BHAGYANAGAR GAS LIMITED

(A JOINT VENTURE OF HPCL & GAIL)

BID DOCUMENT FOR

Procurement of 250 KVA & 650 KVA transformer along with Installation & Commissioning at BGL Mother Station Shamirpet and TSRTC DEPO Medchal for Hyderabad GA

e-TENDER

UNDER OPEN DOMESTIC COMPETITIVE BIDDING

Bid Document No.: BGL/659/2025-26

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SCOPE OF SUPPLY

SCOPE OF WORK

1.0 General Description

Bhagyanagar Gas Limited (BGL) intends to enhance the electricity load and replace the existing transformers on buy back basis at its Mother Station, Shamirpet and Medchal TSRTC Depot. The scope of work shall involve the supply, transportation, installation, testing, and commissioning (STIC) of BIS-certified 1180(4) OLTC transformers of required capacities along with RTCC panel, along with associated electrical works, including panel upgradation, earthing, cable laying, HT breaker servicing, supply, installation of Heat shrinks cable kits and statutory liasioning with CEIG/TGSPDCL etc any other agencies. All works must conform to relevant IS standards and CEIG/TGSPDCL requirements. Scope includes but not limited to the charging of electricity connection at respective stations including agreement preparation, drawings preparation, approvals , etc.

Details of the works are given below:-

I. Disconnecting and removing the existing transformer foundation, transformer, old HT panel and placing all dismantled material at the designated location within the premises. These items are included under buy back items.
II. Supply and installation of new transformer foundation, distribution transformer, HT panel, utility panel, upgradation and APFC panel as per the site requirement.
III. Disconnecting and removing existing HT/LT power and control cables from HT panels, transformers and building panels. Shifting and handing over all the dismantled materials to BGL at directed place within Premises.
IV. Connecting old/new HT/LT power and control cables to HT panels, transformers, utility panels, APFC panels and building panels as required.
V. Supply, laying and termination of cables as per the Electrical SLD.
VI. The successful bidder shall ensure that the power supply to the minimum interrupted during the replacement of the transformer. Necessary arrangement shall be provided by the vendor for providing required power to the building.
VII. Supply, laying and termination of HT cables from 11KV Meter panel to the HT panel & HT panel to transformer primary. Upgrading the load demand also is within the scope of bidder.
VIII. Supply, Installation, Testing and Commissioning of Transformers, HT Panels, Utility Panel, APFC panel, upgradation of panel as per the site requirement.
IX. All necessary approvals, permissions, certifications, etc. from electricity boards is in the scope of the bidder.
The project is a turnkey project and hence any additional supply/works, which are not explicitly mentioned in the Tender document but required to complete the installation, are in the scope of the bidder.

- Before tendering, the agency shall inspect the site of work and shall fully acquaint himself about the conditions prevailing at site for execution of works.
- The work shall be carried out in such a manner so as not to interfere/or effect or disturb other works being executed by other agencies, if any.

X. Bidder should quote the cost of old transformers in the form of buy back basis. Following are the details of old transformers:

1. 630 KVA at Mother station, shamirpet
2. 100KVA at BGL-TSRTC, Medchal depot
3. 250 KVA at Mother station, shamirpet

2.0 Location of Works

1. BGL, Mother Station, Shamirpet,
   Sy.no. 1266, Opp. Nalsar Law University, Shamirpet
   Medchal (Malkajgiri)
   500078, Telangana
2. TSRTC depot, Medchal,
   Medchal (Malkajgiri), 501401, Telangana

3.0 Detailed Scope of Work

A. Transformer Works

Supply, transportation, installation and commissioning of:

1. 630 kVA, 11/0.433 kV OLTC transformer with CRGO core and copper winding at Shamirpet.
2. 250 kVA, 11/0.433 kV OLTC transformer with CRGO core and copper winding at Medchal.

- The transformers shall comply with IS:1180 Part-1 (2014) Amendment no-4, Level-1 and bear valid BIS certification.
- Supply and installation of RTCC Panel and AVR for each transformer.
- Dismantling of existing transformers and disposal through buy-back as per CEIG norms.
- Apart from having BIS License for higher rating, it is mandatory to supply with ISI mark. Failure of this leads to rejection from CEIG at the time of releasing the power supply. Therefore, complete responsibility lies with the contractor.

B. Electrical Load Enhancement Works:

All necessary approvals, permissions, certifications, etc. from electricity boards, Preparation of drawings, coordination

with TGSPDCL, CEIG, any other agencies, Modification and upgrade of HT/LT electrical infrastructure to support enhanced loads:
Shamirpet: Load enhancement / Upgradation from 270 kVA to 630 kVA
Medchal: Load enhancement / Upgradation from 100 kVA to 250 kVA
Installation of LT PCC Panels and MCCBs, as required.
Installation and connection of APFC panels:
Shamirpet: 180 kVAR
Medchal: 120 kVAR

C. Earthing and Cabling
Supply and laying of GI flat and copper flat for transformer and panel earthing.
Installation of GI earth pits and associated connections.
Laying of HT and LT XLPE cables, including straight-through and end termination kits.
Termination of all power and control cables with proper lugs, glands and identification.
D. Metering and Panel Works

- Replacement of CTPT units and installation of energy meters as per TGSPDCL standards.
- Supply and installation of meter boxes, GI piping, and wiring.
- Breaker servicing and fuse replacement (Shamirpet).

E. Liasioning and Statutory Approvals
Complete CEIG coordination and inspection scheduling.
Liasioning with TSSPDCL for service feasibility, load sanction and energization.
Submission of all required drawings, test reports, and documentation.
F. Testing and Commissioning
Routine transformer tests including insulation resistance, winding resistance, voltage ratio, magnetic balance, no-load and full-load losses.
OLTC operation testing.
Earth resistance measurement.
Panel and cable meggering and load testing.
G. Documentation
OEM test certificates, type test reports, warranty certificates.
Final commissioning and CEIG approval documentation.
As-built drawings for HT/LT layout.
H. Technical Specifications of Transformers and service requisition:
Scope works/Service requisition is as mentioned below:

A. Supply(S), transportation(T), installation(I) and commissioning(C) of 630 kVA Transformer, at MS - Shamirept			
Sr. No	**Description**	**Unit**	**Qty**
1	S/T/I/C of 630kVA 11/0.433KV On load tap changer, RTCC Panel, 3 Phase, 50Hz, Dynn11 Vector Group, Copper wound, CRGO Core, Oil Immersed Distribution Transformer with standard fittings confirming to IS1180 Level-I Standard.	Nos	1
B. Supply(S), transportation(T), installation(I) and commissioning(C) of 250 kVA Transformer at Medchal, RTC Depot.			
Sr. No	**Description**	**Unit**	**Qty**
1	S/T/I/C of 250kVA 11/0.433KV On load tap changer, RTCC Panel, 3 Phase, 50Hz, Dynn11 Vector Group, Copper wound, CRGO Core, Oil Immersed Distribution Transformer with standard fittings confirming to IS1180 Level-I Standard.	Nos	1
A.1. Electricity load enhancement works excluding Govt charges, at MS - Shamirpet			
Sr. No	**Description**	**Unit**	**Qty**

1	S/T/I/C of 11KV CT PT and Energy Meter Replacement Work Including Old CTPT Removing, handing over at Dept Stores, Drawing new CTPT, Installation, Commissioning of new CTPT and Energy Meter	Lump sum	1
2	S/T/I/C of Meter Box with GI Piping and Wiring	Lump sum	1
3	S/T/I/C of 11KV LAS	Nos	3
4	S/T/I/C of 50X6mm GI Flat for Earthing for HT Yard	Mtrs	20
5	S/T/I/C of 50X6mm Copper Flat for TF Neutral Earthing	Mtrs	5
6	S/T/I/C of Hardware Items, Monoplast, Silver Paints, 8SWG Copper Wire Etc	Lump sum	1
7	S/T/I/C of APFC 180kVAR Capacitor Bank with Panel	Nos	1
8	Liasoning Work with EB Department including inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lump sum	1
9	CEIG Approvals inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lump sum	1

B.1. Electricity load enhancement works excluding Govt charge, at Medchal, RTC Depot.

