TICEL BIO PARK LTD

COMPETITIVE TECHNO COMMERCIAL TENDER

SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF ELECTRICAL WORKS IN CONSTRUCTION OF TICEL BIO PARK–III,

At SF No. 66, 67, 68 & 75, Off Maruthamalai Road, Somayampalayam Village, Bharathiyar University P.O, Coimbatore - 641 046
(G +13 UPPER FLOORS)

TECHNICAL SPECIFICATION

VOLUME - III

DUE DATE FOR SUBMISSION: ON OR BEFORE 03.04.2019 BY 3.00 PM

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2019

TECHNICAL SPECIFICATION CONTENTS

1.0 GENERAL REQUIREMENT OF RING MAIN SWITCHGEAR

Indoor Floor Mounting type free standing Metal Clad Ring Main Gear Comprising 11KV Vacuum Circuit Breaker.

Construction Features:

Ring main switchgears shall be constructed of MS sheet steel not less than of 3mm for load bearing members and 2 mm for Non-load bearing members. The ring main switchgear shall be provided with a separate for main bus bar, VCB / CT / PT / metering / relay chambers and cable termination. The ring main gear shall be of factory built assembly to high quality standard and shall comply with IS 3247.Panel shall be provided with pressure relief flap at top. Each panel shall have minimum 2 Nos. of lifting hooks at top for easy transportation. Panel shall be provided with 3mm aluminium gland plate at the rear with adequate clearance between the cable terminations. Each panel shall be fully segregated with sheet steel and bus bars through seal of bushing to avoid transfer of oxidation and carbonize during fire accident, if any. The Ring Main Switchgear shall be suitable for degree of protection IP42 for Indoor Ring Main Switchgear shall be finished to shade RAL 7032 of IS5, after undergoing a pre-treatment at 7-tank process.

Bus bars:

Electrolytic Grade Copper Bus bar shall be used as Main Bus bar and interconnection. Bus bar shall have uniform cross section throughout the Ring Main Switchgear. Bus bar is provided with heat shrinkable PVC sleeve. Colour coding as per IS shall be made at regular intervals. The maximum current density of the bus bars shall be 1.0A per Sq mm.

Incomer and Outgoing Feeder Controls

The RMG shall have two Incomers provided with 11 KV, 3 phase, 50 HZ, 500 MVA Load Break Switch with interlocked Earth Switch and VCB of same rating for controlling the outgoing feeder.

VACUUM CIRCUIT BREAKER:

Vacuum Circuit Breakers shall be robust and rigidly constructed, mounted on a wheel, with horizontal draw out and horizontal isolation mechanism. The mechanism shall be of spring charged stored energy type. The mechanism shall be simple, rigid and so constructed; it shall be suitable for both mechanical and electrical spring charging operations. The Vacuum Interrupters shall be of high quality standards. Vacuum Interrupters can withstand 100 operations under short circuit conditions. The interrupters are mounted on epoxy housing to prevent the accidental damages. The spring charging motor shall be suitable for either 110/230V AC and closing & tripping coil shall be110V DC.

THE VCB TRUCKS SHALL HAVE THE FOLLOWING INTERLOCKS:

1. Front door cannot be opened, when the VCB is in Service position
2. VCB cannot be withdrawn from service position when it in “ON” condition.
3. VCB can be switched “ON”, only either in test or Service position
4. In Service Position, both Power and secondary contacts are engaged and in Test Position, Power Contacts are isolated and secondary contacts are engaged.

TECHNICAL SPECIFICATION FOR VCB:

Rated Voltage	:	11KV + 10%
Rated Current	:	630Amps
No. of Pole	:	3
Breaking capacity	:	26.2KA
Making capacity	:	65KA Peak
Short circuit withstanding capacity	:	26.2 KA for 3 sec. At 12KV
Operating duty	:	O-3MIN-CO-3Min-CO
Insulation level		
a) Power frequency	:	28KV rms for 1 Min.
b) Impulse	:	78KV Peak
Standards	:	IS 13118/IEC56

CURRENT TRANSFORMERS:

Current Transformers are Epoxy Resin cast, dual core dual ratio type and shall comply as per IS 2705.

POTENTIAL TRANSFORMERS:

Potential Transformers are Epoxy Resin cast Draw-out type and shall comply as per IS 3516.

PROTECTION RELAYS:

Relays are of Flush Mounted Draw-out type pattern fully Comply as per IS 3231.All other Instruments/Switches and Wires & Cables shall comply with the latest IS.

BILL OF MATERIALS:

Indoor floor mounting, free standing, dust & vermin proof Metal Clad type 11KV 630A, 500MVA RING MAIN GEAR SHALL CONSIST OF:

INCOMER (2 SOURCES): 2NOS.

Each incoming panel of Load break Switch comprising of:

- 1 No. 11KV, 630A, 500MVA 26.2kA for 1Sec. Horizontal draw out / Horizontal isolation Load break switch
- ON Indication Lamp - Red.

- Off Indication Lamp - Green
- Aux. contact 2 NO+2 NC
- Mechanically interlocked Earth Switch

OUTGOING: 1NO.

11 KV 630A, 500MVA 26.2kA VCB Outgoing Panel Comprising of:
1No. 11KV, 630A, 500MVA 26.2kA Horizontal draw out / Horizontal isolation Vacuum Circuit Breaker consists of:

- 3 Nos. 630A Vacuum Interrupters
- Manual / Electrically operated spring charging mechanism (Motor rated for /230V AC)
- Power Pack 230 V AC/110 V DC
- TNC switch
- Compact Fluorescent Lamp 11 W
- Closing coil suitable for 110V DC.
- Tripping coil suitable for 110V DC.
- 8NO+8NC Auxiliary Switch
- Mechanical On/Off indication.
- Mechanical spring closing indication.
- Mechanical On/Off Push button
- 1 set. Tamper proof R/Y/B Phase indication lamp
- Breaker ON indication Lamp - RED
- Breaker OFF indication Lamp- Green
- Breaker Trip Indication Lamp - Amber
- Trip Healthy Indication Lamp - White
- Spring Charged Indication Lamp- Blue
- Terminal Block Disconnecting Type for CT wiring and 6 sq.mm. Clip on type for control wiring.
- Breaker Position indicator
- Mechanical operating counter.
- Automatic safety shutters.
- Secondary self-aligned plug in contacts.
- Anti-pumping feature.
- 1 No. 11KV Epoxy resin cast draw out type 3 limb 3 phase potential transformer of ratio 33KV/110/ class 0.2 with 200VA burden.
- 3 Nos. 11KV Epoxy Resin Cast Dual Core current transformer suitable ratio with class 0.2 accuracy and 15 VA for metering and class 5P20 for protection with 15VA burden as required by EB Authority.
- 50/51. Non-directional IDMT relay with 2 O/C and 1 E/F relay with high set element.
- 86 Master Trip Relay
- 1 set 144sq.mm Misc Ammeter with selector switch
- 1 set 144sq.mm0-15 KV Voltmeter with selector switch
- 1 No. Electronic Trivector Meter

- 1 No. Emergency off Push Button.
- 1 No. Power pack suitable for 110V DC with continuous and stored energy.
- 1 No. Test terminal block.
- 1 set. Power terminals suitable to receive XLPE cables without termination kit.
- Thermostat
- Space heater 230V/80W with Thermistor with toggle switch.
- Bus bar phase to phase clearance not less than 130mm and phase to earth clearance not less than 90mm

Note:

1. ***The panel shall be manufactured as required by the TANGEDCO authorities and approval shall be obtained including commissioning.***
2. ***Any additional features required by the authorities shall be carried out at no extra cost.***

2.0. 11 KV INDOOR SF6 PANEL (To be SHIFTED FROM TICEL - I to TICEL - III)

General

A 11 KV 4 Panel with SF6Breaker is available in TICEL-I. Chennai The 4th unit is a new one added to extend supply to TICELL -II but not used due to modified distribution. The above panel shall be removed from the above 4 panel and this Single Panel has to installed at the Point of commencement of supply at TICEL III - Coimbatore after replacing the existing 11 KV CTs with CT ratio 100-150A/5 A after the RMG unit.

The remaining 3 Panel units shall be installed at the Electrical Room at Utility building at TICEL-III after attending the following works.

In the above Panel, the Power Packs are not working in all the SF6 Breakers. The Power Packs shall be replaced by new ones and other minor repairs shall be attended and this panel and Single panel shall be fully serviced and painted. After servicing them, the above 3 panel & single panel shall be subjected to all Routine Test at CEIG lab or by any other Agency authorized by CEIG and Test certificate shall be obtained and submitted to TICEL. The relays in the above Panels shall also be tested and Test Certificate for the relays shall be obtained and submitted to TICEL

The above 3 panel & single panel shall be transported to TICEL-III at Coimbatore. The cost shall include Repair & replacement of component charges, testing charges, loading, transport to Coimbatore, transit insurance & unloading at site.

The tenderer should inspect the site to access the work involved before quoting.

TESTS

The 11 kV switchboards shall be tested for all routine tests as per the relevant Indian Standards.

Pre-commissioning Checks and Tests should be done at site by you at free of cost.

Tests have to be witnessed by representative of TICEL Bio Park Ltd and hence Test date shall be informed at least a week in advance.

COMMISSIONING

Commissioning should be done at free of cost by you.

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3.0 TECHNICAL SPECIFICATION FOR XLPE CABLE EFFECTIVELY EARTHED 11 KV SYSTEM

TECHNICAL SPECIFICATION

1. SCOPE:

1.1 The specification covers the design, manufacture, testing, supply and delivery in proper packed condition of 3 core, Aluminium Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed, Armoured, screened Power Cables with improved Fire Performance and conforming to Type FRLS and Category C2.

2. **LOCATION:**

2.1 The Cables may be laid buried directly in ground at a depth of one meter in average.
2.2 The Cables may also be laid within covered cable trenches, in cable racks or open air laddertrays etc. for certain portions of lengths.

3.0 SYSTEM DETAILS:

3.1 Voltage grade (KV) of cable required: 11 KV (E)
3.2 Service Voltage : 11 KV
3.3 Highest Voltage : 12 KV
3.4 Earthing System : Solidly earthed
3.5 Frequency : 50 Hz
3.6 BIL : 75 KV

4.0. WEATHER CONDITION :

4.1Maximum ambient temperature: 40 degree C.
4.2 Minimum ambient temperature: 4 degree C
4.3 Thermal resistance of soil : 150 degree C-Cm/Watt
4.4 Maximum Daily average ambient temp: 40 degree C
4.5 Maximum relatively humidity %: 100.00
4.6 Average rainfall per annum : 200 cm
4.7 Maximum height above the Sea level: 1000 Meters.
4.8 Depth of lying: 90 cm

5. STANDARDS:

5.1 The Cable shall conform to the following standards

Sl.No	Standard	Details
1	IS: 7098 (Part-II) / 2011 (Latest)	Specification for cross-linked polyethylene Insulated PVC Sheathed Cables for working Voltages from 3.3 KV up to and including 33 KV
2	IS:8130-2013	Specification for Conductors for insulated electric cables and flexible cords
3		Specification for PVC insulation & sheath of electric cables
4	IS: 3975-1999	Mild steel wires, formed wires and tapes for armouring of cables
5	IS:10810-1984	Methods of test for Cables.
6	IS:10418-1982	Cable Drums for Electric Cables

6. Detailed Specification:

6.1 CONDUCTOR:
The conductor shall be stranded compacted circular construction. Conductor material shall be Aluminum confirming to IS 8130.

6.2 CONDUCTOR SCREEN:
Conductor screening shall be provided over the conductor by extrusion of semiconducting compound. The screen shall fill the interstices between the outer individual strand wires forming the conductor and provide a smooth regular interface to the insulation layer. The extruded semiconducting compound shall firmly bonded to the insulation.

6.3 INSULATION:
The main insulation of the Cable shall be extruded unfilled, chemically cross-linked Polyethylene (XLPE) to form a compact and homogeneous layer in accordance with standards specified. The thickness of insulation shall confirm to IS: 7098 (Part-II)/2011 or latest amendment thereof.

6.4 INSULATING SCREEN:
The screen shall be made up of nonmetallic screen and metallic screen.
The nonmetallic semi-conducting polyethylene (XLPE) screen shall be extruded over the main polyethylene insulating wall.

The extruded layer shall be continuous and shall cover the surface of the insulation completely. The insulation screen shall be cold strippable.

The metallic screen shall consist of layer of copper tape wrapped over the semi conducting tape or extrusion for 3 core cable.

The metal screen so formed around the cores shall be in contact with one another as the cores are laid up at triangular configuration. The cross sectional area of the metallic screen shall be able to withstand the specified fault current & duration Conductor screening, insulation and insulation screening shall be simultaneously extruded by triple extrusion processes so as to obtain continuously smooth interfaces.

6.5 Water Sealing: (Optional)
Cable shall be provided with water sealing of conductor and longitudinal and radial water sealing along with metallic screen as described below:
The conductor water sealing consists of swelling material provided between conductor strands which turns into jelly when comes into contact with water.

The longitudinal water sealing along with metallic screen shall be provided by swelling layer applied under and over the metallic screen or swelling material provided between metallic screen wires as applicable.

Swelling layer to be provided under the metallic screen should be semi conductive and compatible with the extruded insulation screen and metallic screen.

The radial water sealing shall be provided by a corrosion resistant metal or metal polyethylene laminate applied over longitudinal water sealing.

Special care in preventing galvanic corrosion is required in the design.

It is essential the water sealing is efficient is to reduce the length of cable to be cut in case any ingress of water due to mechanical damage.

6.6 LAYING UP:
The individual core shall be laid up in right hand direction of lay.

6.7 Inner covering and Fillers
The interstices shall be filled with non-hygroscopic material fillers laid up with insulated cores to provide substantially circular cross section before the inner sheath is applied. The Fillers and inner sheath materials shall be chosen to be compatible with the temperature rating of the cable and shall have no deleterious effect on any other component of the cable. It shall be in accordance with IS 7098 Part II.

6.8 CORE IDENTIFICATION:
The phase identification of the cores shall be either by colour or by numerals as per I.S.S. for 3 core cables.

Core Color	Numeral
Red	1
Yellow	2
Blue	3

The screened cores shall be laid up with interstices filled with PVC fillers and taped with abinder tape as to obtain a reasonably circular cable.

6.9 INNERSHEATH:
The laid up cores shall be provided with inner sheath bedding applied either by extrusion or by wrapping. It shall be ensured that the shape is as circular as possible and the thickness as per ISS.

6.10 ARMOUR:
The cable shall be strip armoured in case of 11 KV, 3 Core cables to ensure an adequate return path for the flow of fault current and also to provide suitable mechanical protection. The dimensions of galvanized steel wire shall be as per table 6 of IS: 7098 (Part-II)/2011 and its latest amendment and shall be laid closely in the spiral formation to protect the circumference of the cable fully and to provide adequate cross sectional area for flow of maximum fault current within limits of specified temperature rise and duration of fault. The direction of the lay of the armour shall be opposite to that of the cable cores. The joints in armour wires or formed wires shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wires/formed wires shall be at least 300 mm from the nearest joint in any other armoured wire/formed wires in the completed cable.

6.11 OUTER SHEATH:
A reliable serving shall be necessary for maintaining conductivity of the armour particularly under corrosive condition in the form of jacket. The cable shall therefore be finished with extruded PVC over sheath of thickness as per IS. The quality of PVC over sheath (Jacket) shall be ensured for service reliability against moisture intrusion and shall conform to type ST-2 of IS: 5831. It shall be applied over armouring with suitable additives to prevent attack by rodent and termite and its thickness shall be in accordance with Table 7 Clause -18 of IS: 7098 (Part-III) 2011 and latest amendment thereof.

6.12 Embossing:
The following shall be embossed on the outer sheath for the identification.

a) Manufacturer's Name or Trade Mark.
b) Voltage Grade.
c) Nominal section & Material of conductor and number of cores.
d) Year of manufacture.
e) Inscription for length of cables at 1.0 meter interval.
f) Type of insulation i.e. XLPE.
g. Fire performance category C1 or C2 i.e. FR or FRSH

6.13 SEALING OF CABLE ENDS:
The cable ends of cable in the wooden drum for delivery shall be sealed with heat shrinkable caps.

7.0 WOODEN DRUMS:
The Cable shall be packed in non-returnable wooden drums.

7.1 The following information shall be marked on each drum.

a) Drum identification Nos.
b) Manufacturer's Name, Trade Name/Trade Mark, if any.
c) Nominal sectional area of the conductor of the cable.
d) No. of Cores.
e) Type of Cable and Voltage Grade with Cable Code.
f) Length of the Cable in Cable Drum.
g) Direction of rotation of Drum (by means of an arrow)
h) Approximate Weight:
i) Tare: Gross
j) Year and Country of Manufacture.

Drums shall be proofed against attack by white ants or termite conforming to IS: 10418. The Drums shall also be marked with ISI Certificate Mark.

8 ROUTINE TESTS:
The routine test shall be carried out on all cables manufactured in accordance with this Specification.
The following routine tests shall be made on cable length as specified in the ISS.
a) Conductor resistance test.
b) Partial discharge test on full drum length.
c) High voltage test

9. **TEST CERTIFICATE**:
Certified copies of all routine tests carried out at Works shall be furnished in Six (6) copies With the details of drum number, size of cable, year of manufacture and date of test and tested parameters with test values and result of test.

Type Test Certificates of the Cable offered shall be furnished. Otherwise the cable shall have to be type tested on similar rating as per IS 10810 free of any charges to prove the design.

DATA SHHET FOR 11 KV (E) XLPE CABLE

Sl.No	Parameters	Details	Remarks / Requirement
1	**System Particulars**		
	Rated Voltage	Uo/ U 6.35/11KV	
	Frequency	50 Hz	
	Operating Voltage	11KV	
	System Earthing	Earthed	
	Highest Voltage	12 KV	
	Short Circuit current	kA	vendor to provide
	Clearing Time	s	one second
	B.I.L. For Cable	70 KV for 11 KV Grade	
	Confirming Standard		
2	Indian	**IS 7098 Part (II) / 2011** - Specification for cross - linked polyethylene insulated PVC sheathed cables for working voltages from 3.3KV to and including 33KV.	
	International	BS 7835	
3	**Conductor**		
	Material	Aluminum	
	Cross section	240 sq.mm	
	Shape	Stranded	
		Circular shaped	
4	**Conductor Screen**	Extruded semiconducting Compound	
5	**Insulation**	**XLPE**	
6	**Insulation Non Metallic Screen**	Extruded Semiconducting Compound	
7	**Insulation Metallic Screen**	Copper Tape	
8	**Fillers**	Non Hygroscopic PVC fillers	
9	**Inner Sheath/ Bedding**	PVC ST2 as per IS 5831 suitable for maximum operating temperature of 90°C	
10	**Armour**	galvanished Steel Tape / wire	vendor to provide
11	**Outer Sheath**		
	Material	PVC ST2 as per IS 5831 suitable for maximum operating temperature of 90°C	
	Colour	Black	

12	**Improved Fire performance**	FR (category C1) to IS 7098 Part II	Not required
13	**Water Sealing**		Not required
14	**Semiconducting water swell-able tapes if used shall be as agreed between the purchaser and the supplier.**	Optional	Not required
15	**Physical Size**		vendor to provide
	Dia. on core		
	Dia. on insulation		
	Dia. on Screen		
	Dia. on External Sheath.		
16	**Test Certificate**		**Required**
	Routine Test certificates		
	Type Test certificates		

CABLE CODING:

The following Code is used for designing the cable as per IS 7098 Part I
Where

Cable Letter	Constituent
A -	Aluminium conductor
2X-	XLPE Insulation
W –	Steel round wire armour
F-	Steel Strip Armour
WW-	Double Steel round Armour
FF-	Double Steel Strip Armour
Y-	PVC outer Sheath
Wa-	Non Magnetic round wire Armour
Fa-	Non Magnetic Strip Armour
AW-	Aluminum Wire Armour

Now As per A2XWY – This describes that it is Aluminum cable, XLPE insulated, With Steel round wire armour and having PVC outer Sheath.

This coding is as per IS 7098 (Part 1).

There is no coding required in case of copper cables.

LAYING OF CABLES

Cables shall be laid as per the specifications given below:
CABLES - OUTDOOR TRENCHES

HT Cables shall be laid in outdoor trenches wherever called for. **The depth of the trenches shall not be less than 1000 mm**, below the final ground level. The width of the trenches shall not be less than 500 mm. However, where more than one cable is laid, a coaxial distance of not less than 450 mm shall be allowed between the cables. The trenches shall be cut square with vertical side walls and with uniform depth. Suitable shoring and propping may be done to avoid caving-in of trench walls. The floor of the trench shall be rammed level. **The cables shall be laid in trenches over rollers placed inside the trench.**

The cable drums shall be laid unrolled in the direction of the arrow marked on the drum for unrolling.

Wherever cables are bent, the minimum bending radius shall not be less than 15 times the diameter of the cable. After the cable is laid and straightened, it shall be covered with 100 mm thick layer of sand. The cable shall then be lifted and placed over the sand cushion. Over this, 100 mm thick layer of sand shall be covered by 50 mm on either side and RCC troughs shall be provided to cover the cables. Remaining trench shall be backfilled with earth and consolidated as original. Cables shall be laid in Hume pipes/stoneware pipes at all road crossings and in GI pipe at the wall entries. Cable route markers to be provided as per standards

Excess depress shall be removed from site with free of cost

JOINING CABLES

All cable joints shall be made in suitable, approved cable joint boxes, and the filling in of compound shall be done in accordance with manufacturers' instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be jointed **colour to colour (should not be different colours)**; tested for continuity and insulation resistance before jointing. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be commenced and finished on the same day. During the time of joining the cables, sufficient protection from the weather shall be ensured. Joints shall be made by means of suitable solder for conductors, the conductors being firmly butted into the connections or thimbles or ferrules and the whole soldered with proper solder and soldering flux. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

The Cable entries through pipes from outside to inside the building shall run in GI pipes and shall be sealed water tight with approved type of sealant to avoid water entering the building.

4.0 DETAILS OF MAJOR MAINTENANCE WORKTO BE DONE ON OIL TYPE TRANSFORMERS INSTALLED IN TICEL-I (TO BESHIFTED FROM TICEL-I TO TICEL-III FOR ERECTION AFTER MAINTENANCE)

Specification for Major Maintenance work to be carried out in 2 Nos.11 KV, 1250 KVA, 11 KV/433 V,3 Phase, 50 Hz Transformers installed at TICEL Bio Park Ltd,. Chennai - 600 113 before shifting.

1. Scope

General:

Two numbers of 1250 KVA, 11 KV/433 V, 3 Phase, 50 Hz, ONAN type Outdoor Transformers with OLTC and RTTC panel with Primary side cable box and secondary side with flange for bus duct are installed and in running condition at **TICEL Bio Park Ltd, Taramani, Chennai-113.**

hey have to be disconnected from supply and major maintenance has to be carried out at a Transformer manufacturer's works and shifted and erected at TICEL Bio Park III, Coimbatore, for feeding the new installation there.

