

IEEE 802.3ad & IEEE 802.1AX Link Aggregation with at least 8 ports per group & 32 groups per switch.

Port mirroring for Tx/Rx/Both. One-to-One mode, Many-to-one mode. At least 4 mirroring groups should be supported.

IEEE 802.1Q VLAN, at least 4000 Static VLANs, 4000 Dynamic VLANs Groups, GVRP, Voice-VLAN, asymmetric VLAN, auto surveillance VLAN

The switch should have 802.1p support with 8 queues per port. Support strict, WRR & DRR (Deficit Round Robin) queue handling technique. trTCM, srTCM.

The switch should support CoS based on VLAN, IP address, MAC address, Ether type, DSCP, TCP/UDP port number, 802.1p priority

The switch should have Port-based ingress & egress bandwidth control with minimum granularity of at least 64Kbps

The switch should have the following security features from first day: SSH v1 v2 for IPv4 &

v6,SSLv1v2v3forIPv4& v6,Broadcast/Multicast &Unicast

storm control, port security feature with at least 128 MAC per port, traffic segmentation, ARP spoofing prevention, IEEE 802.1x port based & MAC based authentication, DHCP server screening, DAI (Dynamic ARP Inspection), BPDU attack protection, DoS attack prevention, Binding of IP address & MAC address with physical port, IPv6 neighbor discovery inspection. Web based Access Control, MAC based Access Control, Dynamic VLAN assignment, Guest VLAN, RADIUS & TACACS+.

The switch should have feature to protect the CPU from protocol control packet attack.

The switch should have feature of at least 64 static routes, default route, at least 8 no. of IP interfaces & IPv6 Neighbor Discovery from first day

The Switch should have following Management features from first day: Web-based GUI, CLI, Telnet Server, TFTP Client, SNMPv1v2cv3, SNMP trap, DHCP Client, STP, debug command, RMONv1, Syslog, ICMPv6, DHCP Relay Option 82, LLDP, LLDP-MED, Dual Image support, Physical console port for Out of band management.

IPv4 & IPv6 Dual Stack

The switch should have energy saving green technology based on link status & IEEE 802.3az.

The switch should be 1U height

The switch should have following certifications: FCC, CE, VCCI, cUL, CB, C-Tick

#### **TRANSCEIVER:**

10G Base LR Single Mode duplex LC Style SFP+ transceiver

#### **RACK MOUNTED LIU:**

Rack mounted LIU should have following features & specification:

Sufficient slots to accommodate Simplex SC adapters individually. Aluminum base material for light mounting

Should have Splice Tray & Cable Spool provision

Inside panel cover should be slide out for easy maintenance

Removable Rear & Front cover for better access to interior of LIU loaded with 24 nos. of SC Single mode simplex adapters

Adapters should be Telcordia, TIA/EIA, IEC compliance

#### **SINGLE MODE SC PIGTAIL:**

Single mode SC Pigtail should have following features & specification:

Corning Optical Fibers single mode complying G652D, G657A & G657B SC type  
 Single Mode Connector  
 Low insertion & return loss, clean & scratch free faces 1Mtr /  
 2mtr. Length (as required)

#### **SINGLE MODE SC-LC DUPLEX PATCH CORD:**

Single Mode SC-LC Duplex Patch Cord should have following features & specification:

All optical fiber patch leads shall comprise of Single mode 9/125µm fiber with SC & LC fiber connectors terminated at each end. The optical fiber patch leads shall comply with the following specifications:

|                          |                                        |                          |
|--------------------------|----------------------------------------|--------------------------|
| <input type="checkbox"/> | Optical Fiber – Corning Single Mode    | <input type="checkbox"/> |
| <input type="checkbox"/> | Connector: Zirconia ceramic ferrule    | <input type="checkbox"/> |
| <input type="checkbox"/> | Pre-radiused and pre-polished ferrule  | <input type="checkbox"/> |
| <input type="checkbox"/> | Duplex                                 | <input type="checkbox"/> |
| <input type="checkbox"/> | Color-coded Yellow for SM              | <input type="checkbox"/> |
| <input type="checkbox"/> | Insertion Loss - < 0.2dB               | <input type="checkbox"/> |
| <input type="checkbox"/> | Fiber: 9/125, SM                       | <input type="checkbox"/> |
| <input type="checkbox"/> | Repeatability - < 0.2dB                | <input type="checkbox"/> |
| <input type="checkbox"/> | Durability – 1000 mating cycle         | <input type="checkbox"/> |
| <input type="checkbox"/> | Working Temp: -40 deg C. to +85 deg. C | <input type="checkbox"/> |
| <input type="checkbox"/> | Standard: G652D, G657A & G657B         | <input type="checkbox"/> |
| <input type="checkbox"/> | Length: 1Mtr (OR AS REQUIRED)          | <input type="checkbox"/> |

#### **MULTI MODE (OM3) LC-LC DUPLEX PATCH CORD:**

Multi-Mode LC-LC Duplex Patch Cord should have following features & specification:

All optical fiber patch leads shall comprise of Single mode 9/125µm fiber with SC & LC fiber connectors terminated at each end. The optical fiber patch leads shall comply with the following specifications:

Optical Fiber – Multi  
 Mode Connector: Zirconia ceramic  
 ferrule Pre-radiused and pre-polished  
 ferrule Duplex  
 Color-coded :  
 Insertion Loss - < 0.2  
 dB Cable: 50/125, MM (OM3)  
 )  
 Repeatability - < 0.2  
 dB Durability –  
 1000 mating cycle  
 Working Temp : -40 deg C. to + 85 deg.  
 C Standard : G652D, G 657A & G

657BLength:1 Mtr(OR ASREQUIRED

## **8.CAT-6UTP PATCHPANEL:**

Cat-6UTPPatchPanelshouldhavefollowingfeatures&specification:

Made of powder coated steel, in 24 port configurations.  
Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.  
Port identification numbers on the front of the panel.  
Self-adhesive, clear label holders (transparent plastic window type) and white designation labels with the panel, with optional color labels/icons.  
IDC: Suitable for 22-26 AWG stranded and solid wire compatible with both 110 & Krone punch down tools  
Each port / jack on the panel should be individually removable on field from the panel.  
Improved cable management with optional cable management bar  
The Cat-6 transmission performance is in compliance with the ANSI/TIA/EIA 568C.2 standard  
Plastic Housing: ABS , UL94V-0  
rated Operating Life: Minimum 750 insertion cycles  
Contact Material: Copper Alloy  
Contact Plating: 50μ" Gold plated on plug contact area  
Contact Force: 20N max (IEC 60603-7-4)  
Plug Retention Force: 15lb.  
Plastic Housing: Polycarbonate, UL94V-0 rated or equivalent  
IDC cap : ABS, UL94V -0  
Contact Material: Copper Alloy  
IDC Contact Plating: Phosphor bronze with tin plated  
Insertion Force: 20N max (IEC 60603-7-4 )  
Wire Accommodation: 22-26 AWG solid

## **SINGLE PORT CAT6 UTP INFORMATION OUTLET:**

Single Port Cat6 UTP Information Outlet should have following features &

specification: Single Port  
Write on labels in transparent plastic window – supplied with plate  
Screw hole covers – to be supplied with plate  
Face Plate with shutter, Back Box should be provided.  
Support variety of jacks – UTP, STP, Fiber, Coax etc.  
Category 6, TIA 568 C.2-1 – 250MHz  
All information outlets for 100 W, 22-26 AWG copper cable shall be used.  
Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limits.  
High impact, flame-retardant thermoplastic with color and icon options for better visual identification.  
Shutter is on face plate  
Insertion force: 20N max (IEC 60603-7-4)

IDC : Housing PC + glass fiber , UL 94 V-2, 568A/B  
configurationInformation outlet (RJ45 jack) should be covered under  
ETL Verificationprogramfor compliance with TIA568B.2-1,  
OperationTemp:-10Cto60C  
Jack shall have Plastic Housing: Polycarbonate, UL94V-0 rated or  
equivalentJackshallhaveOperatingLife:Minimum750 insertioncycles  
JackshallhaveContactMaterial:Copperalloy  
Jack shall have Contact Plating: 50 pinches gold on plug contact  
areaIDCconnectorshallhavePlasticHousing:Polycarbonate+glassfiber  
UL94V-2 rated  
IDC connector shall have Operating Life: Minimum 200 Re-  
terminationsIDCconnectorshallhaveContactPlating:Phosphorbronzewithtinpl  
ated

### **UTPCAT-6PATCHCORD:**

UTPCAT-6PatchCordshouldhavefollowingfeatures&specification:

The Patch Cord shall, at a minimum comply with proposed ANSI/TIA/EIA-  
568-C.2-  
1CommercialBuildingCablingStandardsTransmissionPerformanceSpecificati  
onsfor 4pair 100WCategory6 Cabling.  
Equipped with modular 8-position modular plugs on both ends, wired  
straightthroughwith standardscompliant wiring.  
50microinchesofgoldplatingovernickelcontacts.  
Covered by ETL verification program for compliance with TIA 568C.2-  
1.Conductorsize: 24 AWGstrandedbarecopper  
Max O.D.: 5.6mm  
(.22")Jacket:PVCUL-  
94V-O  
Temperature range: -10oC to +80 degree  
C.Operating life: Minimum 750 insertion  
cyclesContactblade: Phosphor bronze  
Contactplating:50μ"Gold  
Plugdimensions&tolerancescompliantwithFCCPart68.500andIEC60603  
-7  
Approvals: UL 444 for copper  
conductorDielectric withstanding voltage  
:500 V ACInsulationresistance :35MOhm  
(Max )

### **WALLMOUNTEDCOMMUNICATIONRACK:**

WallmountedCommunicationRackshouldhavefollowingfeatures&specification:

9U/15U/19U(ORASREQUIRED),19"Wallmountnetworkingrack.conf  
irmto DIN41494 orequivalent standard  
ItshouldbeweldedconstructionwithsteelframeLoc  
kabletough endedglassfrontdoor  
19"mountinganglemadeofformedsteelPo  
wderedcoatedstandardfinish  
Top & Bottom welded cover with vented & cable entry exit cut  
outs2 pair of19"mountingrails

1UCableManagerRoof  
MountedFanUnit  
230VAC,6 way,5Amp PowerDistributionUnit

## Mounting Hardware

### FLOOR MOUNTED COMMUNICATION RACK:

Floor mounted Communication Rack (42U) should have following features

& specification: 42U, 19" Floor Standing Network Rack  
19", 42U x 800 x 1000 mm Floor Standing Networking Rack  
confirm to DIN 41494 or equivalent ISO  
standard welded construction with steel frame  
Lockable double toughened glass front door 19"  
" mounting angle made of formed  
steel Powdered coated standard finish  
Top & Bottom welded cover with vented & cable entry exit cut  
outs 4 set of casters wheel  
4 set of adjustable levelers  
Vertical Power Distribution Unit with 12 nos. Of 5/15 Amp round pin  
Indian style sockets  
Vertical & Horizontal Cable  
Manager Mounting Hardware set  
At least 4 nos. Of FANs for cooling purpose

### FIBER OPTIC CABLE:

Fiber Optic Cables should have following features & specification:

6 Core Single Mode Outdoor Unarmored Fiber Optic  
Cable Protected by Glass-yarn in loose tube. LSZH jacket  
material Sequential meter marking  
Standards: ISO 11801, IEC 60793-1, IEC 60794-1.2, ITU-T RECG. 652D,  
Telcordia GR-20 Core  
The fiber type is a Matched Cladding Single Mode Fiber  
dual coated with acrylate coating.  
The fiber is optimized for operation at 1310 nm and at 1550  
nm. Nominal Mode Field Diameter: 9.2  $\mu\text{m}$   
Mode field diameter tolerance:  $\pm 4\%$   
Cladding Diameter: 125  $\mu\text{m}$  (tolerance:  $\pm 1 \mu\text{m}$ ). Mode  
field Concentricity error:  $< 1$   
 $\mu\text{m}$  Cladding non-circularity:  $< 2\%$   
Germanium doped core with no phosphorus i.e. reduced tendency for hydrogen  
degradation.

### UTP CAT-6 CABLE:

It should have following features & specification:

23 AWG Annealed bare solid copper, CAT-6 UTP Cable, Channel  
optimized to 350 MHz  
Meets EIA/TIA 568-B.2-1 Category 6 specifications, Passed UL 444 test  
and meets CM and CMR ratings  
Worst Case Cable Skew: 45 nsec/100 meters

Characteristic Impedance: 100(+/- 3) Ohms 500MHz, Tested till 700 MHz  
Conductor Annealed copper wire Diameter 0.52mm(nominal)  
Insulation High Density polyethylene, Diameter 0.94 mm (nominal)  
support for Fast Ethernet and Gigabit Ethernet IEEE 802.3/5/12, Voice, ISDN, ATM 155 & 622 Mbps and Broadband.

## TECHNICAL SPECIFICATION FOR FALSE CEILING AND ACOUSTICS

### False ceiling

#### Gypsum plaster

Gypsum plaster shall conform to IS-2547 (Part 1). By-product gypsum conforming to the requirements of IS-12679 shall also be used for the preparation of plaster.