Sr. No	Description	Unit	Qty
1	S/T/I/C of 11KV CT PT and Energy Meter Replacement Work Including Old CTPT Removing, handing over at Dept Stores, Drawing new CTPT, Installation, Commissioning of new CTPT and Energy Meter	Lumpsum	1
2	S/T/I/C of Meter Box with GI Piping and Wiring	Lumpsum	1
3	S/T/I/C of Extension Plinths both CTPT and Meter Box, LT Cable Trench and Yard Metal Cleaning and Spreading	Lumpsum	1
4	S/T/I/C of 11KV XLPE 70Sqmm X 3 Core Cable	Mtrs	10
5	S/T/I/C of 11KV XLPE 70Sqmm X 3 Core Cable straight through Joint Kit	Nos	1
6	S/T/I/C of 11KV XLPE 70Sqmm X 3 Core Cable End Joint Kit	Nos	1
7	S/T/I/C of 11KV Breaker Servicing and Fuses Replacement	Lumpsum	1
8	S/T/I/C of 50X6mm GI Flat for Earthing for HT Yard	Mtrs	50
9	S/T/I/C of 50X6mm Copper Flat for TF Neutral Earthing	Mtrs	5
10	S/T/I/C of Hardware Items, Monoplast, Silver Paints, 8SWG Copper Wire Etc	LS	1
11	S/T/I/C of 400Amps LT Main Incoming MCCB with Outdoor type Panel	Nos	1
12	S/T/I/C of LT XLPE 185Sqmm X 3.5 Core Cable (2 Runs TF to MCCB to Main Panel to Capacitor Bank)	Mtrs	60
13	Cable Terminations with DC Glands and Lugs	Nos	12
14	S/T/I/C of LT PCC Panel with	Nos	1

	400Amps Incomer, 160Amps Outgoings - 4 Nos		
15	S/T/I/C of APFC 120kVAR Capacitor Bank with Panel	Nos	1
16	S/T/I/C of GI Earth pits 50mm 3 Mtrs Long with Chambers	Nos	4
17	Liasoning Work with EB Department including inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lumpsum	1
18	CEIG Approvals inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lumpsum	1

TECHNICAL SPECIFICATION OF TRANSFORMER- 630 kVA		
The transformer will be designed and manufactured as per IS:1180-2014 Level -1 and will be supplied with first filling of oil to IS:335 of 1993.		
1.01.	**GENERAL SPECIFICATIONS**	
1	Rated KVA	**630** Level 1
2	Service & Duty	Continuous
3	Make	**NANI**
4	Type	Core Type - Oil Immersed
5	Location	Indoor
6	Specifications & Standard as per IS	IS 1180, IS 335
7	Type of Cooling	ONAN
8	Wound	Copper Double Wound
1.02.	**SYSTEM PARTICULARS**	
1	Nominal Voltage (V)	11000
2	Highest System Voltage (V)	12100
3	No. Of Phases	3
4	Frequency (Hz)	50
5	Voltage Variation	+ / - 10%
6	Frequency Variation	+ / - 3 %
7	Combined Voltage & Frequency Variation	+ / - 5 %
8	Terminal Arrangement	HV - Cable Box
		LV - Cable Box
1.03.	**RATING**	
1	Rated Voltage of H.V. (Volts)	11000 Current: 33.06Amps
2	Rated Voltage of L.V. (Volts)	433 Current: 840Amps
3	Max. Temperature rise above 50 C ambient	
	temperature of winding by resistance	
	method. (Deg. C)	45
4	Max. Temperature rise in oil by	
	thermometer above 50 C ambient	
	temperature (Deg. C)	40
5	Over load capacity	As per IS: 6600
1.04.	**WINDING CONNECTION DETAILS**	
1	Connections	
	a. H.V. Winding	Delta
	b. L.V. Winding	Star
	c. Neutral brought out for earthing	Yes
2	Tapings	
	a. No. of Positions	17
	b. Range	+10 % to -10 % in steps of 1.25%
	c. Voltage of each step	137.5V
3	Vector Symbol	Dyn11

1.05. LOSSES AND OTHERS			
1	Total losses at rated current and rated		
	frequency at 75 deg. C (Watts) At 50% Load	1860W Max.	
2	Total losses at rated current and rated		
	frequency at 75 deg. C (Watts) At 100% Load	5300W Max.	
3	Percentage Impedance at 75 deg. C at		
	Normal Tap.	4.50 Subject to IS Tolerance	
4	No load Current Approx	1.5 % of full load current	
5	Regulation at full load at 75 deg. C u.p.f.	0.78%	
6	Regulation at full load at 75 deg. C 0.8 u.p.f.	3.26%	
1.06. EFFICIENCY			
1	Efficiency at 75 deg. C	U.P.F.	0.8 P.F.
	a. 100 % full load	99.15	98.94
	b. 75% full load	99.26	99.08
	c.50 % full load	99.31	99.14
	d. 25% full load	99.14	98.93
2	Load at Which Maximum efficiency occurs in %		
	of Full Load	50.58	
3	Load at which Max. efficiency occurs KVA	318.65	
4	Maximum Efficiency	99.31	
1.07. CONSTRUCTIONAL DETAILS			
1	Type of Construction	Core Type	
2	Insulation between laminations	Carlit	
3	Type of joint between core limb and yoke	Mitered	
4	Type of Winding		
	a. HV Winding	Crossover	
	b. LV Winding	Spiral	
1.08. WINDING INSULATION LEVEL			
	a. HV Winding (KV uniform)	12	
	b. LV Winding (KV uniform)	1.1	
1.09. INSULATION OF CONDUCTORS			
	a. HV Winding turn Insulation	DPC	
	b. LV Winding turn Insulation	DPC	
	c. Between HV and LV Winding	Oil Duct + Solid Cylinder + Oil Duct	
	d. Between LV Winding and Core	Solid Cylinder	
1.10. TYPE OF JOINTS IN WINDING		Brazed	
1.11. MINIMUM CLEARANCES			
	H.V.to Earth (mm)		
	In Oil	25	
	Out of Oil	140	
	L.V. to Earth (mm)		
	In Oil	10	
	Out of Oil	25	
1.12.TEST VOLTAGES			
	a. Impulse (1.2 / 50 micro second wave)		
	withstand voltage		
	H.V. Winding (KV peak)	75	
	L.V. Winding (KV peak)	N. A.	
	b. One minute power frequency		
	withstand voltage		
	H.V. Winding (KV)	28	
	L.V. Winding (KV)	3	
1.13. DETAILS OF TANK AND MATERIALS M.S.			
1	Thickness of side plates (mm)	4	
2	Thickness of bottom plates (mm)	5	

3	Thickness of cover plates (mm)	5		
4	Thickness of radiator (pipes or sheets)	1.2mm		
1.14. WEIGHTS AND DIMENSIONS (APPROX.)				
1	Net untanking Weight (Kg.)	1765		
	(Core and windings with clamps)			
2	Volume of insulating Oil (Ltr.)	1275		
3	Tank and fittings (Kg.)	1450		
4	Total Weight of Transformer (Kg.)	4300		
5	Overall dimensions of the Transformer	Length	Breadth	Height
	(approx.) in mm	2950	2150	2050
1.15. PARTS TO BE DETACHED FOR TRANSPORT		Rollers, Breather, Radiators		
1.16. STANDARD FITTINGS AND ACCESSORIES				
S.No.	**DESCRIPTION**	**QTY.**		
1	Rating and terminal marking plate	One		
2	Earthing Terminals	Two		
3	Lifting Lugs	Four		
4	On Load Tap Changer (CTR/OLG Make)	One		
	with RTCC (Independent Operation) & AVR			
5	Conservator with Drain plug	One		
6	Oil filling hole with cap	One		
7	Oil Level Indicator	Two		
8	Dehydrating Silicagel Breather	One		
9	Air release device	One		
10	Thermometer Pockets	Two		
11	Drain valve with blanking plate	One		
12	Filter valve with blanking plate	One		
13	Explosion vent with double diaphragm	One		
14	Radiators with shut off valves	Adequate		
15	Buchholz Relay	One		
16	Uni-directional Flat Rollers	Four		
17	Separate Neutral Bushing	One		
18	Oil Temperature Indicator	One		
19	Winding Temperature Indicator	One		
20	Marshalling Box	One		
1.17. PAINTING				
1	Surface preparation	By Sand Blasting		
2	Paint	Enamel Light Grey, Shade No.631, of IS : 5		
1.18. TESTS				
1	**ROUTINE TESTS**			
	As per IS: 1180 all the routine tests are carried out at our works in the presence of your Engineer.			