2. Details of Transformers:

KVA	: 1250 KVA
Phase	: 3
Frequency	: 50
Primary Voltage	: 11000 V (cable Box)
Secondary Voltage	: 433 V (with flange for bus duct)
Type	: ONAN
Type of Wdg.	: **DYN 11 copper wound**
Total Oil capacity	: **1530**litres
Total Weight with Oil	: **5465** Kg.
Tap Changer	: OLTC OLG make
Make of Transformer	: **Voltamp**
Year of Manufacturing	: **2003**

3. Details of Major Maintenance and other associated works:

1) Disconnection of HT cables, Bus Ducts and Earthing from the Transformer
2) Loading, Transporting to the manufacture's works and unloading.
3) Carrying out the following works:

i) Lifting the core and coil and washing them with hosing down with dry transformer oil.
ii) Checking the moisture condition in Paper Insulation/barrier and drying to improve it
iii) Removing the sludge from the Transformer tank and painting the Tank and Pressure testing the tank and radiator for any leakage and rectification if required.
iv) Checking the OLTC for mechanical and Electrical conditions of the drive system, contact wear and revamp the system wherever required.
v) Replacing all Gaskets by new ones.
vi) Replacing the Bolts, nuts and washers.
vii) Checking and calibrating the Buchhzoltz Relay.
viii) Replacing the winding and oil temperature gauges with accessories.
ix) Checking the control wiring in the Marshalling box and do rewiring.

x) Filling the Transformer with new Transformer Oil.
xi) Tap position tracking/counting.
xii) Conducting all routine tests in Manufacturers works/Test House approved by CEIG and submitting test certificates.
xiii) Any other works are required for these transformers to pass through all the Routine Tests of the transformer as per IS2026.

4) Transporting the both Transformers and their RTTC Panels to TICEL Bio Park –III Coimbatore after attending major maintenance and repair work at Manufacturer's works.

5) Erection, testing and commissioning the transformer after conducting pre commissioning tests

4. Tests after major maintenance

The following Routine Tests shall be conducted at Manufacturer's works after maintenance and repair but before shifting them from there in the presence of OWNER/ Engineering Consultant or his authorized representatives**.** The test results shall be satisfactory. Test certificates shall be issued by the Testing authorities acceptable by **CEIG.**

Routine test as per cl. 21 of IS 1180 (Part I): 2014.

1) Measurement of winding resistance at all taps (IS 20 26 Part -1)
2) Measurement of voltage ratio on all taps and phase displacement (IS 20 26 Part-1)
3) Measurement of short circuit impedance (Principal Tapping) and loads loss at 50% load and 100% load
4) Measurement of no load loss and current (IS 20 26 Part -1)
5) Measurement of insulation resistance (IS 20 26 Part -1)
6) Induced over voltage withstand test. (IS 20 26 Part -1)
7) Separate source voltage withstand test. (IS 2026 Part -3)
8) Pressure Test
9) Oil leakage Test

5. Transport, Insurance and Passage of Risk

Transportation charges shall be paid by the Contractor for transporting them from TICEL Park Ltd., Chennai to TICEL - III, Coimbatore, after major maintenance and repair works, which also includes loading and unloading charges at all places.

The Insurance Policy required for transit and other shall be arranged by the Contractor and Premium and other expenses shall be paid by them.

The Insurance Policy shall be in the name of TICEL Bio Park Ltd and deposited with the Owner. The Policy shall be kept in force till then it is reinstalled at TICEL Bio Park - III, Coimbatore and the Owner will inform the amount for which the Insurance Policy has to be taken at the time shifting the Transformers based on the present value of them.

This Insurance Policy has to be taken in addition to the other policies mentioned in Conditions of Contract – Volume - II.

All claim amount against the Policy shall be payable to the Owner and not to the Contractor.

6. Price

The rate quoted shall include all the above works and warranty obligations**.**

7. Warranty

The Contractor shall issue a warranty certificate to meet the warranty obligations by remedying the repair works free of charge by replacing the defective materials free of charge if the repair or maintenance done is defective and not carried out properly.

The period of Warranty is 12 months from the date of commissioning certificate issued by the EC after commissioning of the Transformer at site.

5.0 GENERAL REQUIREMENT OF MV PANEL BOARDS

Scope:

Design, Supply, Integration, Delivery, Testing and Commissioning of Compartmentalized LT Panel Boards in accordance with this specification.

Note: Integration includes supply of materials like Meters, CTs, Bus bars, Bus Supports, Indicating Lamps, Metering Fuses, PLC, etc.

Items not included:

External connections to the equipment.

Conformance to Standards:

The Tenderer shall control the quality of items and services to meet the requirements of this specification, applicable codes and standards and other procurement documents.

Standards:

The Panel Boards shall comply with the latest issue of the following standards

IS 8623 – General requirement for factory built assemblies upto 1000 Volts.

IS 10118 – Code of Practice for selection and maintenance of Switchgear and Control gear.
IS 13947-2 – A.C. Circuit breaker requirements – Voltage not exceeding 1000Vs Part I & II, Sec 1 and IEC 60947 part I & III

IS 2147 – Degree of protection provided by enclosures for low voltage Switchgear and Control gear

IS 2705 – Specification for current transformers

IS 1248 – Specification for direct acting electrical indicating instruments.

IS 3156 – Voltage transformers

IS 3231 – Relays

IS 13703 – Specification for HRC cartridge fuse links upto 650 Volts.

IS 6875 – Control Switches / Push Buttons

IS 11353 – Marketing and identification of conductors and apparatus

IS 13947 – part I & II – Moulded Case Circuit Breaker

IS 375 – Arrangement for Bus bars main connection and accessories

IS 6005 – Code of practice for phosphating Iron and Steel

IS 5082 – Wrought Aluminium & Aluminium Alloy for Electrical Purposes

General:

The LT Panels shall be of

Metal enclosed, indoor, floor mounted freestanding type.

Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.

Provide dust and vermin proof design.

Readily extensible on both sides by the addition of vertical sections after removal of the end covers.

The panels shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses as well as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise:-

A front-framed structure of rolled/folded sheet steel / Angle channel section, of minimum 14SWG thickness, rigidly bolted / welded together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, MCCB's, main horizontal bus bars, vertical risers and other front mounted accessories.

The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3mm thickness and 75mm height. The design shall ensure that weight of the components is adequately supported without deformation or loss of alignment during transit.

The design shall ensure generous availability of space for installation and maintenance of cabling, and adequate safety for working in vertical section without coming into accidental contact with live parts in an adjacent section.

Front doors and rear covers fitted with dust excluding synthetic rubber gaskets with fasteners designed to ensure proper compressions of gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panel should not be more than 2100mm.The total depth of the panel should be adequate to cater for proper cabling space and shall not exceed 1200mm for ACB sections.

Doors shall be minimum 14SWG sheet steel. Sheet steel shrouds and partitions shall be of minimum 16SWG thickness. All sheet steelwork forming the exterior of switchboards shall be smoothly finished, leveled and free from flaws. The corners should be rounded.

Apparatus forming part of the panel shall have the following recommended minimum clearances for un-insulated bus bars are should as per relevant IS codes

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

Metallic/insulated barriers shall be provided between adjacent sections to ensure prevention of accidental contact.

All doors/covers providing access to live power equipments circuits shall be provided tool operated fasteners to prevent unauthorized access.

Provision shall be made for permanently earthing the frames and other metal part of the switchgear by two independent connections.

Operating devices shall be incorporated only in the front of the switchgear. No handle needing manual operation shall be located less than 450mm and not higher than 1800mm above ground level.

BUSBARS

The bus bars shall be air insulated and made of high conductivity, high strength, EC grade **ALUMINIUM 99.5% pure and confirming to IS 19501.**

A current density of 0.8A / Sq.mm. shall be provided for Aluminium bus bars / Interconnect, Cable connectors etc. For Panel, the size of the bus bars shall be designed on the basis of a short circuit rating as of incomer feeder.

The bus bars shall be mounted suitably on non-hygroscopic SMC / FRP supports rigidly fixes to the panel and the supports shall be fixed to the main frame without affecting the clearance structure as per IS and should also be capable of withstanding the stress of electrical fault.

Large clearances and Creepage distances shall be provided on the bus bars system to minimize the possibility of a fault.

High tensile bolts and spring washers shall be minimized the possibility of a fault.

Connections from the main busbars to functional circuits shall be arranged and supported so as to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents.

Bus bars shall be color coded for easy identification of individual phases and neutral with heat shrinkable PVC sleeves.

The main bus bars shall have uniform current ratings through their length. The current rating of the neutral shall be half that of the phase bus bars throughout the length of the switchboard. However for the UPS Panels, the Neutral Bus bars shall be double the size of Phase bus bars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.

The busbar and supports shall be capable of withstanding Short circuit current as of the incomers in panel .Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports. All bus bar supports shall be SMC / FRP only.

All bus bars shall be sleeved with colour coded heat shrinkable sleeves with the exception of joints. Red, yellow and blue colour shall be used for Phase bus bars and Black colour shall be used for neutral bus bars.

The Bus bars shall be capable of withstanding rated capacity without any deration at 55°C over 45ºC Ambient.

The Bus Bar to switch gear terminal connections shall be with rectangular ALUMINIUM Bar with current density as desired for Bus Bars and shall be rigidly fixed with Bus & Switch gear

ends with high tensile Bolts with spring washers & flat washers with necessary full nut and locking nuts to have proper contact area.

The Inter connections also shall be sleeved wit h heat shrinkable OVC sleeves with appropriate colour coding with the exception of joints.

The inter connections between Bus & Switch gear terminals shall be provided with necessary FRP / SMC support to avoid strain to the switch gear terminal .

The outgoing shall be provided with suitable & Adequately rated connections to receive the cables / Bus duct terminal connections .The connection should be supported to main frame in such a way that strains of cable connections shall not transmitted to the switch gear terminal & to withstand the electrical stress.

These connections also shall be sleeved in the colour coded PVC heat shrinkable sleeves with the exception of joints.

Wiring and Cable Terminations:

Inside the switch boards the wiring for power, control, signaling, protection and instrument circuits shall be done with PVC Insulated FRLS multistrand copper conductors. The insulation grade for these wires shall be 660 volts. All control wiring shall preferably be enclosed in plastic channels or neatly bunched together.

For 16 AMPS control fuse circuit, 2.5 Sq.mm size COPPER wires shall be used. Each wire shall be terminated at a separate terminal. Termination of not more than two outgoing wires on a single terminal will not be acceptable. Wires shall not be joined or tied between terminal parts. Shorting links shall be provided for all C.T. Terminals at metering / relay / instrument..

Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC Ferrules. Ferruling of wires shall be as per relevant IS / BS 108.

A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression type lugs. "ELMEX" (direct conductor termination) type terminals will be acceptable for wires up to 10 sq.mm.

The control terminals shall be mounted in such a way that they are separate from the power terminals and shall be easily accessible without any hindrance from the power circuitry.

The cabling chamber of adequate size for accommodation, support and termination of aluminium cables shall be provided at the rear.

Facility to extend cabling area by additional cable chamber shall be preferred.

The wiring shall be complete in all respects so as to ensure proper function of control, protection and interlocking schemes.

COMPONENTS:

I. AIR CIRCUIT BREAKER

- ACB shall confirm to / IEC 60947 (Part I & III) / IS 13947 (Part I & III)
- Suitable for a service voltage of 3 Phase, 660 V minimum, 50 Hz AC supply and shall have an insulation voltage of 1000 V.
- Possible to upgrade the degree of protection of ACB to IP:54. Minimum degree of protection of the ACB shall be IP: 43.

- Suitable for mechanism from front access.
- The microprocessor based Relay shall comply with IS 13947-1 for general rules and IS 13947-1 for standards pertaining to contactor shall be designed for AC3.
- The microprocessor based Relay shall be suitable for Type 2 coordination as per suitable clause in the relevant Indian Standards.
- The microprocessor based Relay shall be capable of withstanding short circuit equal to seventeen times the rated thermal current (17 Ie).
- The microprocessor based Relay incomer ACB should have built in single phasing protection and phase unbalance protection as per IEC947-4.
- The ACB shall be provided with 4 NO & 4 NC spare auxiliary contacts apart from their inherent usage.

Interlock and Safety Arrangement

- The ACB's shall be Three-position draw out type. Any attempt to with draw the Air Circuit Breaker, which the unit is in service, will automatically trip the breaker. It shall be possible to rack the ACB main contacts in to disconnected position with the door closed.
- Remote electrical indication of the circuit breaker status should be possible for all the positions.
- Possible to close the ACB electrically and the spring charging time shall be preferably by less than 5 seconds. The mechanism shall be of stored energy type. The electrical closing mechanism shall have a built- in anti-pumping feature minimum 4 NO & 4 NC spare control contacts should be available for external use.
- The ACBs are to be operated through a PLC programmer and should also provided with electrical interlocking in between them in case of failure of PLC. And shall have a selector switch to select PLC / Electrical Interlock mode.

Rating and Breaking Capacity

- The ACB shall have Minimum Service Breaking Capacity (Ics) equal to Ultimate Breaking Capacity (Icu).
- The Minimum Service Breaking Capacity (Ics) as per BOQ

Protection

- There shall be an option to select the curves (minimum 80 combinations) and also change the operating time for minimum of 8 settings for overload, 7 for short circuit and 7 settings for earth fault.
- There shall be facility for selecting various type of E/F protection if required.
- Trip history feature shall be available.
- Neutral protection of 50 to 100% should be available.
- Self - diagnostic malfunction alarm for microprocessor should be available.

- "The trip unit shall have thermal memory.
- I^2 t cropping facility shall be available for short circuit and earth fault.
- Facility should be there to monitor the load and intimate a pre-trip alarm or have load-shedding feature.
- Fault indication by means of LED should be available for Overload, Short Circuit and Earth Fault and also LCD display for indication of menu's, settings, recorded information.
- Trip reset facility should be manual / automatic.

II. MOULDED CASE CIRCUIT BREAKERS

- MCCBs should comply with IEC 947 Part 2. / IS 13947
- The MCCB shall be suitable for universal mounting (i.e) the Load / Line must be interchangeable.
- The MCCB shall be suitable for operating Voltage of 415 V minimum and an Insulation Voltage of 660 V.
- MCCBs starting from 200 amps shall both variable (O/L, SC) and below shall be variable over load / both fixed and fixed short circuit.

Rating and Breaking Capacity

- The Service Breaking Capacity (Ics) in KA for MCCB shall be as mentioned in Bill of quantities. and Ics shall be equal Icu

Protection

Overload and short circuit setting details:-

- All outgoing MCCBs in the Main Changeover panel and incoming MCCBs of all Sub Panels shall be of adjustable overload and short circuit settings.
- The outgoing MCCBs in the Sub Panels needs adjustable thermal overload settings only and fixed short circuit setting.
- The Thermal setting shall be adjustable from 80% to 100% of its normal rated current.
- The magnetic setting shall be continuously adjustable from 5 to 10 times of its set current.
- Trip reset should be available Manual / Automatic.

CONTACTORS

- Contactors shall comply with IS 13947 1 for general rules and IS13947-4-1 for standards pertaining to contactors and motor starters. The contactor shall be capable of withstanding breaking & making capacities per following:
- AC3 Category
  - Making Current - 10 times Rated Current
  - Breaking current - 8 times Rated current

- Contactor shall be capable of withstanding an impulse voltage of 8KV and have an insulation voltage of 1000V.

- The Contactors shall be capable of frequent switching and should operate without any deration at 55 °. C for AC3 application.

- The coil shall have 3 terminals and the insulation class shall be preferably “H” class, to sustain frequent switching operations. The auxiliary contact block shall have a switching capacity of 240V at 2A.

- Contactors shall have one auxiliary in-built and it shall be possible to have additional 2NO &2 NC contacts and they shall be easily interchangeable from NO to NC.

- Contactors used for capacitor application shall have built in damping resistors & block of early make poles. For capacitors only capacitor duty contactors of respective rating to be provided.

Instrument Transformers:

- Current Transformers shall be tape wound . The CT ratio and VA burden shall be such that it can power all meters.

- Current transformers shall generally conform to IS: 2705.

- Current transformers for instruments shall have an accuracy class 0.5 for MV Panel and class 1.0 for sub panels and accuracy limit factor less than 5.0. The current transformers shall be capable of withstanding the peak momentary short circuit current for 1.0 second. The neutral side of the current transformers shall normally be earthed through a link.

- Wherever provided, the voltage transformers shall generally conform to IS : 3156 and shall be cast resin type. The voltage transformers shall be provided with primary fuses. Miniature circuit breakers with auxiliary contact shall be provided on the secondary side.

- The voltage transformers shall have an accuracy class 3.0 from 50% to 110% of normal voltage and class 1.0 from 80% to 120% of normal voltage.

Measuring Instruments:

- All measuring instruments Digital / Analogue shall be of 144 x 144 mm (or) 96 x 96 mm square flush mounting pattern.

- All A.C Ammeters, Voltmeters, KW meters shall be of Digital type except for the Incoming meters or as per BOQ.

- Control and selector switches shall be CAM operated rotary switches

- The voltmeter selector switches shall be to measured voltage between phases with

  “OFF” and 10A ratings.

- The ammeter selector switches shall be 10A rating and to measure phase current through CT’s of 5A secondary.

Indicating Lamps:

- Indicating lamps shall be provided in all the panels as required and they shall be centre to the visibility requirement as per I.S.

TESTS:

- The Panel design shall have undergone all the type tests as per IS: 8623. Type test certificate shall be submitted along with the panels.

- Routine test as per IS: 8623 on each completed switch boards shall be carried out in the factory and witnessed by owner /Architect representative and approval obtained before dispatch and test certificates for the same shall be submitted.

- Tests required as per IS on the completed panel boards as mentioned above and commissioning are included in the tenderer's scope.

INSPECTION:

- The Inspection of the panel will be carried out by consultants representative at various stages of fabrications.

LABELLING:

General

- Every switchboard, switchboard control contactor, time switch, relay, indicator lamp, meter, motor starter, link and any control or protection equipment within or on a switchboard shall be clearly and accurately labelled.

- Labels shall be engraved laminated plastic or photo anodized rigid aluminum and shall comply with the following requirements.

- Except where otherwise required labels shall be fixed adjacent to, but not on any item of equipment.

- Engraved lettering shall be black on a white background, except that the label for a main switch shall have red lettering on a white background, and warning and caution labels shall have white lettering on a red background.

Fixing of Labels

- Labels shall be securely fixed by :

- Screws and adhesive, are fixed in an extruded aluminum section which shall be countersunk screw fixed or countersunk riveted to the panel. Screws shall be tightened with nuts or into tapped holes in the switchboard. Mechanically expanded plastic rivets of minimum 6 mm. head diameter are acceptable instead of screws. Aluminum rivets may be used to fix aluminum labels only. *Self – tapping screws, thread – cutting screws or other fixing are not acceptable.*

Labels on Exterior of Switchboards and Schedules

- All switchboards shall be labeled with the manufacture's name.

- A switchboard designation label shall be provided. For other than main switchboards, the designation label shall also state the source of electrical supply. Separate sections of enclosures shall be identified. The label for any section or

enclosure containing supply Authority equipment shall be to the satisfaction of the Consultant / Employer and the Supply Authority.

- Every switchboard control shall be labeled and shall include:
- Circuit designation for all main switches, main controls and sub main controls.
- Details of the Consumer's mains and all sub mains
- Incoming busbar& cable rating
- The minimum height of lettering shall be as per the local Inspection regulatory stipulation.

Labels on Interior of Switchboards

- Labels identifying equipment within a switchboard shall be located such that the item referred to is obvious and the lettering is not substantially obscured by the temporary or permanent position of any equipment or wiring.
- For plug- in equipment where items are physically but not functionally interchangeable, the label wording shall be expanded to clearly identify the removable section (e.g to identify the contact configuration or timing range). Where this is not possible, a second identifying label shall be glue fixed to the removable section.
- The function and coding shown on the circuit diagram shall be used.

EARTHING

- Switchgear in the panel shall be provided with COPPER double earth connection of size indicated in the schedule and connected to the earth bus
- Earth bus bar shall be supported at suitable intervals
- All instruments and metering panel doors shall be connected to earth by using 2.5 sq.mm. 650V, FRLS PVC multistranded copper conductor or flexible braided copper wire of equivalent size and directly connected to the earth bus of the panels
- The materials and size of the earth bus bar shall be as specified in the schedule
- At either end of the earth bus provision shall be made for bolting the earth bus to the earth electrode with nuts & bolts and spring washer. The earth bus bar shall run along the entire length of the board

Drawings and Data:

- Vendors shall furnish following drawings for Ticel / Consultant approval before fabrication of the panel.
- Tenderer shall also provide detailed GA diagram, sectional drawings
- Terminal drawings and other drawings with all dimensions indicating compartments cutouts, drill holes etc., for all the panel boards to the Consultant
- Front and rear view of all switch boards indicating Switch Gear arrangements of

- Various feeders/starters giving its location numbers and tag numbers for each as per single line diagram.
- Typical control schematic diagram for each type giving type designation to be referred on Single line diagram
- Switch board foundation/fixing details with all dimensions and details of shipping sections.
- All the catalogues, manuals pertaining to each and every ACB, MCCB, PLC, Meters, CTs etc should be sent along with the panel boards.
- Bill of Materials used in panels indicating the make of each items
- Manufacturers and service providers address, contact person, contact no etc., has to be sent to us for all the components.

GENERAL:

- The gland plates shall be left undrilled and of 3mm thick
- Inter panel partitions / barriers in sheet steel are required to be provided.
- Bus bar joint shrouds are required to be provided , so that it can be easily removed and refitted.
- All internal wiring shall be done with crimping type lugs and all terminals are to be identified / feruled properly.
- All vacant compartments above 100mm to be provided with earth strip.
- "Danger" labels on rear doors shall be provided.
- Necessary terminals has to be provided for BMS interface at all Panels.
- Data sheet shall be referred for specification of the ACB & MCCB to be used in panels.
- No alterations drill holes welding etc., are to be done at site after the panel boards are received from the factory.
- The LT panel board shall comply with all rules & regulations as per CEIG norms and any modifications pointed out by them or any other statuary agencies during their inspection also to be carried at free of cost before commissioning.
- The LT Panels Degree of Protection : IP 52

COMMISSIONING:

The supplier shall render the service of his supervisor during the Installation and commissioning of the panels at free of cost.

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6.0 AUTOMATIC POWER FACTOR CORECTION PANEL

TECHNICAL SPECIFICATION FOR AUTOMATIC POWER FACTOR CORRECTION PANELS

1.0 SCOPE:

The specification covers the Design, Manufacture, Testing at works, supply of 440V Automatic Power factor correction capacitor control panel.

2.0 STANDARDS:

The equipment shall conform to the following Indian standards:
IS-9244- HRC Cartridge fuse links
IS-2147- Degree of protection provided by enclosures for low voltage switchgear
IS-2516- AC Circuit Breakers (MCC
IS-8828- MCB's
IS-2705- Current transformers (Part I to IV)
IS-1248- Direct acting electrical
IS-13585- Capacitors.

