

1.0 GENERAL DESCRIPTION & BASIS OF DESIGN

1.1 SCOPE

The work stated in these specifications together with Consultant's drawings, cover the design, manufacture, delivering goods at site, handling at site, installation, commissioning and carrying out performance tests at site of the complete equipment required for the Air-conditioning System for **Regional office Building of National Bank for Agriculture & Rural Development** at Bhopal.

1.2 BASIS OF DESIGN

Site	:	Bhopal [Madhya Pradesh]
Latitude	:	23° 16' north
Mean sea level	:	523 meters.

AMBIENT CONDITIONS

SUMMER (April)

Dry Bulb Temperature	:	106°F (41.10°C)
Wet Bulb Temperature	:	73°F (22.8°C)
Relative Humidity	:	20%

WINTER (January)

Dry Bulb Temperature	:	45°F (7.2°C)
Wet Bulb Temperature	:	38°F (3.3°C)
Relative Humidity	:	50%

MONSOON (July)

Dry Bulb Temperature	:	92°F (33.3°C)
Wet Bulb Temperature	:	83°F (28.3°C)
Relative Humidity	:	69%

SPACE DESIGN CONDITIONS

All Year Round	:	
Dry Bulb Temperature	:	74 °F ± 2 °F
Relative Humidity	:	55% ± 5%

Lighting load : Approx. 2.0 watt/ft².

Fresh air quantity : 10 CFM per person or 1.0 Air change per hour whichever is more.

HEAT TRANSFER CO-EFFICIENT & TEMPERATURE DIFFERENCE

TEMPERATURE DIFFERENCE FOR EXPOSED WINDOW GLASS-

Room Temperature	:	@ 74°F
East	:	11°F
West	:	165°F
South	:	11°F
North	:	11°F
South East	:	11°F
South West	:	113°F
North East	:	11°F
North West	:	118°F
Glass Exposed	:	26°F
Glass Partition	:	21°F

TEMPERATURE DIFFERENCE FOR EXPOSED WALLS & ROOF-

SUMMER

Room Temperature	:	@ 74°F
East	:	29°F
West	:	23°F
South	:	27°F
North	:	15°F
South East	:	29°F
South West	:	25°F
North East	:	21°F
North West	:	17°F
Roof Exposed (Insulated)	:	43°F
Roof Exposed (Non-Insulated)	:	43°F
Roof Shaded	:	19°F
Ceiling	:	21°F
Floor	:	21°F
Partition Wall	:	21°F

HEAT TRANSFER CO-EFFICIENT (BTU/Hr. x FT² x °F)-

For Exposed Window Glass	:	
For Radiation	:	0.56
For Exposed Window Glass For Conduction & Convection	:	1.10
For Exposed Brick Wall	:	0.36
For Exposed Slabs	:	0.48
For Shaded Slabs	:	0.48
For Insulated Slabs	:	0.12
For Ceiling	:	0.48
For Insulated Ceiling	:	0.12
For Floor	:	0.48
For Insulated Floor	:	0.12
Partition Wall	:	0.40

CALCULATION OF HEAT TRANSFER CO-EFFICIENT "U"
THERMAL RESISTANCES FOR WALL MATERIALS (°F BTU / (Hr. x FT²))

A.	Out Side Air Film	:	0.68
B.	Out Side Plaster	:	0.10
C.	RCC / Brick Wall	:	1.21
D.	Inside Plaster	:	0.10
E.	Inside Air Film	:	<u>0.68</u>
	Total Resistance "R"	:	2.77

"U" = 1/R = 1/2.77 : 0.36

RESPIRATION HEAT (BTU/Hr) :
OF PEOPLE ROOM TEMP. : @ 74°F

A.	Sensible Heat	:	270
B.	Latent Heat	:	180

OTHER CONVERSIONS :

1.	1 KW	:	3410 Btu / Hr.
2.	Bypass Factor of the 3-Row Cooling Coil	:	0.204
3.	Bypass Factor of the 6-Row Cooling Coil	:	0.04
4.	Bypass Factor of the 8-Row Cooling Coil	:	0.02
5.	Supply Duct Heat Gain	:	2.5%
	Return Duct Heat Gain	:	2.5%
	Fan H.P. (Depending Upon Static Press And Temp. Difference)	:	
	Safety	:	5%
	Total On Room Sensible Heat	:	12.5%
6.	Latent Heat Safety	:	5%
	Total On Room Heat	:	17.5% + Fan H.P.

NOTE- THE FACTORS AND PERCENTAGES INDICATED ABOVE ARE THOSE CONSIDERED FOR ARRIVING AT THE PEAK LOADS FOR EACH AIR CONDITIONED AREA.

Exposed roof : All exposed roof to be insulated with 50 mm thick "TF" quality expanded polystyrene or equivalent insulation material so as to provide overall transmission factor of 0.12 BTU / hour – ft²/ °f or better.

Exposed glass : All exposed to be covered with sun control film.

h. Power Supply :

430/415 Volts, 1 Phase / 3 Phase and Neutral 50 c/s., A.C. Electrical power supply will be arranged by the Client. The cabling and earthing work from the main distribution panel to the distribution panels on the floors and to the units shall be in the scope of contractor.

1.3 HEAT LOAD

Based on the above parameters, heat load worked out by the Consulting Engineer is approximate **121.50 TR.**

However, the tenderer should work out heat load and air quantity independently and confirm the same in the tenderer's confirmation.

1.4 DESCRIPTION OF THE WORK TO BE CARRIED OUT

To meet Air conditioning load, we propose to install Air Cooled Package A. C. units as per drawing. The out door units shall be located as per drawing.

HEAT LOAD SUMMARY SHEET

SR.NO	PARTICULARS	AREA (FT ²)	HEIGHT (FT)	OCCUPANCY	LIGHTING (W/FT ²)	EQPT. LOAD (KW)	HEAT LOAD (TR)	AIR QTY (CFM)
1st flr								
1	OPEN OFFICE	7,100	12	115	2.00	15.00	36.25	17,700
2	DGM-1	110	12	3	2.00	0.25	0.95	480
3	DGM-2	110	12	3	2.00	0.25	0.85	415
4	DGM-3	110	12	3	2.00	0.25	0.85	415
5	DGM-4	110	12	3	2.00	0.25	0.85	415
6	DGM-5	110	12	3	2.00	0.25	0.85	415
7	GM CABIN	215	12	5	2.00	0.25	1.85	950
8	COMPUTER ROOM	935	12	10	2.00	10.00	7.00	3,650
	SUB TOTAL – 1st floor	8,800	92	145	16	26.50	49.45	24,440
2nd flr								
1	OPEN OFFICE	7,430	12	115	2.00	15.00	33.00	16,000
2	G.M.	175	12	3	2.00	0.25	0.95	470
3	ADDITIONAL CABIN	175	12	3	2.00	0.25	0.95	470
4	DGM-1	110	12	3	2.00	0.25	0.75	375
5	DGM-2	110	12	3	2.00	0.25	0.75	375
	SUB TOTAL – 2nd flr	8,000	58	127	10	16.00	36.40	17,690
3rd flr								
1	OPEN OFFICE	4,428	12	70	2.00	8.00	21.65	16,200
2	GM-1	418	12	5	2.00	0.25	2.50	1,275
3	DGM-1	175	12	3	2.00	0.25	1.10	550
4	DGM-2	154	12	3	2.00	0.25	0.95	575
5	GM-2	325	12	5	2.00	0.25	2.30	1,200
6	DINING	700	12	50	2.00	-	7.15	2,700
	SUB TOTAL – 3rd flr	6,200	69	136	12	9.00	35.65	22,500
	G.Total	#####	219	408	38	51.50	121.50	64,630

2.0 SPECIFICATION OF EQUIPMENT/ MATERIAL AND INSTALLATION STANDARDS

2.1 SECTION- 1 AIR-CONDITIONING WORKS

2.1.1 AIR COOLED FLOOR MOUNTED PACKAGE UNIT

Scope of this Section comprises the supply, erection, testing and commissioning of the Packaged units with microprocessor based control panel and conforming to these specifications outlined as below and in accordance with the requirements of the Schedule of Equipment.

The Compressor will be Sealed or Semi-Sealed, scroll type complete with integral drive motor and starter of suitable rating, dynamically balanced using FREON - 22 as refrigerant. The compressor will be equipped with lubricating system suction strainer; discharge and section shut off valves, high and low pressurestats and all accessories.

There must be multiple compressors arrangement for the units having capacity exceeding 8.25 TR.

The condenser shall be air cooled, made of Cu. Tubes with extended aluminium fins. Cabinets shall be fabricated out of heavy gauge steel, properly formed for close fit & structural rigidity. All access panels shall be so constructed as to be quickly and easily removable. All outside surface shall be finished with powder coating for protection against humid weather. The condenser fans shall be directly driven and designed to achieve low condensing temperatures and operate continuously and silently. **The Condenser fan to have minimum 3 nos. of blade. Fan may be of metal or FRP material.**

The compressor shall be mounted on the base Plate, which shall be an integral part of the casing. It shall be completed with foundation bolts, leveling isolators etc.

The units will house the DX Evaporator Coils of Copper Tubes and Aluminium fins in multi row configuration, the Filters and the drive arrangement and the Blower, along with Refrigeration Controls, located above the Compressor compartment.

The Contractor will supply adequate charge of refrigerant, lubricant and other consumable till commissioning and satisfactory testing of the equipment is done and handed over to the Owners.

The Contractor will ensure and demonstrate to the engineer, pressure and vacuum tests of the refrigeration system. The pressure will be one & half times the operating pressure maintained over 24 Hours. Similarly vacuum testing will be done for 24 Hours without appreciable permissible drop in vacuum.

All safety controls, low and high pressure controls, starters, overloads trips, will be set and record of all settings will be furnished to the Engineer for checking and passing on the Owners for their checking.

- (a) The Contractor shall furnish and install Packaged Units in accordance with the requirements of the Schedules Specification and Contract Drawings. Units shall of the type, size and capacity as set forth in the schedule. The fan outlet and coil face velocities shall be of the values specified in the Schedule.

- (b) The units as assembled shall be completed with Compressors fans, coils, insulated casing, filters drives and accessories. Internal baffles shall be provided if required to prevent by passing of coils and filters.
- (c) Units shall be generally Floor mounted Vertical Type as permissible at site.
- (d) Equipment design shall be such that the selected filter media, bearings, insulation etc. shall be suitable for a maximum ambient temperature of 40°C.
- (e) All lubrication points shall be easily accessible with external lubrication nipples.
- (f) Lifting lugs shall be provided to enable lifting of equipment and to assist in the positioning of sections at site.
- (g) Frame work shall be designed with recesses suitable to receive enclosure panels, providing neat appearance, airtight enclosure and ease of panel removal.
- (h) Inspection and services access doors shall be provided for access to the units interior, for filter removal and for coil inspection. Coil inspection shall be possible without requiring any piping disconnections.

FANS

Fans shall be double width, double inlet, forward inclined centrifugal type with scroll type housing. Rotating assembly shall be statically and dynamically balanced.

Scrolls shall have rigid cone inlets truly circular and volume and free from dents. All fan scrolls shall be welded on assembly, irrespective of pressure and air volume to provide a rigid airtight housing.

Wheels shall be having streamlined spun front plate and hub to minimise turbulence. Airfoil blades shall be one-piece die formed, with proper cross section. A spun inlet cone shall be fitted to the housing at each inlet opening. Fan wheels shall be constructed of Steel/ Aluminium. Wheels of forward curved fan will be constructed similar to forward curved fans in A/C trade.

Fan scroll casings shall be finished as per casings.

Drive shall be with 'V' belts and fixed pulleys. Drive shall have a service rating of 15% of the maximum estimated load. Each drive shall be provided with easily removable belt guards constructed of expanded metal and finished to match the unit finishes. Where units are externally mounted drive guards shall be totally enclosed with reinforced tachometer access openings.

Bearings shall be self-aligning, grease lubricated ball or roller type with extended greasing points carried to outside the casing. Average life of bearing shall be 2,00,000 hours.

All exposed moving parts of fans and motors liable to deterioration shall be protected by paint or grease before delivery to site.

Fans drive Motors will be with its own IP 55 drive motor.

Mountings & Accessories

Anti-vibrations mounting for indoor & outdoor units shall be provided by the AC Contractor.

Flexible connections shall be securely fixed to the unit sections by means of fixing strips or flange connections. All flexible connection will be air tight and suitable for the maximum operating pressure associated with the system.

MOTORS & DRIVES

Motor shall be unit mounted, externally arranged on pivot bases or on slide rails to provide adequate drive belt adjustment. Where applicable, motors shall be mounted at low level on an out rigger base manufactured from 100 MM mild steel channel as an extension to the fan section sub-frame.

Motors shall be totally enclosed fan cooled. Die cast aluminium foot mounted frames shall be incorporated on all motors. Motors shall be wound for 415 volts, 3 ph., 50 C/s. supply and shall be continuously rated running at approx. 1450 RPM at full load.

COILS

Coils shall be of the size, quantity, arrangement and capacity required by the schedule / design. All Coils shall have certified ratings with supporting catalogue data published by the unit manufacturer. Coils shall be mounted on tracks of structural steel and shall be removable from either end or front of the Unit, without dismantling or unbolting any sections of the unit, other than the front access panel.

Coil headers shall be completely enclosed.

Coils shall be provided in the capacity, quantity and arrangement for each unit as noted in the schedule on Contract Drawings. Unless otherwise stated in Schedule, **coils shall have aluminium fins spaced at a maximum of THIRTEEN fins per 25 MM on 5/8" dia OR 1/2" Outside Corrugated (OC) seamless copper tubes.** No soldering or tinning will be used for bonding.

If pertinent, coils shall be complete, drainable by gravity through a header. Headers shall be fabricated of seamless copper tubing. Coils shall be pneumatically tested at 20 KG/Cm² under water.

Interior baffles shall be provided around all sides of each coil to minimise air bypassing. Provision shall be made to permit free drainage from each section. When two or more cooling coils are used with one stacked above the other individual drain troughs, piped to the main drain pan, shall be provided at the bottom of each of the upper coils.