TECHNICAL SPECIFICATION OF TRANSFORMER-250 kVA

The transformer will be designed and manufactured as per IS:1180-2014 Level -1 and will be supplied with first filling of oil to IS:335 of 1993.

1.01.	**GENERAL SPECIFICATIONS**	
1	Rated KVA	**250** Level 1
2	Service & Duty	Continuous
3	Make	**NANI**
4	Type	Core Type - Oil Immersed
5	Location	Indoor
6	Specifications & Standard as per IS	IS 1180, IS 335
7	Type of Cooling	ONAN
8	Wound	Copper Double Wound
1.02.	**SYSTEM PARTICULARS**	
1	Nominal Voltage (V)	11000
2	Highest System Voltage (V)	12100
3	No. Of Phases	3
4	Frequency (Hz)	50

5	Voltage Variation	+ / - 10%	
6	Frequency Variation	+ / - 3 %	
7	Combined Voltage & Frequency Variation	+ / - 5 %	
8	Terminal Arrangement	HV - Cable Box	
		LV - Cable Box	
1.03.	**RATING**		
1	Rated Voltage of H.V. (Volts)	11000 Current: 13.12Amps	
2	Rated Voltage of L.V. (Volts)	433 Current: 333.34Amps	
3	Max. Temperature rise above 50 C ambient		
	temperature of winding by resistance		
	method. (Deg. C)	45	
4	Max. Temperature rise in oil by		
	thermometer above 50 C ambient		
	temperature (Deg. C)	40	
5	Over load capacity	As per IS: 6600	
1.04.	**WINDING CONNECTION DETAILS**		
1	Connections		
	a. H.V. Winding	Delta	
	b. L.V. Winding	Star	
	c. Neutral brought out for earthing	Yes	
2	Tapings		
	a. No. of Positions	17	
	b. Range	+10 % to -10 % in steps of 1.25%	
	c. Voltage of each step	137.5V	
3	Vector Symbol	Dyn11	
1.05.	**LOSSES AND OTHERS**		
1	Total losses at rated current and rated		
	frequency at 75 deg. C (Watts) At 50% Load	980W Max.	
2	Total losses at rated current and rated		
	frequency at 75 deg. C (Watts) At 100% Load	2930W Max.	
3	Percentage Impedance at 75 deg. C at		
	Normal Tap.	4.50 Subject to IS Tolerance	
4	No load Current Approx	1.5 % of full load current	
5	Regulation at full load at 75 deg. C u.p.f.	0.99%	
6	Regulation at full load at 75 deg. C 0.8 u.p.f.	3.40%	
1.06.	**EFFICIENCY**		
1	Efficiency at 75 deg. C	U.P.F.	0.8 P.F.
	a. 100 % full load	98.86	98.58
	b. 75% full load	99.00	98.75
	c.50 % full load	99.04	98.81
	d. 25% full load	98.75	98.45
2	Load at Which Maximum efficiency occurs in %		
	of Full Load	54.05	
3	Load at which Max. efficiency occurs KVA	135.13	
4	Maximum Efficiency	99.05	
1.07.	**CONSTRUCTIONAL DETAILS**		
1	Type of Construction	Core Type	
2	Insulation between laminations	Carlit	
3	Type of joint between core limb and yoke	Mitered	
4	Type of Winding		
	a. HV Winding	Crossover	
	b. LV Winding	Spiral	
1.08.	**WINDING INSULATION LEVEL**		
	a. HV Winding (KV uniform)	12	
	b. LV Winding (KV uniform)	1.1	

1.09. INSULATION OF CONDUCTORS				
	a. HV Winding turn Insulation	DPC		
	b. LV Winding turn Insulation	DPC		
	c. Between HV and LV Winding	Oil Duct + Solid Cylinder + Oil Duct		
	d. Between LV Winding and Core	Solid Cylinder		
1.10. TYPE OF JOINTS IN WINDING		Brazed		
1.11. MINIMUM CLEARANCES				
	H.V.to Earth (mm)			
	In Oil	25		
	Out of Oil	140		
	L.V. to Earth (mm)			
	In Oil	10		
	Out of Oil	25		
1.12.TEST VOLTAGES				
	a. Impulse (1.2 / 50 micro second wave)			
	withstand voltage			
	H.V. Winding (KV peak)	75		
	L.V. Winding (KV peak)	N. A.		
	b. One minute power frequency			
	withstand voltage			
	H.V. Winding (KV)	28		
	L.V. Winding (KV)	3		
1.13. DETAILS OF TANK AND MATERIALS M.S.				
1	Thickness of side plates (mm)	4		
2	Thickness of bottom plates (mm)	5		
3	Thickness of cover plates (mm)	5		
4	Thickness of radiator (pipes or sheets)	1.2mm		
1.14. WEIGHTS AND DIMENSIONS (APPROX.)				
1	Net untanking Weight (Kg.)	975		
	(Core and windings with clamps)			
2	Volume of insulating Oil (Ltr.)	975		
3	Tank and fittings (Kg.)	1000		
4	Total Weight of Transformer (Kg.)	2800		
5	Overall dimensions of the Transformer	Length	Breadth	Height
	(approx.) in mm	2750	2070	1750
1.15. PARTS TO BE DETACHED FOR TRANSPORT		Rollers, Breather, Radiators		
1.16. STANDARD FITTINGS AND ACCESSORIES				
S.No.	**DESCRIPTION**	**QTY.**		
1	Rating and terminal marking plate	One		
2	Earthing Terminals	Two		
3	Lifting Lugs	Four		
4	On Load Tap Changer (CTR/OLG Make)	One		
	with RTCC (Independent Operation) & AVR			
5	Conservator with Drain plug	One		
6	Oil filling hole with cap	One		
7	Oil Level Indicator	Two		
8	Dehydrating Silicagel Breather	One		
9	Air release device	One		
10	Thermometer Pockets	Two		
11	Drain valve with blanking plate	One		
12	Filter valve with blanking plate	One		
13	Explosion vent with double diaphragm	One		
14	Radiators with shut off valves	Adequate		
15	Buchholz Relay	One		
16	Uni-directional Flat Rollers	Four		
17	Separate Neutral Bushing	One		
18	Oil Temperature Indicator	One		

19	Winding Temperature Indicator	One
20	Marshalling Box	One
1.17. PAINTING		
1	Surface preparation	By Sand Blasting
2	Paint	Enamel Light Grey, Shade No.631, of IS : 5
1.18. TESTS		
1	**ROUTINE TESTS**	
	As per IS: 1180 all the routine tests are carried out at our works in the presence of your Engineer.	

The contractor shall comply with the above-mentioned standards and specifications and shall be responsible for completing any outstanding works, if applicable

Inspection before Dispatch: All routine tests shall be conducted before dispatch of equipment's. No equipment shall be dispatched out from the manufactures premises before such tests are conducted and test result recorded. These test certificates shall be given along the supply of equipment. The Engineer in-charge shall, if he so desires inspect and witness the pre-delivery tests. For this purpose, the agency shall give 07-day advance notice. The contractor shall arrange for inspection/Factory Acceptance Test (FAT) of the department authorized personnel. The main contractor has to organize the FAT inspections with BGL personnel by intimating them in advance. However, the inspection shall be done at the discretion of the Engineer-In-charge without any additional cost implication by the contractor to BGL for FAT but ROUTINE TEST & TYPE TEST Certificates shall have to be submitted for equipment.

Prior to dispatch, all equipment's shall be adequately protected & insured for the whole period of transit, storage and erection against corrosion and incidental damages etc. from the effect of vermin, sunlight, rain, heat, humid climate and accidents etc.