3.0 CONSTRUCTION:

3.1 The panels shall be floor mounting, fixed type, single front, self standing, totally enclosed to make it dust and vermin proof.

3.2 The Panels shall be fabricated with 14 SWG cold rolled sheet metal.

3.3 The Panels shall be fully compartmentalised with all doors in front only.

3.4 The number of steps and the KVAR rating of the Panels shall be as per the data Sheet or as per the drawings.

3.5 Adequate lifting facilities shall be provided and the lifting eye bolts are removable.

3.6 The panel consists of 3 nos. of bus-bars for Phases and 1 no. for neutral. The bus bars are of high conductivity Aluminum and are of sufficient cross section to carry fault current without any damage. The bus-bars shall be supported on epoxy cast resin insulators and covered by heat shrinkable PVC sleeves. The main bus bars shall be adequately supported to withstand stresses developed due to short circuit current.

Tapping points shall be treated against oxidation. Appropriate identification markings/labels shall be provided on the bus-bars and trappings for distinguishing the various phase and neutral.

3.7 The capacitor bank controlled by each step of the APFC relay shall be housed in a separate compartment.

3.8 Each Capacitor Bank shall be provided with Ammeter with selector switch to measure the current in each phase.

3.9 The cable alleys shall be provided with hinged doors for easy access to cables inside. The cable alley door shall be provided with bolts, which can be opened with special keys by authorised persons.

3.10 The compartment doors shall open away from the cable alley and shall be provided with special locks, which will ensure tight closing of doors making the compartment effectively dust proof.

3.11 The fabricated panel shall undergo a treatment of degreasing, picking and 2 coats of primer, before inside and outside powder coating.

3.12 The equipment inside the compartment shall be arranged in a logical manner for ease of reference at site.

3.13 Undrilled gland plates shall be provided at top and bottom of the panel and shall be removable type with nuts and bolts for proper fixing.

3.14 The control supply shall be tapped after the mains incomer ACB. Control circuit shall have protection fuses / MCB's.

3.15 Indicating lamps shall be provided on each rack. Capacitors "ON" & "OFF" indications shall be provided on APFC relay.

3.16 A continuous copper earth strip of 25x3 mm shall run inside the compartment and earth connections from the capacitors connected to it.

3.16 Panels shall be provided with cooling fan for containing the excessive temperature with suitable mesh doors for natural ventilation as required by the Electrical Inspectorate.

4.0 MCCBs:
MCCBs shall be approved make and shall have rupturing capacity as per BOQ.

5.0 CONTACTORS:
Contactor shall be of capacitor duty. The ratings shall be adequate and as recommended by the manufacturer of the particular make for the particular KVAR capacity.

6.0 PUSH BUTTONS
Push buttons shall be generally shrouded. Each push button shall be provided with 1N/O and 1 N/C auxiliary contacts. "Stop" push button shall have 'stay-put' feature. Colour code shall be as per IS-6875.

7.0 INDICATING LAMPS
2 Nos. indicating lamps shall be provided in each capacitor feeder with red and green colour to indicate 'ON' or 'OFF'

8.0 CURRENT TRANSFORMER:
Current transformer shall be double wound, dry type and shall have good regulation (5% or less) to cope with inrush current of contactor coils with sufficient rating.

10.0 CONTROL SWITCHES:
A general purpose control switch shall be provided for selection of "Auto" &"Manual". The switch shall be provided with engraving plate in the front with "Auto", "Manual" & "Off" inscription. This switch shall be normally of the fixed control bar type heavy duty unit.

11.0 APFC RELAY:
The Panels shall be provided with APFC relay having 12 steps of approved make with facility for setting target P.F. range in the form of high and low, step Indication, low current indication, auto manual selection. A 7 segment LED/LCD display shall be provided to indicate existing power factor. The relay also provides over voltage protectionupto10% of rated voltage. Lead power factors are completely eliminated and the switching takes place on FIFO arrangement.

12.0 CAPACITORS: -
The Capacitors shall be Mixed Dielectric as specified in the BOQ confirming to IS 13585. The type of connection, Voltage rating, losses per KVR, compliance to Standards, Inrush current, Safety features shall be as per the Data Sheet.

13.0 Incomer circuit breaker.
ACB as specified in the Bill of quantities.

14.0 EARTHING:
The Panels shall be provided with 2 earthing terminals of minimum M8 size on bothsides of the Panel.

15.0 TESTS & INSPECTION:
The panel shall be completely assembled, wired and tested as per IS-8623 at the factory in the presence of the Consultant/Purchaser's Engineer at no extra cost.
The test shall include wiring continuity tests, insulation resistance tests, high voltage tests (2.5 KV AC for 1 min) and functional tests to ensure operation of control scheme and individual equipment.

Manufacturer's Test Certificates in respect of all meters, contactors, switch fuse, capacitors, ACB, etc shall be forwarded prior to inspection, by Bidder.

16.0 DRAWING & INSTRUCTION MANUALS:

Along with the offer, the Bidder shall submit the following documents:

a. Technical leaflets on meters fuse switches, switches, contactors, lamps, Capacitors, power factor controller and its technical review etc.
b. Type test reports conducted on similar equipment.

After award of the order, the manufacturer shall submit the following documents for Approval:
a. General Arrangement of compartments, capacitor tray etc.
b. Single line diagram
c. Control schematic diagram & power wiring
d. Complete technical particulars of all the equipment, meter etc.
e. Commissioning & maintenance instructions for all equipment supplied

On completion of work:
All the above documents and 6 sets of "AS-BUILT" drawings.

Technical data of Heavy Duty Low Voltage Mixed Dielectric Capacitors

Power	KVAR as per BOQ
Rated Voltage	440 V
Permissible Over Voltage	1.2 times rated.
Permissible over current	1.5 times
Frequency	50 Hz
Inrush Current-I	300 times Rated current
Temperature Category	D 55 deg C max.
Losses in W/KVAr	<0.5
Maximum Humidity	95%
Safety	Internal High Rupturing Capacity HRC Fuses
Impregnation	Non PCB Oil
Useful life	1,50,000 hours

Cooling	Natural
Case Shape	Steel/Rectangular
Terminal	Stud terminal with Steatite bushings
Mounting &Grounding	Self standing with mounting bracket
Enclosure	IP41, optionally IP54
IS	IS : 13585 / IEC-60931
No. of operations/annum	7500 nos.
ISI Marking	Yes
Test Voltage	2.15 x Un
Hidden Losses	Nil
Type Testing	CPRI / ERDA / UCL

7.0 GENERAL REQUIREMENT OF LT BUSDUCT

SCOPE:
The specification covers the technical requirements of design, manufacture, test at works, supply, installation, testing & commissioning of 440V LT, Non-segregated phase, air insulated bus ducts and accessories for efficient and trouble free operation

The bus duct shall be erected from Transformer to Main MV Panel as shown in the enclosed drawings.

STANDARDS:
The equipment covered by this specification shall unless otherwise stated, be designed, Constructed and tested in accordance with the latest revisions of relevant Indian standards and Shall conform to the regulations of local statutory authorities.

IS: 2147 – degree of protection provided by enclosures.
IS: 8623 (part ll) – particular requirements for bus Trunking system

GENERAL:
The bus duct shall be metal enclosed self cooled, Non-segregated, indoor/outdoor type as required and shall include as Standard manufactured components, all straight lengths, elbows, phase change-over boxes, Termination chambers flexible joints. It shall be the responsibility of the contractor to manufacture the bus duct to suit the terminal flange arrangements of the transformer; LT Switchgear & DG control Panel.

CONSTRUCTION:
The bus duct enclosure shall be duct and vermin proof rectangular in cross section and shall be fabricated out of M.S angle and 14 SWG CRCA sheets. It shall be rigid and robust in Construction and shall be treated to prevent any possibility of corrosion.

The bidder shall furnish the external treatment process for approval (10 years life guarantee to be provided) and would be subjected for stage inspection and approval.

Joints in the enclosure shall be bolted and shall be provided with neoprene gaskets. All retaining Catches, screws, bolts and nuts etc. shall be nickel plated. Ends of bus duct connecting to Transformers; LT ACBS shall be provided with flange connectors and flexible.

The bus duct shall be designed to keep enclosure losses to a minimum due to temperature rise. Provision shall be made for the expansion and contraction due to temperature variations. Enclosures shall be with louvers and designed in such a way to have Dust & Vermin proof. Design of expansion joints shall be subjected to approval.

Whenever required necessary phase crossover chambers shall be included the bus duct enclosure shall provide a protection of not less than IP 4X as per IS: 2147 for Indoor and IP 54 for outdoor. Inspection openings of sufficient size shall be made on the enclosures to facilitate inspection/maintenance of supports and bus bar joints.

BUSBARS:
The bus bars shall be air insulated and made up of high conductivity ALUMINIUM, with 99.5% pure confirming to IS 19501 high purity. The bus bars shall have a continuous current rating as Mentioned in the Technical particulars and shall have fault withstand capacity as specified in the Schedule of Quantities. The bus bars shall be TP & N, the cross section of the neutral bus being equal to the cross Section of the half of phase bus bar.

Bus bars shall be identified with red, yellow, blue and black colour tape bands appropriate places and at terminations

The bus bars shall be suitably supported at appropriate intervals with SMC/FRP material to withstand the electro-mechanical stresses during short circuit.

End terminations shall be provided with necessary flexible connectors for bus expansion and contraction.

Appropriate electrical clearance shall be provided between phase, neutral and body as per IS and to withstand temperature rise and electrical stress.

The bus supports shall be of the material as indicated in the Technical particulars.

The bus bars shall be fixed in the supports in such a way to allow for free movement of conductor due to thermal variation, without creating mechanical stresses proof shall be provided .Bolted type bus bar rigid joints shall be considered for connecting successive bus bars of its same phase. Bolted type splice plate, HTS zinc plated bolts and nuts with washers, shall be used to achieve an efficient joint.

Joining method shall be as per international practice and the manufacturer should submit proof, customer may call for testing to verify.

Bidder shall submit calculation for selection of bus bars, support insulator spacing, for approval.

EARTHING:

The bus duct enclosure shall be earthed by a continuous COPPER earth bar size as specified in BOQ, running on both side of the enclosure throughout the entire length of the bus duct.

PAINTING:

Care shall be taken in workmanship and selection of materials to prevent the occurrence of any form of damage of corrosion.

Bus duct enclosure shall be prepared, primed, filled and painted to the highest standards.
All items shall be cleaned and deburred after fabrication and welding is complete. External surfaces shall be filled and rubbed down as necessary to obtain a perfectly flat smooth surface, free from blemishes and imperfections and the whole shall be painted with under coats followed by coats of power coated paint and desired shade after duly heated for rust prevention and applying two coats red oxide metal primer and the sheet metal work shall be passivated prior to other process mentioned. The purchaser shall indicate the exterior colour later and the interior of the enclosure shall be painted matt black. The bus bars shall be painted matt black.

The painting process shall be using a seven-tank phospating system with primer coating within 4 hours of phosphating and two coats enamel Powder Coating.

The painting process shall be pre-approved by the Consultant / Owner.

Painting shall be subject to inspection before assembly.

TYPE TESTS

The bidder shall furnish two copies of type test certificate along with bid for the following.

a. Short time current
b. Temperature rise test.

c. Calculation for support spacing and clearance for specified short circuit current.

INSPECTION AT MANUFACTURER'S WORKS.

Fully assembled bus ducts shall be offered for inspection at works with prior intimation. Materials shall be dispatched to site only after issuing inspection clearance by the representative of purchaser /consultants, following routines tests shall be conducted on the bus duct.

Stage inspection during fabrication

Corrosion test

Paint inspection

Physical verification check

Rubber gasket test.

Megger Test.

Power frequency HV Test.

Milli volt drop test on Rigid and expansion joints.

Temperature Rise Test.

DRAWINGS

After award of the order, the manufacture shall submit the following documents for approval.

General arrangement showing the plan, elevation, different views, detailed typical cross section of bus duct, details of expansion joint, termination arrangement at both ends, bus bar arrangements, erection details with necessary supports.

Tests certificates, if needed,

Complete technical particulars of the components of bus duct

Commissioning and maintenance instruction for the bus duct.

Design calculations.

Bidder shall furnish a cross section of the bus ducts showing the following along with the bid

a. Size of Enclosure
b. Size of Bus bars.
c. Type of Bus support and spacing
d. Short circuit current withstand calculation..

8.0 GENERAL REQUIREMENT OF RISING MAIN

SCOPE:

This specification covers the technical requirements of Design, manufacture, test at works, supply of 440V, **MV RISING MAINS (NON SEGREGATED AIR INSULATED TYPE).**

STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulation of local statutory authorities.

- **IS 2147** : Degree of Protection for enclosure
- **IS 8623(Part-II**) : Particular requirements for Bus trunking system
- **IS 13947 (Part-3)** : Specification for Low Voltage Switch gear and control gear

GENERAL:

Bus Rising system shall be Non-segregated type and shall be supplied for the Sub Distribution of Electricity energy.

Bus Rising main shall have outgoing tap off boxes into the live bus and designed for feeding to the individual floor areas.

These systems shall be installed inside the electrical room.

The supply of mounting materials like clamps, steel channel etc., shall also be included in the scope of this tender.

The bus bars shall be installed vertically supported from wall in the floor electrical room.

The rising main enclosure shall be dust and vermin proof, rectangular in cross section and shall be fabricated out of 2mm thick CRCA sheets. It shall be rigid and robust in construction and shall be treated to prevent any possibility of corrosion joints in the enclosure shall be bolted and shall be provided with neoprene gaskets. All retaining catches, screws, bolts and nuts etc., shall be cadmium plated.

The rising main shall be manufactured in standard lengths of Mts. With arrangements for tap off boxes on either side, if required.

BUSBAR SYSTEM:

The bus bars shall be air insulated and made up of **Aluminium.** The bus bars have a continuous current rating and shall have fault withstand capacity as specified in the Schedule of Quantities.

In their functional position, they shall be vertically pluggable, on edge or flat, and in each position they shall be operable at continuous nominal current and at an ambient temperature of 45°C. The type of protection shall be IP42.

Earth bus bar section shall be provided with lugs on the outer casing suitable for connection to the main earthing system conductor.

FEEDING SYSTEM:

All bus bar system shall be equipped with a central, or end feeder cabinet with rated ACB.as per BOQ. Necessary extension chambers to facilitate easy cable termination shall also be provided.

EXPANSION JOINTS:
The bus bar system shall be equipped with expansion joints as per IS and as per the Electrical Inspection authorities.

As far as local conditions permit, the longest bus bar unit lengths shall be used to minimize electrical losses at the butt or bolted connections of the bus bars.

The bus bar junction points shall be marked with plastic, phenolic or aluminium labels.

TAP – OFF POINTS:
Tap of points shall be provided at every floor intervals as per the Drawing and BOQ requirement, to make connections to the live bus bars safely. These points shall be provided with safety shutters to prevent inadvertent touching of bus bars when no tap off box is fitted and to ensure that no foreign matter enters bus bar chamber.

ACCESSORIES:
All suspension fixings shall be fully tested and approved exclusively as suitable for the installation with particular regard to ambient temperature, environment and loading. The bus system shall be assembled from standard approved components completed at the factory and suitable for the application.

FLEXIBLE JOINTS:
Suitable Aluminum flexible joints shall be provided for rising mains as required by the local Electrical Inspectorate.

MOULDED CASE CIRCUIT BREAKERS:
The MCCB shall comply with the requirement of IS 13947. The MCCB shall comprise of switching mechanism, contact system, are extinguishing device and the tripping unit all mounted inside a moulded case. The MCCB shall be provided with field settable over load protection.

MCCB shall employ quick make break switching mechanism independent of the speed of the speed of operation of the operating handle. The operating mechanism also is trip free. The operating handle shall have provision for door interlock and padlocking .The MCCB shall have rotary handle mechanism as per local inspecting authority requirements.

EARTHING:
The rising main enclosure shall be earthed by a continuous earth bus size as specified in BOQ, running on the outside of the enclosure throughout the entire length of the bus bar trunking.

A protected Neutral bus shall be provided inside the enclosure with a cross section being half the section of the phase bus bars.

TESTS:
Bus bar trunking shall be completely assembled, adjusted and tested for operation under simulated conditions to ensure proper functioning of all equipments.

Types Tests:
The Bidder shall furnish two (2) sets of type test certificates for all the tests conducted on similar equipment.

1. Short time current test.
2. Temperature rise test.
3. One-minute power frequency voltage withstand test.

Routine Tests:

- Mechanical operation test.
- Dielectric test.

Drawings and Documents:

The following drawings and documents shall be furnished in six (6) copies and get approval before execution of work.

General arrangement drawing for rising main showing

1. Overall Dimensions for Different rating
2. Terminal locations
3. Total weight/meter
4. Sectional views
5. Fixing details
6. Sectional view of Tap Off Box.

- Single Line Diagram
- Technical details for MCCB.
- Manufacturing schedule and test schedule.
- Calculation for bus bar sizing and bus bar support spacing.
- O&M Manual

9.0. GENERAL REQUIRMENT OF CABLE MANAGEMENT SYSTEM - TRAYS

LADDER TYPE CABLE TRAYS:

Shall consist of a Bolted rung assembly of field proven design. It shall consist of side rails of 2.5 mtr standard lengths and Slotted rung spaced 250mm center to center.

Coupler, Coupler fasteners, tray assembly fasteners should form the part of the equipment.

The Ladders should be light sheet metal constructions yet robust enough to carry a cable load of 50 kg/m on a span of 1.25 mtrs.

The design shall be flexible enough to accommodate change of widths at site.

Sections of 1.6/2mm shall be standard for different widths of trays as detailed in BOQ.

However where locations demand lighter sections those too shall be detailed in BOQ.

Horizontal bends, Vertical internal / external, tees, crosses shall be standard products.

Provision to add on earth flat holding clamps, trays fixing clamps should be part of cable tray design.

Perforated cable trays of 1.6mm / 2mm thickness and standard lengths 2.5 mtrs as detailed in BOQ shall be offered by bidder if required. Finish shall be as specified earlier.

Wire ways of enclosed type with covers, cover screws, coupler, coupler screws of Pre-Galvanized sheet constructions or of powder coated finish with all accessories shall be offered by bidder as detailed in BOQ. Such Wire ways should be suitable for surface laying or on / under floors.

CONSTRUCTION:

The cable trays shall be either ladder or perforated type. The cable trays and accessories shall be fabricated out of hot rolled steel sheets, which shall be hot dipped galvanized. The complete assembled cable tray sections shall be corrosion resistant, high strength and with extreme smooth surface. Accessories Cable tray manufacturer shall supply suitable accessories for clamping the cable trays on cable tray supports from ceiling and beams of the building structure. Cable trays shall be supplied with GI coupler plates, hardware, nuts bolts and washers for joining the standard lengths of cable tray section.

LOAD DEFLECTION CRITERIA:

For tray system design in addition to self-load, following criteria shall be applied to determine section and thickness of cable tray.

Support span	**2000 mm**
Cable load for 300 mm	50 Kg / m
Cable load for 400 mm	75 Kg / m
Cable load for 500 mm	85 Kg / m
Cable load for 600 mm	100 Kg / m

In addition to this 70 Kg/m concentrated load at the center span shall be considered.

Allowable mid span deflection < 7 mm

SURFACE PREPARATION:

For treatment and preparation of surface of fabricated trays, seven tank process shall be employed comprising of the following cleaning all the members, plates shall be free from grease, paints or any foreign matter. A chemical solvent as trichloroethylene / carbon

tetrachloride or a combination of solvent cleaning and heating shall be employed. Immediately after degreasing the material shall be rinsed with hot / cold water. Pickling Hydrochloric acid and sulphuric acid solutions may be used from pickling. After pickling the material shall be rinsed in running water. After surface treatment, cable trays shall be galvanized.

GALVANIZING:

Zinc confirming to grade Zn 98 of IS 209 shall be normally used for galvanizing. As far as practicable, the fabricated tray and accessories shall not be sunk to the bottom of the bath. Tray and accessories shall be galvanized at the lowest possible temperature, which will allow free drainage of zinc from the work piece during withdrawal. The thickness of the coating shall be minimum 100 microns. The zinc deposited shall not be less than approximately 720 gm/sq.m. The thickness shall be checked by a magnetic method as per IS 3203.

Small components handed in baskets shall be centrifuged to remove excess of Zinc immediately after galvanizing while the coating is still in molten condition. Hardware such as nuts and bolts shall be Electro galvanized / zinc passivated.

PAINTING:

If necessary at site - only, especially after cutting / jointing. The metal surface after cleaning shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. After preparation the tray surface shall be spray painted with two coats of yellow paints.

TESTING AND INSPECTION:

All the cable trays and accessories shall be offered for inspection at the fabricators works to client / consultant. Physical inspection and tests will be conducted on the trays to check its compliance with the specification and approved drawings.

Measurement of the thickness of Zinc coating- Elkometer shall be used to check the thickness of galvanizing. Deflection load test at the manufacturer's works Test span shall be simple bream span with free unrestrained ends.

The cable tray shall be uniformly loaded along the span with cable tray simply supported at the two ends as per the load criteria. Vertical deflection of the tray shall be measured at the two points along the midway between the supports. The average of these two readings shall be considered to be the vertical deflection of the tray. Vertical deflection shall be within the design criteria.

EARTHING:

The cable tray /floor raceways shall be provided with brass earth clamps every 3000mm for connecting suitable copper wire earth continuity.

CABLE TRAYS, ACCESSORIES AND TRAY SUPPORTS:

- Cable racks / trays shall either be run in concrete trenches or on overhead supports, supported from building steel, floor slab etc.
- Cables shall be clamped to the cable trays at regular intervals.

CONDUITS, PIPES AND DUCTS:

- The Contractor shall supply and install conduits, pipes and ducts as per requirement. All accessories / fittings required for making the installation complete, including but not limited to, ordinary and inspection tees elbows, checkouts, male and female reducers and enlarges, wooden plugs, caps, square headed male plugs, nipples, gland sealing fittings, junction boxes, pull boxes, conduits, outlet boxes, splice boxes, terminal boxes,

glands, gaskets and box covers, saddles and all steel supporting work shall be supplied by the Contractor. Conduit fittings shall be of the same material as the conduits.

- Flexible metallic conduits shall be used for termination of connections to equipment such as motors or other apparatus to be disconnected at periodic intervals. Flexible metallic conduits shall also be used for termination of connections to level switches, level electrodes, limit switch, pressure, pressure switches etc.

- Conduits or pipes shall run along walls, floors, and ceilings, on steel supports, embedded in soil, floor, wall or foundation, in accordance with approved layout drawings.

- Exposed conduit shall be adequately supported by racks and clamps or straps or by other approved means. Conduit supports shall be erected square, and true to line and grade with an average spacing of one support for every 2 meters of conduit length.

- Each conduit run shall be marked with its designation.

- All installed conduits shall have their ends temporarily closed by caps, wooden plugs, or other approved means until cable is pulled. Closures shall be made in such a way that they do not get dislodged easily.