The fan & cooling coils sections shall preferably provided with double construction, sandwiching a layer of 12 MM polystyrene insulation between the two layers of metal. Drain pans shall be provided with outlet drain connections on both sides have one & quarter inch dia minimum size. Inner drain pan of cooling Coil section shall be constructed of 16-gauge type G.I. sheet. The drain pans shall extend a minimum distance beyond the cooling coils equal to at least one half of the finned height of the cooling coils or cooling coil banks.

FRESH AIR

Fresh air shall be inducted in to the Unit room from the walls connecting outdoors through inlet cowls filters and control dampers.

All safety controls, low and high pressure controls, starters, overload trips will be set and record of all settings will be furnished to the Engineer for checking and passing on to the Owners for their checking.

The contractor shall provide for pre-shipment inspection and capacity test as per latest IS standard.

NOTE : ALL OUTDOORS UNITS SHALL BE MOUNTED ON M.S. ANGLE FRAME STRUCTURE. THE M.S. ANGLE FRAME STRUCTURE SHALL BE PAINTED WITH EPOXY PAINT. THE SHADE OF THE PAINT SHALL BE APPROVED BY THE CONSULTANTS / BANK'S ENGINEER.

DRAIN PIPING

Condensate from the evaporator unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping shall be made of rigid PVC pipe of 6 Kg/Sq cm. pressure rating with water tight threaded connections, leading from the room unit to a suitable drain point. Complete drain piping shall be made leak proof & water tight by means of precise installation & the use of leak proof sealant / adhesives. Insulation of drain piping by Expanded Polyethylene.

2.1.2 SHEET METAL WORK

Ducts shall be made of either galvanized steel sheet as specified in the BOQ and confirm to IS-655.

The galvanized steel sheet shall confirm to IS-277. Aluminum sheet shall confirm to IS-737 the duct construction shall be as follows-

The thickness of the Galvenised coating should be minimum 120 Grammes/ Sqmt.

RECTANGULAR DUCT CONSTRUCTION-

	MAX SIDE (MM) THICKNESS OF BRACING SHEET (GSS)		TYPE OF JOINT
Up to 750	24 G	25 mm GSS flanges	NONE
751 to 1500 angles	22 G	25 x 25 x 3 MS angle flanges	25 x 25 x 3 M.S.

1501 to 2550	20 G	40 x 40 x 3 MS angle flanges	40 x 40 x 3 M.S.angles at 1.25 centers
2551 & above	18 G	50 x 50 x 3 MS angle flanges	50 x 50 x 3 M.S.angles at 1.25 centers

HANGERS FOR DUCT-

DUCT SIZE (mm)	SPACING (mm)	SIZE OF MS ANGLE NOT EXCEEDING (m)	SIZE OF ROD DIA (mm x mm)
Up to 750	2.5	25 x 25 x 3	6
751 to 1500	2.5	40 x 40 x 3	6
1501 to 2250	2.5	50 x 50 x 3	10
above 2250	2.5	50 x 50 x 3	12

DAMPERS-

All dampers shall be of 18 S.W.G. G.I sheets louver dampers of robust construction and tight fitting. The design, method of handling and control, shall be suitable for the location and service required. Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation, control or setting in any desired position.

Dampers and their operating devices shall be made robust, easily operable and accessible through suitable access door. Every damper shall have indication device clearly showing the damper position at all times. All the bushing will be of brass only.

FIRE CUM SMOKE DAMPER-

The Fire Damper shall be made from minimum 16 S.W.G. Galvanized Steel in multi plate construction. The damper shall be provided with Jam Seal (Compression type) on sides to prevent spread of smoke & fire. The motorized damper shall activate from an air sampling type electronic smoke detector, mounted in the air stream. The fire damper shall be complete with actuator for the fire damper and air sampling type electronic detector. The Fire dampers are to be installed on the supply air duct.

The dampers shall be equipped with a well designed control panel, using high components which consumes less power. It shall operate at 24 volts obtained through a step down transformer. The panel is protected against surge currents or short circuits through a fuse connected on the PCB. The control panel shall be well protected against wrong switching. All Fire cum smoke dampers must be qualified under UL standard 555-1995 of approved 90 mins fire rating.

GRILLES AND DIFFUSERS-

All grilles (SA & RA), diffusers (SA & RA) will be made from extruded Aluminum sections (As specified in the BOQ) duly powder coated to match the interior requirements of Consultant/ Client. All the supply air grilles/diffusers will be provided with opposed blade dampers fabricated from Al. The damper should be suitable for operation from front face of grille/diffuser.

INSTALLATION-

A good quality felt/expanded polyethylene /rubber of uniform thickness and width shall be used as gasket between flange joints. The gaskets shall be fixed by a suitable adhesive and holes made by passing a heated rod through.

1. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angles of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing. All the joints shall be made tight and all interior surfaces shall be smooth. Bends shall be made with radius not less than one half the width of the duct or with properly designed interior curved vanes where metal ducts or sleeves terminate in woodwork, brick or masonry openings, tight-flanged collars. Ducting over false ceiling shall be supported from the slab above or from beams. In no case a duct shall be supported from the false ceiling hangers or to be permitted to rest on a hung ceiling.
2. All holes in concrete, masonry etc. made by contractor for fixing supports etc. shall be made good and restored to original finish by him.
3. Air handling units and fans shall be connected to duct work by inserting at air inlet & air outlet a double canvass sleeve. Each sleeve shall be minimum 100 mm long, securely bolted to duct & units. Each sleeve shall be made smooth & the connecting ductwork rigidly held in the line with unit inlet or outlet.

TESTING-

1. After completion all such system shall be tested for leakage.
2. The entire air distribution system shall be balanced to supply the air quantities as required in various zones and rooms to maintain the specified room conditions. The final shall be recorded and submitted to the Consultant for approval before acceptance and taking over of the entire system by the Employer.

PAINTING-

Angle iron flanges, stiffeners, hangers and supports shall be painted with 2 coats of anti rust primer and those remaining uncovered shall be further painted with 2 coats of synthetic enamel paints of black colour.

2.1.3 INSULATION

(A) THERMAL INSULATION-

The supply air duct shall be insulated with 25 mm thick, factory packed Aluminium foil fiber glass of density 24 Kg. / Cu. M.

Method of applying insulation-

- a) Clean the duct surface to be insulated.
- b) Apply a thin coat of bituminous paint on the duct.
- c) Fix the insulation of specified thickness over the surface of the duct tightly and seal all the joints using BOPP tape. Secure the insulation with 16 Gauge, 10 mm wide PVC box strapping at a distance of 750 mm.

(B) ACOUSTIC INSULATION-

First 5-meter length of supply air duct shall be acoustically insulated with 12.5 mm thick fiberglass of density 48 Kg./Cu.M. and covered with 28 G perforated Aluminium sheets from the inside of the duct.

- a) Clean the duct surface to be insulated.
- b) Apply a thin coat of bituminous paint and Fix-up fiberglass slabs
- c) Cover-up with perforated Aluminium sheets with the help of G. I. Screw Washers.

(C) FALSE CEILING INSULATION-

The false ceiling shall be insulated with 50 mm thick fiberglass slab of 16 Kg. / Cu. M. density. The fiberglass slab shall be wrapped in polyethylene bags.

(D) UNDERDECK INSUALTION-

The exposed roof shall be insulated with 50 mm thick "TF" quality expanded polystyrene of density 24 Kg./Cu. M. with 85-20 grade hot bitumen and GI screw washer & GI diagonal wires.

(E) ACOUSTIC INSULATION FOR PACKAGE A.C. UNIT ROOM-

All the walls of the AHU room shall be insulated for thermal & acoustic treatment.

- a) Apply a thin layer of Bituminous paint on walls/ partitions to be insulated
- b) Rigid boards of 25 mm thick fiberglass of density 48 Kg./Cu. M. will be fixed up with the help of G. I. Framing at 2 ft. x 2 ft. grid and G. I. screw washers.
- c) The insulation slabs shall be covered up with 28 G perforated Aluminium sheets. The insulation sheets shall be fixed with self tapping parker screws.

The insulation shall be done in such a manner that min. 150 mm distance is left out from floor.

2.1.4 ELECTRICAL WORK

The electrical work will be carried out as per IE rules. The distribution including power cabling (1100 V Gr.), control cabling (650 V Gr.) and earthing of Cu. shall be carried out by the contractor. The electrical panel required for all A.C units will be provided by the contractor. The power cabling will be of aluminium whereas the control cabling will be of copper. The electrical work will be carried out by the contractor as per the approved drawings.

2.1.5 REFRIGERATION PIPING & INSULATION

The refrigeration piping between indoor and outdoor units will be carried out with good quality soft / hard copper piping. The complete piping work shall be insulated with formed sections of expanded polythylene. The piping shall be clamped with GI saddles with wooden strips with walls.

2.1.6 ANCHOR FASTNERS :

The Ducts should be hanged from the ceiling/ beam using Screw type Anchor Fastners.

2.2 SECTION- 2 ELECTRICAL WORKS

2.2.1 VARIOUS CODES FOR ELECTRICAL WORKS

A. APPLICABLE IS STANDARDS

- | | | |
|-----|--|-------------------|
| 1. | METERS (MEASURING) FOR ANALOG METERS | IS:1248-1958 |
| 2. | INSTALLATION AND MAINTENANCE OF SWITCH GEARS | IS:3072-1975 |
| 3. | CODE OF PRACTICE FOR EARTHING | IS:3043 |
| 4. | H.D. AIR BREAKER, SWITCH GEARS AND FUSES FOR VOLTAGE NOT EXCEEDING 1000 VOLTS | IS:4047-1977 |
| 5. | SELECTION, INSTALLATION AND MAINTENANCE OF FUSES UP TO 650 VOLTS | IS:8106-1966 |
| 6. | GENERAL REQUIREMENTS FOR SWITCH GEAR AND GEAR FOR VOLTAGE NOT EXCEEDING 1000 VOLTS | IS:4237-1967 |
| 7. | DEGREE OF PROTECTION PROVIDED BY ENCLOSURES FOR LV S/GEARS | IS:2147-1962 |
| 8. | INSULATED CONDUCTOR RATING | IS:8084-1972 |
| 9. | ENCLOSED DISTRIBUTION FUSE BOARDS AND CUT-OUTS FOR VOLTAGE NOT EXCEEDING 1000 VOLTS | IS:2675-1983 |
| 10. | MINIATURE CIRCUIT BREAKER | IS:8828-1978 |
| 11. | FUSE WIRE USED IN RE-WEARABLE TYPE ELECTRIC FUSES UP TO 650 VOLTS | IS:9926-1981 |
| 12. | PVC INSULATED ELECTRIC CABLES HEAVY DUTY | IS:1554 (PART I) |
| 13. | RECOMMENDED CURRENT RATING FOR CABLES | IS:3961 (PART II) |
| 14. | COPPER CONDUCTOR IN INSULATED CABLES AND CORES | IS:2982 |
| 15. | CONDUCTOR FOR INSULATED ELECTRIC CABLES AND FLEXIBLE CORDS | IS:8130 |
| 16. | MILD STEEL WIRES, STRIPS AND TAPES FOR ARMOURING CABLES | IS:3975 |
| 17. | PVC INSULATION AND SHEATH OF ELECTRIC CABLES | IS:5831 |
| 18. | ALUMINIUM CONDUCTOR FOR INSULATED CABLES | IS:1753 |
| 19. | PVC INSULATED AND PVC SHEATHED SOLID ALUMINIUM CONDUCTOR CABLES OF VOLTAGE RATING NOT EXCEEDING 1100 VOLTS | IS:4288 |
| 20. | RECOMMENDED CURRENT RATING FOR CABLE | IS: 961 |
| 21. | CODE OF PRACTICE FOR ELECTRICAL WIRING INSTALLATION SYSTEM VOLTAGE NOT EXCEEDING 650 VOLTS | IS: 732 |
| 22. | CODE OF PRACTICE FOR FIRE SAFETY OF BUILDINGS (GENERAL) ELECTRICAL INSTALLATION | IS: 1646 |
| 23. | RIGID STEEL CONDUITS FOR ELECTRICAL WIRING | IS:1653 |
| 24. | FITTINGS FOR RIGID STEEL CONDUITS FOR ELECTRICAL WIRING | IS:2667 |
| 25. | FLEXIBLE STEEL CONDUIT FOR ELECTRICAL WIRING | IS:3480 |
| 26. | ACCESSORIES FOR RIGID STEEL CONDUITS FOR ELECTRICAL WIRING | IS:3837 |
| 27. | PVC INSULATED CABLES (WIRES) | IS:694 |
| 28. | RIGID NON-METALLIC CONDUITS FOR ELECTRICAL WIRING | IS:2509 |
| 29. | FLEXIBLE (PLAYABLE) NON-METALLIC CONDUITS FOR | IS:6946 |

	ELECTRICAL INSTALLATION	
30.	THREE PIN PLUGS AND SOCKETS	IS:1293
31.	CONDUCTORS FOR INSULATED ELECTRICAL CABLES AND FLEXIBLE CODES	IS:8180
32.	SPECIFICATION FOR CONDUIT FOR ELECTRICAL INSTALLATION	IS:9537-1980
33.	ACCESSORIES FOR NON-METALLIC CONDUITS FOR ELECTRICAL WIRING	IS:3419
34.	SWITCHES	IS:3854
35.	PLUGS	IS:6538
36.	SHUNT CAPACITORS FOR POWER SYSTEMS	IS:2834-1954
37.	HRC CARTRIDGE FUSES AND LINKS UP TO 660 VOLTS	IS:2208
38.	GENERAL AND SAFETY REQUIREMENT FOR LIGHTING FITTINGS	IS:1913-1969
39.	CODE OF PRACTICE FOR LIGHTING PUBLIC THOROUGHFARES	IS:2944-1981
40.	WATERPROOF ELECTRIC LIGHTING FITTINGS	IS:3528
41.	WATER TIGHT ELECTRIC LIGHTING FITTING	IS:3553-1966
42.	MILD STEEL TUBULAR AND OTHER WROUGHT STEEL PIPE FITTING	IS:1239-1958
43.	LUMINARIES FOR STREET LIGHT	IS:2149-1970
44.	HRC FUSES HAVING RUPTURING CAPACITY OF 90 KA	IS:9224
45.	EXHAUST FAN	IS:2312-1967
46.	CLASS I CEILING FAN	IS:374-1979
47.	DANGER NOTICE BOARDS	IS: 2551

NOTE :

All codes and standards means the latest where not specified otherwise the installation shall generally follow the Indian Standard codes of practice or relevant British Standard Codes of Practice in the absence of corresponding Indian Standards.