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General

1.0 **Introduction**

The intent of this specification is to define the requirements for the supply of equipment and materials (as required), erection, testing and commissioning of the electrical power distribution system e.g PDB, cable & UPS etc.

The work shall be carried out in the best workmanship – like manner, in conformity with these specifications, approved drawings and the instructions of the Engineer-in-charge from time to time.

The contract shall include clearing of temporary construction, waste materials and loose earth, which might get collected in and nearby the work site consequent of the execution of work under this contract.

1.1 Standards

The work shall be performed in conformity with, standard specifications and installation standards enclosed and code of practices of the Bureau of India Standards. In case of any conflict, the stipulations under this specification shall govern.

In addition, the work shall also conform to the requirements of the following: The Indian Electricity Act, and the rules framed there under

The fire Insurance Regulations

The regulations laid down by the Chief Electrical Inspector of the state government / Central Electricity Authority (CEA).

The regulations laid down by the Factory Inspector.

The regulations laid down by the Chief Inspector of Explosives.

Any other regulations laid down by the Central, State or Local Authorities from time to time during the pendency of this contract.

1.2 Guarantee

The contractor shall guarantee the installation against any defects of workmanship and materials (supplied by the contractor) for a period of 12 months from the date of issue of the completion certificate. Any damage or defects connected with the erection of materials, equipment's or fittings supplied by the contractor that may be undiscovered at the time of issue of the completion certificate, or may arise or come to light thereafter, shall be rectified or replaced by the contractor at his own expense as deemed necessary and as per the instruction of the Engineer-in-charge within the time limit specified by the Engineer-in-charge.

The above guarantee shall be applicable for the quality of work executed as well as for the equipment / cable / fittings/ other material supplied by the contractor.

Site Conditions

The equipment offered and the installation shall be suitable for continuous operation under the following site conditions.

Max. / Min temperature : 500C/50C Max.
relative humidity : 90 %
Altitude : Less than 1000 m above MSL
Atmosphere : To withstand site conditions
(Dry, dust storms during summer, Humid & Heavy Rainfall during Monsoon)

1.3 Power Supply Parameters :

i) For CNG MOTHER station & Other Equivalent Stations.

NORMAL POWER	415V AC, 3 Phase & Neutral
LIGHTING DISTRIBUTION (Normal)	230 V AC, 1 Phase
INSTRUMENTATION (UPS)	230 V AC, 1 Phase

2.0 SCOPE

2.1 SCOPE OF DESIGN & ENGINEERING

2.1.1 Submission of electrical equipment drawings for review/acceptance, preparation of site engineering drawings and details for installation works wherever applicable or required by the Engineer-in-charge, and submits to the Engineer-in-charge for review/acceptance.

2.1.2 Correction, updating and submission of all Owner's drawings for as-built status.

2.1.3 Obtaining clearance for energizing the complete electrical facilities covered under this tender and approval of installation and drawings from the Chief Electrical Inspector of the State Government/Central Electricity Authority and other statutory authority as required. This includes equipments installed or commissioned by others within the battery limit. This is for the purpose of obtaining a comprehensive approval in one go.

2.2 SCOPE OF SUPPLY

Following electrical equipment and material are in the contractor's scope of supply in this tender.

2.2.1 LV/MV power and control cable (XLPE – insulated armoured Al/Cu conductor 1/2/3/3.5/4 core cables).

2.2.3 GI pipes, GI Cable-trays and accessories, cable markers, identifier tags, GI saddles and all other associated accessories for cable-laying.

2.2.4 FLP type double-compression nickel-plated brass cable glands, tinned- copper lugs, clamping material etc. for cable termination.

2.2.5 Earthing and lightning system, including earthing pits, earth electrodes, earthing strips, grounding conductor of various sizes, Cu strip for flange jumper and Cu earth plates etc.

2.2.6 Safety equipment in the stations/terminals, like shock treatment charts, caution boards, first aid equipment, insualtion mats, portable fire extinguishers, sand bucket etc.

2.2.12 Cables between transformer LT terminals of transformer & load break fuse switch unit, cable supports, double compression cable glands, lugs etc. as required.

2.2.13 Supply of PDB(LT Panel) of suitable rating for indoor type along with type tested by CPRI etc(By Govt agency).

2.2.14 Supply of Earthing System(Earthing Pit, G.I Strip, Earthing system including box for LCV) as per SOR.

2.2.15 Fabrication and supply of MS frames, supports, canopies and brackets for miscellaneous electrical equipments, including welding, supply of bolts, nuts etc for mounting and other necessary supplies, all inclusive of painting as specified.

2.3 SCOPE OF INSTALLATION, TESTING & COMMISSIONING

2.3.1 Laying & termination of all LV/MV power and control cables laid in concrete-lined trenches, buried cable trenches, pipes, road crossings, pipe-racks etc.

2.3.2 Installation testing & commissioning of 415 V switch boards/PDBs/LDBs.

2.3.3 Installation, testing & commissioning of Cables between transformer LT terminals of transformer & load break fuse switch unit, cable supports, double compression cable glands, lugs etc as required.

Installation, testing and commissioning of Earthing System(Earthing Pit, G.I Strip, Earthing system including box for LCV) material including lightning protection system as per SOR.

2.3.4 Installation, testing and commissioning of the contractor supplied materials.

2.3.5 All works relating to statutory approvals of the complete installation, from competent authority like CEA, DGMS, State electricity authority/Board etc, shall be in the scope of contractor.

3.0 OTHER MISCELLANEOUS WORKS

3.1 Preparation of buried cable trenches, including, back filling, compacting providing of brick protection by second-class bricks, spreading of fine river sand, including all supplies.

3.2 The job includes repairing of all civil works damaged during installation of electrical facilities.

3.3 The scope of work under this contract shall be inclusive of breaking of walls, floors and chipping of concrete foundations necessary for the installation of equipment, materials and making good of the same.

3.4 Minor modifications wherever required to be done in the owner free supplied equipments / devices to enable cable entry, termination, etc.

3.5 Sealing of opening made in the walls / floors for cables trays, cables, bus ducts, etc using acceptable practice and standards.

3.6 Supply and installation of all other accessories not specifically mentioned herein, but never the less necessary for completion of the job.

4.0 AREA CLASSIFICATION

Hydrocarbon handling areas have been generally classified as zone 1, gas group IIA/IIB as per IS: 5572, API RP-500, OISD - 113 and IP Rules. All equipments to be installed in these areas shall be suitable for the area classification with temperature class T3 (200^0C), CMRI testing and approved by CCOE, DGFAS and having BIS license.

5.0 JOB SPECIFICAITONS

Various electrical works covered under this contract like equipment erection, cabling, lighting and grounding works, etc. shall be performed in accordance with specifications attached with this tender. (Certain clauses of specifications, which are applicable to equipments or system not covered under this contract, shall not be applicable).

Erection and commissioning of certain special equipments shall be performed in accordance with supplier's instructions and directions of the Engineer-in-charges under supervision by equipment supplier/s.

The equipments/materials to be supplied by the contractor shall conform to the requirements of the applicable specifications enclosed in the tender document.

6.0 STATUTORY APPROVAL OF WORKS

All works relating to statutory approvals of the complete installation, from competent authority like CEA, DGMS, State electricity Authority/Board etc, shall be in the scope of contractor.

The application on behalf of the owner for submission to Electrical Inspector / DGMS etc. along with copies of required certificates and drawings, complete in all respects, shall be prepared by the contractor and submitted to the Engineer-in-charge for onward transmission well ahead of time so that the actual commissioning of equipment are not delayed for want of inspection by the Electrical Inspector / DGMS. The actual Liaison work shall be arranged by the Contractor and necessary coordination and liaisons work in this respect shall be responsibility of the contractors. However, the Owner on submission of bills along with documentary evidence shall reimburse any fee paid to the statutory Authority in this regards.

7.0 MAKES OF EQUIPMENTS AND MATERIALS

All equipments / materials supplied by the contractor shall be as per the list of approved makes enclosed with this document subject to submission of Certification and approvals.