### MANUFACTURE

Gypsum plaster boards consist of a gypsum plaster core with or without fibre encased in and firmly bonded to strong durable paper liners to form rectangular boards. Core shall be dried across full width. The face and back papers shall be securely bonded to the core. The paper surfaces may vary according to the use of the particular type of board, and the core may contain additive to impart additional properties. The longitudinal edges are paper covered and profiled to suit the application.

#### Edge and End Profiles

The paper covered edges of gypsum wall boards are square, tapered, beveled or rounded. The paper covered edges of gypsum base board are square or rounded. Other profiles may be produced for special purposes. The ends of gypsum plaster board are square-cut.

### REQUIREMENTS

#### Dimensions

The dimensions of the wall board shall be as given in Table 1. The dimensions of the base board shall be as given in Table 2.

The lengths of the two longitudinal of the boards shall not differ more than  $\pm 3\text{mm}$  per metre length of the diagonal.

**Table 1 Dimensions of Gypsum Wallboards**

| Dimensions of Wallboard | Value (mm)                      | Tolerance (mm)         |
|-------------------------|---------------------------------|------------------------|
| (1)                     | (2)                             | (3)                    |
| Width                   | 1800 to 3600<br>in steps of 100 | 0<br>-6                |
| Length                  | 600, 900 and 1200               | 0<br>-5                |
| Thickness               | 9.5<br>12.5, 15, 19, 23 and 25  | $\pm 0.5$<br>$\pm 0.6$ |

**Table 2 Dimensions of Gypsum Baseboards**

| Dimensions of Baseboard | Value (mm) | Tolerance (mm) |            |
|-------------------------|------------|----------------|------------|
|                         |            | Non-perforated | Perforated |

| (1)       | (2)                 | (3)  | (4)  |
|-----------|---------------------|------|------|
| Width     | 400 and 900         | 0    | 0    |
|           |                     | -8   | -8   |
| Length    | 1200, 1500 and 1800 | 0    | 0    |
|           |                     | -6   | -16  |
| Thickness | 9.5 and 12.5        | ±0.6 | ±0.6 |

### **Taper Profile**

Taper width shall be in the range 40 to 80 mm. Taper depth shall be in the range 0.6 to 1.9 mm.

### **Transverse Strength**

Breaking load for gypsum plaster boards shall be in accordance with Table 3.

**Table 3 Breaking Load of Gypsum Plaster Boards**

(Clause 7.1)

| Types of Board | Thickness (mm) | Breaking Load, in N | Transverse |
|----------------|----------------|---------------------|------------|
| Longitudinal   | Direction      | Direction           |            |
| (1)            | (2)            | (3)                 | (4)        |
| Wallboard      | 9.5            | 140                 | 360        |
|                | 12.5           | 180                 | 500        |
|                | 15.0           | 220                 | 650        |
|                | 19.0           | 250                 | 750        |
|                | 23.0           | 300                 | 850        |
|                | 25.0           | 380                 | 1000       |
| Baseboard      | 9.5            | 125                 | 180        |
|                | 12.5           | 165                 | 235        |

### **TESTS**

The methods of tests shall be in accordance with IS 2542 (Part 2/Sec 1 to 8).

## **B. Calcium Silicate Board**

Fireproof, Waterproof, Moistureproof. Sound Adsorption, Heat Isolation. Easy to install. 100% Asbestos Free

### **Calcium Silicate Board Features**

Fireproof (A1 Class)

Waterproof  
100% Asbestos  
FreeSound  
AdsorptionHeat  
IsolationImpact  
resistanceEasyto  
install

### **CalciumSilicatePanelsApplications**

ForExternalWall &Ceiling  
For Internal Wall, Partition &  
CeilingTheDecorativeapplications  
TheSub-roof boards  
TheUnderlayboard forFloor andWalltile

### **CalciumSilicateBoardsDescription**

Calcium Silicate Board is manufactured from a mixture of Portland cement, fine silica, special cellulosefibersand selectedfillerstoimpartdurability,toughness, fireand moistureresistance.

Calcium Silicate Sheet is cured by an autoclaving process whereby the ingredients are reacted togetherunder the effects of super-heated steam and high pressure. The synthetic cement silicate binder providesexceptional dimensional stability and an unrivalled resistance to movement due to effects of moisture orheat.

CalciumSilicateBoarddoesnotcontainanysolubleingredientsorfreealkaliwhichcouldbedissolvedbymoisture orcondensationandcausingunsightlymarks.Ifexposedtomoisture,theboardwillcompletelyrecoverondryingout, withno permanentloss of strength.

Calcium Silicate Panels will not degrade with time and within normal applications, the life of the productis limited only by the durability of the supporting structure and materials used in fastening. CalciumSilicateBoardwill not rotorsupport fungal growth andisunaffectedbysunlightorsteam.

CalciumSilicateSheetisspeciallydesignedforapplicationswhichimpactresistance,fireproof,waterproof, sound adsorption and heat isolation are required, products are suitable in a high humidenvironment.

### **CementFibreBoard**

A **cement board** is a combination of cement and reinforcing fibers formed into 4 foot by 8 foot sheets (or3 foot by 5 foot sheets), 1/4 to 1/2 inch thick that are typically used as a tile backing board. Cement boardcan be nailed or screwed to wood or steel studs to create a substrate for vertical tile and attachedhorizontallytopplywoodfortilefloors,kitchencountersandbacksplashes.Itcanbeusedontheexteriorofbuildingsasabaseforexteriorplaster(stucco)systemsandsometimesasthefinishsystemitself.

Cement board adds impact resistance and strength to the wall surface as compared to water resistant gypsum boards. Cement board is also fabricated in thin sheets with polymer modified cements to allow bending for curved surfaces.

## COMPOSITION

Cement boards are mainly cement bonded particle boards and cement fibre. Cement bonded particle boards have treated wood flakes as reinforcement, whereas in cement fibre boards have cellulose fibre, which is a plant extract as reinforcement. Cement acts as binder in both the cases.

The fire resistance properties of cement bonded blue particle boards and cement fibre boards are the same. In terms of load-bearing capacity, cement-bonded particle boards have higher capacity than cement fibre boards. Cement particle boards can be manufactured from 6 mm to 40 mm thickness making it ideally suitable for high load bearing applications. These boards are made of a homogeneous mixture and hence are formed as single layer for any thickness. Cement fibre boards are more used in decorative applications and can be manufactured from 3 mm to 20 mm thickness.

Fibre boards are made in very thin layers, making it extremely difficult to manufacture high thickness boards. Additives like mica, aluminum stearate and ecospheres are used in order to achieve certain board qualities. Typical cement fiber board is made of approximately 40-60% of cement, 20-30% of fillers, 8-10% of cellulose, 10-15% of mica. Other additives like above mentioned aluminum stearate and PVA are normally used in quantities less than 1%. Cenospheres are used only in low density boards with quantities between 10-15%. The actual recipe depends on available raw materials and other local factors.

## INSTALLATION

Cement board is hung with corrosion resistant screws or ring-shank nails. Cement board has very little movement under thermal stress, but the boards are usually installed with a slight gap at joints in shower pans, bathtubs, and each other. These joints are then filled with silicone sealant or the manufacturer's taping compounds before applying a finish. The filled joints are taped like conventional gypsum board, but with fiberglass tapes that provide additional water resistance. Combined with a water impermeable finish, cement board is a stable, durable backing board.

## WATER RESISTANCE

The category of construction material known as *cement board* includes both water resistant and waterproof board. Each has its own best use.

Typically, water-resistant cement board is composed of a treated gypsum core with a non-organic fiber reinforced covering, either on one or both faces. This type of board requires fastidious sealing of all cut edges and penetrations for wet area installations. Gypsum core "cement" board panels are ideal for moist but not truly wet installations of tile and/or stone walls.

There is a class of cement board strictly constructed of a Portland cement based core with glass fiber mat reinforcing at both faces. These panels can be immersed in water without any degradation (excluding freeze thaw cycles). These panels do not require the sealing of edges and penetrations to maintain their structural integrity. These Portland cement-based products are smaller in size compared with the gypsum core-based products. Typically, they range in size from 30" x 48" to 36" x 60". They are, as one would expect, considerably heavier than the gypsum core type panels.

Portland cement-based panels are ideal for truly wet locations like shower surrounds and for locations where a Portland cement based thin-set material is used for bonding tile and stone surfaces to a substrate. They are also ideal for floor tile and stone installation over a structural subfloor.

Cement boards may be classified as water resistant as not affected by water exposure; however, they do allow penetration and passage of water and water vapor. To waterproof cement boards, a liquid or membrane waterproofing material is applied over its surface.

## ACOUSTICS

### Technical Specification:

In order to arrive at recommendations pertaining to the use of interior materials in the Hall that would reduce noise and improve the quality of sound to the audience during different types of performances and would further add to the total aesthetic quality of the area, following provision have been made as finishing materials to ensure a good acoustic environment.

### Proposed Acoustic & Interior Environment

| Sl. No. | Location/ Surface                        | Proposed Material Finish                                                                                                                                                                                     |
|---------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.      | Hall (Floor)                             | Acrylic Carpet                                                                                                                                                                                               |
| 2.      | Portion of Side Wall                     | 12mm thick Teak wood veneering on Plywood base with Timber framing 50mm x 75mm @ 600mm c/c                                                                                                                   |
| 3.      | Portion of Side Wall                     | 12.5mm thick square edge Plain Gyp board panels of 595mm x 1195mm size for decoration with decorative wall paper, print etc. fixed with rigid steel framing.                                                 |
| 4.      | Portion of Side Wall                     | 595mm x 595mm panel having 12.5mm thickness fully perforated with fissure shapes perforations with non-woven lining with 50mm air gap and with 50mm thick glass wool insulation over the air gap as backing. |
| 5.      | Portion of Rear wall of Main Floor Level | 595mm x 595mm panel having 12.5mm thickness fully perforated with fissure shapes perforations with non-woven lining with 50mm air gap and with 50mm thick glass wool insulation over the air gap as backing. |
| 6.      | Portion of Rear wall of Main Floor Level | Wall paneling with polished decorative veneer on 19mm thick BWP grade Plywood                                                                                                                                |
| 7.      | Ceiling Area: over Main Hall             | 595mm x 595mm panels having 12.5mm thickness with 2-3mm deep random perforations with 50mm air gap and with 50mm thick glass wool insulation over the air gap.                                               |

## TECHNICAL SPECIFICATION FOR FURNITURE AND FITTINGS

### MATERIALS:

#### 1.1 Mild Steel Sheets

Mild steel sheets shall conform to Grade 0 of IS 1079:1988 or grade 0 to IS 513:1986

#### 1.2 Angles

Mild steel for hot rolled angle sections shall conform to IS 1977:1975. Hot rolled mild steel angles shall conform to IS 808:1989. Angle and channel sections may also be cold formed from strip steel, conforming to IS 513:1986.

#### 1.3 Timber

Timber shall conform to IS 13622:1993.

#### 1.4 Electrodes

Electrodes for gas, arc and spot welding shall conform to IS 1278: 1972, IS 814: 1991 and IS 1972: 1968 respectively.

### BOOK RACKS

#### 2.1 Types of Book Racks

There are three types of book racks as follows:

- Open skeleton type with side and back strips;
- Closed type with sides and back closed with sheets; and
- Side closed type, where only the sides are closed with sheets.

#### 2.2 Dimensions

The essential dimensions of double faced and single faced unit racks shall be as given in Table 1. The angle posts shall have holes at every 50 mm distance along the length for the flexibility in adjustment of the intermediate shelves. Generally, 350 mm centre – to – centre distance should be adopted for shelves.

**Table 1 Dimension of Book Racks All dimensions in millimeters**

| Sl No | Type                   | Height | Length | Depth | Height of lowest Shelf above Floor Level |
|-------|------------------------|--------|--------|-------|------------------------------------------|
| (1)   | (2)                    | (3)    | (4)    | (5)   | (6)                                      |
| i)    | Double faced unit rack | 2175   | 1840   | 460   | 100                                      |
| ii)   | Single faced unit rack | 2175   | 1840   | 230   | 100                                      |

**NOTE:** For oversized documents depths of 600 mm and 300 mm for the double faced and single faced book racks respectively are recommended.

### **3 BOOK TROLLEY**

- 3.1 The trolley shall have two pairs of slopping shelves each 200 mm wide and one flat – bottom shelf about 425 mm wide for books of large sizes.
- 3.2 The height of the trolley shall be 750 mm, the same as that of the table. The clear distance between the shelves shall be 2650 mm.]
- 3.3 The shelves rigidly connected as the ends so that they are strong enough to bear the following loading:  
Sloping shelf: 40 Kg per  
Shelf Bottom shelf:  
80 Kg per day
- 3.4 The trolley shall be fitted with four rubber tyred ball bearing wheels, one of the swivelling type at each end and two of the fixed type in the centre
- 3.5 Suitable protection may be provided at the bottom corners and the ends of the vertical angle parts, to minimize damage due to knocking against other furniture, fittings, walls or pillars.  
Note: The book trolley shall be so designed as not to make any noise while in use.