PLEASE FOLLOW :

- a. Indian Electricity Act of 1910 and rules issued there under revised up to date.
- b. Special Attention should be given to Rule No. 50.
- c. Regulations for electrical equipment in building issued by The Bombay Regional Council of insurance Association of India.

2.2.2 L. T. PANELS / P.C.C. / M.C.C.

A. SPECIFICATIONS

TYPE OF PANEL :

All the PCC's / PDB's / MCC's shall be metal clad, totally enclosed, rigid, floor / wall mounted, air - insulation, cubical type suitable for operation on three

phase / single phase, 415 / 230 volts, 50 Hz. neutral effectively / Non effectively grounded at transformer and short circuit level not less than 30 MVA at 415 volts.

The PCC's / MCC's shall be designed the withstand and heaviest condition at site, with minimum expected ambient temperature of 45 degree celsius, 80 percent humidity and dusty weather.

Should conform to Indian Electricity Act and rules. (as amended up to ate) & approval of FIA. of India.

STRUCTURE :

The PCCs, MCCs & PDBs shall be metal clad enclosed and be fabricated out of high quality CRCA sheet, suitable for indoor installation having dead front operated and floor mounting type.

All CRCA sheet steel used in the construction of PCCs / MCCs / PDBs shall be 2 mm thick and shall be folded and braced as necessary to provided a rigid support for all components. Joints of any kind in sheet shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.

The PCCs / MCCs / PDBs shall be totally enclosed, completely dust and vermin proof and degree of protection being no less than IP-54 to IS 2147. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasket with neoprene rubber and / or rubber strips and shall be lockable with steel lock.

All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screw shall enter into holes taped into an adequate thickness of metal or provided with bolts and nuts. Self threading screws shall not be used in the construction of PCCs / MCCs / PDBs.

A base channel ISMC 75 shall be provided at the bottom.

PCCs / MCCs /PDBs shall arranged in multi-tier formation. The PCCs / MCCs / PDBs shall be of adequate size with a provision of 20 percent spare space to accommodate possible future additional switch gear. The size of the PCCs / MCCs / PDBs shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component dose not attain temperature more than 40 degree celsius. If necessary louvered openings shall be provided for natural ventilation, but the said openings shall be screened with fine wire mesh.

Knockout holes of appropriate size and number shall be provided in the PCCs / MCCs/ PDBs in conformity with number, and size of incoming and outgoing conduits / cables.

Alternatively the PCCs / MCCs / PDBs shall provided with removable sheet plates (not more than 300 x 300mm) at top and bottom to drill holes for cable / conduit entry at site.

The PCCs / MCCs / PDBs shall be designed to facilitate easy inspection, maintenance and repair.

The PCCs / MCCs / PDBs shall be sufficiently rugged in design and shall support the equipment without distortion under normal and short circuit condition, they shall be suitable braced for short circuit duty.

PROTECTION CLASS :

All the indoor PCCs / MCCs / PDBs shall have protection class of IP - 54.

PAINTING :

All sheet steel work shall undergo a process of decreasing pickling in acid, cold rinsing, phosphating, pesivating and then sprayed with a high corrosion resistant primer. The primer shall be backed in an oven. The finishing treatment shall be by application. The panel shall be treated with 7 tank process and powder coating shall be applied by baking the sheet steel parts in oven.

CIRCUIT COMPARTMENT :

Each circuit breaker and switch fuse units shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly inter locked with the breaker / switch fuse units in ON and OFF position. Safety interlocks shall be from being drawn out when the breaker is in ON position.

The door shall not form as integral part of the drawout position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tires in a vertical section.

INSTRUMENT COMPARTMENT

Separate and adequate compartment shall provided for accommodating instruments, indicating lamp, control contactors, relays and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, switch fuse units, busbars and connections.

BUSBARS

The busbar shall be air insulated and made of high quality, high conductivity, high strength copper and as per relevant IS code. The busbar shall of three phases and neutral system with separate neutral and earth bar. the busbar and interconnection between busbar and various components shall be of high conductivity, hard drawn, electrolytic copper. the busbar shall be of rectangular cross section designed to withstand full load current for phase busbar and half rated current for neutral busbar and shall be extensible type on either side. The busbar shall be rated for the frame size of the main incoming breaker but in any case not less than 200 amp capacity. The busbar shall have uniform cross section through out the length. Current density for the Busbars will be as under:

- A. For Copper Busbar – 1.2 Amp/ Sqmm
- B. For Aluminum Busbar - 0.8 Amp/ Sqmm.

The busbar and interconnection shall be insulated with heat shrinkable PVC sleeves and be colour coded in red, Yellow, Blue and Black to identify the three phases and neutral of the system. The busbar shall be supported on unbreakable, non hygroscopic DMC insulated supports at sufficiently close interval to prevent busbar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 50 KA RMS symmetrical for one second and a peak short circuit withstand of 105 KA minimum.

The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3 mm thick bakalite sheet to avoid any accidental contact. The busbar shall be arranged such that minimum clearance between the busbar are maintained as per below.

Between phases	:	27 mm min.
Between phases and neutral	:	25 mm min.
Between phases and earth	:	25 mm min.
Between neutral and earth	:	23 mm min.

All busbar connection shall be done by drilling holes in busbars and connecting by chromium plated brass bolt and nuts. Additional cross section of busbar shall be provided in all PCCs / MCCs / PDBs to cover-up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.

All connection between busbar and circuit breaker / switches and between circuit breaker/ switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating strips.

ELECTRICAL POWER & CONTROL WIRING CONNECTION

Terminal for both incoming and outgoing cable shall be suitable for 1100 volts grade, aluminum/copper conductor PVC insulated and sheathed, armoured cable and shall be suitable for connections of solder less sockets for the cable size as indicated on the appended drawing for the PCCs, MCCs, PDBs.

Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance.

Both control and power terminals shall properly be shrouded.

10% spare terminal shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire connected per terminal.

Suitable barriers of enclosures shall separate terminal strip for power and control from each other.

Wiring inside the module for power, control protection and instrument etc. shall be done with use of 660/1100 conforming to IS 694 and IS 8130. Power wiring inside the starter module shall be rated for full current rating of contactor, but not less than 4 sq mm cross section area. For current transformer circuits, 2.5 sq mm copper conductor wire shall be used. Other control wiring shall be done with 1.5 sq mm copper conductor wires. Wires for connections to the door shall be flexible. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

Control power for the motor starter module shall be taken from the respective module switchgear outgoing from R phase and Neutral. Control wiring shall have control fuse (HRC type).

Particular care shall be taken to ensure that the layout of wiring neat and orderly. Identification ferrules shall be filled to all the wire termination for ease of identification and to facilitate and testing.

"CUPAL" washers shall be used for all copper and aluminium connections.

Final wiring diagram of the PCC, MCC, PDB power and control circuit with ferrules number shall be submitted along with the PCC/MCC/PDB as one of the documents.

TERMINALS

The outgoing terminals and neural link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformer for instrument metering shall mounted on the disconnecting type terminal blocks. No direct connection of incoming and outgoing cables to internal components connection of the distribution board is permitted, only one conductor may be connected in one terminal.

WIREWAYS

A horizontal PVC wire way with screwed covers shall provided at the top to take interconnecting control wiring between different vertical sections.

CABLE COMPARTMENT

Cable compartment of adequate size shall be provided in the PCCs, MCCs, PDBS for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate support shall be provided in the cable compartment shall be brought out to terminal blocks in the cable compartment.

EARTHING

Copper earth busbar of 25 mm x 6 mm shall be provided in the PCCs, MCCs, PDBs for the entire length of panel. The frame work of the PCCs, MCCs, PDBs shall be connected to this earth busbar. Provisions shall be made for connection from earth busbar to the main earthing bar coming from the earth pit on both sides of the PCCs, MCCs, PDBs.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar.

LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

NAME PLATE

A name plate with panel designation in bold letter shall be fixed at top of the central in panel. A separate name plate giving feeder details shall be provided for each feeder module door.

Inside the feeder compartment, the electrical component, equipments, accessories like switchgear, contactor, lamp, relays etc. shall suitably be identified by providing stickers.

Engraved name plates shall preferably be of 3 ply, (red-white-red or black-white-black) lamicold sheet. However black engraved perplex sheet name plates shall also be applicable. Engraving shall be done with square groove cutters.

Name plate shall be fastened by counter sunk screws and not by adhesives.

DANGER NOTICE PLATE

The danger plate shall be affixed in a permanent manner on operating side of the panel.

The danger notice plate shall indicate danger notice both in Hindi and English and with a sign of skull and bones.

The danger notice plate in general shall meet to requirements of local inspecting authorities.

Overall dimension of the danger notice plate shall be 200 mm wide and 150 mm high. The danger notice plate shall be made from minimum 1.6 mm thick mild steel sheet and after due pretreatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

The letter, the figure, the conventional skull and bones shall etc. shall be positioned on the plate as per recommendations of IS : 2551-1982.

The said letter, the figure and the sign of skull and bones be painted in single red colour as per IS : 5-1978.

The danger plate shall have rounded corners. Locations of fixing holes for the plate shall be decided to suit design of the panel. The plate shall be fitted with counter sunk screws.

The danger notice plate, if possible, be of ISI certification mark.

INTERNAL COMPONENTS

The PCC / MCC / PDB shall be equipped complete with all type of required number of air circuit breakers, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings. Components necessary for proper complete functioning of the PCC / MCC / PDB but not indicated on the drawings shall be supplied and installed on the PCC / MCC / PDB.

All part of the PCC / MCC/ PDB carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the PCC / MCC / PDB.

All units of the same rating and specifications shall be fully interchangeable.

INSPECTIONS / TESTING

Each equipment should be got inspected and witnessed by client & consultant.

The PCC / MCC / PDB shall be inspected and checked as per inspection manual of the PCC / MCC / PDB manufacturer.

Various electrical components and accessories of the PCC / MCC / PDB shall be checked as per drawing for the respective PCC / MCC / PDB.

The PCC / MCC / PDB shall be checked for rigid mounting, earthing connections, proper rating and size of components, internal wiring, etc.

All mechanical fasteners and electrical connections shall be checked and tightened before installation.

Type test certificates for all ACB for similar rating shall be submitted.

Test :

- a) Prior to dispatch of the PCC / MCC / PDB following tests shall be carried out.
- b) Mechanical endurance test shall be carried out by closing and opening of all the ACB's, MCB's switches etc.
- c) Over voltage and Insulation resistance test shall be carried out between phases and between phase to earth bus, keeping the isolating switch in ON position. Similar test shall be carried out keeping the isolating switch in closed position.
- d) All the interlocks, controls and tripping mechanism of the switch gears shall be tested for their proper functioning.

L. T. SWITCHGEARS AND ACCESSORIES :

GENERAL :

- a) The type, size, and rating of the components shall be as indicated on the relevant drawings.
- b) While selection of the capacity of the components resulting from the prevailing conditions like room temperature shall be allowed for the Thermal and magnetic trip rating shall be compensated for the ambient temperature.
- c) The rating indicated on the drawings are rating anticipated at prevailing site condition.

MINIATURE CIRCUIT BREAKER :

Miniature circuit breakers shall be quick make and break and break type conform with British standard BS : 3871 (Part-I) 1965 and IS :8825 (1996). The housing of MCBs shall be heat resistant and having a high impact strength. The fault current of MCBs shall not be less than 10000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faculty current.

The MCB contact shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger relay 3 as for over current and short circuit protection. The over load or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested and certified as per Indian Standard, prior to Installation.

FUSE :

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with IS : 2208-1962 and having rupturing capacity of not less than 35 MVA at 415 Volts. The backup fuse rating for each motor / equipment.

MOULDED CASE CIRCUIT BREAKER :

The MCCB shall be air break type and having quick make quick break with trip free operating mechanism.

Housing of the MCCB shall be of heat resistant and flame retardant insulating material.

Operating handle of the MCCB shall be in front and clearly indicate ON / OFF / TRIP positions.

The electrical contact of the circuit breaker shall be of high conducting non deteriorating silver alloy contacts.

The MCCB shall be provided with electronic trip circuit for overload and short circuit protection. All the releases shall operate on common trip busbar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

The MCCB whenever called for in the appended drawings shall provide an earth fault relay.

The MCCB shall provide two sets of extra auxiliary contacts with connections for additional controls at future date.

The electrical parameters of the MCCB shall be as per the descriptions given in the appended drawings.

CONTACTORS:

The contactor shall meet with the requirements of IS : 2959 and BS : 775.

The contactors shall have minimum making and breaking capacity in accordance with utilization category AC 3 and shall be suitable for minimum class II intermittent duty.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

METER :

Flush mount 96 x 96 x 80 mm load manager type Enercon EM 6400 meter of accuracy class 1 as per IS 13779 shall be provided. The meter shall be accurate on distorted waveforms, simultaneous sampling of voltage and amperes shall be done. It shall have low burden on PT and CT shall have bright display, shall view 3 parameters together shall have auto scaling from kilo to mega to giga units, shall have programmable CT, PT ratios with built in phase analyser. Auto scrolling shall be programmable as per user choice and communication with PC, PLC DCS shall be possible through RS 485 serial port. It shall be dust proof, tamper proof with data import export option and 10 years back up of integrated data.

Parameters to be monitored shall be Frequency, Line to line and average and line to neutral and average voltage, phase wise and average current, phase wise and total KVA, KW and P.F. reading and KWH monitoring.

User programmable facility for delta 2e and star 3e measurement, C.T. and P.T. ratios, sliding window auto sync. And auto scrolling of parameters shall be available.

Sensing shall be 3 phase, 4 wire measuring True RMS with voltage input range of 110 to 415 V nominal and current input of 5 amps or 1 amps as per field configuration. Current range shall be from 50 mA to 7.5 A and burden on PT or CT shall be app 0.2 VA.