- When one or more cables are trained through a conduit, conduit size shall be such that the total cross sectional area of the cable does not exceed 60% of the internal cross sectional area of the conduit.

- The Contractor shall be responsible for boning of metal pipes or conduits in which cables have been installed to the main earthing system. Joints, metal sheath and armour of cables shall be bonded to the earth system in an approved manner. The entire system of conduit after installation shall be tested for mechanical and electrical continuity throughout and permanently connected to earth by means of a special approved type-earthing clamp efficiently fastened to the conduit. Gas or water pipes shall not be used as an earth medium.

10.0 GENERAL REQUIREMENTS OF LT XLPE CABLE

1.0 SCOPE:

The scope shall cover supply, testing, Inspection, Transport of low voltage power and control Fire Retardant FRLS type of Category C2 XLPE cables.
This specification gives the general requirement of cables.

1.1 STANDARDS

The following standards and rules shall be applicable:

IS: 7098 Part I - : XLPE Insulated electric cables .

IS: 8130 - Aluminum conductors for insulated cables

IS : 8130 – 1984 : Conductors for insulated electric cables and flexible cords cables and flexible cords.

IS: 10810 (Pt 58) : Methods of test for cables : Part 58 Oxygen Index test

IS: 10810 (Pt 61) : Methods of test for cables : Part 61 Flame retardant test

IS: 10810 (Pt 62) : Methods of test for cables : Part 62 Flame retardant test for bunched cables

IS:1885-(Part32) : Electro Technical vocabulary - electric cables(1993)

IS:3961-(Part4) (1968) : Recommended current ratings for Polyethylene

IS:3975-(1988) :Mild steel wire, formed wires and tapes for armouring of cables

IS: 5831-(1984) : Specification for PVC insulation and sheath of electric cables
IS: 6474-(1984) : Specification for Polyethylene insulation and sheathof electric cables.
IS: 10418-(1982) :Drums for electric cables.

IS:10462(Part1) :Fictitious calculation methodfor determination ofdimensions of protective (coverings of cables)

IS : 5831–1984 : PVC insulation & sheath of electrical cables.

1.1 TYPES OF CABLES:

Three and half Core Power Cables

Four Core Power cables

Multi core Control cables.

2.0 DETAILED SPECIFICATION
2.0 MATERIAL:

The low voltage cable shall be XLPE insulated. PVC outer sheathed, aluminium / copper conductor, armoured conforming to IS: 7098 Part I.

2.1 Conductor:

The conductor shall be stranded compacted circular construction. Conductor material shall be aluminum or annealed copper with cross section as specified in the specific requirements and shall confirm to IS 8130 /1984.

2.2 Insulation: Extruded XLPE Compound which shall applied using dry cure process designed to eliminate micro voids in the insulation and conform to IS-7098, Part-1. (As applicable)

2.3 Inner Sheath: Inner sheath is provided over the laid up cores. It shall be provided with high quality PVC which acts as bedding for steel wire/strip armouring. It is provided to give circular shape to the cable. PVC Compound provided shall be conforming to type ST2.

2.4 Armour: Galvanized single round steel wire armour for three core cables. Non - magnetic hard-drawn aluminium single round wire conforming to H4 grade for single core cable.

(1) Armouring shall be one of the following:-

(a) Galvanized round steel wire

(b) Galvanized steel strip

2.4.1. A binder tape shall be provided above armour.

2.5. Overall Sheath: Outer sheath shall be with extruded PVC compound conforming to ST2. Outer sheath shall be of an extruded type layer of suitable PVC material compatible with the specified ambient temp. 50 deg. C and operating temperature of cables. The sheath shall be resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The colour of outer sheath shall be black. Sequential length marking required at every 1.0 mtr. interval on outer sheath.

2.6 CORE IDENTIFICATION:

Cores of cable shall be identified by colour coding of PVC insulation by adopting the following scheme.
One core: Red, black, yellow, blue or natural
Two core: Red and Black
Three core: Red, Yellow and Blue
Three & Half core: Red, Yellow, Blue and Black
Four core: Red, Yellow, Blue and Black
Single core: Green, Yellow for earthing
Black shall always be used for neutral.
By numbers for multicore control cables.

2.7 ASSEMBLY :
Two, three or four insulated conductors shall be laid up in right hand direction of lay and filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

2.8 GENERAL REQUIREMENT :
All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, etc.

The cable shall be supplied in single length.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practice.

2.9 CABLEMARKING:

EMBOSSING ON OUTER SHEATH:
The outer sheath shall be legibly embossed with following legend throughout the length.
i) Manufactures' name or Trademark
ii) Voltage Grade
iii) Size :*3.5 C x ----- mm²*

iv) Year of Manufacture
v) Type of Insulation
vi) Type of outer sheath
vii) ISI mark
Viii) Fire performance Category: Fr or FRSH

3.0 TESTING:

1. Testing shall be carried out in accordance with relevant standards.

All routine tests,& additional type tests for improved fire performance shall be carried out as listed in IS-7098 (Part-1).

Routine test certificate for the cable in each drum shall be furnished along with supply.

4.0 SEALING, DRUMMING & PACKING:

1. After tests at the manufacturer's works, both ends of the cable shall be sealed by means of non hygroscopic sealing material to prevent the ingress of moisture during transportation and storage.

2. Cable shall be supplied, packed non-returnable drums of sufficiently sturdy construction.

3. The spindle hole in the drum shall be 110 mm minimum diameter.

4. Each drum shall bear on the outside flange, legibly and indelibly in the English literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

5. The following information shall be stenciled on each drum.

(a) Name of manufacturer, brand name or trademark.
(b) Nominal crosses sectional area of conductor
(c) Number of cores.
(d) Type of cable and voltage grade.
(e) Length of cable on the drum.
(f) Drum number.
(g) Direction of rotation of drum (by means of an arrow).
(h) Reference standard
(i) Approx. gross weight.

11.0 GENERAL REQUIREMENT OF CABLING SYSTEM

GENERAL:

The cabling system covers the design as per relevant national / international standards. It shall be responsibility of contractor to work out a detailed layout for the complete plate cable system. The layout drawing shall be furnished for the approval of Engineer before commencement of installation including cable trays, cable trays, cable racks, accessories, tray supports, conduit etc.

CABLE LAYOUT:

The following points shall be noted while planning cabling system for the plant

Inside the building either cable tray or cable trench shall be planned as per cabling requirement.

Laying of Cables:

- Cables shall be laid as per the specifications given below:

Cables - Outdoor Trenches:

- Cables shall be laid in excavated outdoor trenches wherever called for. The depth and width of the trenches shall be as per BOQ below the final ground level. However, where more than one cable is laid, a coaxial distance of not less than 150 mm shall be allowed between the cables. The trenches shall be cut square with vertical sidewalls and with uniform depth. Suitable shoring and propping may be done to avoid caving-in of trench walls. The floor of the trench shall be rammed level. The cables shall be laid in trenches over rollers placed inside the trench.

- The cable drums shall be laid unrolled in the direction of the arrow marked on the drum for unrolling.

- Wherever cables are bent, the minimum-bending radius shall not be less than 12 times the diameter of the cable. After the cable is laid and straightened, it shall be covered with 75mm thick layer of sand. The cable shall then be lifted and placed over the sand cushion. Over this, 75 mm on either side 150 mm sand shall be provided. The cables shall be covered with country bricks as specified in BOQ and drawing. Remaining trench shall be backfilled with earth and consolidated as original. Cables shall be laid in Hume pipes/stoneware pipes at all road crossings and in GI pipe at the wall entries. Cable route markers to be provided as per standards.

- Excess debris shall be removed from site with free of cost

Cables – Indoor :

- The cables laid indoors should be laid on slotted angle steel cable trays supported on M.S. angles. The cable trays should be routed above false ceilings wherever provided. Suitable clamping with straps and saddles shall be used for keeping the cables in position. Spacing between the cables shall not be less than the overall diameter of the cable.

- The cables on wall surface from panel board up to angle iron shall run in galvanized steel pipes of adequate size.

- The Cables run inside concrete trenches shall be supported on cable trays and shall be neatly arranged and clamped.

- The Cable entries through pipes from outside to inside the building shall run in HUME/GI pipes and shall be sealed water tight with approved type of sealant to avoid water entering the building.

LAYING OF CABLES:

Cables shall be laid as per the specifications given below in BOQ

INSTALLATION OF CABLES:

- (a)The contractor shall install, test and commission the cabled specified in the technical specification in accordance with Contractor's drawings and approved by the Engineer. Cables shall be laid directly buries in earth, or cable racks, in build up trenches, on cable trays and supports, in conduits and ducts or bare on walls, ceiling etc. as per approved drawing. Contractor's scope of work includes unloading, laying, fixing, joining, bending, and terminating of the cables. The Contractor shall also supply the necessary materials and equipment required for joining and terminating of the cables.

- All apparatus, connections and cable work shall be designed and arranged to minimize rise of fire and any damage, which might be caused in the event of fire. Wherever cables pass through floor or wall openings or their partitions suitable bushes of an approved type shall be supplied and put into position by the contractor. If required by the Engineer, the Contractor shall seal the cables into the bushes using fire-resisting materials to prevent the spreading of fire through each partition.

- Inspection on receipt, unloading, storage and handling of cables shall be in accordance with IS: 1255 and other Indian Standard Codes of Practice.

- Standard cable grips and reels shall be utilized for cable pulling. I unduly difficult pulling occurs, the Contractor shall check the pull required and suspend pulling until further procedure has been approved by the Engineer. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering & does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.

- After pulling the cable, the Contractor shall record cable identification and date pulled neatly with waterproof ink on linen tags and shall securely attach such identification tags. Identification tags shall be attached to each end of each cable with non-corrosive wire. The said wire must be non-ferrous material on single conductor power cable. Tags may further be required at intervals on long runs of cable son cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.

- Sharp bending and kinking of cables shall be avoided the bending radii for various types of cables shall not be less than those specified below:

- I.11 kV XLPE Multicore armoured cables: 15 times the overall dia of the cable.

- II.650/1100V XLPE insulated cable. : 10 times the overall dia of the cables.

- If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the Engineer's Representative.

- Power and control cables shall be laid in separate cable racks/trays.

- Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be employed.

- When power cables are laid in the proximity of communication cables, minimum horizontal and vertical separation between power and communication cables shall be normally 600mm, but in any case not less than 450mm for single core cables and 300mm for Multicore cables. Power and communication cables shall as far as possible, cross at right angles to each other.

- **LT** Cable shall be laid in ground in excavated trench of depth 750 mm or as per BOQ from ground on a bedding of 75mm mm sand at the bottom of trench. The cables shall then be covered on top and at their sides with sand to a depth of about 75 mm. The protective cable covers for LV cables shall be of country bricks laid breadth wise and for HV cables of reinforced trough. The trench is then back filled with the excavated soil and well rammed in successive layers of not more than 300 mm in depth, with the trenches being watered to improve consolidation where necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 50 mm in the center and tapering towards the sides of the trench.

Route Markers
Route markers shall be provided along straight runs of the cables at locations approved and generally at intervals not exceeding 25 meters. Markers shall also be provided to Identify change in the direction of the cable route.

Route markers shall be made out of 100mm x 100mm x 5mm GI/aluminum plate Welded or bolted onto 35 mm x 35 mm x 6 mm angle iron 600 mm long duly painted With anti-corrosive paint/ embossed. Such plate markers shall be mounted parallel to and 300.mm or so away from the edge of the trench

Markers shall be embedded in cement concrete 1:2:4 (one cement, 2 coarse sand: 4 graded stone aggregate of 30 mm normal size). The word "Cable" and other details such as voltage grading, size etc. as required shall be painted on the marker.

Identification tags
Plastic identification tags shall be provided at every 30m. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid.

Laying In Pipes / Closed Ducts

In locations such as road crossings, entry to buildings/ poles in paved areas etc. cables shall be laid in pipes or closed ducts. Spun reinforced concrete/HDPE shall be used for such purposes.

These pipes shall be laid directly in ground without any special bed. Unless otherwise specified the top surface of pipes shall be at a minimum depth of 1000 mm from the ground level when laid under roads, pavements etc.

The pipes for road crossings shall preferably be on the skew to reduce the angle of bend as the cable enters and leaves the crossing. Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent .injury to cable insulation or sheathing.

Cable Entry into Buildings

Cable entry into buildings shall be made through RCC pipes recessed in the floor. RCC Hume pipes shall be provided well in advance for service cable entries. The pipe shall be filled with sand and sealed at both ends with bitumen mastic to avoid entry of water.

Suitable size manholes shall be provided wherever required to facilitate drawing of cables as per requirements. The Contractor shall submit a written request to Engineer for inspection of following works for cabling:

On excavation and provision of sand bed at bottom of trench

On laying of cables, and provision of sand bed over the cables

On provision of protective cover & back filling

On commencing termination of cable

These requests shall be serially numbered and shall be in an approved format out of one or two formats to be submitted by the Contractor.

Cable Joints

Cable joints shall be resorted to and permitted only if length of cable route is more than standard cable drum length. Cable joints shall not be permitted in any other circumstances. Wherever unavoidable these joints shall be made with specific approval of Engineer, and shall from a part of cable run /laying. Cable Jointing shall be done only of approved make cable joints. No extra cost shall be paid for jointing of cables.

Cable Loops

At the time of the installation approximately 3 meters of surplus cable shall be left below or as directed by Engineer-In-charge at each end of the cable on each side of underground straight through / tee / termination joints at entries to buildings. This cable shall be left in the form of a loop.

Wherever long runs of cable length are installed cable loops shall be left at suitable intervals as specified by the architect/clients.

- In each cable run some extra length shall be kept at a suitable point to enable on or two straight through joints to be made, should the cable develop a fault at later date.

- Cables on cable racks, on cable trays and in conduits shall be formed to avoid bearing against edges or trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directly into cantilevered cable trays where practicable, but in some cases it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in trays shall be laid only in single layers and unnecessary crossing of cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.

- Cable splices will not be permitted except where permitted by the Engineer. Splices shall be made by the Contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturers and the Engineer. Before splicing, insulated cables shall have conductor insulation stepped and bound or penciled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.

- At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workmanlike and approved manner by men specialized in this class of work. The Contractor shall make terminations for each type of wire or cable in accordance with instructions issued by cable manufacturers and the Engineer.

- Control cable terminations shall be made in accordance with wiring diagrams, using colour codes, numbering ferrules approved by the Engineer for the various control circuits, by code marked wiring diagrams.

- When control cables are to be fanned out and cabled together with cord, the Contractor shall make connections to terminal blocks, and test the equipment for proper operation before dabbles are corded together. If there is any question as to the proper connection, the Contractor shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together where necessary to hold them in place in a workmanlike manner.

- Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be joined until after due examination and testing by the Engineer. Before jointing is commences, insulation resistance of both sections of cable to be joined shall be checked by megger.

- After installation and alignment of motors, the Contractor shall complete the conduit installation, including a section of flexible conduit between the motor terminal box and cable trench / tray. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacture's drawings if any. The Contractor shall be responsible for correct phasing of the motor power connections and shall interchange connections at the motor terminal box if necessary, after each motor is test run.

- Connections to recording instrument, float switches, level electrodes, limit switches, pressure switches, thermo-couples, thermostats and other miscellaneous equipment shall be done as per manufacturer's drawings and instructions.

- Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for boning shall be appropriate with the system fault current.

- All new cables shall be megger tested before joining is completed al M.V cables shall be megger tested. 1100/650 volt grade cables shall be tested by 1000 Volt mugger.

- Cable cores shall be tested for
- Continuity
- Absence of cross phasing
- Insulation resistance to earth
- Insulation resistance between conductors.
- Contractor shall furnish all testing kit and instruments required for field-testing.

POWER AND CONTROL CABLE TERMINATIONS:

- Cable boxes shall be of approved design with adequate clearances between phases and between phases and earth, in accordance with relevant standards.

- Cable boxes shall be complete with combined armour and earthing clamps.

- Suitable compression type cable glands shall be provided for power and control cables.

- Provision shall be made for earthing the body of each cable box.

- Equipment terminal blocks for power connections shall be complete with adequate phase segregating insulating barriers and suitable

- Crimping type of lugs for connecting the insulated cable tails.

- Where more than one core is terminated on each phase, unnecessary bending of cable cores shall be avoided, without decreasing the length of the insulated cable tail and the electrical clearances, which would normally be obtained when using one core per phase.

- All switchboards shall, unless otherwise specified, facilitate bottom cable entry. Removable gland plates shall be mounted at least 300mm above the base of the panel. If the gland plates are provided inside the switchboards cubicles, entries in the base of the cubicle must be adequately vermin proofed.

- The individual cores of power and control cables shall be neatly dressed and supported at regular intervals inside the switchboards, before connecting them to the relevant terminals.

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12.0 GENERAL REQUIREMENT OF MCB DISTRIBUTION BOARD

SCOPE:
Supply, erection, testing and commissioning of standard make distribution boards conforming to relevant Indian standards (IS 8623) and specifications given below.

GENERAL:
Distribution Boards Shall Consist Of Following.

MCBs and ELCBs of reputed make and designed capacity, which shall conform to IS 8878 latest.

Neutral strip/earth strip for connecting all distribution point neutral/earth wires of guest room.

Two numbers brass bolts and nuts on DB base for its earthing.

Cable conduit entry boxes on top and bottom as per design drawing.

However the specifications herein after described shall take precedence over the above wherever this specifications call for a higher standard of material or workmanship. The distribution boxes shall be of standard factory make and flexibility shall be given to mount MCBs and ELCBs of any make.

CABINET DESIGN:
Distribution boards shall be of totally enclosed type with dust and vermin proof construction. The enclosure shall be made of steel sheet of 18G. The steel sheet shall be treated with a rigorous rust inhibition process before fabrication. The distribution boards shall consist of Earth Leakage/Miniature Circuit Breaker as in-comer and required number of miniature Circuit Breakers as outgoing. The distribution boards shall be with top and bottom cable/conduit entry. The incoming and outgoing shall be rated as specified on the drawings and schedule; and both shall be totally isolated from one another. The cabinet shall be spray enameled to required colour shade finish. The interior components of the DB shall be mounted on Din Rails, mounted on the studs provided inside the cabinet. A cover made of hylam sheet, or spray enameled 16G steel sheet, shall be provided over the cabinet, with slots for operating knobs or breakers.

The cabinet shall be equipped with 16/18G inside hinged front door having a spring latch and lock over flanged door. Cabinets shall have detachable gland plates at both top and bottom made out of 16/18G. The hinged type door shall be with **'U'** shape edge to provide square type compressed rubber gasket.

The construction of the hinges shall be to enable the door to swing open by not less than 150°. In addition to this, the hinged design shall permit doors being completely removed whenever necessary.

MINIATURE CIRCUIT BREAKERS (MCB):

Miniature Circuit Breakers shall be quick Make and Break type, and shall conform to relevant Indian Standards. The housing shall be heat resistant and shall have high impact strength. MCBs shall be flush mounted and shall be provided with trip free manual operating lever and 'ON' and 'OFF' indications. The contacts shall be provided with magnetic and thermal releases for short circuit and over current. The device shall have a common trip bar in the case of DP and TPN Miniature Circuit Breakers.

MCB for ratings upto 125 Amps shall be available in 1,2,3 or 4 pole versions. MCB casing shall be made of self-extinguishing material tropicalised treatment 2 (relative humidity) 95% at 55°C).

MCB shall comply with IS 8828-1996/IEC 898 – 1995.

It shall be suitable for use in frequency range 40Hz to 60Hz and shall accommodate AC/DC supply according to requirements.

Arc chutes should be provided for effective quenching of arc during operations and fault conditions.

It shall have trip free mechanism and toggle shall given positive contact indication.

It shall have trip free mechanism ad toggle shall given positive contact indication.

It shall be suitable for mounting on 35mm DIN rail/surface mounting.

Line supply may be connected to either top or bottom terminals i.e. there shall be no line load restriction.

Degree of protection, when the MCB is flush mounted, shall be IP40.MCB & shall be supplied with clamping terminals fully open.

Contact closing shall be independent of the speed of the operator.

MCB's operating temperature range shall be –20 deg C to + 60 deg C.

The characteristics should be in accordance with IS 8828 –1996. The breaking capacity of the MCB shall be 10kA and energy limiting class3.

The rated impulse voltage of the MCB shall be greater than 4kV.

The MCB shall be capable of being used as Incomer circuit breaker and shall be suitable for use as an isolator.

Contact closing shall be independent of the speed of the operator.

Electrical endurance of the MCB shall be greater than 4kV.

Power loss per pole shall be in accordance with IS 8828-1996 and the manufacturer shall furnish the same.
In case of multipole MCBs in a single location (DB), it shall be possible to remove MCB without having to disturb other MCB's in the vicinity.

'C' curve type MCB should be used for lighting & power loads.

RESIDUAL CURRENT CIRCUIT BREAKER (RCCB):
RCCB shall comply with IS 12640-1988 /IEC1008. It shall be available in 2 pole and 4 pole versions and threshold sensitivities (non-user adjustable) of 30m A, 100m A 300mA & 300mA with inbuilt time delay of 200mS for discrimination with downstream ELCB, if specified in schedule of quantities. Tropicalisation: treatment 2 (relative humidity 95% at 55°C).

The current rating shall be from 25A to 125A. Ratings ad sensitivities shall be as specified in schedule of quantities.

It shall be operationally independent of line voltage.

There shall be clear identification of earth fault or overload/short circuit fault on the RCCB.

The RCCB shall not given nuisance tripping due to transient over voltages (lightening, line disturbances or other equipment).

The RCCB should preferably be **'Si'** class type (should be suitable for SMPS loads i.e. unaffected by the D.C pulsated components present if any in the circuit), and should not give nuisance ripping. Details to be furnished confirming suitability.

The short circuit withstands capacity of the RCCB without the associated short circuit/overload protection should preferably be 6kA.

A test device should be incorporated to check the integrity of the system and tripping mechanism.

Terminals should ensure easy termination of cables and should provide covers to shield incoming and outgoing terminals with IP20 degree of protection.

The RCCB should be suitable for DIN rail mounting.

INDICATING LAMPS:

Type	:	Panel mounting "Protected LED" types. (I.e. protection is provided against Electromagnetic interference & over Voltage)
Standard applicable	:	IEC 947-5-1
Electric shock protection	:	class 2(IEC 536)
Degree of protection	:	IP 65 9(IEC 529)
Diameter	:	22mm
Voltage	:	230V AC

PUSH BUTTONS:

Type	:	Manually operated
Spring return type.		
Standard applicable	:	IEC 947-5-1
Electric shock Protection	:	class 2 (IEC 536)

Degree of protection	:	IP65 (IEC 529)
Rated Insulation Voltage	:	600V
Rated Impulse voltage	:	6Kv
Diameter	:	22mm
Type of mounting	:	snap type
Color of actuator	:	Start PB – Green
Stop PB – Red		
Test PB – Black		
Reset PB – Yellow		
Contact configuration	: I NO or I NC	
Contact rating	: AC -15, 3A, 240V	

TERMINALS:
Distribution Boards shall be provided with a terminal block for neutral and earth terminations of adequate size. The terminal block shall be so located as to prevent crowding of wires in the proximity of live parts.