8.0 INSPECTION, TESTING & COMMISSIONING

a. All the equipment supplied and installed by the contractor shall be tested and commissioning as required and no separate payments shall be made. Contractor shall purposes. Any damage or defect noticed shall be brought to the notice of the engineer- in-charge.

b. Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the contractor shall carry out the rectification at his own cost.

c. The contractor shall carry out all the tests as enumerated in the technical specifications and as per applicable codes and standards.

d. Before the electrical system is made live, the electrical contractor shall carry out suitable tests to establish to the satisfaction of engineer-in-charge that the installation of equipments, wiring and connections have been correctly done and are in good working condition and that it will operate as intended.

e. All the tests shall be conducted in the presence of Owner/ Engineer-in/charge or his authorized representative unless he waives this requirement in writing. The contractor shall arrange all testing equipment necessary to carry out the test. The tests shall be recorded on approved Performa and certified records of the tests shall be submitted to Owner/ Engineer-in-charge.

f. After the completion of all tests and rectification of all defects pointed out during final inspection, plant start-up trials would be commenced. During the start-up trials contractor shall provide skilled / unskilled personnel and supervision round the clock at his cost. The number and category of workmen and duration up to which required, will be decided by the Engineer-in-charge. Any defects noticed during the start-up trial relating to the equipment supplied and work carried out by the Contractor, will be rectified by the contractor at his own cost.

g. Engineer-in- charge shall have the right to get these defects rectified at the risk and cost of the contractor if he fails to attend to these defects immediately as desired.

h. After the operating conditions are fully achieved in the plant and the other requirements as stated in the General Conditions of Contract are fulfilled, the contractor would be eligible for applying for a completion certificate.

9.0 DRAWINGS, STANDARD SPECIFICATIONS AND INSTALLATION STANDARDS

9.1 The equipments / materials to be supplied by the contractor shall conform to the requirements of the applicable specifications. Also the installation of various material / equipment shall conform to the installation standards /norms.

9.2 The drawings accompanying the tender documents when read with specification shall depict the electrical system of the Terminal. These are indicative of the nature of work and issued for tendering purposes only. Purpose of these drawings is to enable the tendered to make an offer in line with the requirements of the Owner. Construction shall be as per drawings / specifications issued / approved by the Engineer-in-charge during the course of execution of work.

9.3 Conduit layout drawing in ceiling, wherever required, to be prepared by the contractor and shall be submitted for approval.

9.4 After the job completion, contractor shall prepare AS-BUILT drawings and documents, submit catalogues/manuals (O&M) of major brought out items like UPS, Inverter, HT Substation, Lighting fixture etc. Final certified as built drawings, documents and manuals etc shall be submitted by the contractor to owner in bound volume with one set in soft copy (CD) plus five sets of prints.

ELECTRICAL

LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

Cable – HT(XLPE)

1. Universal Cable Ltd.
2. KEI Industries Ltd.
3. *Industrial Cables*
4. *NICCO Corporation Ltd.*
5. Uniflex
6. Polycab.
7. Torrent cables Ltd.

ELECTRICAL
LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

Cable – LT Power (XLPE)

1. Universal Cable Ltd.
2. Polycab wires Pvt Ltd, Mumbai
3. Industrial cables (I) Ltd
4. Cable corporation of India Ltd, Mumbai
5. Gloster cables Ltd
6. Nicco Corporation Ltd, Kolkata
7. Torrent Cables Ltd
8. RPG Cables Ltd
9. Uniflex cable Ltd
10. KEI Industries Ltd.
11. Havells.
12. Crystal cables Industries Ltd
13. Finolex
14. Ravin Cables

CONTROL & Signal Cables

1. Cords Cable Industries Ltd
2. Universal Cable Ltd
3. Sriram Cables Ltd
4. KEI Industries Ltd
5. Shyam Cable Industries
6. Havells India Ltd
7. Deltron Cables Ltd
8. Thermo Cables Ltd
9. Elkay Telilinks Ltd
10. Ajanta electrical Industries
11. AP Industries
12. Udey Pyrocable Pvt Ltd
13. Finolex Cables Ltd
14. Gemscab Industries Ltd
15. Rallison Electricals Pvt Ltd
16. Suyog Electricals Ltd

17. Gupta Power infrastructure Ltd
18. Torrent Cables Ltd
19. SCOTT Innovation Wires and cables
20. Diamond Power Infrastructure
21. North eastern cables Pvt Ltd
22. KEC International Ltd
23. Assian Galaxy Pvt Ltd
24. Cabtech cable industries
25. Insucon Cables
26. Suraj Cables
27. Windsor Cables Pvt Ltd
28. Polycab

Signal Cables

Cords Cable Industries Ltd

1. Universal Cable Ltd
2. Sriram Cables Ltd
3. KEI Industries Ltd
4. Shyam Cable Industries
5. Thermo Cables Ltd
6. Elkay Telilinks Ltd
7. Ajanta electrical Industries
8. AP Industries
9. Udey Pyrocable Pvt Ltd
10. Gupta Power infrastructure Ltd
11. Insucon Cables & Cond Pvt Ltd
12. Ravin Cables
13. Ravi Industries
14. Suyog Electricals Ltd
15. Associated Cables Ltd
16. Polycab Ltd

Cable – Gland

1. Baliga
2. Comet
3. Flexpro

4. Flameproof
5. FCG
6. Standard Metal Industries
7. Sudhir Switchgear Pvt Ltd
8. Kayao Techno Equipment Ltd

Cable – Lugs

1. Dowels
2. Punitam
3. Varuna Controls & Infrastructure
4. Rapid Manufacturing CO

Cable – Tray

1. Mem
2. Bharati
3. Ratan
4. Slotco
5. Profab

Cable Termination and Jointing Kit

1. Cci
2. Raychem
3. M-Seal
4. Delta
5. RPG

Ceiling/Exhaust/Pedestal Fans & Circulators

1. Bajaj Electricals Ltd.
2. Crompton Greaves Ltd.
3. Khaitan Electricals Ltd.
4. Havell's Contractors –

AC Power

1 BCH
2 ABB
3 GE
4 L&T
5 Schneider
6 Siemens Ltd.

7 Telemechanique

Earthing Materials

1. Rukmani Electrical & Components Pvt Ltd.
2. Indiana Grating Pvt Ltd.
3. Jef Techno Solutions Pvt Ltd

Flame proof LDB's/ JB,s/Control Station/ switches

1. FCG
2. Sudhir Switchgear Pvt Ltd
3. Prompt Engineering Works
4. Flame Proof equipments pvt. Ltd.
5. Baliga Lighting Equipments Pvt. Ltd.
6. Flexpro Electricals Pvt. Ltd.

High Voltage PCC/ MCC panels

1. BHEL
2. Control and Switchgear
3. Siemens
4. Tricolite Electrical Industries
5. Schneider
6. CGL
7. L&T / LK
8. C&S

Indicating Lamps

1. ABB
2. BCH
3. L&T Ltd.
4. Siemens Ltd.
5. Tecknic
6. Schnieder

Indicating Meters

1. ABB
2. AMCO
3. AE
4. Alstom Ltd. (EE)
5. Conzerv/Schneider
6. Elecon Measurement Pvt. Ltd.
7. HPL Electric & Power Pvt. Ltd.
8. MECO Instruments Ltd.
9. Minilec
10. Rishabh Instruments Pvt. Ltd.