Accuracy for kW / kWh shall be as per IS 1377 / CBIP88 and for all other parameters shall be +/- 0.5% of full scale + 0.5% of reading + 1 digit. Digital readout shall be of 3 rows of 4 digit each (12.5 mm size) with 7 segment bright red LED. Input frequency shall be 50Hz / 60Hz +/- 5%. Power factor range shall be 0.5 lag – unit – 0.8 lead.

Resolution for power parameters shall be for 4 digits and energy parameters shall be 8 digits. Display update shall be at every 15 seconds for demand parameters and 1 sec for other parameters. Display sequence shall be

parameter followed by value. Temperature range shall be 0-50°C and humidity <95% non condensing.

Display pages shall be as follows : Instantaneous – VLL, A avg., F
VLn, A avg., F
KVA, kW, PF
Individual pages of above
parameters.

Integrated - kVAh
KWh
Run hours
On hours
Interruption

CURRENT TRANSFORMER :

Where ammeters are called for, CT's shall provided for current measuring. Each phase shall be provided with separate CT of class I accuracy and 10 VA burden Cast Resin Type for operation of associated metering and controls. Current transformer shall be in accordance with IS : 2705 - 1964 as amended up to date.

PUSH BUTTON :

The push button unit shall comprise of the contact element, a fixing holder , and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps. continuous current rating. The actuator shall be of stranded type and colour as per its usage for ON, OFF and Trip.

INDICATING LAMP :

Indicating Lamp shall be transformer operated low voltage rated and shall supplied complete with translucent covers to diffuse the lamp light.

Colour shade for the indicating lamps shall be as below :

ON indicating lamp	:	Red
OFF indicating lamp	:	Green
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow, Blue.

B. WORKMANSHIP

The contractor shall erect the panel at site in co-ordination with the supplier if required. He should check for loose ends on the part of the supplier and shall inform client and consultant

for the same. Contractor shall carry out physical and continuity tests. Also the contractor shall record the field tests carried out by the supplier. ***The panel shall be tested prior to supply at site for various tests as depicted in specifications at the manufacturers works and that shall in presence of the client and consultant.***

C. MODE OF MEASUREMENT

Contractor shall be paid for one panel.

POWER CAPACITORS & CAPACITOR CONTROL PANEL :

General :

- a. The capacitor banks shall be complete with all parts that are necessary or essential for efficient operations. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.
- b. The capacitor bank shall be complete with the required capacitors alongwith the supporting post insulators, steel rack assembly, copper busbars, copper connecting strips, foundation channels, fuses, fuse clips etc. The steel rack assembly shall be not dip galvanized.
- c. The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units.
- d.
 - i. The assembly of the banks shall be such that it provides sufficient ventilation for each unit.
 - ii. Each capacitor case and the cubical shall be earthed to each bus.
- e. Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 Volts within one minute in accordance with the provisions of the latest edition of IS:2834.
- f. Capacitor shall be of APP type with internal elements fuses completely impregnated type non PCB oil.
- g. Each unit shall satisfactory operate at 135% of rated KVAR including factors of over voltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any over voltage upto a maximum of 10% above the rated voltage, excluding transients.
- h. Capacitors shall have built in surge suppression coils –
 - i. The capacitor Banks shall be suitable for Operation with Automatic relays.
 - ii. The capacitor shall be rated for 500 V and connected in Delta.

2. Unit Protection :

Each capacitor unit shall be individually protected by a HRC fuse suitably rated for load current and interrupting capacity, so that a faulty capacitor unit shall be disconnected by the fuse without causing the bank to be disconnected. Thus, the fuse shall disconnect only the faulty unit and shall leave the rest of the units undisturbed. An operated fuse shall give visual indication so that it may be detected during periodic inspection. The fuse breaking time shall co-ordinate with the pressure built up within the unit to avoid explosion. Mounting of the individual fuse may be internal or external to the capacitor case.

2.2.3 CABLE LAYING AND TRENCHES WITH TRAYS

A. SPECIFICATIONS

CABLE TRENCH

Cable trench shall be dug to the minimum depth of 1 mtr and the width shall dependent on the no of cables to be kept with the layer of brick in between two cables.

BRICKS

The bricks shall be hand or machine moulded and made from suitable soils and kiln burnt. They shall be free from cracks, flaws and modules of free lime. They shall have smooth rectangular faces with sharp corners and shall be uniform in colour. The bricks shall be moulded with a frog of size 100 mm. x 40 mm., and 10 mm. to 20 mm. deep on one of its flat sides. The bricks shall not break when thrown on the ground from a height of 6 m. B – grade brick shall be used.

SAND

Sand shall be natural sand, clean, well graded, hard, strong, durable and gritty. Sand particles should be free from injurious amounts of dust, clay, kankar nodules, soft or flaky particles of shale, alkali, salts, organic matter loam, mica or other deleterious substances and shall be got approved from the CLIENT AND/OR ITS ARCHITECT. The sand shall not contain more than 8% of silt as determined by field test, if necessary the sand shall be washed to make it clean. The sand used by civil agency shall be used.

CABLE TRAYS

Cable trays shall be fabricated from Hot Dip GI and channels of 14 gauge and shall be powder coated with 7 tank process if specified. The design shall be ladder type with optional cover. Shall be fixed or suspended from the ceiling with the help of suspenders which shall have adequate diameter to sustain the weight of the cables and channels. Also if necessary anchor fasteners shall be used for grouting purpose.

B. WORKMANSHIP

The cable shall be laid side by side in trench with brick covering on all the three sides. The trench shall be such that sharp bends shall be avoided while laying the cable. The bedding of fine sand under the cable shall be not less than 6 mm. The trench shall be terminated in Manholes with specified size of R.C.C. hume pipes as shown in drawing. Cable markers shall be provided

through out the route of cable at 10 mtrs distance. The trenches shall be refilled after the cable are laid and the Ground level shall be done as per original after pressing the same. The cables shall be checked for insulation resistance and continuity tests shall be carried out.

C. MODE OF MEASUREMENT

The cable laying shall be measured in rmt. The trenches dug and refilled shall be measured in cu. Mtr. The bricks and sand bedding shall be measured in rmt. The cable trays shall be measured in rmt.

2.2.4 1.1 KV GRADE L.T. CABLES AND CABLE TERMINATION:

A. SPECIFICATIONS

All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards.

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

CABLE CONNECTORS:

Cable terminations shall be made with aluminium crimped type solder less lugs for all aluminium cables and stud type terminals. For copper cables copper crimped solder less lugs shall be used. Crimping shall be done with the help of hydraulically operated crimping tool.

CABLE GLANDS:

Cable glands shall be of aluminium single / double compression type as specified. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations. Glands for classified hazardous areas shall be CMRS approved.

FERRULES:

Ferrules shall be of self-sticking type and shall be employed to designate the various cores of the control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

CABLE JOINTS:

Kit type joint shall be done and filled with insulating compound. The joint should be for 1.1 KV grade insulation.

B. WORKMANSHIP

Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the Contractor shall mark it out on the drawings and also on the site and obtain the approval of the CLIENT AND CONSULTANT/OR ITS ARCHITECT before laying the cable. Procurement of cables shall be on the

basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Saddling or support for the cable shall not be more than 500 mm apart. Cable trays shall be used where specified. Cables laid in built-up trenches shall be on steel supports. Plastic identification tags shall be provided at every 30 m.

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

In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc unless marked on drawing by architect / consultant. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 20 meters and at all loop points.

All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. Cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position. So, that no rainwater may enter the building. After the cables are tested. The pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry watertight.

All cables shall be provided with stainless steel/ Aluminium cable identification tags at a maximum distance of 10 m.

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

Continuity on all phases.

Insulation Resistance.

between conductors.

all conductors and ground.

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

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool. Proper insulation tape shall be applied at the cable and lug joint.

C. MODE OF MEASUREMENT

The cables shall be measured in rmt and terminations on unit basis.

2.2.5 DISTRIBUTION BOARDS :

A. SPECIFICATIONS

Distribution boards shall be fabricated from 14 gauge M.S. sheet or shall be readymade as specified in the make of material list. It shall be of double door type with hinged (lockable if required) door suitable for recessed mounting in wall. Distribution boards shall be powder coated with 7-tank process application.

The distribution boards shall be provided with phase barriers, wiring channels to accommodate wires and individual per phase neutral links. There shall be separate or individual earth link as per requirement. Proper arrangement shall be made for mounting of MCB's and other accessories.

Distribution boards shall meet with the requirements of IS 2675 and marking arrangement of bus bars shall be in accordance with I.S. standards.

Bus bars shall be suitable for the incoming switch rating and sized for a temperature rise of 35° C over the ambient. Each board shall have two separate earthing terminals. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed. One earthing terminal for single phase and two terminals for 3 phase DB's shall be provided with an earth strip connecting the studs and the outgoing ECU earth bar.

The top and the bottom faces of the D.B. shall be provided for conduit entry of minimum 1" dia. The faces if asked shall be kept detachable.

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

Up to 15 A	2.5 sq.mm.	40 A	10 sq.mm.
25 A	4.0 sq.mm.	63 A	16 sq.mm.
32 A	6.0 sq.mm.		

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

MINIATURE CIRCUIT BREAKERS (MCB) :

MCB's shall have quick make and break non-welding self-wiping silver alloy contacts for 10 KA short circuit both on the manual and automatic operation. Each pole of the breaker shall be provided with inverse time thermal over load and instantaneous over current tripping elements, with trip-free mechanism. In case of multi-pole breakers, the tripping must be on all the poles and operating handle shall be common. Breakers must conform to BS 3871 with facility for locking in OFF position. Pressure clamp terminals for stranded/solid conductor insertion are acceptable up to 4 sq.mm. aluminium or 2.5 sq.mm. copper and for higher ratings, the terminals shall be suitably shrouded. Wherever MCB isolators are specified they are without the tripping elements.

RCCB / ELCB

The RCCB should suffices all the requirements of IS as per code IS - 12640 - 1988. The RCA should be current operated and not on line voltage.

The RCCB should ensure mainly the following functions:

- i) Measurement of the fault current value.
- ii) Comparison of the fault current with a reference value.
- iii) The RCCB should have a torroidal transformer witch has the main conductors of primary (P - N) which check the sum of the current close to zero.**
- iv) All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant.
- v) It should be truly current operated.
- vi) It should operate on core balance torroidal transformer.
- vii) Its accuracy should be $\pm 5\%$.

- viii) It should operate even in case of neutral failure.
- ix) It should trip at a present leakage current within 100 mA
- x) Its enclosure should be as per IP 30.
- xi) Its mechanical operation life should be more than 20,000 operations.
- xii) It should provide full protection as envisaged by IE rules - 61-A, 71 - ee, 73 - ee, 1985 and also rule 50 of IE rule 1956.
- xiii) It should conform to all national and international standards like IS: 8828-1993, IS: 12640-1988, BS 4293 - 1983, CEE 27 (International commission Rules for the approved of electrical equipment).

B. WORKMANSHIP

The D.B. shall be properly grouted in the wall in concealed manner taking care that the powder coating is not scratched and dents are not formed on the D.B. The MCBs and ELCBs. In the distribution boards shall be fixed as per the circuit details provided. All the wires terminating in the MCBs and the ELCBs shall be lugged for proper contact and ferrules depicting the circuit nos shall be provided. D.B.s mounted in concealed manner shall have a groove around it so as to save the finish of the plaster and colour during future opening of the door. The distribution boards shall have circuit chart tagged on the door for future maintenance. Danger notice plates shall be fitted to the distribution boards with screws and not stuck so as to assure its presence for a longer duration.

C. MODE OF MEASUREMENT

The distribution boards shall be measured in nos and the MCBs and ELCBs shall be measured in nos separately.

2.2.6 INTERNAL WIRING

A. SPECIFICATIONS

RIGID PVC AND FLEXIBLE PVC FRLS CONDUITS:

All conduits shall be rigid PVC alloy low in halogens pipe having minimum wall thickness of medium gauge 1.6 to 1.8 approved by F.I.A. & I.S.I. and shall confirm to IS 9537 part 3 and complying with fire safety standards classification V-0. The temperature stability shall be from -20°C - +80°C and also shall be UV stabilised.

Up to 38 mm diameter - minimum 1.8 mm. wall thickness.

Above 40 mm. diameter - minimum 2.2 mm. wall thickness.

Flexible conduits shall be formed from a continuous length of spirally wound interlocked steel strip with a fused zinc coating on both sides. The conduit shall be terminated in brass adapters.

ACCESSORIES:

PVC conduit fittings such as bends, elbows, reducers, chase nipples, split couplings, plugs etc. shall be specifically designed and manufactured for their particular application. All conduit fittings shall conform to IS: 2667-1964 and IS: 3857-1966. All fitting associated with galvanized conduit shall also be galvanized.

WIRES:

All wires shall be single core multi-strand/ flexible copper or single strand Copper, PVC insulated as per IS: 694 and shall be 660 V\1100 V grade.

All wires shall be colour coded as follows:

<u>Phase</u>	<u>Colour of wire</u>
R	Red
Y	Yellow
B	Blue
N	Black
Earth	Green (insulated)
Control (If any)	Grey
All off wires	Same as Phase wire

SWITCHES & SOCKETS:

Switches shall be modular / plate type / flush piano type with silver-coated contacts. Sockets shall be 3 pins with switch and plate type cover. Combination of multiple switch units and sockets should be used to minimize the switch boxes.

For heavy duty, metal clad sockets with M.C.B / Isolator mounted in a galvanized steel box shall be provided.

SWITCH PLATE AND BOX:

Plates of the same make, as that of switches shall be used with the modular range. For flush piano type hylam plate of approved colour and 3 mm thickness shall be used which shall be bordered with wooden facia. Also M.S. boxes shall be taken as switch boxes.

B. WORKMANSHIP

The size of conduit shall be selected in accordance with the number of wires permitted under table given below. The minimum size of the conduit shall be 25 mm diameter unless otherwise indicated or approved. Size of wires shall not be less than 1.0 sq.mm. Copper or 2.5 sq.mm. Aluminium.