DIRECTORY:
Distribution Boards shall be provided with a directory indicating the areas of loads served by each Circuit Breaker, the rating of breakers, size of conductors, etc. The directory shall be mounted in metal holder with a clear plastic sheet on inside surface of the front door. A suitable size “Danger” plate indicating voltage grade shall also be fixed inside the DB front cover.

INSTALLATION:
Distribution Boards shall be wall surface mounted or recess mounted as required and at the locations shown on the drawings. The Boards shall be fixed on 30 x 40 x 6mm angle iron framework and bolts for surface installation. All the cables/conduits shall be properly terminated using glands/grips/check nuts, etc. Wiring shall be terminated properly, using crimping lugs/sockets and PVC identification ferrules. No bare conductor shall be provided inside the board.

Distribution boards shall be bonded to the earthing system at least at two points using brass bolts and lugs.

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13.0 GENERAL REQUIREMENT OF SPECIFICATION FOR POWER CONTACTORS

SCOPE:

Supply, Installation, Testing and Commissioning of Contactors in Power & Lighting Changeover panels including all accessories as required to automize them as detailed in BOQ.

STANDARDS:

The Panel Boards shall comply with the latest issue of the following standards

IS 8623 – General requirement for factory built assemblies upto 1000 Volts.

IS 10118 – Code of Practice for selection and maintenance of Switchgear and Control gear.

IS 2147 – Degree of protection provided by enclosures for low voltage Switchgear

and Control gear

IS 2705 – Specification for current transformers

IS 1248 – Specification for direct acting electrical indicating instruments.

IS 3156 – Voltage transformers

IS 3231 – Relays

IS 9224 – Specification for HRC cartridge fuse links upto 650 Volts.

IS 4794 – Control Switches / Push Buttons

IS 11353 – Marketing and identification of conductors and apparatus

CONTACTORS:

Contactors shall comply with IS 13947 for general rules and IS13947-4-1 for standards pertaining to contactors and motor starters. The contactor shall be capable of withstanding breaking & making capacities as follows:

AC3 Category
Making Current - 10 times Rated Current

Breaking current - 8 times Rated current

Contactor shall be capable of withstanding an impulse voltage of 8KV and have an insulation voltage of 1000V.

The Contactors shall be capable of frequent switching and should operate without any deration at 55 °. C for AC3 application.

The coil shall have 3 terminals and the insulation class shall be preferably H class, to sustain frequent switching operations. The auxiliary contact block shall have a switching capacity of 240V at 2A.

Contactors shall have one auxiliary in-built and it shall be possible to have additional NO & NC contacts in steps of two.

THERMAL OVERLOAD RELAY:

The Thermal Overload Relay shall comply with IS 13947-1 for general rules and IS 13947-1 for standards pertaining to contactor shall be designed for AC3.

The Thermal Over Load Relay shall be suitable for and Type 2 coordination as per suitable clause in the relevant Indian Standards.

The Thermal Overload Relay shall be capable of offering differential protection and shall be ambient compensated type, operable upto 70 °. C.

The Thermal Overload Relay shall be capable of withstanding short circuit equal to seventeen times the rated thermal current (17 Ie).

The Thermal Overload Relay will be tripping class 10A as a standard or class 20 for certain applications where specified.

The Thermal Overload Relay should have built in single phasing protection and phase unbalance protection as per IEC947-4.

It shall be possible to mount the Thermal Overload Relay on the underside of the contactor directly.

The design of the terminal shroud shall be such that it offers complete protection against direct finger contact with the power terminal, as under IP 20 protection.

The Thermal Overload Relay shall have in built 4NO & 4NC contact.

The “Reset” operation shall be clearly distinguished from the “Stop” operation.

The Thermal Overload Relay shall have separate “Stop” and “Test” button.

The setting shall be of the adjustable type and there should be a provision of sealing to make the same tamper proof.

The Thermal Overload Relay shall be suitable for copper termination, with a maximum permissible temperature rise of 65K, at the terminals, with an ambient temperature of 40 °. C.

Capacitor Duty Contactors of adequate rating should be provided for the capacitor bank controls and substantiating the ratings selected.

WIRING AND CABLE TERMINATIONS:

Power, control, signaling, protection and instrument circuits shall be done with PVC Insulated FRLS multistrand copper conductors. The insulation grade for these wires shall be 1100 volts. All control wiring shall preferably be enclosed in plastic channels or neatly bunched together.

For 16 AMPS control fuse circuit, 2.5 Sq.mm size wires shall be used. Each wire shall be terminated at a separate terminal. Termination of two outgoing wires on a single terminal will not be acceptable. Wires shall not be joined or tied between terminal parts. Shorting links shall be provided for all C.T. Terminals.

Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC Ferrules. Ferruling of wires shall be as per relevant IS.

A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression type lugs. "ELMEX" (direct conductor termination) type terminals will be acceptable for wires upto10 sq.mm.

The control terminals shall be mounted in such a way that they are separate from the power terminals and shall be easily accessible without any hindrance from the power circuitry.

The wiring shall be complete in all respects so as to ensure proper function of control, protection and interlocking schemes.

INDICATING LAMPS:

LED Type Indicating lamps shall be provided in all the panels as required.

INSPECTION:

Stage Inspection before dispatch at your factory to witness routine tests

GENERAL:

Every switchboard, switchboard control contactor, time switch, relay, indicator lamp, meter, motor starter, link and any control or protection equipment within or on a switchboard shall be clearly and accurately labelled.

Labels shall be engraved laminated plastic or photo anodized rigid aluminum and shall comply with the following requirements.
Except where otherwise required labels shall be fixed adjacent to, but not on any item of equipment.

Engraved lettering shall be black on a white background, except that the label for a main switch shall have red lettering on a white background, and warning and caution labels shall have white lettering on a red background.

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14.0 GENERAL REQUIREMENT OF LIGHT FITTINGS AND ACCESSORIES

Erection, testing, commissioning of light fittings and accessories conforming to relevant IS standards and specifications.

STANDARDS:

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

Electric Light Fittings : General and Safety requirements IS - 1913.

Industrial Light Fittings with metal reflectors IS - 1777

Decorative lighting outposts - IS - 5077

Flood lights - IS - 1947

Luminaries for street lights - IS - 2149

Bayonet lamp holders - IS - 1258

Bi-pin lamp holders for tubular-fluorescent lamps -IS - 3323

Ballast's for use in fluorescent light fittings IS - 1534

Starters for fluorescent lamps IS - 2215

Ballast for HP MV lamps-IS - 6616

Capacitors for use in fluorescent, HPMV and LP sodium Vapour lamps circuits. – IS-2215

Tubular Fluorescent lamps-IS - 2418 (Part I)

High pressure mercury vapour lamps - IS - 2183

Tungsten filament general electric lamps-IS - 418

Water proof electric Light Fittings: IS 3524.

Water tight electric Light Fittings: IS 3553.

LIGHT FITTINGS - GENERAL REQUIREMENTS:

ALL THE LIGHT FIXTURES SHOULD BE ENERGY EFFICIENT:
Fittings shall be designed for continuous trouble free operation under any atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather and rain proof.

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

All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballast's, power factor improvement capacitors, starter, etc. Outdoor type fittings shall be provided with weatherproof boxes.

Fluorescent lamp fittings shall be complete with all accessories like ballast's, power factor improvement capacitors, and starters capacitors for correction of stroboscopic effect.

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

All hard wares used in the fitting shall be suitably plated or anodized and passivated for use in industrial atmosphere
For Earthing, each light fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.

ENERGY EFFICIENCY:
Fluorescent lamps are reasonably efficient at converting input power to light. Nevertheless, much of the power supplied into a fluorescent lamp – ballast system produces waste heat energy.

There are three primary means of to improving the efficiency of a fluorescent lamp-ballast system:

Reduce the ballast losses.
Operate the lamp(s) at a high frequency.
Reduce losses attributable to the lamp electrodes.

Newer, more energy-efficient ballasts, both magnetic and electronic, exploit one or more of these techniques to improve lamp-ballast system efficacy, measured in lumens per watt. The losses in magnetic ballasts have been reduced by substituting copper conductors for aluminum and by using higher-grade magnetic components. Ballast losses may also be reduced by using single ballast to drive three or four lamps, instead of only one or two.

Careful circuit design increases efficiency of electronic ballast's. In addition, electronic ballasts which convert the 60Hz supply frequency to high frequency, operate fluorescent lamps more efficiently than is possible at 60 Hz. Finally, in rapid start circuits, some magnetic ballasts improve efficacy by removing power to the lamp electrodes after starting.

BALLASTS:
The ballast's shall be designed for long life and low power loss. They shall be mounted using self-locking, anti-vibration fixtures and shall be easy to remove without demounting the fittings. The enclosures shall be dust tight and non-combustible.

Ballast's shall be electronic type, inductive, heavy-duty type, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with taps to set the voltage. The ballast wiring shall be of copper and they shall be free from dust.

HIGH FREQUENCY BALLAST:
High Frequency ballast shall be of electronic type with high voltage with stand capacity. Ballast shall be provided with re-fuse able type. The harmonics level of the electronic ballast shall be within 10% THD.

BALLAST FACTOR:
One of the most important ballast parameters for the lighting designer/engineer is the ballast factor. The ballast factor is needed to determine the light output for a particular lamp-ballast system. Ballast factor is a measure of the actual lumen output for a specific lamp-ballast system relative to the rated lumen output measured with reference ballast under ANSI test conditions (open air at 25 degrees C [77 degrees F]).

Ballast factor is not a measure of energy efficiency. Although a lower ballast factor reduces lamp lumen output, it also consumes proportionally less input power. As such, careful selection of a lamp-ballast system with a specific ballast factor allows designers to better minimize energy use by "tuning" the lighting levels in the space. For example, in new construction, high ballast factors are generally best, since fewer luminaries will be required to need the light level requirements. In retrofit applications or in areas with less critical visual tasks, such as aisles and hallways, lower ballast factor ballast's may be more appropriate.

To avoid a drastic reduction in lamp life low ballast factor ballast's (<70%) should operate lamps in rapid start mode only.

Harmonics:
When a current or voltage wave shape deviates from the ideal (sinusoidal), current or voltage harmonics are produced. Harmonics are sinusoidal voltage or currents that are higher multiples of the fundamental frequency. For example the harmonics of 60Hz, 120 Hz, 180Hz, etc., representing the first (fundamental), second, third, etc. multiples. Fluorescent ballast's affect the current, as opposed to the input voltage; in the process, current harmonics are generated. The amplitude of these harmonics are expressed as a percentage of fundamental.

Recently electrical utilities have been concerned with the growing use of electrical equipment that generates harmonics. Such equipment may include variable speed drives, uninterruptible power supplies, personal computers, and electronic ballasts, any circuit that is nonlinear (e.g. a gas discharge lamp) uses rectifying circuits, or uses high speed switching systems will generate harmonics. If any on or combination of the above systems makes up a significant portion of building's electrical load, the following undesirable effects may result:

Overloading of transformers
Adding of current to the neutral in three phase electrical distribution systems

Current/Voltage surges and/or spikes due to circuit resonance's with one or more of the harmonic frequencies
Interference with electrical equipment or communications on the same circuit
Distortion of the electrical service entrance voltage with accompanying adverse effects on the performance of other electrical equipment in the building.

Harmonic Distortion and Electronic Ballasts:
The harmonic issue first surfaced as a concern to the professional lighting community when a major utility announced that electronic ballasts were required to have total harmonic distortion (THD) of less than 20% of the fundamental in order to qualify for their rebate program. Electronic ballasts manufacturers responded to the utility's requirement by employing passive filtering that met the 20% limit at a slightly higher cost to the end user.

To help understand the issue, magnetic ballasts of interest to examine and compare the harmonics generate it. The harmonics for some magnetic ballasts exceed the 20% limit, and have been measured at levels over 37%. This suggests that there are presently many magnetic ballasts in use that exceed the 20% THD limit. These ballasts have not been known to cause any problems with electrical distribution where they are installed, further suggesting that the choice of a 20% limit on THD may be arbitrarily conservative. In any case, most electronic ballasts manufacturers now make electronic ballasts that are well under the 20% limit.

Harmonic Distortion and power factor:
Utilities are concerned with low power factors because end users draw higher currents for the power that they are using. Ideally, lighting equipments should have a power factor greater than 0.9 and is possible. Power factors of less than 1.0 occur when the voltage and current generated by electronic ballasts reduce power factor due to a distorted current wave shape. (Harmonic currents produced by other types of electronic equipment can also lower the power factor produced by producing a phase shift between the voltage and current.)

Electronic ballast manufacturers now make a habit of publishing the percentage of total harmonic distortion (THD) produced by their products. This allows lighting professional to quantity how the installation of electronic ballasts in a building will affect power factor. Electrical distribution wiring may be sized accordingly. The relationship between power factor and total harmonic distortion with no voltage-current phase shift may be determined as follows:

Power factor = $\sqrt{}$ 1 /(1+THD2)

As long as there is no voltage –current phase shift contribution to the power factor, THD may be as high as 48% and maintain a power factor of over 0.90.

Guideline Specifications:
The following ballasts specifications may be used as a guideline for full-size fluorescent lamp ballasts. In general, for important applications, detailed specifications should be included for ballasts. The specification may include acceptable manufacturers and model numbers, especially when using electronic ballasts.

Electronic Ballast's:

1. UL listed Class P.
2. Sound Rated A
3. Total harmonic distortion 32% (< 20% for rebates) with input current third harmonic not to exceed ANSI recommendation.
4. Ballast shall conform to ANSI specification C.82, 11-19XX
5. Power factor 0.90

6. Enclosure size and wiring in same color as magnetic ballast (retrofit applications).
7. Ballast factor of manufacturer's literature, or as required.
8. Light regulation ± 10% with ± 10% input voltage Variation.
9. Lamp current crest factor ⊥1.7.
10. Flicker 10% or less with any lamp suitable for the ballasts.
11. Lamps shall be operated in (instant start0 (rapid start)(rapid start, stepped output)(rapid start, continuously adjustable output) mode.
12. Shall be designed to with stand line transients, per IEEE 587,category A.
13. Circuit diagrams and lamp-ballast connections shall be displayed on all ballast packages.

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

The housing shall be stove-enameled or anodized as required. The surface shall be scratch resistant and shall show no sign or cracking or flaking when bent through 90° over.

DECORATIVE TYPE FITTINGS:
Decorative fluorescent fittings shall be provided with mounting/housing channel cum reflectors or CRCA steel sheet, stove enameled diffusers or louvers shall be translucent white prystyrene.

ACCESSORIES FOR LIGHT FITTING REFLECTORS:
The reflectors shall be made of CRCA steel sheet / aluminium / silvered glass / chromium plated sheet copper as required. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/vitreous enameled/ epoxy coating finish for the reflectors shall be as specified. The reflectors shall be free from scratches blisters and shall a smooth and glossy surface with optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

LAMP / STARTER HOLDERS:
Lamp holders shall have low contact resistance and shall be resistant to wear. They shall hold lamps in position under normal conditions of shock and vibration prevalent in an industrial atmosphere.

Lamp holders for fluorescent lamps shall be of spring loaded bi-pin rotor type. Live parts of the lamp holder shall not be exposed during insertion or removal of the lamp or after the lamp has been taken out.

Lamp holders for incandescent and mercury vapour lamps shall be bayonet type up to 100 W and Edison screw type for higher wattage.

Starter holder for fluorescent lamps shall be so designed that they are mechanically robust and shall be capable of withstanding shocks during transit, installation and use.

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

The capacitor shall have a value of capacitance so as to correct the power factor of its corresponding lamps circuit to 0.95 lag or better capacitor shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnate and ingress of moisture.

LAMPS:
Lamps shall be of LED/PL/SL/incandescent as specified type in BOQ. Fluorescent lamps shall be "day light colour" type unless otherwise specified and shall be provided features to avoid blackening of lamp ends.

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

Lamps shall be capable of withstanding vibrations prevalent in an industrial atmosphere and connections at lend in wires and filament/electrodes shall not break under such circumstances.

15.0 GENERAL REQUIREMENT OF 1.1KV WIRING SYSTEM

SYSTEM OF WIRING:

The system of wiring shall consist of FRLS insulated copper conductor wires in Heavy duty PVC conduits for concealed installation and 14 Swg metal conduits for surface installations as called for.

GENERAL:

Prior to laying and fixing of conduits, the Contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and size of conduits, locating of junction boxes, size and location of switch boxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the Consultant/employer. Any modifications suggested by the Contractor shall be got approved by the consultants before the actual laying of conduits is commenced.

Generally concealed electrical wiring installation shall be in heavy duty PVC conduits and surface wiring in MS conduits.

MS CONDUITS:

Conduits and accessories shall conform to IS: 9537-Latest and the specifications given below. MS conduits shall be of black, round, heavy gauge Milled Steel (MS). The internal surface of the conduit shall be smooth. All flexible conduits shall be of steel. Only approved quality as recommended by the consultant and factory made bends/accessories shall be used.

Conduits and Accessories shall conform to IS: 9537 (Latest) and tender specifications. The steel conduits shall be solid drawn, mild steel, 16 gauge, heavy duty electrical welded, thread type, having perfect circular tubing with tight fitting joints and shall be capable of being cleaned easily. The conduit shall be protected from rust by one coat of paint applied inside and outside in its manufactured form.

Minimum Conduit Dia (OD) For Electrical Wiring Shall Be 25.0 mm.

Minimum Conduit Dia (OD) For Telephones and Audio/Video shall be 19.0 mm

Joints between conduits and accessories shall be securely made, to ensure earth continuity.

Where called for, buried wiring passing underground, shall run in galvanized steel conduit.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer. This shall be approved by respective Engineer-in-charge and same shall be submitted along with bills for payment.

The number of 650/1100 volts grade insulated copper conductor wires that may be drawn in the conduits of various sizes are given below. The space occupied by the wires shall not exceed 60% of the conduit Internal Area and 40% of conduit space should be left free.

Maximum permissible number of 650/1100 volt grade insulated wires that may be drawn into rigid non-metallic or MS conduits are given below:

Size of Wire Sq.mm	Maximum Number of wires within conduit of size (mm)				
	19	25	32	38	51
1.5	-	6	10	14	-
2.5	-	5	10	14	-
4.0	3	5	10	14	-
6.0	2	5	8	11	-
10.0	-	4	7	9	-
16.0	-	2	4	5	12
25.0	-	-	2	2	6
35.0	-	-	2	5	-

BENDS IN CONDUIT:

Conduit bends shall be of 14 SWG. Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet terminations. In case of recessed system each junction work shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 2½ times the outside diameter of the conduit. Ready-made bends shall be used where required.

Run of conduit pipes through expansion joints in RCC member should be avoided as far as possible and if unavoidable, flexible conduit pipe shall be used with ceiling outlet box on both sides of expansion joints, after getting approval from the Consultant.

Outlet boxes for lights/fans shall be protected at the time of laying by filling with jute/earth/cotton etc.,

Locating junction boxes on outer surface of exterior walls of building should be avoided to prevent exposure to weather as also to preserve aesthetics.

Junction boxes should never be closed permanently by plaster. The covers of the boxes should match the colour of the wall.

Junction boxes inside the guest room/areas shall be avoided. In case these are unavoidable they can be located in toilet/corridor/service areas/stores etc., One bolt shall be welded to receive earth wire inside all switch points.

All switch points shall be fixed at a level accessible from floor level.

Conduits in wall crossing area shall be sealed with M-Seal/epoxy compound after pulling the wires.

SWITCH OUTLET AND JUNCTION BOXES:
All concealed outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of thick Galvanized steel (GI) boxes having smooth external and internal surfaces.

All outlet boxes for receiving plug sockets and switches shall be of standard factory make and of approved size, and shape. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall have a minimum depth of 65 mm.

LIGHT OUTLET BOXES:
The Light Outlet Boxes for concealed installation shall be round in shape and shall be made of MS knock out holes/projections to connect MS pipes. Light outlet boxes for surface installation shall be of MS (painted).

INSPECTION BOXES:
Rust proof inspection boxes of 2 mm thick mild steel having smooth external and internal finish shall be provided to facilitate removal and replacement of wires, where required.

FAN OUTLET:
For fixing of ceiling fans, circular outlet boxes made of 16 SWG steel sheet, 100 mm diameter, complete with fan hook fabricated art of 12 mm dia mild steel rod.

SWITCHES, RECEPTACLES AND FIXTURES:

SWITCHES:
All 5/15 amps switches shall be enclosed type flush mounted for 240 volts AC. The box in which the switches are fixed shall have an adjustable plate cover. Ample space at the back and sides shall be provided for accommodating wires. Switch, controlling the light point shall be connected to the phase wire of the circuit. The Switch plate shall be white plastic or any other approved type and it should match the interior design.

WALL SOCKET OUTLETS:
Following types of socket outlet shall generally be used for interiors:
All sockets shall be of shutter type.5A 3 Pin Switched Socket outlet in guest rooms, Toilet, office area, lobby, restaurant etc.,5A 3 Pin switched socket outlet for TV supply with Independent 5A SP Control switch near the bedside.

15/5A 3 pin switched socket with Indicator for power points.

15A, 5 pin domestic plug point for using mixie, microwave oven etc., should be provided. Guest rooms kitchen, main kitchen and split AC units, etc., shall only be operated by metal clad industrial type socket and plug with suitable rating of MCBs of any one of the following combinations as per design and rating of the equipment's used. In pantry area, where the domestic appliances are used, flush type switches and sockets can be fixed.

16 Amps SP Industrial type socket controlled by 16 Amps SP MCB mounted on a fabricated MS box with cover plate.

20 Amps SP Industrial type socket controlled by 20 Amps SP MCB mounted on a fabricated MS box with cover plate.

32 Amps S.P/T.P 230V/415V, Industrial type socket controlled by 32 Amps S.P/T.P. MCB mounted in a fabricated MS box with cover plate.

No electrical cable/temporary cabling shall be allowed at floor level for connecting any equipment on any account.

INSTALLATION OF CONDUITS:

CONCEALED CONDUIT SYSTEM:
Unless otherwise specified all wiring shall be in heavy gauge rigid PVC conduit embedded in wall, or ceiling and Surface type MS conducting above false ceiling. The size of the conduit shall be selected in conformity with relevant IS code and as specified in the table 6.8.3.b.6 given above. Factory made conduit bends and accessories shall be used. MS conduit shall be jointed using solvent cement as recommended by the conduit supplier. The conduit in ceiling slab shall be straight as far as possible. Before the conduits are laid in the ceiling, the position of the outlet points, controls, and junction boxes shall be set out clearly as per the dimensions and to minimize off-sets and bends. Conduits in ceiling shall be bonded to the reinforcement rods with GI bonding wire to secure them in position. MS light outlet/pull boxes shall be provided as required. The conduit in ceiling slab shall be laid above the first layer of reinforcement rods to avoid cracks in the ceiling surface.

Conduits concealed in the wall shall be secured rigidly by means of steel hooks/staples at minimum 750 mm intervals. Before conduit is concealed in the walls, all chases, grooves shall be neatly made to proper required dimensions to accommodate number of conduits.