11. Trinity energy system
12. kaycee
13. Salzer

Lighting Fixtures (Flameproof)

1. Baliga Lighting Equipment Pvt Ltd.
2. Flameproof Equipments Pvt Ltd
3. Flexpro Electricals Pvt. Ltd.
4. FGG
5. Sudhir Switchgear Pvt Ltd
6. Flameproof Control gears Pvt Ltd
7. Ex Protecta

Miniature Circuit Breakers (MCBs) and Lighting DB

1. ABB
2. Hagger
3. Havell's India Ltd.
4. Indo Asian Fusegear Ltd.
5. Legrand
6. MDS Loadstar
7. Schneider
8. C & S Electric
9. L & T or LK

Moulded Case Circuit Breaker (MCCBs)

10. ABB
11. Hagger
12. Havell's India Ltd.
13. Indo Asian Fusegear Ltd.
14. Legrand
15. MDS Loadstar
16. Schneider
17. C & S Electric
18. L & T or LK

Indicating Meters

1. L & T
2. AE
3. Conzerv
4. HPL Electric Power Pvt Ltd
5. Meco Industries Ltd
6. Rishabh Instruments Pvt Ltd

7. Secure Meters
8. Schneider

Protection Relays – Thermal

1. L&T Ltd.
2. Siemens Ltd.
3. GE
4. ABB
5. Schnieder

Low Voltage Power Control Center (PCC)/ MCC/ PDB/ MLDB/ LDB

1. ABB
2. BCH
3. C & S
4. Elecmech Switchgear & Instrumentation
5. KMG ATOZ
6. L&T or LK
7. Pyrotech Electronics Pvt. Ltd.
8. Risha control Engineers Pvt. Ltd.
9. Siemens
10. Tricolite Electrical Industries
11. Unilec Engineers ltd.
12. Vidyut Control India Pvt. Ltd.
13. Control and Schematic
14. Zenith Engineering
15. Skytech House
16. Mundra Electricals Pvt. Ltd.

Push Buttons

1. BCH
2. ABB
3. L&T
4. Siemens Ltd.
5. Telemenchanique & Controls (India) Ltd.
6. Schnieder

Switches-Control

1. L & T
2. Siemens
3. GE Power
4. Schnieder
5. ABB
6. Havells
7. Legrand

Switches – 5/15A Piano/ Plate, Switch Socket

1. Anchor Electronics & Electricals Pvt. Ltd.
2. L & T
3. Siemens
4. GE Power
5. Schnieder
6. ABB
7. Havells
8. Legrand

Switch Socket Outlets (Industrial)

1. Anchor
2. Havells
3. Legrand
4. ABB

Solar Modules

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.
4. HBL Power

Solar Street Lighting

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.

3. CEIL, Sahibabad.
4. HBL.

Terminals Blocks

1. Connectwell
2. Controls & Switchgear Co. Ltd.
3. Elmex Controls Pvt. Ltd.
4. Essen Engineering Co. Pvt. Ltd.

Fuse

1. L& T
2. Siemens
3. GE Power
4. Cooper Bussman
5. Schnieder

Transformers

1. ABB
2. Andrew Yule
3. Areva
4. BHEL
5. Bharat Bijlee
6. Crompton Greaves
7. EMCO Ltd.
8. Intra Vidyut
9. Nani electro technics pvt ltd
10. Power tech Transformers
11. Indushree
12. Indcoil
13. Kirloskar
14. Skippers Electricals
15. Transformers & Rectifiers (I) Ltd.
16. Voltamp
17. ESENNAR Transformers
18. Toshiba Transformers

Change Over Switch

1. MSD
2. Indoasian
3. Crompton Graves
4. CGM
5. L & T

GI-Octogonal Pole

1. Bajaj
2. Transrail
3. Wipro

Capacitors:

1. Siemens
2. L&T
3. ABB

NOTE:- Item/Vendor,which are not listed above,shall be subject to prior approval from Client/Consultant.

Note:

1. Apart from the vendors detailed in the above list or items with no Vendor list, the contractor may propose any other vendor having Credentials for supply of respective items (for the same or higher Size, schedule, capacity, etc as applicable) in the Last 7 years in Oil & Gas applications. In such cases the bidder shall provide supply records viz. Copy of P.O, inspection reports, inspection release note, proven track record, experience details or any other documentary evidence to establish past supply, for owner's review and approval, as applicable.

2. At the time of P.O placement, proposed vendors supplier shall not be in holiday list of BGL.

Specifications for LV SMALL POWER DISTRIBUTION BOARD

ANNEXURE - I		
	Switch Board	
1.1	Rated voltage and frequency	415V, 3phase, 4 wire, 50Hz
1.2	Maximum voltage	500V
2.0	Continuous current rating at design ambient temperature	As per approved SLD at 45˚C with IP 52 enclosure
3.0	Type of enclosure as per IS 2147	IP 52
3.1	Minimum thickness of sheet steel	2mm
4.0	Applicable standards	IS 2147, 8623
5.0	Design ambient temperature	45˚C
6.0	One second short time rating of switch board with minimum busbars, feeder busbars, kA(RMS)	As per SLD
7.0	Dynamic through fault current with complete busbars, kA (peak)	
8.0.	The formation (Max.)	Max 6
9.0	Maximum No. of cable terminations in each type of cubicle	
9.1	Size and no.	As per SLD
10.0	Incoming termination of LT switch board	As per SLD
11.0	Incoming termination top/bottom	Bottom for cable Top for busduct
12.0	Outgoing feeder cable entry top/bottom	Bottom
13.0	Minimum clearances at front and back of board	1.5m/1m
14.0	Dimensions LxBxH	
15.0	Maximum Dimensions of shipping sections LxBxH	2.5 x 1.5 x 2.4M
16.0	Min. clearances in air in mm	
16.1	Between phases	25.4mm
16.2	Between live parts and ground	19.0mm
17.0	One minute PF withstand voltage	2.5kV
18.0	Paint shade	631 of IS-5
	Busbars	
1.0	Busbar material & cross section	

1.1	Main busbars	E91E aluminium' Max. current density 0.6A/mm^2
1.2	Bus connections to circuit breakers	
2.0	Continuous rating at design ambient	
2.1	Main busbars	As per SLD
2.2	Bus connections to circuit breakers	As per rated current of
3.0	Temperature rise at rated continuous current of the busbar in the busbar chamber	40deg.C over 45deg.C
4.0	Type of busbar insulators	Resin cast/fibre glass
	Breakers/SFU	
1.0	Type of breakers	As per SLD
2.0	Standards applicable	IS 13947-2/IEC947 – part-II
3.0	Rated service voltage	415V, 3ph., 50Hz
3.1	Highest system voltage	500V, 3ph., 50Hz.
4.0	Rated current at design ambient for breakers	As per SLD
4.1	Rated with breaker in IP 52 enclosure in two tier formation in the LT switch board	As per SLD
5.0	Symmetrical breaking capacity im kA (RMS)	
	-at 415V, 0.25 PF	50 kA RMS
	-at 440V, 0.25 PF	50 kA RMS
6.0	Making capacity kA (Peak)	105kA Peak
7.0	Capacitor breaking capacity at 440V	Incomer: 600A (min.) Outgoing: 300A(min.)
8.0	1 sec. Short time rating, kA (RMS)	50kA RMS
8.1	With release in any setting	50kA RMS
9.0	Thermal release setting ranges (temperature compensated)	As per SLD
10.1	Short circuit release range	As per SLD
10.2	Short circuit release timer setting range	0.1 to 0.6 sec. mechanical
Note	All the releases O/L, S/C and E/F shall be Static/microprocessor based.	

STANDARDSPECIFICATIONS (ELECTRICAL SYSTEM)

SPECIFICATION FOR

CABLE LAYING

CONTENTS

1.0 SCOPE

The intent of this standard specification gives recommendation & Board Guideline for selection, transportation, laying, jointing, termination, testing and commissioning of the cabling system up to 33kV.

2.0 STANDARDS

The work shall be carried out in the best workmanship like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorised representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

In general the equipment covered by this specification shall, unless otherwise specified, be in line with the requirement of any of the latest applicable standards of

a) Bureau of Indian Standards
b) British Standard Institution
c) American Standard Institution
d) International Electro Technical Commission

2.2 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 GENERAL REQUIREMENTS

3.1 ENVIRONMENTAL CONDITIONS

The cables shall be laid for continuous operation at full load under the climatic and environmental conditions as described in the specification “Design Basis Electrical”.

3.2 COMPONENTS AND EQUIPMENT

a) The Contractor has to take care that all components, equipment & cable routes are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals. All components and equipment shall be designed for continuous duty at rated load and under the given climatic conditions. Standard industrial high performance systems and components shall be used as far as possible.

3.3 TAGGING

All components, equipment, cable route and installations shall receive the respective tagging plates, labels, etc which have to be of extremely durable material resistant against the environmental conditions.