Nominal Dia of wires (mm)	Nominal Cross sec. Area (mm ²)	20 mm		25 mm		32 mm		38 mm	
		S	B	S	B	S	B	S	B
1/2.40	1.50	4	3	8	6	15	9	--	--
1/1.80	2.50	4	2	6	4	10	8	--	--
1/2.24	4.00	2	2	4	3	8	6	--	--
1/2.80	6.00	1	--	4	3	6	6	--	--
1/3.55	10.00	1	--	3	2	5	4	6	5

S - runs of conduits which have distance not exceeding 4.25 m. between draw boxes & which do not deflect from the straight by an angle more than 15 degree.

B - runs of conduits, which deflect, from the straight by more than 15°.

Conduits shall be kept at a minimum distance of 100 mm. from the pipes of other non-electrical services. And maintain minimum 300 mm distance between telephones, TV & Computer piping.

Separate conduits/raceways shall be used for :

Normal lights and 5 A 3 pin sockets on lighting circuit.

Separate conduit shall be laid from D.B. to switch board.

Power outlets - 15 A 3 pin 20 A/30 A, 2 pin scraping earth metal clad sockets.

Emergency lighting.

Telephones.

Fire alarm system.

Public address system & Music system.

For all other voltages higher or lower than 230 V.

T.V. Antenna.

Water level guard.

Computer Wiring

Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors etc., shall be installed in flexible conduits. Otherwise rigid conduits shall be used. No flexible extension shall exceed 1.25 m.

Conduits run on surfaces shall be supported on metal 12 mm. thick G.I. pressure saddles which in turn are properly screwed to the wall or ceiling. Saddles shall be at intervals of not more than 500 mm. Fixing screws shall be with round or cheese head and of rust-proof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building. Unseemly conduit bends and offsets shall be avoided by using fabricated mild steel junction/pull through boxes for better appearances. No cross-over of conduits shall be allowed unless it is necessary and entire conduit installation shall be clean and neat in appearance.

Conduits embedded into the walls shall be fixed by means of staples at not more than 500 mm. intervals. Chases in the walls shall be neatly made and refilled after laying the conduit and brought to the finish of the wall but the building Contractor will do final finish.

Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the CLIENT AND/OR ITS ARCHITECT, before the concrete is poured. Proper care shall be taken to ensure that the conduits are neither dislocated nor choked at the time of pouring the concrete suitable fish wires shall be drawn in all conduits before they are embedded.

Where conduit passes through expansion joints in the building, adequate expansion fittings shall be used to take care of any relative movement.

Inspection boxes shall be provided for periodical inspection to facilitate withdrawal and removal of wires. Such inspection boxes shall be flush with the wall or ceiling in the case of concealed conduits. Inspection boxes shall be spaced at not more than 12 meters apart or two 90° solid bends or equal. All junction and switch boxes shall be covered by 6 mm clear plate. These junction boxes shall form part of point wiring or conduit wiring as the case may be including the cost of removing the cover for painting and re-fixing. No separate charges shall be allowed except where specially mentioned.

Conduits shall be free from sharp edges and burrs and the threading free from grease or oil. The entire system of conduits must be completely installed and rendered electrically continuous before the conductors are pulled in. Conduits should terminate in junction boxes of not less than 32 mm. deep.

An insulated earth wire of copper rated capacity shall be run in each conduit.

Lighting & Power Wiring :

All final branch circuits for lighting and appliances shall be single conductor/ stranded/ flexible wires run inside conduits. The conduit shall be properly connected or jointed into sockets, bends, and junction boxes.

Branch circuit conductor sizes shall be as shown in the schedule of quantities and or drawings.

All circuits shall preferably be kept in a separate conduit up to the Distribution Board. No other wiring shall be bunched in the same conduit except those belonging to the same phase. Each lighting branch circuit shall not have more than ten outlets or 800 watts whichever is lower. Each conduit shall not hold more than three branch circuits.

Flexible cords for connection to appliances, fans and pendants shall be 650/1100 V grade (three or four cores i.e. with insulated neutral wire of same size) with tinned stranded copper wires, insulated, twisted and sheathed with strengthening cord. Colour of sheath shall be subject to the CLIENT AND/OR ITS ARCHITECT'S approval.

Looping system of wiring shall be used. Wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors. No such joints shall be made unless the length of the sub-circuit, sub-main or main is more than the length of the standard coil.

Control switches shall be connected in the phase conductors only and shall be 'ON' when knob is down. Switches shall be fixed in 3 mm. thick painted or galvanized steel boxes with cover plates as specified. Cadmium plated brass screws shall be used.

Power wiring shall be distinctly separate from lighting wiring. Conduits not less than 25 mm. and wires not less than 2.5 sq.mm. copper shall be used.

Every conductor shall be provided with identification ferrules at both ends matching the drawings.

Testing: the entire installation shall be tested for :

Insulation resistance.
Earth continuity.
Polarity of single pole switches.

General: All the wiring switch board, outlet points shall be done in a concealed manner in wall & slab in PVC conduit of minimum 25 mm dia. (medium gauge) & with 650v / 1100v grade PVC insulated flexible copper conductor wire. The switches should be modular with moulded cover plates, blank plates for outlet boxes. The accessories, connectors, sockets, should be fixed with brass chrome / cadmium plated machine screw. For fan points the rates should be with hum -free type 300 W regulators as required to complete the point wiring. The wiring shall be as per IS: 732 and IS: 4648. The wiring shall be done in a looping manner so as to avoid junction boxes at any place. All

the looping shall be done only in the switchboard and outlet points. The size of the wire shall be as per the specification. Colour code shall be strictly followed.

The size of wires shall as follow :

32 Amp. metal clad points:

Phase / Neutral	6.0 mm ²
Earth	4.0 m m ²

25 Amp. out let points :

Phase / Neutral	4.0 m m ²
Earth	2.5 m m ²

Two nos. of 15 Amps. socket out let connected in parallel from DB to first outlet

Phase / Neutral	4.0 m m ²
Earth	2.5 m m ²

Two nos. of 15 Amps. socket out let connected in parallel from first outlet to second outlet.

Phase / Neutral	2.5 m m ²
Earth	1.5 m m ²

Light, fans, exhaust fan, 5 Amp. plug point, two way light points, bell point etc.

Phase / Neutral	1.5 m m ²
Earth	1.0 m m ²

15/20 Amps. Socket outlet for appliances / AC (Single Phase/Three Phase) / Geyser

Phase / Neutral	4.0 m m ²
Earth	2.5 m m ²

Separate pipes shall be laid for off wires and circuit mains.

Circuit mains of same phase shall be drawn in one pipe with prior permission/discussion with the consultant.

Separate phase, neutral and earthing wire of sizes recommended by consultant shall be drawn for each and every circuit mains.

Mains for lighting and on board plug points shall be of one-size higher wires than those used in off.

The point definition shall be conducting and wiring from D.B. to S.B. and there from to final outlet point including switches and accessories, junction boxes, fan boxes, zarri work with cement –sand etc of approved make.

C. MODE OF MEASUREMENT

The items shall be measured on unit basis or on mtr basis as per BOQ.

2.2.7 EARTHING

A. SPECIFICATION

PIPE ELECTRODE EARTH STATION:

The earth station shall be as shown on the drawing and shall be used for equipment earth grid and/or street light pole earthing and shall be as per IS 3043.

The earth electrode shall be 2.5 M long 50 mm dia class "B", galvanized steel pipe.

The earth resistance shall be maintained with a suitable soil treatment as shown on the drawing.

The resistance of each earth station should not exceed 5 ohms.

The earth lead shall be fixed to the pipe with a nut and safety set screws. The clamp shall be permanently accessible.

The earthing grid and the earthing conductor shall be hot dip galvanized iron strips of the size as shown in the drawing.

G.I. pipe with funnel of approved quality shall be used for watering the earth electrode \ station.

The block masonry chamber with Cast Iron hinged cover shall be provided for housing the above referred funnel and pipe.

The hardware and other consumable for earthing installation shall be hot dip galvanized iron material as shown on the drawing.

EARTH LEADS AND CONNECTIONS:

Earth lead shall be galvanized steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. Galvanized steel buried in the ground shall be protected with bitumen and Hessian wrap or polythene faced Hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

B. WORKMANSHIP

Following activities shall be carried out for the earthing station

- Excavation in hard murrum.
- Laying Watering pipe.
- Brick masonry with hinged covers.
- Charcoal and Salt fill.
- Earth station should be 1 mt. away from building.
- Keep minimum 2 mt. distance between two earth pits.
- The pit should be minimum 10ft deep.
- The earth resistance should not exceed 5 ohm.
- All earth pits of same category shall be interlinked with strip.

Following points shall be followed strictly.

The pipe electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 2.5 M below finished ground level

The pipe electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall \ column.

The pipe electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

20 mm. dia. G.I. pipes for watering shall run from top edge of the pipe electrode to the mid level of block masonry chamber.

Top of the pipe shall be provided with G.I. funnel and screen for watering the earth \ ground through the pipe.

The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame, which shall be embedded in the block masonry.

Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

The earth conductors (Hot dip G.I. strips) inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

Following tests shall be carried out:

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3043.

The following earth resistance values shall be measured with an approved earth megger and recorded.

- Each earthing station
- Earthing system as a whole
- Earth continuity conductor

Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 Ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

C. MODE OF MEASUREMENT

Earthing stations shall be measured in units whereas earthing strips and wires shall be measured in rmt.

2.2.8 FACTORY ACCEPTANCE TEST FOR ALL BOUGHT OUT ITEMS

Client, his consultant and their authorized representative shall have the right to inspect and test or get inspected and tested the goods at the works of the Seller or its sub suppliers any time during manufacture and prior to dispatch and to inspect within a reasonable time after arrival of goods at the

ultimate destination and during and after erection, testing and commissioning. The goods shall not be deemed accepted until after the said inspection, testing and commissioning and signing of the Acceptance Certificate. Failure to make any inspection of or payment for or acceptance of goods shall in no way impair client right to reject non-conforming goods or to avail itself of any other remedies to which client may be entitled, notwithstanding client knowledge of the nonconformity, its substantiality in the case of its discovery. In the event of failure of Seller to remove the rejected goods within the time allowed, client shall have the right to dispose of the same at the seller's risk and cost. During the time the rejected goods lie with client awaiting removal by the seller, they will so lie at the seller's risk. All goods rejected by client after receipt at the destination shall be removed by the seller within a reasonable time allowed by client, not exceeding 30 (thirty) days at seller's expense and risk.

The Seller will permit client Inspectors, Consultant and their authorized representatives free access during normal working hours to his works, Godown, storage or loading spot etc. and will give them all necessary assistance to perform their task including free use of all accessories, testing and control instruments. The seller shall ensure that the same facilities are granted by his sub-suppliers.

Unless specifically stated to the contrary in the order, all expenses relevant to the preparation and performance of testing, inspection and preparation of any test reports or certificates shall be borne by the Seller EXCEPT for the salaries, fees, traveling, lodging and boarding expense of the Consultant's / client's representatives. However, if the visit duration of UCJ / client's representatives is extended for the reasons not attributable to UCJ / client, the cost of the extended period of visit shall be borne by the seller.

The sellers shall carry out tests related to performance tests as described in the specifications and specified in the order. All such performance tests shall be at supplier costs. Supplier shall also provide all the tests certificates and documents as demanded by the Inspector for his satisfaction that the order has been executed as per PO specifications. All such certificates, documents in original shall be submitted to the Client before dispatch of material. The goods shall be dispatched from suppliers shop only after written confirmation from clients / or its authorized representative.

2.2.9 TESTING OF INSTALLATION

1.0 SCOPE

This chapter describes the details of tests to be conducted in the completed internal electrical installations, before commissioning.

1.1 GENERAL

1.1.1 Tests

On completion of installation, the following tests shall be carried out:-

- 1) Insulation resistance test.
- 2) Polarity test of switch.
- 3) Earth continuity test.
- 4) Earth electrode resistance test.

1.1.2 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.

1.1.3 Test instruments

All necessary test instruments for the tests shall be arranged by the contractor if so required by the Engineer-in-charge.

1.2 **INSULATION RESISTANCE**

1.2.1 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 from a three wire D.C. or a polyphase A.C. system, the neutral pole of which is connected to earth either directly or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

1.2.2 The insulation resistance shall also be measured between all the 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 conductors 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 16.2.3.

1.2.3 The insulation resistance in mega ohms measured as above shall not be less than 12.5 mega ohms for the wiring with PYC insulated cables, subject to a minimum of 1 mega ohm.

1.2.4 Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 mega ohm, is acceptable.

1.2.5 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 mega ohms for the wiring with PYC insulated cables, subject to a minimum of 2 mega ohms.

1.2.6 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.

1.2.7 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 be not less than that specified in the relevant Indian Standard Specifications, or where there is no such Specification, shall be not less than one mega ohm.

1.3 **POLATITY TEST OF SWITCH**

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.4.1 **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.

1.5 **MEASUREMENT OF EARTH ELECTRODE RESISTANCE**

1.5.1 Two auxiliary earth electrode, besides the test electrode, are placed at suitable distance from the test electrode (see figure 14). A measure current is passed between the 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 ohms,
V	-	Reading of the voltmeter in volts.
I	-	Reading of the ammeter in amps.

1.5.2 (i) Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.

(ii) 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.

1.5.3. At the time of test, the test electrode shall be separated from the earthing system.

1.5.4 The auxiliary electrodes shall be of 13 mm diameter mild steel rod driven upto 1 m into the ground.

1.5.5 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 30 m away from it, and the auxiliary potential electrode 'B' shall be placed mid-way between them.

1.5.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C upto 50 m, and each time placing the electrode B midway between them.

1.5.7 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.