### **BOOK ENDS**

Book ends made of steel shall conform to IS 7076:1983.

### **CATALOGUE CARD STRAY**

- 5.1 The size of catalogue card stray shall be based on the international catalogue card size 75 X 125 mm (Refer IS 7150:1974.)
- 5.2 The internal dimensions of the tray shall be 105 X 135 X 500 mm, the side and back plates of the tray shall be minimum 50 mm high.
- 5.3 A guide rod of mild steel, suitably painted to prevent rusting, shall be fitted right through the centre of the tray to lock up the cards by some suitable means.
- 5.4 A suitable stop shall be provided to prevent the tray from being pulled entirely out of the cabinet.

### **CARD INDEX CABINETS.**

- 6.1 The cabinet shall have two or four drawers.

#### **6.2 The dimensions of the card index cabinets as shown in Table 2**

**Table 2: dimensions of card Index Cabinets**

(all dimensions in millimeters).

| S/No | Type                | Height | Length | Depth |
|------|---------------------|--------|--------|-------|
| (1)  | (2)                 | (3)    | (4)    | (5)   |
| i)   | Two drawer cabinet  | 135    | 320    | 510   |
| ii)  | Four drawer cabinet | 255    | 320    | 510   |

**6.3** The cabinet should be placed on a 570 mm high stand or table

### **CATALOGUE CARDS WORK TRAY**

**7.1** The internal dimension of catalogue cards work tray shall be as follows

Length: 300  
Width:  
135 mm Depth: 50 mm

**7.2** The tray shall be made from steel sheet or not less than 0.8 mm thick.

**7.3** A movable card rest shall be provided as 7.5

### **CHARGING TRAY**

**8.1** Charging trays are meant for containing readers' tickets. The tray may have one, two, three or four compartments.

**8.2** The overall dimensions of charging tray depend upon the number of compartments and the size of the tickets issued. The internal dimension of each compartment shall be as given below:

For New rack Charging System

- 1) Length: 370 mm
- 2) Width: 85 mm
- 3) Height: 125 mm

For Browne Charging System

- 1) Length: 370 mm
- 2) Width: 55 mm
- 3) Height: 75 mm

**8.4** The tray shall be made from steel sheet or not less than 0.8 mm thick.

### **READING ROOM TABLE:**

The size of the reading room table shall be 900 X 600 mm for single and 2400 X 600 mm for three readers. Height of the table top shall be 750 mm and that of the foot rest rod shall be 150 mm.

### **10 STUDY TABLE:**

Study table shall have the same dimensions as reading room table for a single reader. It shall have, in addition, a pedestal on one side with one or two drawers.

## **CHAIRS**

- 11.1** The essential dimensions of steel chairs shall be as specified in IS 3663:1991
- 11.2** The materials, construction and finish of steel chairs shall conform to IS 3499 (Part I): 1985
- 11.3** The back-rest of the steel chair shall be curved in plan or so shaped to give comfort to the body. It shall neither be too curved to restrict the movement of back nor be too flat.
- 11.4** The chair seats shall not be hard or upholstered but shall preferably be of woven material to ensure ventilation and slight yielding when in use.
- 11.5** The height of the seat of the counter chair shall depend upon the height of the counter.

## **BOOKCASES**

Steel/ Wooden book cases for use in library shall conform to IS 7761: 1983.

## **GLASS-FRONT CABINETS**

Steel glass-front cabinets for use in library shall conform to IS 7760:1985.

## **FINISHING**

- 15.0** All the steel items specified shall be finished as specified in 15.1 to 15.3.
- 15.1** All dents, burrs and sharp edges shall be removed from various components and they shall be picked, scrubbed and rinsed to remove grease, rust, scale or any other foreign matter.
- 15.2** Immediately after pickling, all mild steel parts shall be given phosphating treatment in accordance with IS 3618: 1966, followed by a coat of suitable primer, such as red oxide (see Note): Two coats of enamel paints shall then be applied as follows:

Undercoat conforming to IS 149:1950; and

Finish coat with enamel conforming to IS 151:1985, IS 2932:1974 or IS 2933:1975.

**NOTE:-** Putty shall be applied to all the surfaces requiring filling and shall conform to IS 110: 1983. Aluminum primer shall conform to IS 5660: 1970.

- 15.2.1** The finish shall be smooth and uniform with a hard and tough film of enamel strongly adhering to the surface. The finish shall be free from all visible defects and the film shall not chip when tapped lightly with a dull pointed instrument.

- 15.3** All other components shall be finished in color as agreed to between the purchaser and manufacturer.
- 15.4** Powder coating as specified in IS 13871:1993 may be done on the mild steel components if required by the purchaser.

## **16 PERFORMANCE REQUIREMENTS OF FINISH FOR STEEL**

### **16.1 Hardness Test**

Test to be carried out as per 5 of IS 101 (Part 5/Sec 1): 1988.

### **16.2 Flexibility and Adhesion Test**

Test to be carried out as per 2 of IS 101 (Part 5/Sec 2): 1988.

### **16.3 Impact Resistance Test**

Test to be carried out as per IS 101 (Part 5/Sec 3): 1988.

### **16.4 Resistance to humidity under continuous condensation test to be carried out as per 2 of IS 101 (Part 6/Sec 1): 1988.**

## **17 MARKING**

### **17.1 All items manufactured as per this standard shall be marked with a suitable mark identifying the manufacturer.**

### **17.2 They may also be marked with Standard Mark.**

All wooden furniture shall conform to IS: 1829 (Part-1) (Latest Revision).

## TECHNICAL SPECIFICATION FOR 10 KLD CAPACITY EFFLUENT TREATMENT PLANT

### DESIGN BASIS AND ASSUMPTIONS

The design of the Effluent treatment plant is on the basis of the following Effluent characteristics.

| PARAMETERS        | UNIT | RAW EFFLUENT | TREATED EFFLUENT (FOR DISPOSAL) | TREATED EFFLUENT (AFTER TTP) |
|-------------------|------|--------------|---------------------------------|------------------------------|
|                   | KLD  | 10           | 10                              | 10                           |
| pH                | -    | 6.5-7.5      | 6.5-8.5                         | 6.5-8.5                      |
| BOD less than (<) | ppm  | 250-300      | 30                              | 20                           |
| COD less than (<) | ppm  | 500-600      | 250                             | 100                          |
| Suspended Solids  | ppm  | 250-450      | 100                             | 20                           |
| O&G               | ppm  | 50           | 10                              | 10                           |

The treatment scheme is for domestic effluent application and based on the following assumptions:-

The design of Plant is for COD, BOD, O&G, & TSS removal only.

Any other parameter which may be hazardous in nature and will affect the biological process should not be present in the raw effluent.

The oil present is to be in free floating form.

Industrial effluents are not present in the influent effluent. Temperature Range: 35 degC, Min– 15 degC.

### PROCESS DESCRIPTION

#### Screen

Raw effluent from the source is usually received into the screening chamber by gravity. Screen provided will remove all floatables and big size matter such as plastic bottles, polythene bags, glasses, stones, etc., which may otherwise choke the pipe line and pumps.

#### Oil and Grease Trap

If the effluent generated includes maximum quantity from kitchen and canteen, there is a possibility of higher concentrations of oil and grease in the raw effluent. It needs to be removed before biological treatment as it otherwise may cause problems for biological treatment. Usually, a small civil construction tank with a baffle wall is provided. The oil and grease removed by gravity floats to the surface, which is removed manually.

#### Equalization Tank:

Usually, effluent generation is more during morning hours and evening hours. Visually no effluent is generated during night hours. Any biological system needs constant feed for bacteria to work efficiently. Hence, it is important to put an equalization tank to collect the excess flow

during peak hours and feed effluent in lean hours. A typical equalization tank has a capacity of MINIMUM 6 hours of average flow rate. The tank is generally of civil construction by client. Provision of a grid is to be made for thoroughly mixing the effluent to make it of homogeneous quality and to keep the suspended matter in suspension and to avoid septic conditions.

### **Biological Treatment**

The main pollutants in the raw effluent are represented in the form of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The bacterial ability to synthesize the organic matter to harmless end products like Carbon dioxide and water molecules is utilized to treat the raw effluent.

The bio reactions are carried out in controlled environment in the bio reactor. The bio reactor comprises of a tank, fitted with aeration grid. The bacterial activity needs dissolved oxygen to synthesize the organic matter. This is supplied by passing air in the form of small bubbles.

The air is passed at the bottom of the tank, so that complete volume of tank is utilized. Oxygen dissolves in liquid, which can now be used by the bacteria.

The bacteria grow on the plastic media, by using the organic content in the raw effluent, and the dissolved oxygen available. Due to constant aeration, the media is set in whirling motion, so that continuous mixing takes place. The bacterial layer growth on the media surface increases to a certain extent, and then gets sloughed off after a specific period. This phenomenon is called sloughing. This creates new surface for further bacterial growth. Sloughing takes place only after complete growth and subsequent dying-off of the bacterial layer and hence the sloughed off material is completely digested.

The bacterial reaction is carried out in two stages, for maximizing the BOD removal efficiency. Hence, two such reactors are provided in series. Within the reactors, arrangements are made to retain the plastic media in place. Air supply is done through coarse bubble diffusers.

### **Tube Settler**

The sloughed biomass must be removed before the treated effluent can be disposed of. Hence a secondary clarifier in the form of a tube settler is provided. In the tube settler the sloughed biomass is removed & suspended solids are settled under action of gravity. The settled mass is drained and discarded as sludge.

### **Disinfection**

The treated effluent is then added with chlorine to kill the pathogens/E-coli coli-forms, so that it becomes fit for disposal in the lake / water ways. Chlorine being a very strong oxidizing agent, a small dose of 3 – 4 mg/l is enough to achieve desired levels of disinfection. Small residual chlorine (of the order of 0.2 -0.25 mg/l) also ensures that there is no re-growth of E-coli, till the final disposal point. The treated effluent, now substantially free from organic contamination, free from coli-form bacteria can be safely disposed of in the river, or in other water bodies. This water can also be re-used for gardening/toilet flushing or for other secondary applications after suitable tertiary treatment.

### Tertiary Treatment

In case the water is to be reused the treated effluent after disinfection is first passed through a bed of filtration sand and anthracite and subsequently through a bed of activated carbon for further polishing. While filtration restricts the suspended solids, activated carbon absorbs organic color and odour. The filtration bed periodically requires a backwash.

### Sludge Holding Tank

Sludge is transferred to a collection tank either by gravity or through pump depending on site condition. Sludge present in the tank is dispersed through private/municipal tankers in regular intervals.

### Mechanical Dewatering

We have offered Filter Press for dewatering of sludge. It requires less space than sludge-drying beds. However, they offer a greater degree of operational control. They usually have to be preceded by a step, in which chemicals are added to the liquid sludge to coagulate solids and improve drainability. The Filter press feed pumps will be screw pumps.

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### MAKE SOF DIFFERENT PLANT ELEMENTS

| PRETREATMENT      |                                                                                                                                                                        |       |      |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|
| 1.                | <u>SCREEN</u><br>To arrest floatables from entering the biological reactors and remove oil and grease from the incoming effluent.<br><u>Make:</u> As approved          | 1     | No.  |
| 2.                | <u>AIR GRID</u><br>To homogenize the effluent and increase the dissolved oxygen in the water to avoid septic degradation inside EQT & SHT.<br><u>Make:</u> As approved | 1     | Set  |
| 3.                | <u>EFFLUENT TRANSFER PUMP</u><br>For pumping effluent from receiving tank to the stilling chamber with 100% standby.<br><u>Make:</u> As approved                       | 1W+1S | Nos. |
| AEROBIC TREATMENT |                                                                                                                                                                        |       |      |
| 4.                | <u>AIR BLOWERS</u><br>Rotary type twin Lobe air blower is provided for aeration inside Equalization Tank, Sludge Holding Tank, and MBBRs.<br><u>Make:</u> As approved  | 1W+1S | Nos. |
| 5.                | <u>MBBR MEDIA</u>                                                                                                                                                      | 1     | Lot. |