4.0 CABLE SPECIFICATIONS

Refer Specification for HV & LV Cable (Specification No. MEC/TS05/E9/24)

5.0 MISCELLANEOUS MATERIALS SPECIFICATIONS

5.1 Connectors

The cable accessories shall include end termination kits, straight through joints and also any special tool and tackles and accessories required for making the joints/terminations.Cable terminations shall be made with Aluminium/tinned copper crimped type solder less lugs of approved make for all Aluminium/Cu conductors cables and stud type terminals and shall be as per IS: 8309.

The straight through joint/termination arrangement shall be complete with all fittings and consumables. The joint shall have electrical and mechanical withstand capability, same as that of the associated cable. For all cables, a minimum extra length of 2 metres will be left before jointing. The termination kit shall be of heat shrinkable type only.

The termination kits/straight through joints shall have the following features:

- Electrical stress control to be provided at the cable insulation shield terminus.
- An external leakage insulation to be provided between the cable conductors and ground.
- Adequate protection to be provided at the end of the cables against the entrance of the moisture and, provision to maintain the constant pressure in the cable

5.2 Cable Identification

Cable tags shall be of 2 mm thick, 20 mm wide aluminium strap of suitable length to contain cable number, equipment no etc.
All cables shall be provided with identification tags indicating cable numbers in accordance with the cable/circuit schedule. Tags shall be fixed at both ends of cable, at joints and at 20 m spacing for straight runs. When a cable passes through a wall, tags shall be fixed at both sides of the wall. The tags shall be of aluminium sheet with the numbers punched on them and securely attached to the cables with non-corrosive wire. For single core cables wire shall be non-ferrous material. Individual cores of control cables shall have for identification, plastic ferrules with engraved numbers at both ends of the circuit.

5.3 Ferrules

Ferrules shall be of approved type size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected for case in identification and maintenance. Ferruling shall be done at both end of cables.

5.4 Cable Glands

Cable glands shall be nickel-plated Brass double compression type of approved/ reputed make with tinned copper lugs. Sealing kits with associated accessories like stress relieving cones, insulating tape, trifurcating boot, HT insulating tape, etc. Glands for classified hazardous areas shall be certified by CMRS and approved by CCE, Nagpur.

5.5 Cable trays

This shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays as specified elsewhere. Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. For requirements of larger than 750 mm width two trays shall be run side by side. Cable trays shall be suitable for a cable weight of 50 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively.

Power cables shall be laid on ladder type cable trays. Ladder type cable racks shall be selected from three sizes viz., 300, 450 and 600 mm and shall be fabricated from 50 x 50 x 6 mm MS angles for longitudinal members and 30 x 6 mm MS flats for cross members placed at an interval of 300 mm along the length of the rack with a provision of double cross members at locations, where cables are to be clamped. Supporting brackets for ladder type racks shall be provided at an interval not exceeding 1500 mm. Both horizontal and vertical members shall be of 50 x 50 x 6 mm MS angle and the bracket shall be welded to the embedded inserts or as approved by engineer-in-charge. Alternatively prefabricated sheet steel/ aluminium racks and supporting brackets of bolted construction may be used for power and control cables.

Vertical spacing between cable racks shall be between 300 mm to 250m depending upon size and number of cables.

If unit rate is not included in schedule of rates, then cable trays if required, shall be fabricated and installed at site as per ton rate for electrical structural supports etc.

5.6 GI Pipes

GI pipes shall generally be adopted for routing cables embedded through concrete foundations/ floors/walls (including the portion above floor level to be laid in continuation for protection against mechanical damage) generally in plant buildings. These shall be medium gauge, hot dip □galvanized□, electric resistance welded (ERW) screwed type conforming to IS:1239-1990 (Part-I). All pipe fittings shall conform to IS:1239 -1992 (Part-II). Not more than 40% of GI pipe cross sectional area shall be used(Blocked).

G.I conduits shall generally be used for exposed cabling along building walls/structures etc. in both plant and non plant buildings as well as concealed cabling in offices, canteens and other non plant buildings. These shall be of □galvanized□□ steel, screwed type conforming to

IS:9537-1981 (part-II). Conduit accessories and fittings shall be of standard types conforming to IS:3837-1976.

All GI pipes/conduits shall be provided with pull wires to facilitate cable pulling.

GI pipe/conduit runs shall not have more than three 900 bends (2700 total) including bends immediately at the outlet or fitting. Straight runs shall be limited to 30 m by providing approved type pull/junction boxes as required.

Normally, no joints shall be made in through runs unless same is more than standard cable lengths. In cases where a jointing is to be done, the same shall be made with proper jointing material and kits.

G.I conduit/PVC pipe systems shall be firmly supported in position by means of heavy gauge saddles either screwed to concrete/brick walls using suitable plugs or screwed to MS brackets/cleats welded on to building structures. The spacing between support for both horizontal and vertical runs shall not be more than 1000 mm for straight runs. At or termination to junction/pull boxes, the nearest support shall

be 300 mm from such fittings. Exposed GI conduits shall run parallel or perpendicular to column/building lines to match the existing architectural arrangement. Embedded GI pipes shall however, run in direct lines with minimum bends. Bends for GI pipes/conduit where required shall be made such that the diameter of the pipe is not deformed. The radius of inner edge of field bend shall not be less than 8 times diameter for GI pipes and 6 times for conduits.

In damp locations exposed GI conduit and fittings shall be made water tight. Also, the conduit shall be mounted on steel spacers having a minimum thickness of 6 mm. Stub ups of embedded GI pipes shall be fitted with coupling plugged suitably to avoid damage to threads or entry of foreign matters during construction.
GI pipes/conduits shall be selected on the basis of percent fill in area as given in IS:1239- 2004 (Part-I) for medium gauge GI pipe as per IS 9537-1981 (Part-II).

6.0 CABLE LAYING

Cable network shall include power, control, lighting and communication/signal cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings and cable schedules. Erection of cable trays as required shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc and minor adjustments shall be done to suit the field conditions wherever deemed necessary without any extra cost.

High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cables trays, as applicable as per IS 1255.

All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works Before the start of cable laying, cable drum schedule shall be prepared by contractor and get that approved by Engineer-in-Charge to minimize/avoid straight through joints required. Contractor shall work out the actual number of straight through joints required.

Laying & installation of Cable Routes

6.1 Cables laid on walls, structures, concrete trenches & cable tunnels

6.1.1 In the plant buildings, substations, switch/control rooms etc. power and control cables shall generally be taken exposed on brackets, cable racks/hooks laid in tunnels, concrete trenches, cable cellars, basements, cable galleries or along building and technological structures.

6.1.2 In the auxiliary shops and utility buildings, power and control cables shall generally be taken on cable racks either laid in concrete trenches or supported from building structures, walls, ceiling etc.

6.1.3 Power and control cables installed along buildings and technological structures, ceiling, walls etc which are required to be protected against mechanical damage and/or radiation of heat shall be taken in GI conduits. GI conduits shall also be used for flame-proof installation, where required. In corrosive atmosphere where 1,100 V grade cables are required to be taken in pipes, rigid heavy duty PVC pipes shall be adopted. Where direct heat radiation exists, heat isolating barrier shall be provided.

6.1.4 Cables to individual drives, control devices etc shall be taken in embedded/ exposed rigid GI pipes/ flexible conduits. Extra length of cables shall be provided suitably where possible for any future contingency.

6.1.5 For interplant cabling in plant outdoor yard, the power and control cables shall generally be laid in the manner as follows:

- Directly buried in ground or in concrete trenches with cables laid on rack.
- In underground cable tunnels and overhead cable galleries, for main distribution feeders and for locations having large number of cables.
- In concrete ducts buried in ground, where direct burial and provision of concrete trench/tunnel are not possible due to presence of other service lines.

6.1.6 All cables irrespective of type of installation shall be protected by means of GI pipes or sheet metal protective cover up to a height of 1500 mm from the working floor level and platforms for protection against mechanical damage.

6.1.7 For higher size cables a loop of about 4/5m is to be kept in the cables for meeting future contingency of jointing/termination length.