2.3 SECTION- 3 CIVIL / INTERIOR WORKS

2.3.1 BRICKWORK :

BRICKWORK :

- (a) The bricks shall be table moulded first quality of regular and uniform size, shape and colour, uniformly well burnt throughout but not over burnt. They shall have plane rectangular faces with parallel sides and sharp, straight and right angled edges. They shall be free from cracks or other flaws. They shall have a frog of 10mm depth on one of their flat faces.
- (b) They shall give a clear metallic ringing sound when stuck.
- (c) They shall show a fine grained uniform, homogeneous and dense texture on fracture and be free from lumps of lime, lamination, cracks, air holes, soluble salts causing efflorescence or other defects which may in any way impair their strength, durability, appearance or usefulness for the purpose intended. They shall not have any part under-burnt. They shall not break when thrown on the ground on their flat face in a saturated condition from a height of 60 cm.
- (d) The size of brick shall be 23 x 11.5 x 7.5 cm. Only bricks of one standard size shall be used on work.
- (e) After immersion in water, absorption by weight shall not exceed 20 per cent of the dry weight of the brick when tested according to I.S.S. No. 1077-1957.
- (f) Unless otherwise specified the load to crush the brick when tested according to I.S.S. No.1077-1957 shall not be less than 40 Kg/sq.cm.

MORTAR :

Unless otherwise specified , mortar for brick work shall be composed of 1 part of cement to 6 parts of coarse approved sand (CM 1:6) for walls of one brick thick (i.e. 23 cms) and above, and one part of cement to 4 parts of coarse approved sand (CM 1:4) for half brick thick wall. Other specifications for mortar in brick work shall be as per I.S.S.No.2116-1965.

WATER:

Water used for masonry shall be clean and free from injurious amounts of deleterious materials and shall conform to IS 456. The PH value of water shall not be less than 6.0

WORKMANSHIP :

Soaking: All bricks shall be immersed in water for two hours before being put into work so that they will be saturated and will not absorb water from the mortar.

Brick Bats: No bats or cut bricks shall be used in the work unless absolutely necessary around irregular openings or for adjusting the dimensions of different openings, wall sizes, and for closers in which case full bricks shall be laid at corners, the bats being placed in the middle of the courses. Brick bats shall be nest cut in proper line and maintaining neat edge for proper bonding.

Laying: The bricks shall be laid in mortar to line, level, and plumb and in shapes shown on the plans, slightly pressed and thoroughly bedded in mortar. All joints shall be properly flushed and packed with mortar such that they will be completely filled and no hollows left anywhere. Bricks shall be handled carefully so as not to damage their edges. They should not be thrown from height to the ground and should be put down gently. All courses shall be laid truly horizontal and in line, level and plumb.

Vertical joints in one course and the next below and above shall not come over one another and shall not normally be nearer than quarter of a brick length. For battered faces bedding shall be at right angles to the face. Fixtures, plugs, frames etc. if any, shall be built in at places shown in the plans while laying the courses only and not later by removal of brick already laid. Care shall be taken during construction to see that edges of bricks at quoins, sills, heads etc. are not damaged.

The verticality of the walls and horizontality of the courses shall be checked very often with plum bob and spirit level respectively.

Bond:

Unless otherwise specified, brick work shall be done in English bond.

Joints: Joints shall not exceed 10mm in thickness and this thickness shall be uniform throughout. The joints shall be raked out not less than 10mm deep when the mortar is green where pointing is to be done. When the brick surfaces are to be plastered, the joints shall be raked to a depth of 5mm when the mortar is green, so as to provide good key to plaster.

Uniform Raining: Brick work shall be carried up regularly in all cases where the nature of work will admit, not leaving any part 60cm. lower than another. But where constructing at different levels is necessary, the breaks shall be stepped so as to give later a uniform level and effectual bond. Horizontal courses should be to line, level, and plumb or to batter as shown on the plan. The rate of laying masonry may be upto a height of 1.5M per day.

Scaffolding: Scaffolding will be double or single as is warranted for the particular work. Put-log holes shall be made good by bricks with cm filling to match the face work after put-logs are removed.

CURING:

All brick work shall be kept well watered for 7 days after laying and thoroughly wetted before plastering.

RCC PATLI:

RCC patli of thickness 150 mm shall be provided after every 1600 mm height with nominal reinforcement of 2 nos of 8 mm dia bars placed at top and bottom and 6mm dia stirrups at 150 mm c/c.

RATES TO INCLUDE:

Apart from other factors mentioned elsewhere in this Contract the rate for items of brick work shall include for the following:

- (a) All labour, materials, use of tools, equipment and other items incidental to the satisfactory completion of brick masonry at all heights and levels.
- (b) Erecting and removing of all scaffolding, ladders and plant required for the execution of the work to the height and depths and shapes as shown on the plan or as ordered by the Project Manager.
- (c) Constructing brick work to line, level, batters, pillars, curves and to any position or shape to any levels including raking of joints and housing frames, fixtures etc.
- (d) Curing the brick work, including water charges.
- (e) Removing of all stains and mortar lumps on the brick work surfaces.
- (f) Cost of RCC Patli.

- (g) Making holes, openings, etc. for outlets, embedding downtake pipes, pipes, ends of beams, joists, slabs, trusses, sills, etc. whatever required during construction and neatly finishing the exposed surfaces and opening as per instructions of the Project Manager.
- (h) Making holes, openings, outlets, etc. embedding pipes, ends of beams, joists, slabs, trusses, sills, etc. whatever required during construction and neatly finishing the exposed surfaces and opening as per instructions of the Project Manager.
- (i) Forming and preparing expansion, contraction or construction joints as detailed above or specified in the BOQ or drawings.

MEASUREMENTS:

- (a) One brick thick and half brick thick wall shall be measured in SQ.M. And masonry steps in CU.M. unless otherwise mentioned.
- (b) No deductions or additions shall be made on any account for:
 - (i) Ends of dissimilar materials (i.e. joints, beams, lintels, posts, girders, rafters, purlins, trusses, pillars, corbels, steps etc.).
 - (ii) Opening upto 0.1 SQ.M.

NOTE: In calculating the area of openings, any separate lintels or sills to be included along with the size of the openings but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any shall be excluded.

- (iii) Wall plates, bed plates and bearing of slabs, chajjas in which the thickness does not exceed 10cm and the bearing does not extend over the full thickness of the wall.

2.3.2 INTERNAL CEMENT PLASTER WITH / WITHOUT NEERU FINISH

General:

All as mentioned in the above section is also applicable under this section, unless specified.

Proportion of Mortar:

Unless otherwise mentioned, the proportion of internal cement plaster of walls and ceiling shall be 1:4 (1 cement: 4 sand) Sand shall be from approved source, free from foreign matter and shall be as per IS 1542 -1960 as applicable to internal wall and ceiling plastering. No more cement mortar shall be prepared than that can be used within half an hour.

Thickness of Plaster:

The thickness of plaster shall be minimum 12mm over the proudest part of the surface of brick wall and R.C.C. surfaces and 20mm over stone walls. Plaster for ceiling shall not be more than 12 mm.

Neeru/Smooth cement Finish:

- a) If the plaster surface is to be given neeru finish, the surface shall be combed slightly with wire brush before it is completely set to form key for neeru. The under coat shall be only damped but not soaked before the application of neeru. The lime for preparing neeru shall be fat lime and shall be of approved quality and source. Lime shall be slaked and mixed with sufficient water to form a thick paste. It shall be reduced to a fine paste by grinding. It shall then be passed through a fine sieve (3mm mesh) to remove all unslaked particles and foreign matter and allowed to mellow under water for at least 10 days in large slaking tanks. The surplus water on the top shall be allowed to run off. The slaked lime paste thus formed shall be used for preparing neeru. The neeru shall be prepared by mixing together 4 parts of this lime paste and

1 part of approved fine sieved sand by volume. Jute fibres finely chopped shall be added to the above mortar at the rate of 4 kg of jute to every cubic metre of lime sand mixture. The mixture shall then be properly grouted to a fine paste between two stones or a mill. The neeru thus prepared shall be kept moist until used and no more than what can be consumed in 15 days shall be prepared at a time.

- b) Neeru shall be applied to the prepared surface with steel trowel to a thickness of average 1.5 mm (about 1/16") and rubbed down to 1.5 (1/16") thickness and polished to a perfectly smooth and even finish, working from top to bottom. While towelling is going on soap stone powder contained in thin muslin bags shall be dusted over the surface and worked in.
- c) Moistening shall be commenced as soon as the plaster has hardened sufficiently and is not susceptible to injury. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used. The surface shall be kept sprinkled with water for 7 days.
- d) When neat cement finish is specified over the plaster surface, a coat of pure Portland Cement slurry 1.5mm thick shall be applied and well rubbed to the plaster surface while the plaster surface itself fresh.
- e) When no finish is specified, the plastered surface shall be rubbed well to an even plane with steel trowel for internal surface.

Rates to include:

Apart from other factors mentioned in the general section, rates for the item shall include for the following:

- a. Providing and applying neeru finish.
- b. Providing and applying smooth cement finish.
- c. Plaster works in jambs, rounded angles, fair edges, narrow returns, quirks 'V' joints, splays, drip mouldings, making good to metal frames, junctions with skirting or dados, narrow widths and small quantities, marking good around pipes, conduits, timbers, sills, brackets, railings etc. and making good after all the contractors or nominated sub-contractors and other agencies have done their work.

Mode of Measurement:

Plaster shall be measured in SQUARE METRE.

(a) Walls:

- (i) The measurement of wall plastering shall be taken between the walls or partitions (the dimensions before plastering shall be taken) for the length, and from the top of floor skirting / dado (as the case may be) to the ceiling for the height.

(ii) Deduction:

- (A) For Jambs, soffits, sills, etc. for openings not exceeding 0.5 M² each in area, ends of joists, beams, posts, girders, steps etc. not exceeding 0.5m each in area and openings not exceeding 3m each, deductions and additions shall be made in the following manner:

(a) No deduction shall be made for ends of joists, beams, posts etc. and openings not exceeding 0.5 m² each, and no addition shall be made for reveals, jambs, soffits, cills etc. of these openings not for finishing the plaster around ends of joists, beams, posts etc.

(b) Deductions for openings exceeding 0.5 m² but not exceeding 3 m² each shall be made as follows and no addition shall be made for reveals, jambs, soffits etc. of these openings:

- (c) When both faces of wall are plastered then deduction for openings happening in the wall shall be made for both faces.
- (B) In case of openings of area above 3m² each, deductions shall be made for the openings but jambs, soffits and sills shall be measured.

2.3.3 PAINTING:

2.3.3.1 WHITE WASHING: (in interior spaces)

Material: White wash shall be prepared from fresh burnt fat lime. The lime shall be dissolved in a tub with sufficient quantity of water (about 4/5 litres /Kg of lime) and the whole thoroughly mixed and stirred until it attains the consistency of this cream. The wash shall be taken out in small quantities and strained through a clean coarse cloth. Clean gum dissolved in hot water shall be added in suitable proportion of two grams of gum arabic to a litre of lime to prevent the white wash coming off easily when rubbed.

Scaffolding: This shall be double or single according to requirements and as directed. If ladders are used places of old gunny bags or cloth rags shall be tied to avoid damage or scratches to the plastered surfaces etc. Proper stage scaffolding shall be erected when white washing the ceiling.

Preparation of surface: The surface shall be prepared by removing all mortar droppings and foreign matter and thoroughly cleaned with hair or fibre brush or other means as may be ordered by the Project Project Manager to produce an approved clean and an even surface. All loose pieces and scales shall be scrapped of and holes cracks etc. stopped with mortar to match with the surrounding finish. In case where the surfaces have been previously white washed or colour washed, the old white or colour wash shall be entirely removed and surfaces broomed down before the new white wash is applied. In case the old white wash cannot be removed by brooming, the surfaces shall be cleaned by scraping. No separate rates shall be provided for scratching and scrubbing.

Application of White Wash: On the surface so prepared, the white wash shall be laid on with a brush. The first stroke of the brush shall be from top downwards, another from bottom upwards over the first stroke and similarly one stroke from the right and another from the left over the first brush before it dries. This will form one coat. Each coat must be allowed to dry and shall be subject to inspection and approval before the next coat is applied. When dry, the surface shall show no signs of cracking. It shall present a smooth and uniform finish free from brush marks and it should not come off easily when rubbed with a finger. Minimum 3 coats of white wash shall be applied.

No portions in the surface shall be left out initially to be patched up later on. The white washed surfaces shall present a smooth and uniform finish. For old work, patches and repairs shall be white washed first. Thereafter, the whole surface shall be white washed with the required number of coats to present a smooth and uniform finish.

Doors, windows, floors and other articles of furniture etc. shall be protected from being splashed upon. Splashing, droppings, if any, shall be removed and the surface cleaned.

Rates to include:

Apart from other factors mentioned elsewhere in this contract, the rates for white wash shall include for the following:

- (i) All labour, materials, equipment required for white washing
- (ii) Scaffolding including erection and removal

- (iii) Providing and preparing the white wash
- (iv) Preparing the surface for white wash including the scratching and scapping
- (v) Applying the white wash in three coats minimum. If a proper even surface is not obtained to the satisfaction of the Project Project Manager in 3 coats. Contractor shall carry out additional coats of white wash to approval, at contractor's expenses.

Mode of Measurement: The measurement shall be in SQUARE METERS. The mode of measurement shall be applicable to that for internal plaster.

2.3.3.2 CEMENT PAINTING: (in external spaces)

Material: External waterproof cement painting shall be of approved colour. Manufacture - Snowcem/Durocem or other equivalent and approved quality.

Preparation of Surface:

Before painting is commenced on surface all dirt, oil, grease, efflorescence and organic material shall be completely removed. The surface shall be wetted by sprinkling of water with fine spray. The surface shall be sprayed several times with a few minutes intervals between each spraying to allow the moisture to soak into the surface.

Application: Cement paint solution shall be applied to the surface with hairbrushes in a manner of coats to get uniform finish. After the first coat of paint is hardened it shall be cured with water at least 24 hours, before the application of the second coat. At least 24 hours should lapsed between the two coats. Similarly 3rd coat shall be given to get uniform colour.

Curing:

Cement paintwork shall be kept damp at least for 7 days.

Rates to include:

Apart from other factors mentioned elsewhere in this contract, the rate of providing cement paint shall include for the following:

- (a) All labour, materials and equipment to provide cement paint.
- (b) Scaffolding including erecting and removing.
- (c) Preparing the surface as stated above.
- (d) Applying 3 coats of approved Snowcem paint. If a proper and even surface is not obtained to the satisfaction of the Project Manager in the 3 coats applied, the contractor shall provide additional coats of painting to approval at contractor's expenses.
- (e) Curing as stated above.