The chased portion of the walls for electrical works shall be plastered by electrical Contractor to bring it to the finished wall surface. The outlet boxes, control switches, and inspection and draw boxes shall be fixed as and when conduits are being fixed.

The recessing of conduits in walls shall be so arranged as to allow at least 12 mm plaster cover on the same. Where conduit passes through expansion joints in the building, adequate expansion fitting or other approved devices shall be used to take care of the relative movement of expansion joints.

All grooves, chases etc., shall be refilled with cement mortar and finished up to wall surface before plastering of walls is taken up by the general civil Contractor. Whenever the conduits terminate into Control Boxes, distribution boards etc., conduits shall be rigidly connected to the boxes/boards with check nuts on either side of the entry to ensure electrical continuity. All opening of conduits, junction boxes shall be properly plugged with MS stoppers or any other suitable materials, so that water, mortar, vermin or any other foreign materials do not enter into the conduit system. All conduit ends terminating into an outlet shall be provided with bushes of MS or rubber after the conduit ends are properly filed to remove burrs and sharp edges. Necessary GI pull wires shall be inserted into the conduit for drawing wires. The Insulated Earth wires shall be run in each conduit originating from the panel board up to the Light, Socket and Switch boxes. If the Electrical Contractor forgets to install any conduit/boxes etc., before the plastering/painting work is done by other agencies, he may be permitted to install the same with prior permission of Owner/Consultant and the expenses towards redoing the wall, floor, ceiling etc., shall be borne by the Electrical Contractor.

OPEN/SURFACE CONDUIT SYSTEM:
Conduits on surface of **treated walls**/RCC slabs shall be avoided as far possible. In case it is not avoidable, prior approval in writing shall be obtained from Employer/Consultant on the exact route. Heavy gauge GI saddles shall fix conduit. Distance between two consecutive saddles shall not exceed 900 mm. No wooden gutties for fixing saddles/clamps shall be used. Use of Rawl plug/steel fastener with hard setting/scaling compound is recommended. Conduits shall be run in square and by metrical lines. Wherever couplers, bends, or similar fittings are used, saddles shall be provided at either side at a distance of 300 mm from the center of such fittings. Conduits shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers/junction boxes shall be provided.

Threading shall be long enough to accommodate pipe to the full threaded portion of the Couplers and accessories. Cut ends of conduits shall have neither sharp edges nor any burrs left, to avoid damage to insulation's of wires.

Using pipe-bending machine shall do bends in conduit runs. Sharp bends shall be accomplished by introducing solid bends, inspection bends or cast iron/ MS inspection boxes. Radius of solid bends shall not be less than 75mm. Not more than 90-degree bend shall be used in a conduit run from outlet to outlet.

All conduits opening shall be properly plugged with MS stoppers/bushes. Conduits shall be adequately protected against rust by applying two coats of approved synthetic enamel paint after the installation is completed and should be certified by the Site Engineer. The certificate shall be submitted along with bills for payment.

Wherever conduits terminate into control boxes, outlet boxes, distribution boards etc., it shall be rigidly connected to the box with check nuts on either side of the entry.

In ground floor, conducting below the flooring should be avoided. Wherever it is unavoidable, GI pipe should be used with prior approval of Employer/Consultant.

The entire conduit system shall be bonded to the earth.

WIRING:

All wires shall have been manufactured in accordance with the latest IS Specification (IS 694 - Part II).

All wires shall be FRLS insulated, copper conductors of 650-volt grade. Cross section of the conductor shall be as per the specification mentioned in schedule of quantities.

Minimum cross section of conductor for electrical wiring shall be 2.5 mm square.

For single phase wiring, the colour of the insulation of phase conductors shall be Red / Yellow / Blue and black for neutral. The colour coding adopted should be uniform for the entire Project.

Earthing is to be done by Green FRLS insulated copper conductor. For three phase the insulation of phase conductors shall be Red/Yellow/Blue, as per relevant phase and Black for neutral.

Earth wire shall always be of copper conductor FRLS insulated and colour of insulation shall be Green.

Whenever wires are being terminated in a Distribution Board/Switch Box/Plug point / Outlet Box etc., a minimum of 200 mm long extra wire should be provided in the form of a loop for further maintenance use.

For each lot of wires, the Contractor shall submit all relevant test certificates issued by the Manufacturer stating its origin, date of manufacture, constitution and standards to which it complies. All wires and cables shall bear the manufacturer's label and shall be brought to site in original packing.

Only Authorized / certified wiremen and cable jointers shall be employed to do the cable jointing work.

Wires shall not be jointed inside the conduit or pull boxes. Where unavoidable, joints shall be made through approved mechanical connectors with prior permission of Employer/Consultant.

Control switches shall be connected in the phase conductors only; and shall be 'ON' when knob is down. Switches shall be fixed in galvanized steel boxes. Plated screws shall be used.

Power wiring shall be distinctly separate from lighting wiring.

Each circuit phase wire from the distribution boards should be followed with a separate neutral wire of the same size as that of the circuit wire.

Wires originating from two different phases shall not run in the same conduit.

DRAWING CONDUCTORS:

The drawing and jointing of MS insulated copper / aluminium conductor wire and cables shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches, etc., Care shall also be taken to ensure that the insulation is not peeled off either in portions or as a whole; and the conductor is not broken anywhere. There shall be no sharp bends that may lead to the breakage of the conductor.

FRLS Insulated copper conductor wire ends shall be soldered (at least 20 mm length) before inserting into the switch for termination and Conductors having nominal cross sectional areas exceeding 10 Sq.mm shall always be provided with cable sockets/lug of same material as that of conductor.

Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional area to take all strands and shall be soldered. Connecting brass screws shall have flat ends. All looped joints shall be soldered and connected through block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

At all bolted terminals, brass flat washer of large area and approved steel spring shall be used. Brass nuts and bolts shall be used for all connections.

For all internal wiring, FRLS insulated wires of 650/1100 volts grade shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. If the uses of joint connections are unavoidable due to any specific reason, prior permission, in writing, shall be obtained from the Owner / Consultant. No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire, is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of wire. Before the wires are drawn into the conduits, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other construction debris, by forcing compressed air through the conduits. All sub-circuit wiring for light points shall be with 2.5 Sq.mm FRLS insulated copper conductor.

MAINS AND SUB-MAINS:

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub-main wire shall be drawn into an independent adequate size conduit. An independent earth wire of the proper rating shall be provided for each sub main, two earth wires of proper rating shall be provided for every single phase sub main. For every 3-phase sub main, two earth wires of proper rating shall be provided along with the sub main. The earth wires shall be fixed to conduits by means of clips at not less

than 1000 mm distance. For mains and sub-mains extra lengths of cable shall be provided to facilitate easy connections and maintenance.

LOAD BALANCING:
Balancing of circuits in three phase installation shall be planned before the Commencement of wiring and shall be strictly adhered to.

COLOUR CODE OF CONNECTORS:
Colour code shall be maintained for the entire wiring installation as red, yellow, blue for three phases, black for neutral.

MEASUREMENTS:

POINT WIRING:

All outlets connected on a lighting circuit shall be measured under point wiring. It shall Include wiring from switch point of the circuit up to light, fan, socket outlet via switches, regulators, controls etc., as called for. Generally, the following accessories shall be included.

- Light outlet box with ceiling rose
- Lamp holder
- Switches
- 5/15 A socket outlets with plug tops
- M.S./G.I. outlet box
- Fan hook
- Fan regulator
- Small wiring from outlet to Fan/Light
- Conduit and accessories
- Circuit main for light circuit

Circuit main/ sub circuit main is inclusive in the point wiring (i.e. wiring from mcb's in DB to First Switch Box/Switch Box to Switch Box looping) and however wherever called for separately in the BOQ alone shall be measured in length from the Distribution Board/Panel Board up to the first switch box on that circuit only; from Switch Box to Light Point for single control Light point and for group control Light Point all the points connected to a single switch will be termed as group light point.

GENERAL:
Point wiring and circuit wiring should be done in independent conduits and should not be taken through one conduit.

Fan regulator box, fans, light fittings, calling bells are to be properly earthed. In respect of 5 Amps conventional plug point, the third pin should be earthed with 2.5 Sq.mm green FRLS insulated copper wire.

All flush type switches and accessories will be used with 3-mm thick hylam sheet in MS box.

For the purpose of determining the load per circuit. The following electric rating of points shall be assumed.

Light point	:	60 watts
Conventional plug point	:	100 watts
(Plug point in light switch box or independent)		
Fan points	:	60 watts
Exhaust fan points	:	40 watts or as specified

Lights, fans and 5 A points shall be wired on a common circuit. Each circuit shall not have more than a total of ten points of lights, fans and 5 A socket outlets or a load of 800 watts whichever is less. The ceiling fan point shall be complete with special outlet box including fixing and connection of regulator. Supply and fixing of 5A switch for each ceiling fan is included in scope of Contractor.

FOR 15A POWER PLUG POINTS:
In one circuit, there shall not be more than two 15A power plug points and 2 x 4 Sq.mm copper conductor wires shall connect circuit.

One flush type plug socket outlet and switch shall be fixed for each power point on 3mm thick hylam sheet cover. Plug socket can be standard type or 15/5 A universal type as shown in the diagram. The circuit main would commence from DB and end up to the switch box. Looping of circuit would be done to second 15A power point from first 15A power point and shall be counted as power point wiring.

Each circuit would have its own 2.5 Sq.mm green FRLS insulated copper wire from DB to switch box and would be connected to third pin of socket outlet.

Electrical load for each 15A power point would be considered as 1000 watts.

GROUP WIRING:

The following specification is applicable only when three or more lights (or) more than 500 watts of lighting load are controlled by one MCB / Switch.

Lights would be controlled by rated capacity MCB/switch and connected by wire size, as specified in schedule of quantities. However, it shall not be less than 5A and 2.5 sqmm respectively.

MCB/Switch for these lights should be installed in a suitable MS box with hylam / Front Plat as per OEM.

Total electric load is to be controlled from each of the single Phase MCB DB shall not exceed 3000 watts or six groups of lights or as specified in the approved drawings. Circuits with earthing for this Group Lighting Board would always be from DB of size as specified in schedule of quantities.

“Group lights” points would commence from DB including circuits, surface/concealed conduit system, necessary wiring, MS switch box, M.C.B, hylam sheet cover and outlet box up to last light of the group.

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16.0 GENERAL REQUIREMENT OF STREET LIGHTING

SPECIFICATION FOR STREET LIGHT POLES:
The Street Light Poles shall be of steel tubular type with suitable arrangement at the top of the pole for fixing the lighting fixture. Poles shall be fabricated out of MS medium class pipes seamless type, in two or three stepped sections as per design and drawings. For reducing the section of street light poles for stepped design, “swaging” process only shall be used. Each pole would have one MS water tight box fabricated out of 16 SWG steel sheet complete with a suitable way connector, neutral link rewirable fuse etc., as per design and drawing. The pole shall be painted with one coat of anti-corrosive oxide primer before

dispatch to site and two coats of enamel/aluminium paint of approved make and shade after installation.

The earthing of each street light pole shall be carried out by connecting the Armour of the cable to the Earth Electrode, as specified in the design.

BRACKET FOR STREET LIGHT FITTINGS ON BUILDINGS:

The brackets shall be made of specified size NB MS class 'B' pipe approx. 1.8 M long, bent at the center at an angle of 120 degree, with necessary holding brackets, hold fasts etc. with special reducer at end to accommodate type of street light fitting to be fixed. The bracket shall have one coat of anti-corrosion paint before dispatch to site and two coats of approved make and shade of enamel paint.

INSTALLATION OF POLES:

Installation of poles shall be done as per design and drawing. The depth of pole to be buried in ground shall be 1/5th of total pole length or as specified in drawing, whichever is more. Special care shall be taken in erecting poles so that these are not strained or damaged during erection and are firmly stayed till the foundation is secured.

The pole shall be grouted inside ground pit (cross section 600 x 600 mm) with cement concrete 1:2:4 with necessary GI 'A' class pipes (not less than 38 mm dia, NB) to facilitate pulling of cables. Separate pipes shall be provided for incoming and outgoing cables. The cement concrete shall be protected from premature drying by curing for at least seven days after pouring. All concrete surfaces from 150 mm below ground level to top shall be finished smooth with cement mortar 1:4.

INSTALLATION OF STREET LIGHT FIXTURES:

This includes fixing of streetlight fitting complete with accessories and lamps at the end of the pole/bracket, connecting it with designed capacity and size Aluminum conductor, PVC insulated cable from water tight MS box, testing and commissioning. The third core shall be connected to earth point of marshaling MS box at the other end. If the pole has more than one light fitting, each fitting should have independent wiring from MS Box to fitting.

Fixing of street light fittings on bracket (6.10.2 above) is in Contractor's scope and also it includes the supply, fixing of necessary conduit between MS Box and fitting.

INSTALLATION OF POST TOP LANTERN FOR ENTRANCE GATE:

This includes providing and fixing of specified size NB GI class 'B' pipe of 1.5M long in brick/RCC column, including MS water tight box (specification same as that of street light pole) and installation of post top lantern complete with all accessories and lamp, connecting it with designed capacity and size Aluminum conductor PVC insulated flexible cable, testing and commissioning. Painting of the exposed portion of the pipe with two coats of approved make and shade of enamel paint is also included.

FOR OPEN GROUND:

This includes providing and fixing of specified size MS class 'B' pipe of total length 4M (including 1 M in ground to be grouped with 450 x 450 x 1000 mm cement concrete 1:2:4) and water tight switch box (size 200 x 150 mm) fabricated out of 14 SWG steel sheet complete with a suitable way connector, neutral link and rewirable fuse etc., installation of post top lantern complete with all accessories and lamp connecting it with designed capacity and size Copper conductor, PVC FRLS insulated flexible cable, testing and commissioning. Painting of exposed pipe length with 2 coats of approved make and shade of enamel paint is also included.

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17.0 GENERAL REQUIRMENT OF LIGHTNING ARRESTOR

EXTERNAL LIGHTNING PROTECTION SYSTEM AS PER INTERNATIONAL & NATIONAL STANDARDS - IS IEC 62305-3/& IS 3043

GENERAL:
Lightning Protection System shall be in accordance with IS IEC 62305-3 & IS 3043

ZONE OF PROTECTION:
The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

LPL (Lightning Protection Level):
LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS IEC 62305-2.

LPL levels and probability of protection:

Lightning protection Class	Lightning current peak value MINIMUM	Lightning current peak value MAXIMUM	Interception probability
LPL 1:	3 kA	200 kA	98%
LPL 2:	5 kA	150 kA	95%
LPL 3:	10 kA	100 kA	88%
LPL 4:	16 kA	100 kA	81%

Components of External LPS:

- Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)
- Down conductor
- Earthing

1) Air termination system:
No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS:

Class of LPL/LPS	Rolling sphere radius (m)	Mesh size (m)	Protection angle
1	20	5*5	Refer figure 1
2	30	10*10	Refer figure 1
3	45	15*15	Refer figure 1
4	60	20*20	Refer figure 1

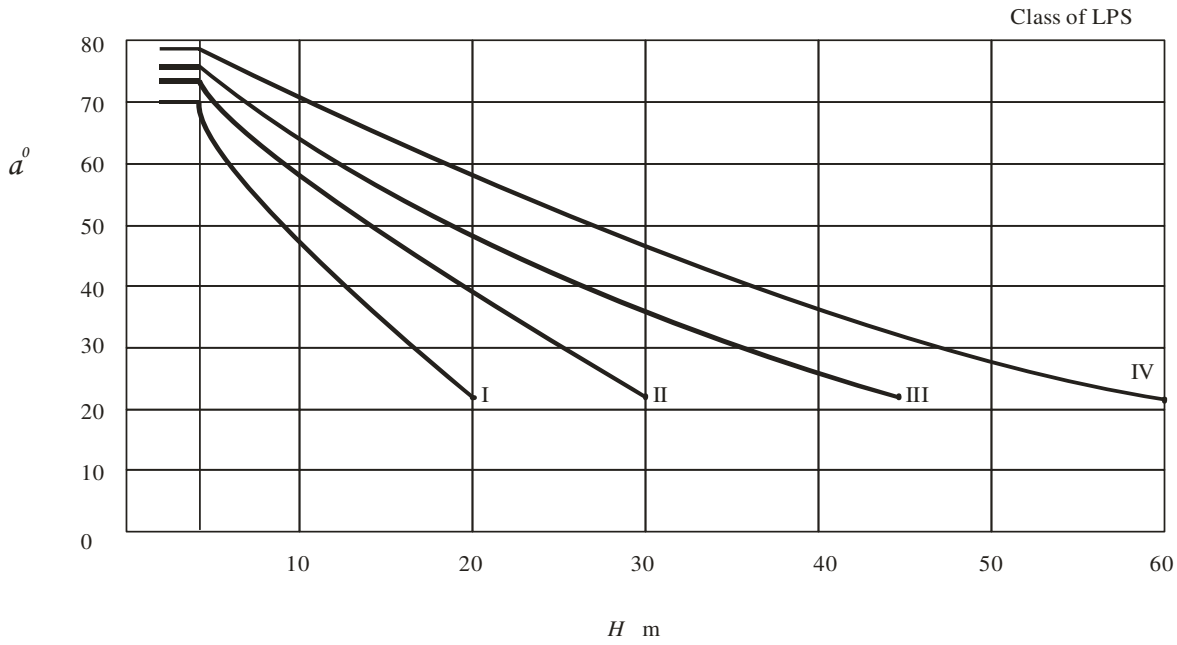

Fig 1.Class of LPS Vs Angle of protection.

If the structure height is more than 60 meters, top 20% of the height of the structure shall be protected with a lateral air termination system. This is needed because, the probability of flashes to the side is generally more for structures more than 60 meters in height. For structures of height more than 120 meters, ring has to be formed for every 20 meters height of the building above 60 meters height.

Material and Dimensions:
Material of air terminal, down conductor, earth termination etc. shall be as below:

Material	May be destroyed by galvanic coupling with
Copper(Solid)	GI and Aluminium
Hot galvanized steel(Solid)	Copper
Stainless steel(Solid)	……
Aluminium(Solid)	Copper

Dissimilar metals (e.g. Copper with Aluminium) must be connected only by using bimetal connectors.

Minimum thickness of metal in air termination system for LPL /LPS:

Material	Thickness (a) in mm	Thickness (b) in mm
Galvanized steel	4	0.5
Stainless steel	4	0.5
Copper	5	0.5
Aluminium	7	0.65

(a) Prevents puncture.

(b) Allowed only if **it is NOT important to prevent** puncture or water leakage.

Material, Configuration and Minimum cross sectional area of air terminal & down conductors

Material	Type	Minimum cross section area	Remarks
Copper	Solid tape	50 sq mm	2mm min thickness
Copper	Solid round	50 sq mm	8mm dia
Aluminum	Solid tape	70 sq mm	3 mm min thickness
Aluminium	Solid round	50 sq mm	8 mm dia
GI	Solid tape	50 sq mm	2.5 mm min thickness
Stainless steel	Solid tape	50 sq mm	2 mm min thickness

AIR TERMINAL HOLDER:

Concrete Roof structure:
Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

Metal Roof structure:
Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning current as per IS IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there are no min. height criteria for metal conductor holder.

Recommended distance between air terminal holders:

Arrangement	Recommended distance for SOLID TAPE	Recommended distance for ROUND conductors
Horizontal conductor on horizontal surface	500 mm	1000 mm
Horizontal conductor on vertical surface	500 mm	1000 mm
Vertical conductor from Ground to 20m height	1000 mm	1000 mm
Vertical conductor above 20m height	500 mm	1000 mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

At the crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IS IEC standard. Vendor has to beprovided proof.

Safety or Separation distance:
It is must to calculate safety or separation distance in order to avoid flash over to the electrical equipment when the lightning current is passing through the vertical air terminal.

Safety/Separation distance(S) in m = (ki * kc*L) / km

Coefficient ki depends on class of LPL/LPS

ki = 0.08 for LPL1,
ki = 0.06 for LPL 2,
ki = 0.04 for LPL3 and 4.

Coefficient kc depends on no of down conductors:

kc = 0.66 for 2 down conductors
kc = 0.44 for 3 or more down conductors

Value of coefficient km = 1

Value of L is the total distance between the equipment to be protected (for e.g. Antenna) to the equi-potential bonding bar situated just above the ground.

Expansion piece:
In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

Joints and Bonds:
The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree bend.

Down conductor system:
In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equi distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum**.** Down conductors can be installed separately or more wisely it can be part of natural components of the building. Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows. Down conductors should be installed at each exposed corner of the structure as a minimum.

Value of distance between down conductors as per Class of LPL / LPS

Class of LPL/LPS	Typical distance (m)
1	10
2	10
3	15
4	20

Test joints:
At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

Earth Terminations
Earth mat is most preferable. Where earth mat is not possible, ring earthing is the next best method. Ring earthing must be 1 meter away from the building and 0.5m below the ground level.

The resistance of earthing system shall not exceed 10 ohm as per IS IEC 62305.
Lower earth resistance is more preferable.

For earth termination system, 2 basic types of earth electrode arrangements are applicable.

Type A& Type B arrangement.

Type A arrangement:
Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor.

In type A arrangement, the total number of earth electrodes shall not be less than two.

Type A arrangement is suitable in places where electronic equipment are not located.

Type B arrangement:
This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length or a foundation earth electrode. Such earth electrodes can also be meshed. For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. Corrosion proofing band has to be used wherever down conductor is connected to earth termination system. Bitumen has to be applied at the point of inter-connection. In potentially corrosive areas, Stainless steel must be used.
References:

IS IEC62305 – PROTECTION AGAINST LIGHTNING:
Part 1: General Principles
Part 2: Risk Management
Part 3: Protection of structures
Part 4: Protection of Electrical & Electronic equipment within structure
IS3043: 1987: Code of practice for earthing.

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18.0 SPECIFICATIONS FOR 30KVA UPS

These specifications describe requirements for a Micro Processor Controlled Uninterruptible Power System. The UPS shall automatically maintain AC power within specified tolerances to the critical load, without interruption, during failure or deterioration of the mains power supply.

The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental, and space conditions at the site. It shall include all equipment to properly interface the AC power source to the intended load and be designed for unattended operation.

STANDARDS:
The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards:

- EN 50091-1-1 (incorporating EN 60950)
- EN 50091-2 (incorporating)
  - IEC 801-2, Level 4
  - IEC 801-3, Level 3
  - IEC 801-4, Level 4
  - IEC 801-5, Level 3
- ENV 50091-3
- EN 60146-4 / IEC 146-4
- EN 60529 / IEC 529
- IEC 364 / CENELEC HD 384

The Quality System for the engineering and manufacturing facility shall be certificated

To conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics.

SYSTEM DESCRIPTION:
For redundant operation, the UPS system shall be sized to provide a minimum of 3**0kVA/24 kW** output.

Load voltage and bypass line voltage will be 400 VAC, three phase and Neutral.
Input voltage will be 400 VAC, three phase.
The battery system shall have a capacity to withstand full load (24 KW) for 30 minutes backup per system.