|                                  |                                                                                                                                                                                             |   |      |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------|
|                                  | Media helps in increasing protected surface area for bacterial growth. Acts as a medium to keep bacteria in suspended form. Also ensuring better oxygen contact.                            |   |      |
| 6.                               | <u>AIR DIFFUSERS MBBR</u><br>To homogenize the effluent and increase the dissolved oxygen in the water to create aerobic degradation. Fine Bubble, Header & Lateral type, with diffusers.   | 1 | Set  |
| 7.                               | <u>MOVING BED-BIOREACTOR I &amp; II (MOC-MSERP)</u>                                                                                                                                         | 1 | No.  |
| <b>CLARIFICATION SYSTEM</b>      |                                                                                                                                                                                             |   |      |
| 8.                               | <u>TUBE SETTLER MEDIA</u><br>These are multiple tubular channels sloped at an angle of 45/60 degrees adjacent to each other which combine to form an increased and effective settling area. | 1 | Lot. |
| 9.                               | <u>TUBE SETTLER (MOC-MSERP)</u>                                                                                                                                                             | 1 | No.  |
| 10.                              | <u>WATER FLOW LAUNDER</u>                                                                                                                                                                   | 2 | Nos. |
| <b>DISINFECTION SYSTEM</b>       |                                                                                                                                                                                             |   |      |
| 11.                              | <u>HYPODOSING TANK</u><br>For Chlorine contact Tank                                                                                                                                         | 1 | No.  |
| 12.                              | <u>HYPODOSING PUMP</u><br>For Chlorine dosing, Electronic metering type<br><u>Make:</u> As approved                                                                                         | 1 | No.  |
| 13.                              | <u>CHLORINE CONTACT TANK (MOC-HDPE)</u>                                                                                                                                                     | 1 | No.  |
| <b>TERTIARY TREATMENT SYSTEM</b> |                                                                                                                                                                                             |   |      |
| 14.                              | <u>FILTER FEED PUMP</u><br>Centrifugal, Horizontal, Monobloc Type<br><u>Make:</u> As approved                                                                                               | 1 | No.  |
| 15.                              | <u>DUAL MEDIA FILTER</u>                                                                                                                                                                    | 1 | No.  |

|                                       |                                                                                                                                                                                                                                                                                |    |      |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|------|
|                                       | <p>Filtration is achieved in 2 stages due to presence of 2 different beds of filtering media. Since both media (i.e. sand and anthracite) are employed, the dirt holding capacity of these filters is twice that of pressure sand filters.</p> <p><u>Make:</u> As approved</p> |    |      |
| 16.                                   | <p><u>ACTIVATED CARBON FILTER</u></p> <p>Contains activated carbon as the principle media which is highly porous in nature. Thus, has ability to absorb and reduce free chlorine, colloidal organic matter and odor.</p> <p><u>Make:</u> As approved</p>                       | 1  | No.  |
| <b>SLUDGE HANDLING SYSTEM</b>         |                                                                                                                                                                                                                                                                                |    |      |
| 17.                                   | <p><u>AIR GRID</u></p> <p>To homogenize the sludge and increase the dissolved oxygen in it to avoid septic degradation inside SHT. Header &amp; lateral type, without diffusers.</p>                                                                                           | 1  | Set  |
| 18.                                   | <p><u>FILTER PRESS UNIT</u></p> <p>For dewatering of treated sludge, making sludge handling easy</p>                                                                                                                                                                           | 1  | Set  |
| 19.                                   | <p><u>FILTER PRESS FEED PUMP</u></p> <p>Screw pump to feed treated sludge into the centrifuge</p> <p><u>Make:</u> As approved</p>                                                                                                                                              | 1W | No.  |
| 20.                                   | <p><u>DEWATERING POLYDOSING PUMP</u></p> <p>For Polydosing, electronic metering type</p> <p><u>Make:</u> E-dose/Equivalent</p>                                                                                                                                                 | 1W | No.  |
| 21.                                   | <p><u>DEWATERING POLYDOSTING TANK</u></p> <p>For Poly electrolyte solution penetration</p>                                                                                                                                                                                     | 1  | No.  |
| <b>INTERCONNECTING PIPING NETWORK</b> |                                                                                                                                                                                                                                                                                |    |      |
| 22.                                   | Interconnecting piping for Air blower line                                                                                                                                                                                                                                     | 1  | Lot. |
| 23.                                   | Interconnecting valves for Air blower line                                                                                                                                                                                                                                     | 1  | Lot. |

|                                          |                                                                                   |   |      |
|------------------------------------------|-----------------------------------------------------------------------------------|---|------|
| 24.                                      | Interconnecting piping for Effluent line                                          | 1 | Lot  |
| 25.                                      | Interconnecting valves for Effluent line                                          | 1 | Lot. |
| 26.                                      | Puddle Pipes & Flanges                                                            | 1 | Lot. |
| <b>ELECTRICALS &amp; INSTRUMENTATION</b> |                                                                                   |   |      |
| 27.                                      | Cable, Cable Tray, Cable Tie, Earthing Strip, Glands Lock Nuts etc.               | 1 | Lot. |
| 28.                                      | <u>AIRFLOWMETER</u><br>Manual Rota Meter Type                                     | 2 | Nos. |
| 29.                                      | Pressure Indicator                                                                | 1 | Lot. |
| 30.                                      | <u>LEVEL SWITCH</u>                                                               | 2 | Nos. |
| 31.                                      | <u>CONTROL PANEL</u><br>Manually operated panel equipped with 07 Nos. DOL Feeders | 1 | No.  |

**B] LIST OF CIVIL UNITS**

| SL.NO. | ITEM                          | QTY | SIZE                  | MOC |
|--------|-------------------------------|-----|-----------------------|-----|
| 1.     | Bar Screen                    | 1   | 0.5 mx 1mx 0.5m SWD   | RCC |
| 2.     | Oil & Grease Trap             | 1   | 0.5 mx 1.5mx 1.2m SWD | RCC |
| 3.     | Equalization Tank             | 1   | 1.0 mx 1.5mx 2.5m SWD | RCC |
| 4.     | Sludge Holding Tank           | 1   | 1.0 mx 1.0mx 1.5m SWD | RCC |
| 5.     | Foundations for all the units | --- | Suitable              | RCC |

**E] LIST OF CONTAINER UNITS**

| SL.NO. | ITEM                | QTY | SIZE          | MOC    |
|--------|---------------------|-----|---------------|--------|
| 1.     | MBBR + Tube Settler | 2+1 | Suitable      | MSFR P |
| 2.     | CCTCUMFFT           | 1   | 500 Ltrs Tank |        |

All dimensions are tentative and are reliable for change depending on detailed engineering and prevailing site conditions.

We will provide the necessary GA drawings.

## TECHNICAL SPECIFICATION

### A. MECHANICAL ITEMS

| SI No | DESCRIPTION                                                       | SPECIFICATIONS                                 | MOC                      |
|-------|-------------------------------------------------------------------|------------------------------------------------|--------------------------|
| 1     | Bar Screen                                                        | 0.48X0.5M                                      | MSEP                     |
| 2     | Air Grid for Equalization Tank with lateral pipe without diffuser | Suitable                                       | UPVC                     |
| 3     | Effluent Transfer pump from Equalization Tank to MBBR             | 0.5m <sup>3</sup> /hr @ 12mwc head centrifugal | CI casing, CI impeller   |
| 4     | Air Blower for Equalization Tank, Sludge Holding Tank & MBBRs     | 10m <sup>3</sup> /hr. @ 4.0mwc                 | CI Twin Lobe type        |
| 5     | MBBR media                                                        | suitable                                       | PVC                      |
| 6     | Air distribution grids (SHT)                                      | Suitable header & laterals type                | UPVC                     |
| 7     | Air diffusers for MBBR                                            | Fine Bubble, Stick type                        | Membrane: EPDM Pipe: PVC |
| 8     | Tube Settler Media                                                | Suitable                                       | PVC                      |
| 9     | Hypo Dosing Tank for Chlorine contact Tank                        | 100 litres                                     | HDPE                     |
| 10    | Hypo Dosing Pump for Chlorine contact Tank                        | 0-4 LPH                                        | PP                       |
| 11    | DMF                                                               | 500mm DIA x 1200mm HOS                         | MSEP                     |
| 12    | ACF                                                               | 500mm DIA x 1200mm HOS                         | MSEP                     |
| 13    | Filter Feed Pump                                                  | 0.5m <sup>3</sup> /hr @ 30mwc                  | CI casing, CI impeller   |
| 14    | Filter Press                                                      | 12" X 12" - 10 plates                          | CI/PP                    |
| 15    | Filter Press Feed Pumps                                           | 1.0m <sup>3</sup> /hr. 40MWC Screw pumps       | CI with SS               |
| 16    | Interconnecting piping for Air blower line                        | To Suit                                        | MSEP                     |
| 17    | Interconnecting valves for air blower line                        | To Suit                                        | CI                       |
| 18    | Interconnecting piping for Effluent line                          | To Suit                                        | UPVC                     |
| 19    | Interconnecting valves for Effluent Line                          | To Suit                                        | UPVC                     |
| 20    | Puddle pipe                                                       | To Suit                                        | MSEP                     |

**B. ELECTRICAL AND INSTRUMENTATION**

| Sl No | DESCRIPTION                                                      | SPECIFICATIONS                        |
|-------|------------------------------------------------------------------|---------------------------------------|
| 1     | Cable, Cabletray, Cabletie, earthing strip, glands, locknut etc. | All industrial grade electrical items |
| 2     | Airflowmeter                                                     | Rotameter Type                        |
| 3     | Pressure Indicator                                               | Gauge Type                            |
| 4     | Level Switch                                                     | For both High & Low Level sensing     |
| 5     | Control Panel                                                    | 7 Nos feeders                         |

**C. ELECTRICAL LOAD (APPROXIMATE)**

| Sl No | Drive                        | Connected Load (KW)    | Operating Load (KW)    |
|-------|------------------------------|------------------------|------------------------|
| 1     | Effluent Feed Pumps          | $2 \times 0.37 = 0.74$ | $1 \times 0.37 = 0.37$ |
| 2     | Air Blowers                  | $2 \times 2.2 = 4.4$   | $1 \times 2.2 = 2.2$   |
| 3     | TTP Feed Pump Motor          | $1 \times 0.75 = 0.75$ | $1 \times 0.75 = 0.75$ |
| 4     | Filter Press Feed Pump Motor | $1 \times 0.75 = 0.75$ | $1 \times 0.75 = 0.75$ |
| 5     | Filter Press Hydraulic Motor | $1 \times 0.37 = 0.37$ | $1 \times 0.37 = 0.37$ |
| 6     | Total                        | 7.01                   | 4.44                   |

## TECHNICAL SPECIFICATIONS FOR SOLAR WATER HEATER

All material should be as per the standard features & specifications. Solar Water Heating Systems should have following specifications:-

### 1. Design: -

- |                      |                                        |
|----------------------|----------------------------------------|
| a. Capacity          | : 200LPD x 2 Nos. and 300LPD x 2 Nos.  |
| b. Output Temp.      | : 55degC                               |
| c. Collector Type    | : Flat Plate                           |
| d. No. of Collectors | : 2 Nos. x 3 / 3 Nos. X 3              |
| e. System Type       | : Non-Pressurized/Indirect pressurized |
| f. Application       | : Washing                              |
| g. Circulation       | : Thermosyphon                         |
| h. Electric Back Up  | : 2kw/3KW                              |

### Tank Specifications: -

- |                   |                                               |
|-------------------|-----------------------------------------------|
| a. Inner Tank     | : SS 304                                      |
| b. Insulation     | : CFC free PUF (32-42Kg/cum)                  |
| c. Outer Cladding | : GI Pre Coated d. End Caps: Al Powder Coated |

### Collector Specifications: -

- |                      |                                         |
|----------------------|-----------------------------------------|
| a. Type: Cu-Cu       | b. Size : 2060 x 1055 x 100mm (approx.) |
| c. Absorptivity      | : > 0.95                                |
| d. Emissivity        | : < 0.2                                 |
| e. Transmittivity    | : > 0.85:                               |
| f. Insulation        | : CFC free PUF                          |
| g. Hardware          | : SS 304                                |
| h. Collector Frame   | : Extruded Al                           |
| i. Bottom Insulation | : CFC free PUF (32-42Kg/cum) (50mm)     |
| j. Side Insulation   | : CFC free PUF (32-42Kg/cum) (50mm)     |

- k. AbsorberPlate : Copper
- l. Riser :Cu-12.5mmx 0.55mm
- m. InletHeader : Cu-25.4mm
- n. Certification : BIS-IS12933

4. piping"s:-

- a. Type :GI"B" Class
- b. Insulation :CFCfreePUF(32-42Kg/cum)/RockWool(48Kg/cumx50mm)
- c. Cladding :Al (28gauge)

Listofapprovedmakes

- SolarWaterHeatingSys. :TATABP/RACOLD/NUETECH
- GIPipes :Jindal/TATA/SuryaPrakash
- OtherAssociatedMaterials :AsperManufacturerStandard

# **TECHNICAL SPECIFICATION FOR SITE DEVELOPMENT WITH INTERNAL ROAD, PATHWAY, SURFACE DRAINS, LANDSCAPING & HORTICULTURE, BOUNDARY WALL, SECURITY HUT**

## **1.0 SITE/TERRACE DEVELOPMENT**

The Site/Terrace development will involve earthwork in excavation and filling in all types of soil, including watering, and rolling with 8 to 10 tons smooth wheel rollers as well as construction of brick masonry in Cement mortar 1:4 / RCC (M-20) / Random Rubble/Course Rubble / retaining wall / other types of protective works upto the design height from existing ground level in hilly slopes, all in conformity with approved design and drawings and as directed by Engineer-in-Charge.