Mode of Measurement: Measurement shall be in SQUARE METRE and as applicable to white wash. Nothing extra shall be allowed for painting on rough surface, for example external sand faced plaster, roughcast plaster etc.

2.3.4 DOORS

2.3.4.1 INDIAN STANDARDS :

Indian Standards to be followed are : All relevant standards as specified elsewhere in this volume are applicable. IS 287 Recommendation for maximum permissible moisture content for timber used for different purposes in different zones. IS 851 Specification for synthetic resin adhesive for construction (non-structural) in wood. IS 852 Specification for animal glue for general wood working purposes. IS 1141 Code of Practice for seasoning of timber IS 3087 Specification for wood particle board (medium density) for general purpose

2.3.4.2 A MATERIAL FOR DOOR FRAMES.

Timber shall be of good second quality and well seasoned. When a kind of timber is not specified, good quality teak shall be used. It shall have uniform colour, be free from defects such as cracks, dead knots, soft spongy spots and waves of injurious open shakes. Grains shall be reasonably straight. The individual hard and sound knot shall not be larger than 6 sq cm. The aggregate area of all knots shall not exceed 0.5% area of a piece.

All timber shall be kiln-seasoned to IS 1141 and conform to IS 287 for moisture content. Maximum permissible limit shall be + 3% for average moisture content of all samples from a given lot and + 5% for individual sample of the given lot. This is applicable when thickness of timber is more than 50 mm. Small size tolerance shall be +2 % and +3% respectively.

Timber used shall be treated with a 10-years guaranteed and approved anti-termite treatment. Wood work in contact with masonry or concrete shall be painted with hot bitumen coaltar before being placed in position. All nails, screws etc. shall be hot deep galvanised or of brass or non ferrous material. Adhesives and glue shall be as per IS for exterior quality and water repellent.

B HARDWARE FIXTURES:- All fixtures i.e. holdfasts to be used shall be of best quality GI as approved by the project manager/his representative.

2.3.4.3 WORKMANSHIP :

Timber brought at site shall be as approved in prior by the Project Manager.

No timber shall be painted, tarred, oiled, etc. before its inspection by the Project Manager. Any effort to hide the defects by plugging, painting, etc. shall render the piece to be rejected by the Project Manager. All rejected timber shall be removed at once from the site of work. All sawing of timber shall be done in straight lines and planes of uniform thickness. All joints shall be tongued and grooved or of the type shown in the drawings specified in the item or as directed by the Project Manager. All joints shall be glued with approved adhesive.

Joints shall be strong, neat and shall fit without wedging or filling. They shall be pinned with hard wood or bamboo pins of 10-15 mm dia after the members of the frame are glued and pressed together in a suitable vice-mechanism. Prior to joining, wood members of frame shall be planed smooth and accurate to the full depth. Rebates, roundings, mouldings, etc. as shown in the drawing shall be done before the members are joined. All timber items shall be subjected to inspection by the Project Manager prior to any treatment to be carried out. No item shall be installed unless it is approved by the Project Manager.

2.3.4.4 Mode of Measurement

The measurement for all types of doors, unless otherwise specified in the item of work, shall be for the over all opening size as shown in the relevant drawings and in Sqare Meter. Rate shall include cost of frame, fixities, fittings and fixtures as approved by the project manager and installation at site at any level to the satisfaction of the project manager.

2.3.5 GYPSUM FALSE CEILING/ RETURN AIR BOXING:

The filler, paper tapes, finishes and primers suitable for Gypsum plaster boards, shall be as per recommended practices of India Gypsum or equivalent. Framework grid and suspenders shall be fixed to avoid fouling with services such as ducting, sprinklers, electricals fixtures, etc. T.W. framing may be allowed in certain areas for the Gypsum Board ceiling with the approval of the Architects. Metal frame False Ceiling of 12.5mm thk. Gypsum Board including vertical drop panels.

Providing and Fixing 12.5mm Thk. Gypsum board on metallic grid, conforming to IS: 2095: :1982. The metallic grid shall consists of the following components. GI Perimeter channels of size 27mm and 0.5mm thk. having one flange of 20mm and another flange of 30mm. GI Intermediate channel of size 45mm 0.5mm thk. With two flange of 15mm each at 1200mm centre to centre. GI Hanger of size 25mm X 25mm, 0.5mm thk. at 1200 mm centre to centre distance. GI Cleat and Steel Expansion Fasteners. Ceiling section of 0.5mm thickness having curled wedge of 51.5 mm and two flanges of 26mm each with lips of 10.5mm at 450mm center to center. Connecting clips & 12.5 mm dry wall screws at 230 mm center to center. Edge Read.

The metallic grid shall be installed as follows. The perimeter channel along the perimeter of the ceiling, with screw fixed to brick wall / partition with the help of raw plugs and screws. The intermediate channels shall be suspended from the ceiling with steel GI hanger fixed to the slab soffit with GI cleat and steel expansion fastereners. The intermediate channels shall be at 1200 mm centre to centre distance. The ceiling section placed in a direction perpendicular to the intermediate channel at 450 mm C/C distance shall be fixed to the intermediate channel with the help of connecting clips and 12.5 mm dry wall screws at 230 mm centre to centre distance. Finally, the 12.5 mm thk.

Gypsum boards shall be fixed to the metal frames and the tapered/square edges of the boards shall be finished to a flush joint with requisites filler, paper tapes, finisher and primer suitable for Gypsum plaster boards, (as per recommendations of manufacturers, Indian Gypsum or equivalent). For light fittings, grills, diffusers, speakers, smoke detectors, sprinklers etc cut outs have to be made with provision of the frame along perimeter of the cut outs/ opening with channels/ ply to support the ceiling adequately.

ANNEXURE - I

SPECIFICATIONS FOR PAINTING WORK

1. Cleaning the surface
2. Apply a primer coat of Red Oxide
3. Applying tow coats of enamel paint of APPROVED colour code after applying cement primer for plastered surface.
4. Standard colour code.

a) Condensing unit	:	Battleship Grey.
b) Gauge panel	:	Siemens Grey
c) All supports /stands	:	Black
d) Ducting		
Concealed	:	Black Rust Proof
Exposed to Grilles		
insulated/uninsulated duct	:	Black
Exposed	:	Fiesta Blue
e) Electric Panels	:	Steel Grey
e) Motor	:	Siemens Grey

MODE OF MEASUREMENT

All painting works shall form part of the cost equipment, piping etc. No separate payment shall be advisable.

ANNEXURE - II

I. S. CODES

Following IS CODES will be applicable for the project.

1. IS : 655 - 1963 : Ducting work.
2. IS : 659 - 1964 : Safety Code for Air-conditioning.
3. IS : 660 - 1963 : Safety Code for Mechanical Ref.
4. IS : 5111-1969 : Code of Practice and Measurement Procedure for Testing Refrigerant compressors.
5. IS : 325-1970 : Specifications for 3 Ph. Induction Motor. Also confirm to IS : 1231 for Foot Mounted and IS : 2223 for flange mounted motors.
6. IS : 2147-1962 : Degree of protection provided by enclosures for low voltage switch gears and control gears.
7. IS : 3012-1965 : Code of Practice for installation PART-I) maintenance of switch gear.
8. IS : 3061-1982 : Code of Practice for Fire precautions in welding & cutting operations.
9. IS : 3651-1967 : Glossary of terms used in Refrigeration & Air-conditioning.

10. IS STD. FOR INSULATION WORK

11. IS : 4671-1984 : Expanded polystyrene For Thermal Insulation purposes
12. IS : 661-1974 : Code of Practice for Thermal Insulation of Cold Storages.
13. IS : 7240-1981 : Code of Practice for Application and finishing of Thermal Insulation material at Temp. from 80°C to 40°C.
- 14) IS : 7413-1981 : Code of Practice for Application and finishing of Thermal Insulation material at Temp. from 40°C to 700°C.
- 15) IS : 8183 - 1976 : Specifications for Bonded Mineral Wool.
- 16) IS : 1239 : Pipes up to 150 MM Dia.
- 17) IS : 3589 : Pipes above 200 MM Dia.
- 18) IS : 780/ISI Certificates : Valves of PN 1.6 rating
- 19) IS : 5312 / ISI Certificate : Check Valves
- 20) IS : 277 : For Sheet galvanising spec.
- 21) IS : 900 : Installation of motor
- 22) IS : 4064 & 4047 : Switch fuse unit.
- 23) IS : 2516 : ACB

- 24) Relevant ISS : MCCB
- 25) IS : 3043 - 1963 : Earthing
- 26) IS : 3043 : Earth Station.
- 27) IS : 732 - 1963 : Testing of Electrical Installation
- 28) IS : 520 : Standard for positive displacement Refrigeration, compressor and condensing unit.

- 29) IS : 2825 : Unfired pressure vessels
- 30) IS : 4503 : Shell and Tube type Heat Exchanger
- 31) IS : 1520 : Horizontal Centrifugal Pumps for Chiller, Cold, Fresh Water.

- 32) IS : 737 : Specification for Wrought al. And al. Sheet and strip.

- 33) IS : 3069 : Glossary of items symbols & units relating to thermal materials.

- 34) IS : 702 : Industrial bitumen.
- 35) IS : 8183 : Rounded Mineral Wool.

ANNEXURE - III

1.0 TESTING OF AIR CONDITIONING SYSTEM

- 1.1 Routine and types tests for various items of equipment shall be performed at the contractor's work and the test certificates furnished. Functional test shall be conducted at site. The Employer and Consultant may witness the testing of the A. C. units at the Works
- 1.2 The performance test to determine whether OR not the full indent of the specification is met shall be conducted by the contractor. After notification to the Employer's that the installation has been completed and the plant has run continuously for a period of at least two weeks, the contractor shall conduct under the direction of the Consultant's and in the presence of Employer's representatives test, such test as specified to establish the capacity of various equipment supplied and installed by the contractor.
- 1.3 The contractor shall operate test and adjust the air conditioning system units, fans, motors, all air conditioning appliances including adjustment of regulators, dampers etc.
- 1.4 All test equipment, labour, operating personnel, oil and refrigerant required for this test shall be furnished by the contractor to enable the plant to be put in continuous running test for a period of 2 days after all other tests and adjustments have been made.

The contractor will be provided with electrical power water for testing by the client. The performance test shall be conducted during peak summer and peak monsoon.

2.0 PROCEDURE

2.1 Design Conditions

The inside and outside conditions will be recorded for 48 hrs. (2 days) duration on hourly basis. The outside and inside Dry Bulb and Wet Bulb temperatures shall be recorded by the means of a sling psychrometer with mercury thermometers. The relative humidity shall be computed from the psychrometric chart. The inside Dry Bulb temp. and relative humidity shall fall within the specified limits.

2.2 CAPACITY OF THE SYSTEM

The following aspects shall be checked before conducting the performance tests-

- 1) The outside conditions shall be as close to the design values as possible. The tests shall be arranged during the peak summer and monsoon.
- 2) The internal loads of various spaces shall be close to the design values as far as possible.
- 3) The system shall be fully loaded and the temperatures stabilized.
- 4) Hourly readings of air flow shall be recorded by a calibrated flow meter.
- 5) Hourly readings of pressure, temperature, electrical current, voltage and power factor shall be properly recorded

The capacity of the system and various other equipment and accessories shall be ascertained as follows.

2.3 Cooling coil of AHUs and Indoor units

The flow of air over the cooling coil will be measured by recording the velocity of air across each filter placed before the cooling coil. The velocity shall be measured by means of end anemometer

Air quantity across the filters = velocity of air across the filters in FPM x net filter area (in sq. ft.).

The wet bulb temperature of air entering the coil and that leaving the coil shall be measured. The enthalpy of entering and leaving air shall be noted from the psychrometric chart, corresponding to the wet bulb temp. recorded.

SAY,

he - Enthalpy of Entering Air in Btu /lb

H1 - Enthalpy of Leaving Air in Btu / lb.

Ve - Specific Volume of Entering Air (CFT. / lb. of air)

V1 - Specific volume of Leaving Air (CFT. / lb. of air)

Average specific volume = $(ve + v1) / 2 = v$ (CFT/ lb of air)

cap. Of cooling coil = $(CFM \times 60) / v \times (He -H1) / 1200$
 $(CFM \times \{He -H1\} \times 4.5 / 12000)$

2.4 Condenser

The capacity of the condenser shall be computed from the following parameters-

- 1) Flow of air through condenser by means of calibrated flow meter OR checked by pressure drop in the condenser. The inlet and outlet air pressure shall be read by the same pressure gauge. The air-flow can be read against the recorded pressure drop from the manufacturers rating curves.
- 2) Inlet and outlet temperature shall be recorded by means of a single thermometer

- 3) The voltage and current of the compressor motor shall be recorded by means of a volt-meter and an ammeter respectively. Power factor can be ascertained from the subtraction. Heat rejection by the condenser (HR) in Tons

$$= \frac{(\text{air flow through the condenser} \times \text{temperature difference})}{24}$$

Capacity of the system

$$= \frac{\text{HR} - (\text{compressor motor KW} \times 3400)}{12000}$$

2.5 System capacity

The capacity of the AHU / Indoor unit will be the capacity of system.

2.6 Power consumption by Compressor

The following readings shall be recorded-

- i] Suction gas pressure
- ii] Discharge gas pressure
- iii] Suction gas temperature.
- iv] Discharge gas temperature.
- v] Readings of Ammeter, voltmeter and power factor meter.

Same pressure gauge shall be used for different pressure measurements and the same thermometers shall be used for different temperature measurements. The capacity of the compressor shall be computed from the performance chart supplied by the manufacturer.

IKW / Ton of compressor-

$$= (\text{Power in put in KW}) / \text{Compressor Capacity in Tons.}$$

2.7 Motor

For all electrical motors the current, voltage and power will be recorded.

2.8 Air Balancing

After the desired inside conditions are achieved, the quantity of air through every outlet shall be measured. Air quantity in CFM = Air velocity at the outlet in FPM x effective area of the outlet in Sq. Ft.