Modes of Operation:
The UPS system shall operate as a true on-line system in the following modes:

Normal:
The critical AC load is continuously powered by the UPS inverters. The rectifier/chargers derives power from the mains AC power supply source converting this to DC power to supply the inverters, while simultaneously float charging the battery system. Power supplied by the UPS inverters is, to within close tolerances, at rated voltage and frequency.

Emergency:
Upon failure of the mains AC power supply source, the critical AC load is powered by the inverters which, without any switching, obtain power from the battery system. There shall be no interruption in power to the critical load upon failure or restoration of the mains AC power supply source.

Recharge:
Upon restoration of the mains AC power supply source, power to the rectifier/chargers initially is restricted by a gradual power walk-in. Following this relatively short power walk-in period, the rectifier/chargers power the inverters and simultaneously recharge the battery. This shall be an automatic function

Bypass:
If the UPS system must be taken out of service for maintenance or repair, the static bypass switch shall transfer the load to the bypass source. The transfer process shall cause no interruption to the critical load.

Off-Battery:
If the battery system only is taken out of service for maintenance, it is disconnected from the rectifier/charger and inverters by means of external disconnect breaker. The UPS shall continue to function and meet all of the specified steady-state performance criteria, except for the power outage back-up time capability.

PERFORMANCE REQUIREMENTS:
The UPS is VFI classified (according to CEMEP / ENV 50091-3) producing an output waveform that is independent of both the input supply frequency and voltage

UPS AC Input

Voltage Range: 415 ±15%

Frequency Range: 50 Hz ±5%

In-rush Current Limiting: 20% to 100% of full rated current over 10 seconds.

Power Factor: minimum 0.9 @ Full Load.

2-Step Input Current Limit: Maximum of 120% normal full load input current. (100% for generator operation.)

Temperature Compensated Charging: Above 25ºC the battery charge voltage should be reduced by 2mV per cell per ºC in order to optimise on the battery lifetime.

Current Distortion: Less than 5 % THD at full load current.

UPS Output

Load Rating: 100% continuous load rating at 40ºC for any combination of linear and non-linear loads

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Voltage Regulation: 1% steady state for balanced load, 2% for 100% unbalanced load.

Frequency Regulation: ± 2Hz synchronized with bypass source, ± 0.01Hz free running or on battery operation.

Frequency Slew Rate: 0.1Hz per second.

Efficiency: Defined as output kW / input kW at a load power factor of 0.8 lagging: Not less than 93 % at full rated load when operating as a true on-line configuration with **harmonic reduction options.**

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Phase Imbalance:

120º ±1º el. for balanced loads.

120º ±1º el. for 100% unbalanced loads

Voltage Transients: ± 5% for 100% output load step.

Transient Recovery Time: To within 1% of steady state output voltage within 20ms

Voltage Distortion (at 100% rated load with crest factor 3:1):
~1% typical
≤3% Ph/Ph voltage total harmonic distortion (vTHD) for non-linear loads
<5% Ph/N voltage total harmonic distortion (vTHD)

Overload Capability at Rated Output Voltage:
110% of rated load for 60 minutes.
125% of rated load for 10 minutes.
150% of full load for a minimum of 1 minute.

UPS System Bypass

Voltage Range: 415 ±15% (adjustable ±1% to ±99%)

Frequency Range: 50Hz ± 2Hz.

Overload Capability:

10.0 times rated current for 10ms

Neutral Conductor Sizing: 1.5 times rated current.
Earthing

The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment earth terminal. Provisions for local bonding are to be provided.

ENVIRONMENTAL CONDITIONS

Operating Ambient Temperature:
UPS: 0ºC to 40ºC without derating.
Battery: 25ºC for optimum battery performance.

Storage/Transport Ambient Temperature:
UPS: -20ºC to 70ºC.
Battery: 20ºC for optimum battery storage.

Relative Humidity:
0 to 95%, non-condensing.

Altitude:
Operating: To 1000 m above sea level without derating.

UPS Delivery Submittals:

The specified UPS shall be supplied with 2 user manuals to include details of Functional description of the equipment with block diagrams.

Detailed installation drawings, including all terminal locations for power and control connections for both the UPS and battery system.

Safety precautions.

Step-by-step operating procedures

General maintenance guidelines

The UPS shall be supplied with a record of pre-shipment final factory test report.

QUALITY ASSURANCE

Manufacturer Qualifications:
A minimum of fifteen years experience in the design, manufacture and testing of solid-state UPS systems is required. The manufacturer shall be certified to ISO 9001.

Factory Testing:
Before shipment, the system shall be fully and completely tested to ensure compliance with the specification.

PRODUCT

Materials:
All materials of the UPS shall be new, of current manufacture, high grade and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All electronic components shall be accessible from the front without removing sub-assemblies for service access.

Wiring:
Wiring practices, materials and coding shall be in accordance with the requirements of EN. All electrical power connections shall be torqued to the required value and marked with a visual indicator. Provision shall be made in the cabinets to permit installation of input, output, and external control cabling. Provision shall be made for either top or bottom access, allowing for adequate cable bend radius, to the input and output connections.

Construction:
The UPS shall be housed in an IP20 enclosure, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling. Maximum cabinet height shall be 1.9 meters. The UPS panel shall be fabricated with Cold Rolled MS sheet of thickness not less 1.8 mm. with proper supporting member.

Cooling:
Adequate ventilation shall be provided to ensure that all components are operated well within temperature ratings.

Temperature sensors shall be provided to monitor UPS internal temperature. Upon detection of temperatures in excess of manufacturer's recommendations, the sensors shall cause audible and visual alarms to be sounded at the UPS control panel. A separate room ambient temperature sensor shall be provided to allow control of the battery charging voltage with change of temperature.

No clearance shall be required at the rear of the UPS for the purpose of ventilation or otherwise.

UPS System:
The UPS system shall consist of 1 Nos. of 30 KVA modules, battery disconnect breakers and battery systems.

UPS system should be True ON Line double conversion type with Micro Processor Controller. Each Unit shall consist of a rectifier/charger and three-phase inverter with associated static transfer switch, protective devices, and accessories as specified.

System Protection:
The UPS shall have built-in protection against: surges, sags, and over-current from the AC source, over voltage and voltage surges from output terminals of paralleled sources, and load switching and circuit breaker operation in the distribution system. The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting current limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off line. The load shall be automatically transferred to the bypass line uninterrupted, should the connected critical load exceed the capacity of the available on-line modules. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

COMPONENTS

Rectifier/Charger;
The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert AC to regulated DC for input to the inverter and for charging the battery.
Input Current Total Harmonic Distortion: The input current THD shall be < 5% at full load current.

AC Input Current Limiting:

The rectifier/charger shall include a circuit to limit AC input current to 120% of the full input current rating. An optional secondary circuit shall provide limiting to 100% on receipt of an external low voltage signal, i.e. during generator operation.

Battery Charge Current Limiting:
The rectifier/charger shall include a circuit to limit the battery charging current to 20% of maximum battery discharge current. An optional secondary circuit shall reduce the charging current to 0% on receipt of an external low voltage signal, i.e. during generator operation.

Battery Charge Compensation:
The rectifier/charger shall automatically adjust the battery float charging voltage by ±2mV per cell per ºC when used in conjunction with an optional remote temperature sensor.

Input Power Walk-in:
The rectifier/charger shall provide a feature that limits the total initial power requirements to 20% of rated load, and gradually increases power to 100% of full rating over a 10 second time interval.

Input Isolator:
The rectifier/charger shall have an input isolator and shall be fuse protected. The isolator shall be of the frame size to supply full rated load and recharge the battery at the same time, and shall withstand a short circuit current of up to 100 kA rms.

Fuse Protection:
Each AC phase shall be individually fused with fast acting fuses so that loss of any semiconductor shall not cause cascading failures.

DC Filter:
The rectifier/charger shall have an output filter to minimize ripple current in to the battery. The AC ripple voltage of the rectifier DC output shall not exceed 1% rms of the float voltage. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter without the battery connected.

Battery Recharge:
In addition to supplying power to the load, the rectifier/charger shall be capable of producing battery charging current sufficient to replace 95% of the battery discharge power within ten (10) times the discharge time. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

Inverter:
The term inverter shall denote the equipment and controls to convert DC from the rectifier/charger or battery to provide AC power to the load. The inverter shall be solid-state, capable of providing rated output power. For increased performance, the inverter shall be a pulse width modulated (PWM) design and utilise insulated gate bipolar transistors (IGBTs), switching at high frequency in order to minimise output voltage distortion. Output of inverter should pass through a K rated transformer to load.

Overload Capability:
The inverter shall be able to sustain an overload across its output terminals up to 150% with ±1% output voltage regulation. The inverter shall be capable of supplying at least 150% current for short circuit conditions.

Output Frequency:
The inverter shall track the bypass mains supply continuously providing the bypass source maintains the rated frequency (of either 50 or 60Hz) ±2Hz. However, the range can be set. The inverter will change its frequency at 0.1Hz per second (adjustable 0.1 to 1.0Hz per

second) to maintain synchronous operation with the bypass. This shall allow make-before-break manual or automatic transfers of the load between the inverter and the bypass mains supply. If the bypass mains supply frequency falls outside of these limits, the inverter shall revert to an internal oscillator which shall be temperature compensated and hold the inverter output frequency to within ±0.01Hz of the rated frequency for steady state and transient conditions

Phase-to-Phase Balance:
System logic shall provide individual phase voltage compensation to obtain phase balance ±1% under all conditions including up to 100% load unbalance

Fault Sensing and Isolation:
Fault sensing shall be provided to isolate a malfunctioning inverter from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits. The inverter output static switch shall be switched off to isolate a malfunctioning module from the critical load.

Battery Protection:
The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Shutdown of the inverter shall be initiated when the battery has reached the end of discharge (EOD) voltage. The battery EOD voltage shall be calculated and automatically adjusted for reduced load conditions to allow for extended autonomy periods without damage to the battery. Automatic shutdown control shall not be a function of discharge time.

Bypass Static Switches: Static bypass switches should be provided in UPS.

Manual Load Transfers:
A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel. A means to perform manual transfers remotely shall be made available as an optional extra.

Automatic Load Transfers:
An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload or short circuit condition is sustained for a period in excess of the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads shall initiate an automatic retransfer of the load back to the inverter only after the load has returned to a level within the rating of the inverter source

Maintenance Bypass:
A fully rated bypass circuit shall be fitted in the UPS to provide an alternative path for power flow from the alternate AC supply to the critical load for the purpose of maintaining all the UPS modules while they are completely powered down.

Display and Controls

UPS Display and Control Panel:
Each UPS shall be equipped with a alphanumeric LCD display. This shall automatically provide all information relating to the current status of the UPS or the system, respectively, as well as being capable of displaying metered values. The display shall be menu-driven, permitting the user to easily navigate through operator screens.

Metered Values:
A microprocessor shall control the display functions of the monitoring system. All three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accurate (±1%) representation of non-sinusoidal waveforms typical of computers and other sensitive loads.

Power Flow Mimic:
Each UPS shall be equipped with a mimic to indicate power flow to the critical load along with an indication of the availability of the rectifier mains supply, battery supply and the alternate AC mains bypass supply. Under normal operation, the UPS mimic shall also display the amount of charge stored in the battery system. During mains failure, the battery charge indication will alternate to identify the remaining battery autonomy time; as well as indicating low battery voltage conditions.

Alarms and Status **Information:**

Alarm and status conditions shall be reported at UPS system. Each alarm shall be visually displayed in text form and an audible alarm will sound for each alarm displayed.

Communications

SNMP/HTTP Network Interface Card:
The UPS shall have internally fitted, network interface card to provide all alarm status information as SNMPv1 traps for connection to a 10-baseT Ethernet connection. In addition the same card will also transmit the same status information and all measured parameters for display at a web browser in LAN/WAN.

BMS CONNECTIVITY:

The system shall be compatible with Building Management System. BMS connectivity can be achieved through MOD BUS Protocol.

Battery Circuit Breaker (BCB):
Each UPS module shall have a properly rated circuit breaker to isolate it from the battery. This breaker is to be housed in a separate enclosure, or mounted inside an optional battery cabinet. When the BCB is open, there shall be no battery voltage inside the UPS enclosure. Each UPS module shall automatically be disconnected from the battery by opening its breaker when it reaches the minimum discharge voltage level or when signaled by other control functions.

BATTERY
Sealed Maintenance Free Batteries of suitable capacity for 30 minute backup for each 30 KVA UPS shall be supplied. Batteries shall have a minimum life of 5 years. The inter connection between batteries shall be carried with appropriate size of copper cables.

DATA SHEET FOR 30 KVA UPS

30 KVA, UPS unit and sealed maintenance free VRLA battery bank to run it for half (½) hour at full load.

Topology: Voltage & Frequency Independent VFI-SS-111 conforming to IEC62030-3, true online double conversion scheme, with input isolationtransformer

Input

Nominal Voltage	415 V AC, ± 15%, 3 phase, 4 wire
Nominal Frequency	50 Hz, ± 3%
Power factor	≥ 0.99 with full load
Current Harmonic Distortion	<3%
Protection	Input Phase reversal protection

Output

Power In KVA	≥ 30 KVA
Voltage	400 V / 415 V AC (± 1%) 3 Phase
Frequency	50 Hz (± 0.1 Hz)
Waveform	Sinusoidal
Total Harmonic Distortion	<1.5 % max linear load
Overloaded capacity	≥ 125% for 10 minutes
Inverter efficiency	≥ 93%
Bypass	Manual
Operating temperature	0-40 ^{O}C
Relative humidity	Max. 95% (non-condensing) at 25°C
Ventilation	Forced Air cooling
Testing standard	IEC 62040-3
Safety and EMC	CE, IEC6040-1 and IEC 62040-2
Emergency Power off	Remote /manual
Interface and protocol	1) RS232 or Galvanic isolated Ethernet 10/100 T RJ45 or higher 2) SNMP card for monitoring status using network system (IPV4 or IPV6) 3) Necessary software for remote monitoring though PC

Alarms and protections

Input voltage:	Under voltage, Over voltage
Rectifier	Over voltage, Under Voltage, IGBT/SCR limb fault, Overload/Overload trip, Over temperature
DC bus :	Over voltage
Battery :	Discharging, Under voltage, End of battery discharge
Inverter	Over voltage, Under voltage , IGBT limb fault Over load, Overload shutdown /Overload trip (inverse time) Over temperature
Alternate	Over voltage, Under voltage, Frequency out of range
Static switch	Transfer to bypass
MCCB with Micro- processor based release	At input and output

Indications

LCD/LED Mimic	Comprehensive with the single line power flow dia.
Bypass input :	Absence, within range, out of range
Mains input :	Absence, within range, out of range
Charger operation :	ON, OFF, Trip
Charging level	Battery discharge
Battery operation :	Boost Charge, Float Charge, Discharge
Battery MCCB :	ON, OFF
Inverter operation :	ON, OFF, Trip
Load on inverter :	Inverter SSW ON, Inverter SSW OFF
Load on bypass :	Bypass SSW ON, Bypass SSW OFF
Synchronization :	Synch., No synch.
Common alarm indication	Any alarm present

Battery

Battery	Long life **2V Cell**, sealed maintenance free, valve regulated lead-acid (VRLA) type with 30minutes backup on 30 KVA UPS. The minimum AH of the battery should be given with detailed calculations to substantiate the AH ratings arrived/ offered for 30 minutes backup for a load of 30 KVAUPS.
Battery VAH (Total) (guide line of batterycalculation for VAHcalculation)	≥ 35 ,000 VAH , Battery correction factor (K) : ≥1.26, Designmargin : ≥1.1, Batteryagingfactor : ≥ 1.25 Battery Temp.Corr.factor : ≥1
Battery charging current	10-20 % of battery capacity
Cell containers	Polypropylene
Cell covers	Shall be permanently fixed such that the seepage of electrolyte gas escapes and entry of electro static spark are prevented, it shall be fire retardant.
Plates & electrolyte	Positive grid shall be of pure lead/ suitable alloys to have long life. Positive plate shall not contain cadmium. Design and constructional details shall be brought out clearly to substantiate long life feature of the offered batteries. Negative plate shall be of flat pasted type with lead calcium or suitable alloy. The electrolyte shall be high purity sulphuric acid.
Grid growth provision	This provision should be made in the cell design to prevent failure due to internal shorting / rupture of cell because of grid growth.
Separators	Shall be of glass mat or synthetic material having high acid absorption capability, resistant to Sulphuric acid and good insulating properties.
Pressure regulating valve	Each cell shall be provided with a pressure- regulating valve.
Terminal posts	The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion / fire retardant material. Both positive and negative posts shall be clearly and unambiguously identifiable.
Connectors, nuts, bolts, & heat shrinkable sleeves	Non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Nuts and bolts for connecting the cells shall be made of
Flame Arrestor	Each cell shall be equipped with a flame arrestor to defuse the hydrogen gas escaped during charge and discharge. Material of the flame arrestor should not affect the performance of the cell
Battery bank stand and cell orientation	All batteries shall be mounted in a suitable metallic frame of stainless steel or epoxy coated metal for acid resistance. The cell orientation in the steel trays shall be horizontal
Design float life Battery cycle life	20 years. 1200 Cycles at 80% DOD 4000 Cycles at 20% DOD
Accelerated life test	A test report on accelerated life test, attested by an external certification agency for 20 years of design life shall be submitted along with the tender for similar type of design, without which the offers are likely to be ignored
Minimum Discharge Voltage	Not less than 1.75V per cell
Standard	IEC60896 Part 1 & 2

Low self discharge	Antimony free alloy, > 97% life after 1 month
Recharge Time	8 - 10 hrs full recharge
Protection system	Battery circuit breaker with enclosure

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19.0 GENERAL REQUIREMENT OF EARTHING

SCOPE:
Supply, fabrication, installation, testing and commissioning of earth pits. Conforming to relevant IS Specifications and standards. The scope includes all related civil work for making pit, providing suitable covers and writing identifications marks etc.

GENERAL:
All the non-current carrying metal parts of electrical installation shall be earthed as per IS: 3043.All equipments, metal conduits, rising main, cable armour, switch gear, distribution boards, meters, cable glands and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall be in conformity with the provisions of Rules 32, 61, 62, 67 and 68 IER 1956.

CONSTRUCTION:

COPPER PLATE EARTH:
Plate electrodes shall be made of 3.3mm thick copper plate of 600X 600mm size. The plate shall be buried vertically in ground at a depth of not less than 2.5 meters to the top of the plate. The pit should be filled with charcoal in such a way that the electrode is encased to a minimum thickness of 300mm all round. The electrode, to the extent possible, should be buried in a depth where subsoil water is present. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the plate electrode with brass bolts, nuts and washers.

A GI pipe of not less than 40mm dia shall be clamped with bolts vertically to the plate and terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450mm x 450mm dimensions. The chamber shall be provided with GI frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identification label tag.

EARTHING CONDUCTORS:
All earthing conductors shall be of high conductivity copper/GI strips and shall be protected against mechanical damage and corrosion. The connection of earth electrodes shall be strong, secure and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable tunnel conduits and cables by using suitable clamps.

Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage network.

Earthing conductors shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All Switch Boards, Distribution Boards, Disconnecting Switches and Isolators shall be connected to the earth bus. Earthing conductors shall be terminated at the equipment end using suitable lugs, bolts, washers and nuts.

All conduits, cable armouring etc., shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/protective device and Circuit Breaker and shall not exceed 2 ohms.

PRECAUTIONS:
Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance always. Joints shall be tinned, soldered and/or double riveted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be protected against corrosion.

The following table gives an idea on selection of size of earth conductors for electrical equipments such as Transformers, Motors, Generators, Switch gears, Cable Glands, etc.,

Size of the Conductor:

Rating of 400 V, 3 ϕ **50 Hz Equipment** (KVA)	Bare Copper swg	Aluminium PVC Insulated sqmm
Up to 5	14	6
6 to 15	10	16
16 to 50	10	16
51 to 75	8	25
76 to 100	6	35
101 to 125	4	50
126 to 150	2 or 1”x1/16”	70
151 to 200	2 or 1”x1/16”	70
201 and above	1” x 1/8”	185

Conductors shall be protected so that no mechanical damage could be caused.

Earth connections for all HT switchgears and equipments shall be carried out by not less than 0.1sq. inch. Copper tapes or 185 Sq.mm PVC insulated stranded aluminium conductor or 2” *1/4” Galvanised iron strip.

20.0 SPECIFICATION FOR INSTALLATION

SCOPE:
The specification covers the installation, testing and commissioning of all electrical equipments and accessories required for the switchyard for efficient and trouble free operation.

STANDARDS:
The electrical installation work covered by this specification shall unless otherwise stated comply with the requirements of the latest edition of relevant Indian Standard, statutory regulations and codes of practices.

- Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations amended up to date.
- IS – 10118: Code of practice for selection, installation & maintenance of Switch gear and control gear
- IS – 6600: Guide for loading of oil immersed transformers.
- IS – 3043: Code of practice for earthing.
- IS – 2309: Code of practice for protection of building and allied structures against lightning.
- IS – 2274: Code of practice for electrical wiring installation.
- IS – 6665: Code of practice for industrial lightning.

GENERAL REQUIREMENTS:

The installation shall be carried out by an electrical contractor holding a valid license as required by the respective State Government. The contractor shall provide particulars of the license held by him or his subcontractor to the purchaser. The installation shall require approval of the Chief Electrical Inspector to the Government of Tamilnadu and the contractor shall prepare all necessary drawings / documents and submit to CEIG and get safety certificates from CEIG. He shall also fully assist the purchaser in obtaining approval from any other statutory authorities for the successful commissioning of the Substation. Getting approval for other areas like 11KV/22KV/33KV switch gear, Diesel generator, control and relay panels, auxiliary transformers and LT panels shall also be in the contractors scope for which the necessary details shall be arranged by Purchaser / Consultant.

Any modification in the equipment or installation that may be demanded by the inspector shall be carried out at no additional cost to the purchaser.

In accordance with the specific installation instructions or as directed by the purchaser, the contractor shall unload, erect, assemble, install, wire, test and commission all electrical equipments included in this contract. Equipments shall be installed in a neat workman like manner with highest regard for safety.

The purchaser shall not supply erection materials, tools, testing instruments or any other machinery of any nature. The contractor shall arrange for the same in a timely manner and he shall not be allowed to claim for any delay or extra cost of any nature.

Consumable materials of any nature required for the erection job shall also have to be arranged by the contractor

Clearing the site after completion of erection as well as regular clearance of unwanted, materials from site, returning all packing material and excess material and excess material shall also be covered under the scope of work.

All equipments and instruments of indoor and outdoor, shall be inscribed with number, nomenclature, danger boards and other instructions.

The contractor shall touch up the surface for all equipments, which are scratched and / or damaged during transportation and erection. The paint used shall match exactly the surface being touched up.