## **2.0 APPROACH ROADS**

The work shall consist of Construction of Bituminous Road pavement including protective works & drainage work in hilly terrain, in conformity with detailed drawings and specification. The work shall include furnishing of all plants, equipments, materials and labor & performing all operation in connection with the work as approved by the Engineer-in-charge, and in conformity with the specifications for Rural Roads of Ministry of Rural Development (MORD) as published by Indian Road Congress Aug 2004 with upto date amendments/corrigendum.

### **2.1 General Requirements**

All materials incorporated and all works performed shall be strictly in conformity with the specification requirements and the Contractor shall be responsible for the quality of the work in the entire construction within the contract. He shall have his own independent and adequate set up for ensuring the same.

### **2.2 Quality Control for Road Works**

- 2.2.1 The Contractor shall provide necessary co-operation and assistance in obtaining the samples for test & carrying out the field test as required by the Engineer - in - Charge from time to time.
- 2.2.2 For the work of embankment, subgrade and pavement, construction of subsequent layer of same or other material over the finished layer shall be done after obtaining permission from the Engineer-in - charge.
- 2.2.3 The Contractor shall carry out modification in the procedure of work, if found necessary, as directed by the Engineer - in - Charge during inspection. Works falling short of quality shall be rectified by the Contractor at his own cost as directed.

### **2.3 Earthwork in Hilly Area**

- 2.3.1 All earthwork in excavation, including rock excavation, shall be carried out true to lines, grades, side slopes, width, camber, super-elevation and levels as shown on the drawings or as directed by the Engineer, in conformity with the requirements of Clause 302 of MORD Specifications.

2.3.2 Identification of areas for proper disposal of debris and waste materials shall be done before commencement of work. Safe disposal of materials shall be done as per direction and satisfaction of the Engineer-in-Charge. The Contractor shall arrange necessary construction equipment and adequate labor camps and camp equipments at his own cost. Prompt removal of debris shall also be ensured by the Contractor at his own cost.

2.3.3 Hill cutting shall be done in a manner so that deforestation comes to minimum so as to reduce the environmental imbalance. It shall be done in conformity with Environment Management Plan after assessment of adverse impact on environment. Necessary mitigation measures shall be ensured before start of hill-cutting work.

## **2.4 Sub-Base**

2.4.1 Granular sub-base material comprising natural sand, moorum, gravel, kankar, brick metal, crushed stone or combination thereof meeting the prescribed grading & physical requirements shall be used with the approval of Engineer-in-Charge. The sub-base material should have minimum CBR of 20 percent.

2.4.2 The sub-base material should be tested at the dry-density and moisture content expected in the field. Where the proposed sub-base material contains an appreciable number of particles coarser than 20mm, its suitability can be estimated from past experience or by conducting the CBR test on the fraction of material passing 20mm sieve.

## **2.5 Preparation of Sub-Base**

2.5.1 Immediately prior to laying of Sub-base, the sub-grade already finished to proper level shall be removed of all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with 8 to 10 tons smooth wheeled roller, to achieve a minimum CBR of 5 percent.

2.5.2 The sub-base material of grading as specified shall be spread on the prepared sub-grade. The thickness of the loose layer, shall be regulated so that the maximum thickness of the layer after consolidation does not exceed 150 mm.

2.5.3 Immediately thereafter, rolling shall be started with 8 to 10 tons smooth wheeled rollers at optimum moisture content or other approved equipment. Rolling shall commence at the edges & progress towards the centre longitudinally. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

## **2.6 Water Bound Macadam-Base**

2.6.1 The water bound macadam base comprises of conventional water-bound-macadam. The base material consists of clean, crushed coarse aggregates, mechanically interlocked by rolling with 8-10-ton roller and bound together with screening, binding material where necessary and water laid on a properly prepared sub-grade / sub-base as the case may be and finished in accordance with the requirements of the specifications and in close conformity with the lines, grades, cross-section and thickness as per approved drawings.

- 2.6.2 The aggregate shall conform to the physical requirements of Los Angeles Abrasion value or Aggregate Impact Value and flakiness index as per IS:2386 (Part-IV) and IS:2386 (Part-I).

## **2.7 Spreading Coarse Aggregate**

- 2.7.1 The coarse aggregates shall be spread uniformly and evenly upon the prepared subgrade/ sub-base/ base to proper profile by using templates placed across the road about 6 Metre apart. In no case shall the aggregates be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over uncompacted or partially compacted base be permitted. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The surface of aggregates shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved plan.

## **2.8 Rolling**

- 2.8.1 Following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tons capacity or vibratory roller to be used shall be approved by the Engineer-in-Charge based on trial run. Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges shall be compacted with roller running forward and backward the roller then shall move inwards parallel to the centre line of the road in successive passes uniformly lapping the preceding tracks by at least half width.
- 2.8.2 Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary.
- 2.8.3 The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of the aggregates and re-rolling until the entire surface conform to desired camber and grade. In no case, use of screenings shall be permitted to make up the depressions.

## **2.9 Application of Screenings**

- 2.9.1 After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate.
- 2.9.2 The screenings shall be applied at a slow and uniform rate so as to ensure filling of all the voids. This shall be accompanied by dry rolling and brooming by mechanical brooms or hand-brooms. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

## **2.10 Sprinkling of Water and Grouting**

- 2.10.1 After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand-broom shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued with additional screenings as necessary until the coarse aggregate has been thoroughly keyed, well bounded and firmly set in its full depth and a grout has been formed of the screenings. Care shall be taken to see that the base of subgrade does not get damaged due to addition of excessive quantities of water during construction.

## **2.11 Binding Material**

- 2.11.1 After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate.

Binding material to be used for water Bound Macadam as a filler material meant for preventing raveling, shall comprise of a suitable material approved by the Engineer-in-Charge having a plasticity index (P-1) value of less than 6 as determined in accordance with I.S. 2720 (Part-V).

The quantity of binding material where it is to be used shall depend on the type of screenings. Generally, the quantity required for 75 mm. compacted thickness of Water Bound Macadam will be 0.06-0.09 cum/10 sqm. and 0.08-0.10 cum/10 sqm. for 100 mm compacted thickness.

Application of binding materials will not be necessary when the screenings used are of crushable type such as moorum or gravel.

## **2.12 Prime Coat**

- 2.12.1 The work shall consist of the application of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment of mix. The primer shall be slow setting Bitumen Emulsion Grade SS-I; complying with IS-8887.

- 2.12.2 The surface to be primed shall be prepared in accordance with clause 501 of MORD specification. Immediately prior to applying the primer the surface shall be carefully swept clean of dust & loose particles, care being taken not to disturb the interlocked aggregate.

- 2.12.3 The bituminous primers shall be sprayed uniformly over the dry surface, using self-propelled or towed sprayer, capable of supplying primer at specified rates and temperatures so as to provide a uniform unbroken spread of primer. The primers shall be applied at the rate as specified in Table 500.1 of MORD specification. The temperature of application of primer need only be high enough to permit to be effectively spread through the jets of the spray-bar to cover the granular surface uniformly in the desired quantity. For a bituminous emulsion primer, the range of spraying temperatures shall be 20°C to 60°C & for cutback 50°C to 80°C if medium curing grade is used.

## **2.13 Tack-Coat**

- 2.13.1 Over the primed surface, a tack-coat should be applied in accordance with clause 503 of MORD specification.

- 2.13.2 This work shall consist of application of a single coat of low viscosity liquid bituminous material on prepared granular surface treated with primer cleaned with hydraulic broom. The surfaces should be clean and free of dust, dirt and extraneous material.
- 2.13.3 The binder used for tack-coat shall be rapid setting Bitumen Emulsion Grade RS-I, complying with ES:8887 and shall be sprayed on the base at the rate specified in Table 500.2 of MORD specification. The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 60°C and for a cut back 50°C to 80°C if medium curing grade is used. Work should be planned, so that no more than the necessary tack-coat for the day's operation is placed on the surface. The tack-coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicle shall be allowed on tack-coat.
- 2.13.4 For control of the quality of materials supplied and the works carried out, the relevant provision of Clause 111 of MORD specification is applicable.

## **2.14 Premix Carpet**

- 2.14.1 Open graded premix carpet using Bituminous binder shall be penetration grade bitumen of grade S-90 and satisfying the requirements of IS-73. The work shall consist of the preparation, laying and compaction of a pre-mix surfacing material of 20 mm thickness composed of small-sized aggregate premixed with a bituminous binder on a previously prepared base, in accordance with the requirement of the MORD specification 508, to serve as a wearing course.
- 2.14.2 The aggregate shall conform to clause 504.22 of MORD specification, except that the water absorption shall be limited to a maximum of 1 percent. The material shall be proportioned in accordance with Table 500.13 of MORD specification.
- 2.14.3 Hot mix plant of appropriate capacity and type shall be used for the preparation of the mix. The hot mix plant shall have a separate dryer arrangement for the aggregate. The temperature of the binder at the time of mixing shall be in the range of 150°C to 163°C and that of the aggregate in the range of 155°C to 163°C provided that the difference in temperature between the binder and aggregate at no time exceeds 14°C. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregate are coated uniformly and the discharge temperature of mix shall be between 130°C to 160°C. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or hand barrow. For further guidance refer Appendix 8.5 of IRC:SP:20:2002: Rural Road Manual.
- 2.14.4 The pre-mixed material shall be spread by suitable means to the desired thickness, grades and cross-fall (camber) making due allowance for any extra quantity required to fill up depressions, if any. The cross-fall should be checked by means of camber boards and irregularities levelled out. Excessive use of blades or rakes should be avoided. As soon as sufficient length of bituminous material has been laid, rolling shall commence with 80 to 100 kN static weight roller, or other approved equipment. Rolling shall begin at the edge and progress towards the centre longitudinally, except that on super elevated and unidirectional cambered portions, it shall progress from the lower to upper edge parallel to the centre line of the pavement.

- 2.14.5 When the roller has passed over the whole area once, any high spots or depressions, which become apparent, shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled and all the roller marks eliminated. In each pass of the roller, the preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels. In no case shall fuel/lubricating oil be used for this purpose. Excess use of water for this purpose shall also be avoided.
- 2.14.6 Rollers shall not stand on newly laid material. Rolling operations shall be completed in every respect before the temperature of the mix falls below 100°C. Joints along and transverse to the surfacing laid and compacted earlier shall be cut vertically to their full depth so as to expose fresh surface which shall be painted with thin coat of appropriate binder before the new mix is placed against it.
- 2.15 Seal Coat**
- 2.15.1 The seal coat shall be premixed seal coat Type-B as per MORD clause 510 of Technical Specification, comprising of a thin application of a fine aggregate premixed with bituminous binder.
- 2.15.2 The aggregate shall be sand or grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36 mm sieve and be retained on 180-micron sieve. The quantity used for premixing shall be 0.06 cu.m per 10 sq.m area.
- 2.15.3 The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other extraneous matter.
- 2.15.4 A mixer of appropriate capacity and type approved by the Engineer shall be used for preparation of the mixed material. The plant shall have separate dryer arrangements for heating aggregate. The binder shall be heated in boilers of suitable design, approved by the Engineer to the temperature appropriate to the grade of bitumen or as directed by the Engineer. The aggregates shall be dry and suitably heated to a temperature between 150°C to 165°C or as directed by the Engineer before these components are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued until the latter are thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as a sufficient length has been covered with the premixed material, the surface shall be rolled with an 80 to 100 kN static weight roller. Rolling shall be continued until the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.
- 2.15.5 In the case of Type B seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature.
- 2.15.6 For Surface Finish and Quality Control of work, the surface finish of construction shall conform to the requirements of clause 1802 of MORD specification and for control on the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

### 3.0 **PROTECTIVEWORKS(RetainingWalls/BreastWalls)**

Retaining/BreastwallsforstabilityofvalleysideandhillsideslopesshallbeprovidedasperiterequirementandaftertheapprovalofEngineer-in-Charge,basedonapproveddrawings&specification.

#### 3.1 **Earthwork**

3.1.1 The earthwork for foundation shall conform to the requirements of Clause 305 of MORD Specifications. The depth of foundation shall be as shown on the drawing or as directed by the Engineer-in-Charge. The foundation bed shall have 3:1 (H:V) slope towards hillside.

3.1.2 For demarcation of foundation bed of retaining walls, the top width of wall section shall be laid out with the help of bamboos and strings. The strings shall be hung from bamboos according to the designed front and back slopes. In case of breast-walls, the outer edge of the wall, at road level, shall be the same as the hill side edge of roadway. In case of stable rocks, the foundation bed of retaining walls shall be stepped up with 150 mm depth in hard rock and 600 mm in soft rock.

#### 3.2 **Materials**

3.2.1 All materials used in stone masonry shall conform to the requirements of Clause 702 of MORD Specifications.

#### 3.3 **Masonrywork**

3.3.1 The masonry of retaining / breast walls shall be of random rubble dry masonry conforming to Clause 704.6 of MORD Specifications or random rubble dry masonry with 1:6 cement masonry bands or with a course of cement concrete 1:4:8 throughout the section both in length-wise and breadth-wise direction of the wall or as shown on the drawings or as ordered by the Engineer-in-Charge. The bands shall be 0.6m wide with clear space of 3m between them, both horizontally and vertically.