3.0 TESTING OF VARIOUS LOADING CONDITIONS

The performance test shall be conducted for various loads such as 100%, 75%, 50% of the capacity of the system, if feasible.

4.0 FUNCTIONAL TESTS

4.1 Electrical equipment

- i] All the cables shall be tested for continuity and absence of cross phasing. Insulation resistance between the phase conductors and earth shall be measured with the help of a 500 v megger,
- ii] Motors
 - a) Insulation resistance of all motors shall be tested with a megger and the value shall not be less than 1 Meg-Ohms. If observed value is less than 1 Meg-Ohms, the voltmeter winding shall be tried out and winding shall be given a coat of approved insulating varnish.
 - b) Starting current shall be recorded every time the motor is started.
 - c) Starter operation shall be checked for a single phasing by removing one of the phase.
 - d) Over load protection shall be checked by altering the starter thermal over load setting.

4.2 Safety Devices and Controls

- i) Interlocks for compressor motor with that of condenser fan, AHU / Indoor unit fan shall be checked.
- ii) High pressure stat - shall be checked by varying the Settings of the cutout.
- iii) Low pressure stat - shall be tested by closing the pilot solenoid valve.
- iv) Anti-freeze thermostat shall be tested by varying the settings.
- v) Oil failure switch shall be tested by varying the settings.

4.3 Capacity Controls

The capacity control arrangement shall be tested by varying the load on the system. Any other procedure recommended by the manufactures may be adopted with the prior permission of the Employers and Consultants.

5.0 TEST READINGS

- 5.1 The following reading shall be recorded hourly during the tests and capacity of the system shall be computed.**

[I] COMPRESSOR

1) Suction pressure	-	Kg/Cm2 (PSI)
2) Suction Temperature	-	°C (°F)
3) Discharge pressure	-	Kg/Cm2 (PSI)
4) Condensing Temperature	-	°C (°F)
5) Oil Pressure	-	Kg/Cm2 (PSI)
6) Compressor Speed	-	RPM
7) Motor		
a) Rated Capacity	-	HP
b) Rated Volts	-	Volts
c) Rated Current	-	Amps
d) Starting Current	-	Amps
8) Power Consumption for		
100%		
75%		
50% loads		
a) Motor current in amps		
b) Voltage		
c) Starting Current		

[II] CONDENSER

1) Refrigerator condensing Pressure	-	Kg/Cm2 (PSI)
2) Refrigerator condensing Temperature	-	°C (°F)
3) Airflow rate	-	Ltr. Sec. GPM)
4) Entering Air Temp.	-	°C (°F)
5) Leaving Air Temp.	-	°C (°F)
6) Pressure drop through Condenser	-	Kg/Cm2 (PSI)

[III] INDOOR UNITS

1) Air velocity	-	M/Hr. (FPM)
2) Coil Face Area	-	M ² (SFT)
3) Air Quantity	-	Cu. M/Hr. (CFM)
4) Entering Air Temp. DB.	-	°C (°F)
5) Entering Air Temp. WB.	-	°C (°F)
6) Leaving Air Temp. DB.	-	°C (°F)
7) Leaving Air Temp WB.	-	°C (°F)
12) Motor		
a) Rated Horse Power	-	HP
b) Rated volts	-	volts
c) Rated Current	-	Amps
d) Actual Current	-	Amps
e) Actual volts	-	Volts
f) Actual Current	-	Amps

g) Starting Current - Amps

[IV] FILTERS

- | | | |
|--------------------|---|------------------------------|
| 1) Total Area | - | M ² (SFT) |
| 2) Effective Area | - | M ² (SFT) /M/ Hr. |
| 3) Velocity of Air | - | M/Hr (FPM) |
| 4) Quantity of Air | - | M3 /Hr. (CFM) |

[V] CONTROLS, INTERLOCKS etc. :

The observations of the test shall be recorded for each item separately.

NOTE : ALL CALIBERATED INSTRUMENTS WITH CALIBRATION CERTIFICATE WILL BE ARRANGED BY CONTRACTOR FOR MEASUREMENT PURPOSE.

ANNEXURE - IV

MODE OF MEASUREMENT

1.0 The following measurement code shall apply to this contract

1.1 For Ductable / Non-Ductable Split Unit

The entire split unit with out-door unit and in-door unit with DX coil and all accessories, Starters, Controls, Control Panel, Control Wiring, Refrigerant charge, Oil etc., Erection, Commissioning and Testing shall be regarded as one unit for purpose of measurement.

2.0 SHEET METAL WORK

Ducting

- 1) All sheet metal ducting work will be measured in terms of final sheet area installed in Sq. meters.
- 2) No measurement of vanes, splitters, duct, dampers deflectors, access doors etc. which are required to be installed in the duct work will be made as the same shall be deemed to be part of ducting work.

a) Grilles

All grilles will be measured in terms of effective areas, Example : 600 x 100 will be measured as 0.06MT².

b) Diffusers

Diffusers will be measured in terms of diameter of each diffuser in centimeter or in terms of area of diffuser. Example : 600 x 100 will be measured as 0.06MT².

c) Dampers

- i) All duct dampers shall be measured separately in terms of effective area.
- ii) Fire dampers will be measured in terms of effective area in Sq. metes.
- iii) Fresh air / exhaust air dampers will be measured as (II) above. No separate measurement will be made for inlet/ outlet louvers, bird screen etc.
Example : 600 x 100 will be measured as 0.06MT².

3.0 PIPING

- a) Piping will be measured in running lengths (meters)

- b) No special measurement of bends, elbows, reducer, expanders, tees, cross etc. will be made. All such fittings/ accessories will be treated as normal piping.
- c) The length of the piping including accessories and fittings will be measured along the center line of piping.

4.0 INSULATION

a) Ducting Insulation

- i) Duct insulation will be measured on the basis of INNER LINE of insulation and not the outer line of insulation.
Example : (Perimeter) x 1 meter length.
- ii) No special measurement shall be made for insulation of bends, transformation pieces, tap offs, elbows, etc. All such insulation shall be treated as standard duct insulation
- iii) Insulation items shall include all accessories and finishes as specified. No separate measurement will be made for such items.
- iv) Duct fittings such as bends, elbows tap offs, collars, transformation pieces etc. shall be treated as ordinary duct pieces with their length measured along their center line.
- v) No duct support, stiffening, member etc. shall be measured separately. All such supports/ hangers shall form part of the duct work.
- vi) Equipment connections such as canvas/ rein shall be deemed to be part of the duct work and no separate measurement will be allowed.

b) Piping Insulation

No separate measurement of insulation shall be made for fittings such as bends, elbows, reduces, expanders, tees, crosses, flanges, etc. All such insulation shall be linear in meters measurement along the center line of piping.

c) Electrical Work

- a) All cables shall be measured in running lengths as finally installed at site. No wastage measurement will allowed.
- b) Control cable /wiring for a plant inside the plant room shall be treated as a lump sum item.
- c) All measuring instruments indicating lamps etc shall form part of the equipment specified and no separate measurement shall be made for such items.

Note-Contractor should note that all the measurement should be carried out strictly as per mode of measurement stated above. However, all the work should be carried out as per relevant I. S. codes specified.

3.0 INFORMATION TO BE FURNISHED BY THE TENDERER ALONG-WITH THE TENDER

3.1 AIR- COOLED FLOOR MOUNTED PACKAGE A.C. UNITS

[A]	COMPRESSOR	16.50TR	11.00 TR	8.25 TR
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- a. Type / Refrigerant
- b. Make / Model
- c. Quantity
- d. KW (Motor-connected)
- e. KW (Motor-consumed)
- f. Full Load current
- g. Refrigeration capacity
(At 5°C suction 50°C discharge)
- h. Refrigerant

[B] CONDENSER

- a. Type
- b. Air Quantity
- c. Coil Face Area
- d. No. of rows
- e. By pass factor
- f. Fan Motor KW/RPM
- g. Full Load current of Fan motor
- h. St. pressure of fan
- i. No. of speed for fan
- j. Copper Tube thk/ dia mtr
- k. Al. Fin spacing / Gauge

[C] EVAPORATOR

- a. Type
- b. Air Quantity
- c. Coil Face Area
- d. No. of rows
- e. Bypass factor
- f. Fan Motor KW/RPM
- g. Full Load current of Fan motor
- h. St. pressure of fan
- i. No. of speed for fan
- j. Copper Tube thk/dia mtr.
- k. Al. Fin spacing/Gauge

[D] OVERALL DIMENSIONAL DETAILS

- a. Condensing Unit
- b. Evaporating Unit

[E] SAILENT FEATURES

- a. Type of filter
- b. Filter Area
- c. Filtration level
- d. Any other details

[F] TOTAL POWER CONSUMPTION OF THE UNIT

	Compressor	Condenser Fan	Evaporator Fan	Total
i.	For 16.50 TR			
ii.	For 11.00 TR			
iii.	For 8.25 TR			

[G] TOLERANCES

- i) Voltage
- ii) Power Factor
- iii) Frequency

3.2 PIPES & FITTINGS

REFRIGERANT

DRAIN

- a. Manufacturer
- b. Class
- c. Material
- d. Thickness/Diameter

3.4 INSULATION MATERIAL

FIBRE-GLASS

EXPANDED POLYSTYRENE

- a. Manufacturer
- b. Material
- c. "K" value at 10°C mean temperature
- d. Density

3.5 CABLES

- a. Make
- b. Type
- c. Grade

3.6 PLEASE REFER TO THE LIST OF APPROVED MAKES/VENDORS FOR VARIOUS ITEMS AS INDICATED IN PARA-4.0 (PAGE-59-61)

3.7 **4.0 LIST OF APPROVED MAKES**

SR. NO.	COMPONENT	APPROVED MAK
4.1	PACKAGE SPLIT UNITS	VOLTAS / BLUESTAR / ETA/ BATLIBOI
4.2	EXPANDED POLYTHYLENE	NIKIFOAM / PROFEEL / ARMOUR.
4.3	EXPANDED POLYSTYRENE	BEARDSSELL / COOLINE / STYPACK/ SUKASO
4.4	FIBRE-GLASS	FGP / KHIMCO / UP TWIGA
4.5	CABLES	CCI / GLOSTER / POLYCAB / FINOLEX
4.6	SWITCH GEARS/ELECTRICAL COMPONENTS	SIEMENS/ L&T/ SNIEDER/ G.E.
4.7	GRILLES/ DIFFUSER/DAMPER	DYNACRAFT / COSMOS
	FIRE DAMPER FIRE DAMPER ACTUATOR	DYNACRAFT / COSMOS/ CARRYAIRE BELIMO
4.8	G. I. SHEETS	NIPPON DENRO / ISPAT / SAIL/ JINDAL/ TATA
4.9	P.V.C. PIPES	SUPREME / PRINCE / EQ. APPROVED
4.10	Rigid PVC FRLS LHSFT Conduit 1.6-1.8 mm wall thickness ISI & FIA approved & manufactured from virgin material Precision plastic industries	
4.11	Accessories for conduit	Same make as of pipe
4.12	Copper Conductor PVC	Stranded copper wire – FRLS category A Finolex, R R Kabel, Havells, Polycab
4.13	Flexible Wires	As Above
4.14	Switches	Legrand (Mosiack), Anchor Woods, L.K., Toyoma Wallart Premium.
4.15	HRC Fuses	Merlin Gerin – multi 9, Legrand, Hager, Seimens
4.16	MCBs	Merlin Gerin – multi 9, Legrand, Hager, Seimens

4.17	Distribution boards – double door type	Merlin Gerin – multi 9, Legrand, Hager, Seimens
4.18	Compound	Shalimar No. 6.
4.19	Main Cables down stream up to 35 sq.mm. PVC armoured cable for 1.1 KV as per IS: 1554.	Finolex, CCI, Gloster, Havells, Polycab
4.20	Branched Cable downstream from 35 sq.mm.	Finolex, CCI, Gloster, Havells, Polycab
4.21	Glands	Double Compression type, siemens type with rubber ring and double washers. – comet, Standard Metal Industries
4.22	Cable Lugs	Dowells, 3-D
4.23	PVC type industrial Plugs sockets	Merlin Gerin – multi 9, Legrand, Hager, Seimens
4.24	Switch Plate	Same range as switches.
4.25	Connectors	Connectwell, Elmex.
4.26	Button holder, Angle holder, ceiling rose	Anchor
4.27	M.S. Conduit- ISI MARK	BEC, Steel Craft, Vimco
4.28	M.S. Junction boxes for electrical wiring	Fabricated out of 16 gauge continuously welded (sample to be approved) Zinc Passivated.
4.29	Capacitor (APP / Heavy duty type)	L&T , Epcos, Havells
4.30	Relay	Alstom, ABB, EE
4.31	MCCB range of MCCBs	Schneider, ABB, L & T – as per specs
4.32	Meter (Digital)	Conzerv, AEE.
4.33	Heavy pipes should be 6 kg/sq.cm.	Jyoti

- | | | |
|------|--|--|
| 4.34 | Light Fixture - Commercial - Indoor | Wipro, Philips, Crompton & Greaves, Havells - cat nos as per BOQ |
| 4.35 | Cable Tray – Perforated 14 G hot dip GI | Profeb, Asian ancillaries |
| 4.36 | Steel Wire Rein Forced PVC Flexible Hose | Finolex . |
| 4.37 | PVC wall raceway | MK, LK, Legrand. |
| 4.38 | Contactor | SIEMENS/ L&T/ SNIEDER/ G.E. |
| 4.39 | Measuring Instruments | AE/ IMP/ L&T/ RISHABH |
| 4.40 | Power Factor Control Relay | Beluk/ L&T/ G.E. |

5.0 DEVIATIONS STATEMENT

5.1 TECHNICAL DEVIATIONS STATEMENT

The Tenderer shall fill this Deviation statement for the any deviations made in the standard Tender Terms & Conditions.

Sr. No.	Original Tender Conditions	Deviations
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1.

2.

3.

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5.2 COMMERCIAL DEVIATIONS STATEMENT

The Tenderer shall fill this Deviation statement for the any deviations made in the standard Tender Specifications.

Sr. No.	Original Tender Conditions	Deviations
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		