The contractor shall employ skilled and semi-skilled laborers for erection, installation & testing as required. All electricians, cable jointers, wire men, welders and others employed shall be suitably qualified possessing valid certificates / licenses recognized by the competent authorities

The contractor shall also furnish a list of Engineers/Supervisors and staff employed by him for erection and installation jobs, giving in brief, qualification and experience of such staff and indicating whether they hold such competency certificates / licenses to supervise the electrical installation jobs as required under Indian Electricity Rules & State electrical Inspectorate Rules.

The contractor shall set up his own workshop and other facilities at site to undertake fabrication jobs, pipe bending, threading etc.

The contractor shall be responsible for recording of all readings and observations during erection, testing and commissioning, in registers or on prescribed proforma. These shall be carried the presence of purchaser's representative. All such test data and records shall be duly signed by the contractor's Engineer / Purchaser's representative and shall be submitted to Purchaser in triplicate.

The contractor shall carry out all tests at site for outdoor and indoor electrical equipment and commission the installation in the presence of Purchaser's representative. The contractor shall be responsible for final adjustment of relays, instruments, meters breakers etc., and also for submission of relay settings and calculations.

EQUIPMENT ERECTION:

All support insulators, Circuit breakers, Isolators, Power Transformers, Instrument Transformers, etc. shall be properly handled an erected as per the relevant codes of practice and manufacturer's drawings and instruction manuals.

For power transformer, drying out and oil filling as required, after checking and testing the dielectric strength shall be carried out by the contractor. If required oil filtration shall be carried out and the contractor shall arrange for the necessary equipment.

Handling equipment, sling ropes etc. should be tested before erection and periodically for strength.

For cleaning the inside and outside of hollow insulators, only muslin or leather clothes shall be used.

Necessary Junction boxes for CT's and PT's shall be supplied and installed.

POWER CABLES:

Contractor's scope of work includes unloading, laying, fixing, jointing, bending and terminating of cables. Contractor shall also supply all the necessary hardware's for jointing and terminating of cables. Cable shall be laid directly buried in earth, on cable racks in built up trenches, on cable trays and supports in conduits and ducts or bare on walls, ceiling etc. Where specific cable layouts are not shown in the drawing contractor shall route these cables as directed by Consultant/Purchaser.

It is the contractor's responsibility to ensure that he acquaints himself with the nature of the ground conditions of the project site.

Markers shall be installed at all road crossing where the cables cross and as well as cable joint positions. Their provision and installation shall be included in the areas.

The contractor while designing, excavating trenches and installation of cables, must take all necessary care.

Contractor shall install, test and commission the cables specified in accordance with the latest revisions of Indian Standards.

All cable work and the allied apparatus shall be designed an arranged to reduce the risk of fire and any damage that may cause in the event of fire. Wherever cables pass through any floor or wall opening suitable bushes supplied shall be sealed using fire-resisting materials to prevent fire spreading.

Standard cable installation tools shall be utilized for cable pulling. Maximum pull tension shall not exceed the manufacturer's recommended value. Cable grips, reels or pulleys used shall be properly lubricated. The lubricant shall not injure the overall covering and shall not set up undesirable conditions of electrostatic stress.

Sharp bending and kicking of cables shall be avoided. The bending radius for various types of cables shall not be less than those specified by manufacturer.

Power and control cables shall be laid in separate cable trays. The order of laying of various cable in trenches shall be as specified below:

11KV cables on top most tiers from top.
415V cables on middle tier.
Control cables in bottom most cable tier.

Where cables cross roads and water, oil, gas or sewage pipes the cables shall be laid in reinforced spun concrete pipes. For road crossing the pipe for the cable shall be buried at not less than one-meter depth. Cable shall be protected at all times from mechanical injury and from absorption of moisture.

Some extra length shall be kept in each cable run at a suitable point to enable one or two straight through joint to be made at a later date, if any fault occurs.

Cable jointing shall be in accordance with relevant Indian Standard Codes of practice and Manufacture's special instruction. Contractor should supply materials and tools required for cable jointing work. Cable shall be firmly clamped on either sides of a straight through joint at not more than 300 mm away from the joints. Identification tags shall be provided at each joint and at all cable terminations. Before jointing insulation resistance of both sections of cables to be jointed shall be checked.

Metal sheath and armour of the cable shall be bonded to the earthing system of the station.

Each cable shall be identified with its designation number as indicated in the drawings.

Cable clamps shall be of 3 mm thick galvanized M.S. spaced at every 1.5-M interval.

CABLE TRAYS, ACCESSORIES AND TRAY SUPPORTS:

Cable trays shall either be run in concrete trenches or overhead supports from building steel, floor slab, etc.

Cables shall be clamped to the cable trays in both horizontal runs and vertical runs by suitable prefabricated clamps.

All cable trays and fitting will be ladder type and fabricated from M.S. sheet. They shall be hot dip galvanized.

Cable trays shall be suitably supported at an interval of not more than one meter.

CIRCUIT BREAKER:

The vacuum circuit breaker shall be tested and installed in accordance with the manufacturer's inspection.

The operating mechanism shall be installed and connected to the three poles and the control cubicle with compressor, air receiver, etc. shall be connected to the breather pole operating mechanism through pipes.

Each pole of the circuit breaker and operating mechanism shall be accurately positioned not to cause any undue strain on the terminals and they shall be properly earthed.

ISOLATOR:

The contractor shall inspect, clean, assemble and install the isolator on the fabricated base structure.

The operating mechanism shall be installed on the structure and shall be tested by slowly bringing the isolator to the closed position and necessary adjustments shall be carried out as per manufacturer's instruction.

Earth switches, frames, operating handles, etc. shall be earthed.

LIGHTNING ARRESTORS:

The earth terminal of each lightning arrestor shall be connected to a separate earth electrode by as short direct lead as possible.

Insulating base and surge counter shall be installed as per manufacturer's instruction.

INSTRUMENT TRANSFORMERS:

The CT's and PT's shall be installed on the fabricated base structure.

The phase to phase clearance between three units of each set shall be accurately and adjusted so as not to cause strain on the terminals.

Oil in each unit shall be properly checked for insulation.

LIGHTING SYSTEM:

The contractor shall provide lighting of the complete switchyard. Flood light fixtures with HPSV/MH lamps shall be used and shall be mounted on steel pole of required height with adequate facility for revamping without the help of any portable ladder. The contractor shall prepare the lighting layout drawings showing the approximate location of lighting fixtures for approval. The Contractor will submit all foundation drawings. All illumination system including switchgear, lighting fixtures, poles, cabling, etc. shall be in contractor's scope.

The switchyard lighting shall be designed to have mean illumination level of 50 lux.

Lighting wiring between lighting panel and lighting fixtures shall be done by PVC insulated 3 core (phase, neutral and earth) 2.5 sq.mm copper conductor armored cables. Wiring between power panel and 20A sockets shall be done with PVC insulated 3 core (phase, neutral and earth) 4 sq.mm. copper conductor armoured cables.

Emergency DC lighting shall also be considered for switchyard for which necessary cabling, switch gear, etc. will be in contractor's scope.

LIGHTING AND POWER PANELS:
Lighting and Power Panels shall be located in the control room. The panel shall be made of 2.5mm CRCA sheet steel. The panels shall have hinged lockable doors with gaskets. Removable bottom gland plate shall be provided along with nickel plated double compression glands. An earth bus shall also be provided with two external grounding terminals.

MISCELLANEOUS ITEMS:
The successful bidder shall supply and install the safety devices as required by the statutory authorities, but not limited to the following:

Danger boards.
Fire extinguishing appliances.
Rubber mats for switchgear panels, power distribution boards battery charges, control and relay panel, etc.
Rubber gloves, first aid charts, first aid box, etc.
Earthing rods.

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21.0 TESTING AND COMMISSIONING

GENERAL:
The testing and commissioning for all electrical equipment at site shall be according to the procedure laid down below.

- All electrical equipment shall be installed, tested and commissioned in accordance with the latest relevant standards and codes of practices published by Indian standards, institution wherever applicable and stipulations made in relevant general specifications.

- The testing of all electrical equipment as well as the system as a whole shall be carried out to ensure that the equipment and its components are in satisfactory condition and will successfully perform its functional operation. The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted design, engineering and construction standards, as well as accepted codes of practice and stipulations made in the relevant general specifications.

- The contractor using his own instruments, testing equipment as well as qualified testing personnel shall carry out all tests.

- The results of all tests shall be conform to the specification requirements as well as any specific performance data guaranteed during finalization of the contract. General

- At the completion of the work, the entire installation shall be subject to the following tests in presence of Owner / Consultant.

    - Wiring Continuity Test
    - Insulation Resistance Test
    - Earth Continuity Test
    - Earth Resistivity Test

PREPARATION OF THE ELECTRICAL SYSTEM FOR COMMISSIONING:
After completion of the installation at site and for the preparation of Electrical system commissioning, the contractor shall carry out check and testing of all equipment and installation in accordance with the agreed standards, codes of practice of Indian Standards Institution and specific instructions furnished by the particular equipment suppliers.

Checking required to be made on all equipment and installations at site shall comprise, but not be limited, to the following:

The following checks shall be made on all equipment and installation at site:

Physical inspection for removal of any foreign bodies, external defects, such as damaged insulators, loose connecting bolts, loose foundation bolts etc.

Check for grease, insulating/lubricating oil leakage and its proper quantity.

Check for the free movement of mechanism for the circuit breakers, rotating part of the rotating machines and devices.

Check for tightness of all - cable, bus bars at termination/joints ends as well as earth connections in the main earthing network.

Check for Clearance of live bus bars and connectors from the metal enclosure.

Check the proper alignment of all draw out device like draw out type circuit breakers.
Continuity checks in case of power cables.

Checking of all mechanical and electrical interlocks including tripping of breakers using manual operation of relay.

Checking of alarm and annunciation circuits by manual actuation of relevant relays.

Check and calibrate devices requiring field adjustment/ calibration like adjustment of relay settings etc.,

Check proper connection to earth network of all non-current carrying parts of the equipment and installation.

Test reports for all meters are to be furnished.

These tests shall be carried out on the equipment shall include but not be limited to the above.

H.T. BREAKER PANEL:

The following tests shall be carried out in accordance with IS 13118.

- Mechanical operation tests.
- Power frequency HV test.
- Insulation resistance test.
- Functional tests on control circuits.
- Relay operation tests by primary, secondary injection method.
- Checking of settings of all relays/releases as per single line diagram/specification.

DISTRIBUTION TRANSFORMER:
The following tests shall be carried out in accordance with IS

Measurement of insulation resistance test between:-

- HT & LT Windings

- Between HT & Earth
- Between LT & Earth

EARTH RESISTANCE TEST:

- Earth resistance of the Body earth Electrodes
- Earth resistance of the Neutral earth Electrodes
- Earth continuity

VOLTAGE RATIO TEST:

Ratio test on all taps of the transformers

TRANSFORMER TEST:

- Winding resistance at all taps
- Measurement of voltage ratio on all taps.
- Vector group check.
- Measurement of impedance voltage / Short Circuit impedance
- At principal tapping and load loss.
- Measurement of no load loss and current.
- Measurement of insulation resistance.
- Power frequencies withstand test.
- Operational tests to know the correct functional of all devices associated with the transformer.
- Low Voltage Switch gear (up to 1000V AC OR 1200V DC)
- Insulation resistance test with 1000V megger for main circuits. The minimum value of insulation resistance shall be 1mega ohm.
- Insulation resistance test with 500V megger for control, metering and relaying circuits. The minimum value of insulation resistance shall be 1mega ohm.
- Relay operation test by primary & Secondary injection method.
- Functional tests of control circuit.
- Checking of settings of all relay/releases as per single line diagram/specification.
- ON/OF operation of breakers both manually and electrically in "Test" as well as "service" positions.

CABLES:

- Insulation resistance test with 2,500V megger for high voltage power cables rated above 1.1KV grade and 1,000V megger for cables rated up to 1.1KV grade.
- All cables of 1.1KV and all H.V. cables shall be subjected to high voltage test after joining and terminating but before commissioning as per relevant standards.
- In each test, the metallic sheath/screen/armour should be connected to earth.
- Continuity of all the cores, correctness of all connections as per wiring diagram, correctness of polarity and phase of power cables and proper
- earth connection of cable glands, cable boxes, armour and metallic sheath, shall be checked.

EARTHING SYSTEM:

- Tests to ensure continuity of all earth connections.
- Tests to obtain earth resistance of the complete network by using earth tester. The test values obtained shall be within the limits.

All documents / records regarding test data, oscillographs and other measured values of important parameters finalized after site adjustment shall be handed over to the Owner in the form of test reports for their future use and reference.

ELECTRICAL:

1.The scope of work for testing and commissioning of the total installation shall be for the capital equipment's like switchgears, cables, etc., and also for the associated equipment like relays Cts, Pts cable etc.,

2. The scope of work for testing and commissioning of electrical equipment for the above shall include but not limited to the following.

Providing sufficient number of experienced Engineers, supervisors, Electricians, so that the installation can be commissioned in stipulated time.

All the instruments, tools, and tackles required for carrying out the testing and the bidder shall provide commissioning.

The testing of electrical equipments shall be carried but as per the relevant Indian standards/codes practices/Manufacturers instructions.

Cleaning of Electrical equipment, contracts, cleaning and greasing etc., all the equipments and materials required for above shall be supplied by the bidder.

Correcting the panel/equipment wiring for proper functioning for the schemes required /called etc.,

Installation and wiring of additional equipment on panels like auxiliary contractors, timers, etc., which may be additionally required for proper functioning of the schemes.

Checking of equipment earthing and system earthing as a whole.

Testing of all the cables.

Co ordination with other contractors for testing and commissioning of interface cables.

TEST TO BE CONDUCTED:

a) All tests shall be performed in the presence of the bidder and customer / consultant. For all types of visual inspections, checkings, precommissioning, commissioning test and acceptance tests, relevant IS for the tests given therein shall be followed in addition to the instructions in this technical specification the intention of giving the few test procedures, described below, is to provide a guideline for the bidder. However bidder shall not restrict themselves in carrying out only the tests described in this document.

b) Bidder shall submit their proposed test procedures for approval and shall not commence testing without such approval is given.

c) Bidder shall check and test all electrical equipment and system installed and supplied them, including equipment supplied by the owner.

d) Bidder shall ensure that no tests are applied which may stress equipment above the limits for field-testing recommended by the manufacturer. Bidder shall be responsible for any damage to personnel or equipment resulting from improper test procedure including the equipments supplied by Client.

e) All defective materials furnished by the bidder and defects due to poor workmanship revealed through field testing, shall be corrected at bidder expense without affecting the completion of the project.

f) CLIENT reserves the right to interpret and approve all test results prior to energisation of circuits or apparatus.

g) Bidder shall visually inspect all equipment for defects immediately results upon arrival at site including those supplied by CLIENT.

h) Bidder shall test the buried earth grid and shall record the values. Bidder shall inspect and test all earthing work carried out by him, including all interconnections between ground loops, grounding of equipment and ensure all connections are permanent and that the earthing circuit is continuous.

i) Bidder shall meggar and record earth resistance at various earth connection points.

j) Switchgear rated 433 volts or more shall be tested with a 1000 volts megger.

k) Auxiliary wiring rated less than 415 volts shall be tested with a 500 volts megger.

l) ALL protective relays shall be tested at sufficient points to establish their proper functioning in accordance with manufacturer's specification and curves.

m) Operation checks and functional checks on all switchgear panels.

n) Bus bar

o) Wires and cables rated 433 volts or more shall be tested joints check with torque wrench for tightness.

p) Continuity testing of all wires and cables.

with a 1000 volts megger. Cables rated less than 433 volts shall be tested with a 500 volts megger.

q) No wires or cable having resistance between conductors or between conductors and ground if less than 100 megaohm shall be accepted.

r) All precommissioning test stated as per IS for respective items.

NOTE: THE TENDERERS SHALL NOTE THAT ALL THE RATES QUOTED BY THEM ARE INCLUDING THE TESTING CHARGES FOR DOING THE ABOVE TESTS. CLIENT SHALL NOT REIMBURSE SEPARATLY ANY AMOUNT FOR ANY TESTING OF MATERILS.

22.0 APPROVED MAKE OF EQUIPMENTS / COMPONENTS

S.No.	Name of Equipments	Approved Make
1	HT Breaker	Megawin /Crompton / ABB / Kriloskar / Schneider / Voltech
2	Transformer	Volt Amp / Kriloskar / Esennar /Current Electrical / Voltech
3	HT Cables	HAVELLS/ POLYCAB / UNIVERSAL / KEI
4	HT End termination kit/ Jointing Kits	Raychem / Brila 3m
5	ACB	L& T (U Power) / Siemens(Sentron – WL) / SCHNEIDER (Master Pact – NW)/ABB
6	MCCB	L& T (D-Sine) / Siemens(Sentron – VL) / SCHNEIDER (NS Compact)/ABB
7	SFUs /Isolators	L& T / Siemens / SCHNEIDER
8	Starters/ Contactor/ Bi metal Relay	L&T / Siemens / Telemechanic
9	MCB / ELCB	L&T / Legrand / SCHNEIDER / HAGER
10	MCB DB	L&T / Legrand / SCHNEIDER / HAGER
11	Weather proof junction box / mcb control	Legrand / Hensel / Mennekes
12	MotorisedChange over Switch	(HPL) / GE /L &T/HAVELLS/ SIEMENS
13	Battery	Exide / AMCO
14	UPS/ Inverter	ABB / Numeric / Consul
15	Fittings	Bajaj / Philips / Wipro / Havells / Crompton
16	Fans	Bajaj / Crompton / Usha / Orient
17	L.V Power / Control Cables	Havells / UNIVERSAL/ Polycab
18	CABLE GLANDS	COMMET / MULTI / DOWELLS
19	CRIMPING SOCKETS	COMMET / MULTI / DOWELLS
20	Wires	Havells / Polycab / Anchor
21	MS Conduit	Gupta / Supreme
22	PVC Conduit	AVON PLAST / Finolex
23	Accessories for PVC Conduit	AVON PLAST / Finolex
24	Switches & Sockets	MK – Wraparound / Crab Tree - Thames / Siemens
25	Cable Tray (GI)	Sub- Contractor to be approval by TICEL (Pinnakal/JKR / PROFAB / HITECH)
26	MS TRAY / ANGLES	ANY ISI MARKED BRAND

S.No.	Name of Equipments	Approved Make
27	Capacitors	GE/Kirloskar
28	Relays	L &T /GE /ABB
29	Digital Meters	L&T / Enercon
30	Automatic Power factor Correction relay (APFCR)	L & T / Enercon
31	Energy Meter	L&T / Enercon
32	Measuring Instruments	Conserve / AE
33	Push Button / Indicating Lamps	L & T / Tecknic
34	CTs	Kappa /AE
35	Control Fuse Base with HRC Fuse	L&T / GE
36	Selector Switch	Salzer / Kaycee
37	Panels / Bus Ducts/ Raising Mains	Sub-Contractor to be approval by TICEL
38	Lightning Arrestor	OBO, JKR Solution, Universal power tech Engineers, Erico, ABB,ShreeSastha& Co
39	Aviation Lamp	Bajaj / K-Lite / Philips
40	Poles	Sub-Vendor shall be approved by TICEL
41	PTs	Kappa / Silcon

NOTE:

- **All Equipment / Components used in execution of work shall be preferred make listed above subject to the approval of Owner / Engineering Consultant. The Owner / Engineering Consultant reserve the right to choose any one of the make listed above. The rates quoted above shall be valid for any of the makes mentioned above.**

23.0 LIST OF DRAWINGS

S.NO	DRAWING NAME	DRWING NUMBER
1	MAIN SINGLE LINE DIAGRAM	TMA/CBE/TICEL/LAB/E-SLD/E-01
2	EXTERNAL CABLE ROUTING & EARTHING LAYOUT	TMA/CBE/TICEL/LAB/E-EE/E-02
3	SUBSTATION EQUIPMENT LAYOUT	TMA/CBE/TICEL/LAB/E-EE/E-03
4	SUBSTATION CABLE ROUTING LAYOUT	TMA/CBE/TICEL/LAB/E-EE/E-04
5	GROUND FLOOR EQUIPMENT & CABLE ROUTING LAYOUT	TMA/CBE/TICEL/LAB/E-EE/E-05
6	TYPICAL FLOOR EQUIPMENT & CABLE TRAY LAYOUT (TYPE-B)	TMA/CBE/TICEL/LAB/E-EE/E-06
7	TYPICAL FLOOR EQUIPMENT & CABLE TRAY LAYOUT (TYPE-A)	TMA/CBE/TICEL/LAB/E-EE/E-07
8	TERRACE FLOOR EQUIPMENT & CABLE TRAY LAYOUT	TMA/CBE/TICEL/LAB/E-EE/E-08
9	LAB BUILDING LIGHTNING PROTECTION LAYOUT (SHEET 1 OF 5)	TMA/CBE/TICEL/LAB/E-LP/E-09
10	LAB BUILDING LIGHTNING PROTECTION LAYOUT (SHEET 2 OF 5)	TMA/CBE/TICEL/LAB/E-LP/E-09
11	LAB BUILDING LIGHTNING PROTECTION LAYOUT (SHEET 3 OF 5)	TMA/CBE/TICEL/LAB/E-LP/E-09
12	LAB BUILDING LIGHTNING PROTECTION LAYOUT (SHEET 4 OF 5)	TMA/CBE/TICEL/LAB/E-LP/E-09
13	LAB BUILDING LIGHTNING PROTECTION LAYOUT (SHEET 5 OF 5)	TMA/CBE/TICEL/LAB/E-LP/E-09
14	UTILITY BUILDING LIGHTNING PROTECTION LAYOUT	TMA/CBE/TICEL/LAB/E-LP/E-10
15	EXTERNAL LIGHTING LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-11
16	SUBSTATION LIGHTING & POWER LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-12
17	SUBSTATION LIGHTING & POWER CONDUIT LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-13
18	GROUND FLOOR LIGHTING & POWER LAYOUT(SHEET 1 OF 2)	TMA/CBE/TICEL/LAB/E-LTG/E-14
19	GROUND FLOOR LIGHTING & POWER LAYOUT(SHEET 2 OF 2)	TMA/CBE/TICEL/LAB/E-LTG/E-14
20	GROUND FLOOR LIGHTING & POWER CONDUIT LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-15

21	TYPICAL FLOOR (TYPE-B) LIGHTING & POWER LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-16
22	TYPICAL FLOOR (TYPE-B) LIGHTING & POWER CONDUIT LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-17
23	TYPICAL FLOOR (TYPE-A) LIGHTING & POWER LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-18
24	TYPICAL FLOOR (TYPE-A) LIGHTING & POWER CONDUIT LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-19
25	TYPICAL 5th, 11th FLOOR LIGHTING & POWER LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-20
26	TYPICAL 5th, 11th FLOOR LIGHTING & POWER CONDUIT LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-21
27	TYPICAL 8th FLOOR LIGHTING & POWER LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-22
28	TYPICAL 8th FLOOR LIGHTING & POWER CONDUIT LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-23
29	TERRACE FLOOR LIGHTING & POWER LAYOUT	TMA/CBE/TICEL/LAB/E-LTG/E-24