3.3.2 The depth of foundation shall be as shown on the drawing or as directed by the Engineer-in-Charge and shall be safe from scour, frost and surface water. The foundation pit in front of wall shall be filled up to original ground level and well compacted. In case of retaining wall, the top courses shall be horizontal and in case of breast wall, it shall be sloping down 2:1 (H: towards valley side. The masonry work shall start only after prepared foundation has been approved by the Engineer-in-Charge. The top level of retaining wall shall match the adjoining shoulder edge with camber / super elevation and shall not be an obstruction to water flowing towards it.

#### 3.4 **Bond Stones**

3.4.1 The bond stones shall conform to the requirements of Clause 704.5.4 of MORD Specifications. The bond stones shall be provided in dry stone masonry. The spacing of the bond stones shall be 1m horizontally and 0.5 m vertically.

### **3.5 BackFill**

- 3.5.1 The back fill behind retaining wall / breast wall shall be done only after the masonry work of wall has been approved by the Engineer-in-Charge. The backfill shall conform to the requirement of Clause 301.5.6 of MORD Specifications.
- 3.5.2 The surface shall be filled with impervious material to prevent seepage of water behind the retaining wall. Back filling shall not be started until retaining wall has attained a suitable height to the satisfaction of the Engineer-in-Charge.

### **4.0 DRAINAGE**

Appropriate system of drainage shall be provided depending upon site requirement. Initial studies shall be done regarding identification of any sediment traps and its effect on drainage. Adverse effect of nearby streams, lakes and ponds shall also be studied at design stage keeping in view that existing drainage facilities are not disturbed. Need for provision of catch water drain shall also be studied. Adequate drainage shall then be designed based on available hydrological data.

#### **4.1 Hillside Drain**

- 4.1.1 Hill side Drain shall be of the shape as specified in the drawings and preferably of Kerb and Channel type (K. C. Drain) with normal flow and of trapezoidal shape in case of heavy flow of water.
- 4.1.2 The work shall consist of constructing hill side drain in accordance with the requirements of these Specifications and true to lines, grades, dimensions and other particulars shown on the drawings or as directed by the Engineer-in-Charge. Schedule of work shall be so arranged that the drain is completed in proper sequence with road works, to ensure that no excavation of completed works is necessary subsequently or any damage is caused to these works due to lack of drainage.
- 4.1.3 The depth of the Kerb and Channel drain shall be uniformly increased from 100 mm at start to 200 mm at the outfall near cross drainage structure. Lining of the K. C. drain shall be so located that thickness of lining towards hillside shall be outside the formation width. It shall be a part of shoulder towards road side.
- 4.1.4 The trapezoidal drain shall be designed as per anticipated volume of the discharge and shall also have guide posts of R.C.C. or stone masonry along the edge for safety of the traffic. Proper outfall design shall be ensured for efficient drainage.

#### **4.2 Materials**

All materials for construction of hillside drain shall conform to relevant provisions of these specifications noted below:

- |     |        |                      |
|-----|--------|----------------------|
| (1) | Stone  | Clause 702.4 of MORD |
| (2) | Cement | Clause 702.2 of MORD |
| (3) | Sand   | Clause 602.5 of MORD |
| (4) | Water  | Clause 802.5 of MORD |

### 4.3 Constructionwork

- 4.3.1 The excavation in rock for hillside drain shall preferably be done along with hill side cutting for the sake of ease of construction. Earthwork in excavation for hill side drains shall be true to the specified lines, grades, levels and dimensions and in accordance with the requirements of Clauses 302 and 304 of MORD Specifications. The excavated materials shall be removed from the area adjoining the drain and if found suitable, utilized in sub-grade construction. All unsuitable material shall be disposed of as directed by the Engineer-in-Charge.
- 4.3.2 The excavated bed and sides of the drain shall be dressed to bring these in close conformity with the specified dimensions, levels and slopes.
- 4.3.3 Where the sub-grade is erodible or when directed by the Engineer-in-Charge, the drain shall be lined with random masonry coursed with 1:5 cement sand mortar conforming to the requirements of Clause 704.6 of MORD Specifications or as directed by the Engineer-in-Charge. Where lining of concrete is specified the concrete shall be of M15 grade (1:3:6 nominal mix) and of thickness 150 mm or as directed by the Engineer-in-Charge.
- 4.3.4 Where the drain is constructed in unerodable rocky strata the excavated surfaces shall be dressed as specified with M20 grade concrete (1:2:4 nominal mix).

### 4.4 Catch Water/Intercepting Drain

- 4.4.1 Catch water / Intercepting Drain shall be provided on hill slopes to intercept water flowing from upper reaches to prevent it from entering slide/unstable areas. These drains shall be provided over stable slopes, outside periphery of slide, and unstable areas, as per drawings of the Contract. Surface-cum-trench drains may also be provided at critical locations where subsurface water needs to be intercepted.
- 4.4.2 These drains shall generally be of trapezoidal shape. The lining shall be of R.R. dry stone masonry as per design/drawing to the satisfaction of the Engineer-in-Charge. Where the strata are previous the masonry shall be in cement sand mortar, preferably 1:6 or at least pointed with 1:6 cement sand mortar. The catch-water drains shall be located close to the periphery of the area to be protected and shall be located in stable areas.

### 4.5 Materials:

All materials for construction of catch water/intercepting drain shall conform to relevant provisions of these Specifications noted below:

|       |        |                      |
|-------|--------|----------------------|
| (i)   | Stone  | Clause 702.4 of MORD |
| (ii)  | Cement | Clause 602.2 of MORD |
| (iii) | Sand   | Clause 602.5 of MORD |
| (iv)  | Water  | Clause 802.5 of MORD |

### 4.6 Construction

The earthwork in excavation for catch water /intercepting drain shall be true to the specified lines,

grades, levels and dimensions and in conformity to the requirements of Clause 302 and

304 of these Specifications. The excavated material shall be removed from the area adjoining the drain and if found suitable, utilized in sub-grade construction or filling work. All unsuitable material shall be disposed of as directed by the Engineer-in-Charge.

- 4.6.1 The excavated bed and sides of the drain shall be dressed to bring these to close conformity with the specified dimension, levels, and slopes. The lining of the drain shall be cured for 7 days.

## **5.0 PATHWAYS & MULTILEVELLED HARD STANDINGS**

- 5.1 The pathways & Multileveled Hard standings consist of colored chequered cement concrete tiles of designed specification & thickness laid in conformity with the detailed drawing and specification over Jhama bricks laid flat, over compacted earth and compacted sand filling will be used as sub base material. Plain Cement Concrete (1:3:6) base shall be laid over subbase of flat brick soling, over which the chequered PCC colored tiles shall be laid in cement mortar 1:4 of the required thickness as indicated in the drawing as an alternative specification for pathways.

## **6.0 SURFACE DRAIN**

### **6.1 Pathway Surface Drain**

- 6.1.1 The surface drain consists of Brick masonry in Cement mortar 1:4 laid over Plain Cement Concrete (1:3:6) which is laid over flat brick soling and finished with cement plaster in cement mortar (1:4) with neat cement finish, all in conformity with the detailed drawing and specification.

### **6.2 Building Side Surface Drain**

- 6.2.1 The Surface drain consists of Brick masonry wall of 125/250 mm thick laid in cement mortar 1:4 laid over PCC (1:3:6) foundation base flat brick soling finished with 20mm thick cement plaster with neat Cement finish all in conformity with approved design & drawing.

### **6.3 Stormwater drain**

- 6.3.1 The storm water drain consists of Brick masonry wall of 250mm thick laid in cement mortar 1:4 over PCC (1:3:6) foundation base over flat brick soling, side surface finished with 20mm thick cement finish of variable depth and width all in conformity with approved design, drawings & specification.

#### **6.3.2 Covered Surface drain for Road crossing**

- 6.3.2.1 Brick masonry of 375 mm thick laid over PCC (1:3:6) foundation bed over float brick soling and inside surface finished with 20mm thick cement plaster in Cement mortar (1:4) along with RCC (M-20) covers slab of 150mm thick all in conformity with approved design, drawing & specification.

## **7.0 LANDSCAPING WITH HORTICULTURE**

- 7.1 The surrounding of the land area of the proposed different structural units, conclave, related to the functioning as well as the periphery Road have been systematically developed with the development of road network, pathways, hard standing and plantation of different species of flowering plants, fruit bearing trees, shrubs, bushes, climbers, hedges and lawns etc. The details of plantation have been adequately indicated in the landscape drawing.

## **8.0 BOUNDARY WALL**

- 8.1 Boundary wall consists of RCC Columns and beams as frame work of M-20 grade fitted with 40mm x 40mm 6m Angle Iron with rows of barbed wire and chain link fencing or any other approved type of fencing on top of brick boundary wall. The wall panels are made of 125mm thick brick work in cement mortar 1:4 finished with 20mm thick plastering in cement mortar 1:4, on both sides and in conformity with detailed drawings and specification.

## **9.0 STEEL GATES**

The steel gates are made of 25mm MS square bars and 40mm  $\phi$  (O.D.) M.S. Pipe or any other approved MS Section as the framework with 1mm thick M.S. sheet in conformity with detailed drawings and specifications.

## **10.0 SECURITY HUT**

- 10.1. Security Hut is a R.C.C (M-20) frame small building structure constructed in close proximity of steel gate, all in conformity with detailed drawings & specification.

**SPECIAL CONDITIONS AND TECHNICAL SPECIFICATIONS FOR CENTRALISED MEDICAL GAS PIPELINE SYSTEM SPECIAL CONDITIONS**

**1.0 System Description**

- 1.1 The Central Medical Gas Pipe Line System, should comply with the Medical Gas outlet disposition for the construction of 300 bedded Hospital.
- 1.2 The system shall have the provision of following:
  - 1.2.1 Oxygen Manifold
  - 1.2.2 Fully Automatic Oxygen Control Panel
  - 1.2.3 Nitrous Oxide Manifold
  - 1.2.4 Fully Automatic Nitrous Oxide Control Panel
  - 1.2.5 Vacuum System
  - 1.2.6 Compressed Air System
  - 1.2.7 MCC Panel (for compressor and vacuum pumps)
  - 1.2.8 BPC Flow Meter with Humidifier
  - 1.2.9 Ward Vacuum units
  - 1.2.10 Theatre Vacuum units
  - 1.2.11 Distribution piping
  - 1.2.12 Optional Gas Outlet
  - 1.2.13 Double Lock Gas Outlet
  - 1.2.14 Alarm System
  - 1.2.15 Valve Box Assembly
- 2.0 Services outside the Scope of Centralized Medical Gas Pipe Line System, but included in the scope of Civil and Electrical works for Lump-Sum Tender/Contract.
- 2.1 Civil and Electrical Works associated with the construction of Plant room for Vacuum Pumps Air Compressor, Cylinder manifold room, minor civil works like equipment foundations, cable trench, providing & laying of pipe under pavements, making holes, through walls/floor repair thereof, etc.
- 2.2 Wiring & electrical connection to alarm, pendants etc. through conduits, power supply both single & 3 phase etc.

## **TECHNICAL SPECIFICATIONS**

### **1.0 Oxygen Manifold:**

- 1.1 Top frame comprising of high pressure copper pipe of size 5/8" I.D X 7/8" OD with high pressure brass fittings made of high tensile brass, NRV and high-pressure copper tailpipes made of high pressure copper pipe of size 3/16-inch ID X 3/8-inch OD. The manifold will be hydraulically tested to 3500 psig.
- 1.2 The manifold will be so designed that it shall suit easy cylinder changing and positioning. The system will have non-return valve for easy changing of cylinders without closing the bank.
- 1.3 The cylinder will be placed with the help of cylinder brackets and fixing chains which will be zinc plated.

### **2.0 Fully Automatic Oxygen Control Panel (Imported).**

- 2.1 Fully automatic oxygen control panel will be designed for continuous supply and smooth automatic changeover from the left and right banks of cylinders.
- 2.2 The control cabinet will have state-of-art advanced electronic system technology. The automatic control cabinet will be designed for continuous supply and smooth automatic bank switchover. The cabinet will contain the line pressure regulators, the line pressure gauge, indicators, a set of by-pass valves for manual operation in case of malfunctioning and an electronic control board. There will be an alarm panel with pilot lamps indicating the "in use" and "empty" banks and mutuable bell for local alarm.

### **2.3 Technical Data**

- |                        |   |                                           |
|------------------------|---|-------------------------------------------|
| a) Piping System       | : | All materials should be oxygen compatible |
| b) Line pressure gauge | : | 4" diameter                               |
| c) Control Unit        | : | Electronic (micro-processor)              |
| d) Input power supply  | : | 220V, 50Hz                                |

The control panel will be made to provide heavy duty and have minimum flow **Capacity of approx. 2100 LPM at 4 bar pressure.**

The Control Panel will comply with the regulations of EN737/NFPA-99 Standard.

### **3.0 Nitrous Oxide Manifold:**

- 3.1 Top frame comprising of high pressure copper pipe of size 5/8" ID X 7/8" OD with high pressure brass fittings made of high tensile brass, NRV and high-pressure copper tailpipes made of high pressure copper pipe of size 3/16-inch ID X 3/8-inch OD. The manifold will be hydraulically tested to 3500 psig.
- 3.2 The manifold will be so designed that it shall suit easy cylinder changing and positioning. The system will have non-return valves for easy changing of cylinders without closing the bank.
- 3.3 The cylinder will be placed with the help of cylinder brackets and fixing chains which will be zinc plated.

### **4.0 Fully Automatic Nitrous Oxide Control Panel (Imported):**

- 4.1 The control cabinet will have state-of-art advanced electronic system technology. The automatic control cabinet will be designed for continuous supply and smooth automatic bank switchover. The cabinet will contain the line pressure regulators, the line pressure gauge, indicators, a set of by-pass valves for manual operation in case of malfunctioning and an electronic control board. There

will be an alarm panel with pilot lamps indicating the “in use” and “empty” tanks and a bell for local alarm.

#### 4.2 Technical Data

- a) Piping System : All materials should be oxygen compatible
- b) Line pressure gauge : 4” diameter
- c) Control Unit : Electronic (micro-processor)
- d) Input power supply : 220V, 50Hz

The control panel will be made to provide heavy duty and have minimum flow **Capacity of approx. 900 LPM at 4 bar pressure.**

The Control Panel will comply with the regulations of EN737/NFPA-99 Standard.

### 5.0 Vacuum System:

#### 5.1

To design, fabricate, test & install medical vacuum system comprising of Triplex System of Ingersoll Rand Model 15V vacuum pump each having 10 HP Motor, common 4000 litres Receiver Tank, Filter, NRV, Isolation Valves, Auto Switch Gear to set minimum & maximum operating vacuum and surface mounted copper piped distribution system by silver brazing, painting as per standard color codes, terminating to required nos of double lock type non-interchangeable outlet points.

#### 5.2 Specification of Pumps:

- a) Type : Reciprocating, Air cooled
- b) Make : Ingersoll-Rand India Ltd.
- c) Model : 15V
- d) No. of Stage : Single
- e) No. of Cylinders : 3
- f) Type of Drive : V Belt
- g) Type of Motors : TEFC
- h) Motor HP : 10
- i) Piston Displacement : 4235 LPM
- j) Maximum vacuum : 742 mmHg

The vacuum Pump System will have 3 identical pumps (one or two will run at time according to demand of the College/Hospital when the other remains as stand by) with online starter and pump protection filters. Each Vacuum pump will be complete with baseplate, Belt Guard, V-Belts, Motor and Starter. The system will be of Automatic Start and Stop Type.

The Pumps will be connected to a common vertical receiver of 4000 litres capacity. The receiver will have a drain valve at the bottom.

Optional: The vacuum system should be equipped with Bacterial Filter which should be provided for complete bacteria removal down to 0.0001% penetration when tested to BS3928 Standard.

### 6.0 Compressed Air System

#### 6.1 The compressed air system will have 3 nos. of identical air compressor (Model TFT 150B-9 of Anest Iwata Mothersen Ltd.) with following main features:

100% oil free air,

Continuous & heavy-duty application

Suitable for continuous use at high temperature up to 300°C

d) Very low vibration resulting in low noise level.

## 6.2 Specification of each Air Compressor:

|                        |   |                                              |
|------------------------|---|----------------------------------------------|
| a) Make                | : | AnestAwata                                   |
| b) Model               | : | TFT150B-9                                    |
| c) Type of Compressor  | : | Air Cooled Oil Free Reciprocating Compressor |
| d) Piston Displacement | : | 57.18 CFM                                    |
| e) Working Pressure    | : | 8.5 Kg/cm <sup>2</sup>                       |
| f) No. of Cylinders    | : | Three                                        |
| g) No. of Stages       | : | Two                                          |
| h) Motor               | : | 15 HP                                        |
| i) Air Receiver        | : | 1500 litres (2 nos.)                         |
| j) Type of drive       | : | V-belt                                       |

## 6.3 Breathing Air Filtration System:

6.3.1 The filters should have maximum contaminant removal efficiency with maximum pressure drop. The filtration system should conform to breathing air filtration as per ISO 8573 Ch-I Standard. Total 3-stages of filters should be used as mentioned below:

|         |   |                                                                                                                             |
|---------|---|-----------------------------------------------------------------------------------------------------------------------------|
| Stage 1 | : | Oil aerosol contents removal up to 0.5 mg/cum                                                                               |
| Stage 2 | : | Oil aerosol contents removal up to 0.01 mg/cum                                                                              |
| Stage 3 | : | Oil content removal up to 0.003 mg/cum along with removal of oil vapor and hydrocarbon odors as per ISO 8573 Ch-I Standard. |

## 7.0 Distribution Piping:

### 7.1 Scope:

7.1.1 The scope of work shall cover all distribution piping and terminal units for oxygen, nitrous oxide, vacuum and compressed air.

### 7.2 Materials:

7.2.1 Solid drawn, seamless, deoxidized, non-arsenical, half hard, tempered and degreased copper pipe conforming to BS: 6017-1981, Table 2 (Cu-DHP) and manufactured as per BS: 2871-1971, Part I, Table X (or as per EN 1057). All copper pipes should be degreased & delivered capped at both ends. The pipe should be accompanied with manufacturer's test certificate for the physical properties & chemical composition. Copper pipe should also have third party inspection certificate from Lloyd's Register Services.

7.2.2 **Copper Fittings** shall be made of copper and suitable for a steam working pressure of 17 bar and especially made for brazed socket type connections. All copper fittings will be imported and conform to BS 864.

7.2.3 The **Isolation Valves** will be Non-Lubricated Ball Type and suitable for oxygen service. All valves shall be pneumatically tested for twice the working pressure and factory degreased for medical gas service before supply.

### 7.3 Installation & Testing:

7.3.1 Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves which have been degreased and fittings brought in polythene sealed bags shall be used at site. Pipe fixing clamps shall be non-ferrous or non-deteriorating plastics suitable for the diameter of the pipe.

7.3.2 All pipe joints shall be made using fluxless brazing method. All joints shall be made of copper to copper and brazed by silver brazing filler material without flux.

7.3.3 Adequate supports shall be provided while laying pipelines to ensure that the pipes do not sag. Suitable sleeves shall be provided wherever pipes cross through walls/slabs. All pipe clamps shall be non-reactive to copper.

7.3.4 After erection, the pipes will be flushed with dry nitrogen gas and then pressure tested with dry nitrogen at a pressure equal to 1.5 times of the working pressure or 150 psig, whichever is higher for a period of not less than 24 hours.

7.3.5 All the piping system shall be tested in the presence of the site engineer or his authorized representative.

#### 7.3.6 Painting

All exposed pipes should be painted with two coats of synthetic enamel paint and color codifications should be as per IS: 2379 of 1963.

8.0 The pipe sizes to be used are from among as

under: 8.1

| 8.2<br>Outlet | Pipe OD (in mm) | Thickness (in mm) | <b>Double Lock<br/>Gas (Indigenous)</b> |
|---------------|-----------------|-------------------|-----------------------------------------|
|               | 12              | 0.7               |                                         |
|               | 15              | 0.9               |                                         |
|               | 22              | 0.9               |                                         |
|               | 28              | 0.9               |                                         |
|               | 42              | 1.2               |                                         |
|               | 54              | 1.2               |                                         |
|               | 76.1            | 1.5               |                                         |

8.2.1 Outlet shall be manufactured with a 165 mm length, Copper inlet pipe stub which is silver brazed to the outlet body. Body shall be of one-piece brass construction. For positive pressure gas services, the outlet shall be equipped with a primary and secondary check valve and the secondary check valve shall be rated at minimum 200 psi in the event the primary check valve is removed for maintenance.

8.2.2 The outlet assembly should accept only corresponding gas specific adaptors.

8.2.3 All outlet shall be cleaned and degreased for medical gas service, factory assembled and tested.

8.2.4 The medical gas outlet should be of quick connecting and wall mounted modular type.

### 9.0 Optional: Gas Outlet (Imported as per NFPA 99 Standard)

#### 10.0 Alarm System (Indigenous):

10.1 The area line pressure alarm is micro-processor based which will monitor the pressures of medical gases like oxygen, nitrous oxide, compressed air and vacuum levels at a specific area of piped gas system in any hospital. The electronic circuitry should be such that if the pressure / vacuum in the gas pipeline drops below the present limit, the equipment should give an audio-visual alarm. Visual alarm will remain active even after pressing of "Mute" button. But it will come to normal condition when gas pressure/vacuum returns to normal level.

10.2 The equipment should have

Low voltage operation for  
safety High/Low indication  
Test  
facility Mute/Silence  
facility

10.3 Optional: Alarm System (Imported as per NFPA 99 standard)

#### 11.0 Valve Box Assembly:

11.1 Valve Box will be made of Powder Coated MS material.

11.2 Valve Box material will consist of the following:

11.2.1 Lever operated quarter turn valve (i.e. 90° shut off ball valve should be manufactured by ISO 9001 company-imported and factory degreased) with brass body and chrome plated brass ball.

11.2.2 Brass fittings (Nut, Nipples and extruded brass Adaptor) KE Type Seat

11.2.3 Brass Block for pressure gauge

11.2.4 2" Dial gauges (0-10 kg/cm<sup>2</sup>, 0-760 mmHg)

11.2.5 Nylon Bush for copper pipe holding with the valve box

- 11.2.6 Beedingfor boxlead
- 11.2.7 Lockablecover withbreakableglasssothatduringnormal operationaccessshallbebykey.But duringemergencyoperation access bybreakingthe glass panel.
- 12.0 SpecificationsofMCCPanel (ForCompressor&VacuumPumps)**
- 12.1 Incoming-MCCBwithaluminumBusBarandcompletemetering(i.e.Ammeter&Voltmeter)withR-Y-Bselector switches.
- 12.2 R-Y-Bphaseindicatinglamps(LEDtype)
- 12.3 IndividualMCCBandAmmeter forAirCompressors.
- 12.4 IndividualMCCB forVacuumPumps.
- 12.5 Individualstart&stoppush buttonswithON/OFFindicatinglamps.
- 12.6 IndividualSingle-phasepreventersforaircompressorsandvacuumpumps
- 12.7 Timerswitch-  
forchangingAircompressor&Vacuumpumpsfromonetoootherinevery6hours,therebyallowingeach equipmenttrestfor 6 hours.
- 12.8 IndividualAutoManualswitches forVacuumPumps
- 12.9 Trippingforabnormal operatingconditionslikeover current
- 12.10 Specialfeature-Ifrunningcompressortripsbyanycauseoftripsmentioned,theothercompressor should start immediately by-passing timer switch. This feature ensures uninterruptedsupplyofcompressed air (as a backup system).
- 13.0 BPCFlowmeterwithHumidifier**
- 13.1.1  
Backpressurecompensatedflowmeterwillbeofaccurategasflowmeasurementwithfollowingfeatu res:
- 13.1.2 It shouldmeet strictprecisionanddurabilitystandard
- 13.1.3 Theflowmeter bodyshouldbemadeofbrasschromeplatedmaterials.
- 13.1.4 Theflowtubeandshroudcomponentsshouldbemadeofclear,impactresistant polycarbonate.
- 13.1.5 FlowTubeshouldhave largeand expanded0-5 lpmrangefor improvedreadabilityat lowflows.
- 13.1.6 Inletfilterofstainlessteelwiremeshtoprevententryofforeignparticles.
- 13.1.7 The humidifier bottle should be made of unbreakable polycarbonate material and autoclavable at134-degreecentigradetemperature.
- 14.0 WardvacuumUnits:**
- 14.1 WardVacuumUnitwill beof light weightandcompact.Theunit willconsist of
- 14.1.1Aregulator
- 14.1.2  
A600ml.reusablecollectionJar,madeofunbreakablepolycarbonatematerialandfullyautoclavableat 134degreecentigrade.
- 14.1.3 Awall bracketformountingthejarassemblyon thewall.
- 14.1.4 The vacuum regulator willbe infinitely adjustable andhavevacuum gaugewhich indicatessuction supplied by the regulator. Safety trap will be provided inside the jar to safeguard theregulatorfromoverflowing.
- 15.0 Theatre VacuumUnits:**
- 15.1  
Theunitwillbeconsistingoftworeusable2000mlshatterresistantbottle,eachmadeupofpolycarbonate materialandfullyautoclavableat134degree centigrade.
- 15.2 AvacuumregulatorwithinstantON/OFFswitchandthree-wayselectorswitchwithanoptiontooperateeither:Left,Rightor Both
- 15.3All theaboveitemsshouldbemountedonaTrolleyhavingfreemovingcastor wheels.

### **LIST OF APPROVED MANUFACTURERS**

List of approved make/manufacturers are given below and tenderer must quote their rates accordingly.

3.

#### **For Civil Works**

| <b>Description</b>                              | <b>Manufacturer</b>                                            |
|-------------------------------------------------|----------------------------------------------------------------|
| ● Cement                                        | : PENDEN/LAFARGE/ULTRATECH/ACC/AMBUJA                          |
| ● Reinforcement steel                           | : SAIL/TATA/RINL/JINDAL                                        |
| ● Waterproofing chemicals (Concrete Admixtures) | : SIKA/HINDCON/CICO/PIDILITE/CHOKSEY                           |
| ● A.C.P. (Aluminum Composite Panel)             | : ALSTRONG/ALUDECOR                                            |
| ● Anti-termit treatment                         | : TRICEL/ BIFLEX/PCI                                           |
| ● Commercial ply/ Flush Door Shutter            | : GREENPLY/ CENTURY/ KITPLY/ARCHIDPLY/ MAYUR/ ALISHAN/GLOBEPLY |
| ● Pre-laminated Particle Board                  | : GREENLAM/ CENTURY/ ARCHIDPLY                                 |
| ● Wooden Flooring                               | : ACTIONTESA/EGO                                               |
| ● Synthetic Enamel Paint                        | : ASIAN/ BERGER/ICI/NEROLAC                                    |
| ● Acrylic Emulsion                              | : ASIAN/BERGER/ICI/NEROLAC                                     |
| ● White Cement                                  | : JK/ BIRLA                                                    |
| ● Adhesive (for timber work)                    | : PIDILITE/BALENDURA/FEVICOL/ARALDITE                          |
| ● Vitrified tiles                               | : NITCO/JOHNSON/SOMANY/ORIENT/KAJARIA                          |
| ● Ceramic Tiles                                 | : NITCO/JOHNSON/SOMANY/ORIENT/KAJARIA                          |
| ● Wall putty                                    | : JK White/ BIRLA/ BERGER/ ICI/ ASIAN                          |
| ● Aluminum works                                | : HINDALCO/JINDAL                                              |
| ● Elevators                                     | : THYSSENKRUPP/ OTIS/KONE/SCHINDLER / JOHNSON                  |
| ● uPVC pipe                                     | : SUPREME/ ORIPLAST/ ASTRAL/ASHIRVAD/ PRINCE                   |
| ● RCC pipe                                      | : Best quality as approved by the Engineer-in-charge           |
| ● GI pipe                                       | : TATA/JINDAL                                                  |

| <b>Description</b>                                                                                                                                                                       | <b>Manufacturer</b>                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| • Sanitary Ware (Wash Basin, Water Closet, Urinal, etc)                                                                                                                                  | : HINDWARE/PARRYWARE/CERA                    |
| • SSSink                                                                                                                                                                                 | : KINGSTONE/NIRALA                           |
| • CPFittings                                                                                                                                                                             | :HINDWARE/PARRYWARE /CERA/ESSCO              |
| • Mirror/Glass                                                                                                                                                                           | :MODIGUARD/ ST.GOBAIN/ATUL                   |
| • PVCDoorShutter                                                                                                                                                                         | :RAJSHREE/ DUROPLAST /SUPREME                |
| • PVCDoorFrame                                                                                                                                                                           | :RAJSHREE/DUROPLAST /SUPREME                 |
| • GypBoard                                                                                                                                                                               | :ST.GOBAIN/ARMSTRONG/LAFARGE                 |
| • CalciumSilicate Board                                                                                                                                                                  | : RAMCOHILUX                                 |
| • CementFibreBoard                                                                                                                                                                       | :EVEREST/VISAKA/BORAL/ST.GOBAIN              |
| • Floor Spring                                                                                                                                                                           | :GARNISH/ OZONE/DOORSET / EVERITE/<br>GODREJ |
| • DoorCloser                                                                                                                                                                             | :GARNISH/ OZONE/DOORSET / EVERITE/<br>GODREJ |
| • Locksand Handles                                                                                                                                                                       | :KODIA/ GODREJ / HARRISON/EVERITE/<br>ZOOM   |
| • DoorFittings                                                                                                                                                                           | : KODIA/GODREJ /EVERITE/ZOOM                 |
| Furniture–Chair/Table/:GODREJ /<br>NUTECH/RAJKAMAL/NEELKAMALCabinets/ Shelves/ Dining<br>/ MOBEL or LOCAL MAKETablesand Chairs/<br>Conference and<br>SeminarTables/ReceptionDe<br>sksetc | / DAMRO                                      |

Note:

If the above manufacturers are not available, equivalent make/manufacturers can be used upon approval from Engineer-in-charge.

Any material not fully specified in the above specifications and not mentioned in the approved manufacturers' list shall be ISI marked. Where ISI marked materials are not available, the materials shall be from the best quality available in the market, subject to submission of satisfactory test report.

### **For Electrical Works**

| <b>Description</b>                    | <b>Manufacturer</b>                             |
|---------------------------------------|-------------------------------------------------|
| • Module Case Circuit Breakers (MCCB) | : L&T, GE, Legrand, Schneider, Siemens, Havells |
| • Load Break Changeover Switches      | : C&S, Havells, GE, L&T                         |

| <b>Description</b>                                                                          | <b>Manufacturer</b>                                 |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------|
| MiniaturecircuitBreakers(MCBs):L&T,GE, Legrand,Schneider,Havells,<br>Isolatorsand ELCB/RCCB | Hagger, MDS                                         |
| • SwitchFuseUnits(SFUs)                                                                     | :L&T,Siemens, GE,Schneider,MDS,<br>Havells,C&S      |
| • Ammeters/Voltmeters                                                                       | :AutomaticElectricCo.,SIMCO, IMP                    |
| • KWhmeters                                                                                 | : L&T,Havells,Accurate                              |
| • OCand EF relays                                                                           | :Alsthom,Easun,ABB,VXL-Landis                       |
| • SelectorSwitches                                                                          | :L&T,Kaycee, Siemens, Schneider                     |
| • IndicationLamps                                                                           | :Siemens,L &T, BCH                                  |
| • Power Cables1100 vgrade                                                                   | :Polycab,RRCable, Universal,Havells                 |
| • PVCConduit                                                                                | :AKG,Uiplast,Prestoplast,Plazza                     |
| • PVCinsulatedflexiblecoppercable<br>1100Vgrade                                             | : Finolex,Havells,Polycab, RRCable,<br>Universal    |
| Switches, ceiling rose etc. Plug, Top etc.                                                  | :Anchor(ISI), SSK, MK,<br>AKG(Pianotype)            |
| • GIpipes                                                                                   | : TATA,JindalTubes                                  |
| • Streetlight poles                                                                         | : CalcuttaPoles/Utshkars                            |
| • Fusefittings                                                                              | :L&T,Siemens,Alsthom,GE,Schneider                   |
| • Switch,Socket,Regulator(Standard<br>Modulartype)                                          | : MK,Havells,Legrand, Schneider                     |
| • LightFittingsandLamp                                                                      | :Phillips,Crompton,Bajaj,GE,Havells,<br>Wipro       |
| • Ceilingfans(Doubleball-bearing)                                                           | :CromptonGreaves,Bajaj,Polar,Usha,<br>Havells       |
| • Wall-bracketfans                                                                          | :Usha,Polar,CromptonGreaves,Bajaj,<br>Havells       |
| • ExhaustFans(i)Light Duty                                                                  | :Bajaj,Usha,CromptonGreaves,Havells                 |
| • (ii)HeaveDuty                                                                             | :Bajaj,Usha,CromptonGreaves,Havells                 |
| • IndustrialPlugsocketsandassociated<br>Switches                                            | : Havells,Standard,Legrand,Crompton<br>Greaves,Usha |

| <b>Description</b>                                     | <b>Manufacturer</b>                                                               |
|--------------------------------------------------------|-----------------------------------------------------------------------------------|
| • Contractors                                          | : Siemens, L&T, Alsthom, Legrand, Schneider                                       |
| • Cable Lugs                                           | : Dowell, Clippon, Ismal                                                          |
| • Alkathene Pipe                                       | : DALDA/ AKG                                                                      |
| • Switch-board Cover (Modular type)                    | : Legrand, Schneider, Havells, MK                                                 |
| • DING-DONG Bell/Buzzer                                | : Anchor, Rider, S.S.K, Legrand, Schneider, MK, Havells                           |
| • Electronic Regulator                                 | : Legrand, Schneider, Havells                                                     |
| • PVC casing and capping with all accessories          | : AKG, Uiplast, Prestoplast, Piazza                                               |
| • Auto Changeover cum Current Limiter                  | : Electronorequivalent                                                            |
| • Telephone Cable                                      | : Finolex, Polycab, RRCable                                                       |
| • Telephone Cable                                      | : Delton, Polycab, Finolex, RRCable                                               |
| • Computer LAN Cable                                   | : Polycab, Finolex, RRCable                                                       |
| Diesel Generator Set (i) Engine                        | : Cummins, Caterpillar, Perkins, Kirloskar Oil Engine, Ashoke Leyland, Kirloskar, |
| (ii) Alternator                                        | : Crompton, Stamford                                                              |
| • Fabricated LV Switch Board, AMF Panel, MDB, PDB etc. | : Made by CPRI approved Manufactures                                              |
| • Geyser                                               | : Racold, Bajaj, Venus                                                            |
| • TV Cable                                             | : Polycab, Finolex, RRCable                                                       |
| • Digital Meters                                       | : Reputed Make on prior approval of Engineer-in-Charge.                           |
| • Modular Type Switch, Socket, Regulator etc.          | : Legrand, Schneider, Havells, MK                                                 |

**(c) For Fire Protection & Fire Fighting Appliance**

| <b>Description</b>                     | <b>: Manufacturer</b>                |
|----------------------------------------|--------------------------------------|
| • Fire Pump/Jockey Pump/Sprinkler Pump | : Kirloskar/Mather & Platt/Beacon    |
| • Electric Motor                       | : Kirloskar/Crompton/Siemens/Alsthom |
| • Diesel Engine                        | : Kirloskar/Layland/Greaves          |

| <b>Description</b>                                                                                             | <b>: Manufacturer</b>                                    |
|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| ● C.I., Valves(Sluice/NonReturn)                                                                               | : Kalpana/Koley/Upadhyay                                 |
| ● MS.(ERW)Pipe                                                                                                 | : Tata/Jindal                                            |
| ● G.M.Valves(Gate/Globe/Check)                                                                                 | :Leaderor BearingISImark                                 |
| ● Hydrant/landingValves                                                                                        | :BearingISICertificationmarks                            |
| ● 63mmFireFightingHose                                                                                         | : CRC/BRG/Newage                                         |
| ● 20mmRubberHose                                                                                               | : ISIApproved                                            |
| ● HoseBoxandSwingingHose Reel                                                                                  | :Anyfabricatoracceptablebylocal Fire<br>Brigadeauthority |
| PumpstartingPanel withL&T/Siemens:Manufacturershavinghighvoltage&primary<br>makeContractor                     | injectiontestingfacility.                                |
| ● PressureSwitch                                                                                               | : Indfoss/Switzer                                        |
| ● PressureGauge                                                                                                | :H.GuruorFlebig                                          |
| ● PortableExtinguishers                                                                                        | : FireShield/SteelageIndustries/Newage                   |
| ● InstallationControlValve                                                                                     | : HDFire Protect                                         |
| ● AnalogueAddressabletypefireAlarm<br>ControlPanel                                                             | : Notifier/Siemens/Edward/Apollo/Agni                    |
| ● MultiCriteriaDetector<br>(Analogueaddressable heatcumphoto<br>electricismokedetector                         | : Notifier/Siemens/Edward/Apollo/System<br>Sensor/Agni   |
| Analogue addressable Rate of Rise<br>cum:Notifier/Siemens/Edward/Apollo/Systemfixedtemperaturetypeheatdetector | Sensor/Agni                                              |
| AnalogueaddressableManualCallPoint                                                                             | :Notifier/Siemens/Edward/Apollo/System<br>Sensor/Agni    |
| AnalogueaddressableControlModule:                                                                              | Notifier/Siemens/Edward/Apollo/SystemSensor/<br>Agni     |
| AnalogueaddressableIsolatorModule:                                                                             | Notifier/Siemens/Edward/Apollo/SystemSensor/<br>Agni     |
| ● HornwithStrobe                                                                                               | : Notifier/Siemens/Edward/Apollo/System<br>Sensor/Agni   |
| ● AmplifiedwithMicrophone                                                                                      | : Ahuja/Sonodyne                                         |
| ● Battery(SMF)                                                                                                 | : Exide/Amco                                             |

| <b>Description</b> | <b>: Manufacturer</b>                    |
|--------------------|------------------------------------------|
| • Control Cable    | : Polycab, RRCable, Finolex/ISI approved |
| • Power Cable      | : Polycab, RRCable, Universal, Havells   |

Note: All the materials shall be I.S.I. marked whenever available from the list of manufacturer given above; where ISI marked materials are not available the materials shall be from the best quality available in the market, subject to submission of satisfactory test report.