6.1.8 For 415 V power wiring in auxiliary buildings offices and laboratories etc cables shall be taken in embedded/exposed GI conduits or rigid PVC pipes.

6.1.9 The installation work shall be carried out in a neat workman like manner by skilled, experienced and competent workmen, with experience in jointing and termination of aluminium conductor cables. Cable runs shall be uniformly spaced, properly supported and protected in an approved manner. All bends in runs shall be well defined and made with due consideration to avoid sharp bending and kinking of the cable.

6.1.10 The bending radius of various types of cables shall be as per IS: 1255-1983:

Type of cable and voltage	Minimum bending radius		
Grade	Single core	Multi core	
		Unarmoured	Armoured
11 kV XLPE cables	20 D	15 D	15 D
1.1 kV PVC cables	15 D	12 D	12 D

6.1.11 Cable installation shall be properly co-ordinated at site with the routing of other services/utilities. Where necessary, suitable adjustment shall be made in the cable routings with a view to avoid interference with any part of the building, structures, equipment, utilities and services. Exit of cables from underground trenches or tunnels shall be through pipe sleeves. Pipe sleeves shall be properly sealed. Pipe sleeves shall be laid at an angle of maximum 45˚ to the trench wall. In case of larger diameter cables, i.e., 50 mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Engineer-in-Charge.

6.1.12 All cables shall be tested for proper insulation prior to laying. The cable drums shall be transported on wheels to the place of work. The cable shall be laid out in proper direction as indicated on the drum using cable drum stands. In case of higher size cables, the laid out finally transferred carefully on to the trenches and racks. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Approved cable pulling grip or other devices shall be used.

6.1.13 Adequate length cables shall be pulled inside the switchboards, control panels, terminal boxes etc so as to permit neat termination of each core/ conductor. Control cables entering switchboard or control panels

shall be neatly bunched/strapped with PVC perforated tapes and suitably supported to keep it in position at the terminal block. All spare cores shall be neatly dressed and suitably tapped at both ends.

6.1.14 Power cable terminations shall be carried out in such a manner as to avoid strain on the terminals by providing suitable clamps near the terminals. All power cable terminations shall be by means of crimping type cable lugs. Control cables shall be terminated directly at the terminal blocks by screws.

6.1.15 No joint shall normally be made at any intermediate point in through runs of cables unless the length of the run is more than the length of standard cable drum. In cases where jointing is unavoidable, the same shall be made by means of standard cable jointing kits. All opening for cable entry in the equipment shall be sealed and made proof against entry of creeping reptiles.

6.1.16 Power cables of different voltage grades shall be laid in separate racks/ hooks. Control cables as well as signal and communication cables shall be laid in separate racks. The cables in racks/hooks shall be laid in the order of their voltage grades such that the cables of lowest voltage grade are on the topmost tier and highest voltage grade on the bottom- most tier. Where there is possibility of mechanical damage to cable rack, sheet steel covers shall be provided for adequate protection.
All communication/signal cables (telephones, P.A.S, Instrument) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench with a minimum clearance of 300 mm away from electrical trench as per IS 1255 & direction of Engineer-in-Charge. Communication cables shall cross power cables at right angles.

Clearance –The desired Minimum clearance are as follows-

Power Cable to Power Cable - Clearance is not necessary. However, there would be some clearance so that, the current carrying capacity become better.

Power cable to control cable	-	0.2m
Power cable to communication/ Signal cable	-	0.3m
Power cable to Gas/Water Main	-	0.3m

Inductive influence/interference on signal/control/communication cable should be checked.

The Power cable should not be laid above the Communication Cable. While laying of power cables the likely interference to existing communication/signal cable should be avoided by referring to and coordinating to appropriate authority.

6.1.17 For future installation of cables, provision shall be made to keep 20 percent space as spare on each rack. Alternatively, one spare rack can be provided all along the route. Cable racks shall be so arranged that they do not obstruct or impair movement in passage way. Particular attention shall be given to this aspect at rack crossing in cable tunnels and cable cellars where a minimum clearance of around 1800 mm shall be kept for free movement. For dusty area cable racks shall be vertical type(for horizontal run).

6.1.18 For laying cables along steel/ technological structures on concrete walls/ceiling etc. the cable shall be taken by clamping with MS saddles screwed on to MS flats welded to the structure or to embedded inserts provided in walls. Where inserts are not available the saddles may be directly fixed to the walls using drawl plugs and MS flat spacers of minimum 6 mm thick.

6.1.19 The MS saddles shall be placed at an interval of not less than 500 mm both for horizontal and vertical

runs. However, at bends, it shall be placed within 300 mm and when terminated to equipment/junction box the cable shall be clamped immediately before such termination. In areas prevailing with corrosive atmosphere, PVC saddles instead of MS saddles shall be provided.

6.1.20 The termination of GI pipes/conduits to rotating or other equipment subject to vibration or connection/disconnection at intervals shall be made by means of flexible metallic conduits. The use of flexible metallic conduits in outdoor locations shall be avoided as far as practicable.

6.1.21 Flexible pipes shall be liquid tight, □galvanized□□ heavy duty interlocked type with extruded PVC jacket on top generally conforming to IS:3480-1966The adapter for coupling flexible conduit to rigid pipes/equipment shall be of cast aluminium, screw/gland type. Alternatively, steel wire reinforced PVC hose may be used with matched adapters.

6.1.22 All fabricated pull/junction boxes shall be made of 3 mm thick sheet steel, painted as specified. The pull boxes shall be sized to suit the largest recommended bending radius of the cables to be accommodated. Larger boxes (generally exceeding 600 mm in length) shall be fabricated with standard steel sections.

6.1.23 RCC cable trenches with removable covers as shown on the drawings will be provided by the Owner. Cables shall be laid in 3 or 4 tiers in these trenches as indicated on the sectional drawings. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases, RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purpose of cable laying and reinstalling them in their proper positions after the cables are laid shall be done by the electrical Contractor at no extra cost.

6.1.24 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection upto a minimum of 300 mm above grade or as shown in the standard drawings.

6.2 Buried Cables

6.2.1 Power and control cables laid directly buried in ground shall be laid as per the requirements of code of practice IS: 1255-1983. Generally cables shall be taken at a depth of 1000 mm from finished ground level.

6.2.2 For laying of multiple 11 kV grade power cables horizontal axial spacing shall be 250 mm. For 1100 V grade power cables, the horizontal axial spacing shall be 150 mm. Control cables shall be laid touching each other without any horizontal spacing. However, the distance of the control cable from the nearest power cables shall be 200 mm. Power and control cables may be laid in a common trench, but power cables for each voltage grade and the control cables shall be laid separately in groups. Generally cables shall be laid in one layer. In general, communication cables shall not be taken in a common trench. In case the same is required to be taken along with power cables, the minimum axial spacing between two cables shall be 300 mm.

6.2.3 Directly buried cables shall be laid underground in excavated cable trenches where specified in layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

6.2.4 Desired Minimum depth of laying from ground surface to top of cable is as follows-

High voltage cables, 3.3kV to 11kV Rating	:	0.9m
High voltage cables, 22kV to 33kV Rating	:	1.05m
Low voltage & control cable	:	0.75m
Cables at Road Crossing	:	1.00m
Cables at railway crossing (Measured from Bottom of sleepers to top of pipe)	:	1.00m

The depth and the width of the trench shall vary depending upon the number of layers of cables.

6.2.5 Precast concrete protective cover shall be placed centrally along the cables. The concrete slab shall be of RCC type as per Appendix-C of IS:1255-1983 having suitable provision for dovetailing with the adjacent slab. The length depending on the number of cables in the trench as well as axial s spacing. The minimum width of slab shall not be less than 200 mm.

6.2.6 After laying of cables, the trench shall be back filled with good excavated soil and well rammed in successive layers not less than 300 mm depth. The excavation of trenches shall be done with vertical sides and trenches shall be kept as straight as possible. The width of trench shall be in accordance with the number of cables to be laid out but in no case shall be less than 400 mm. The minimum clearance between trench edge and cable shall not be less than 100 mm. At turning and tee-off points of the cable trench suitable chamfering shall be made keeping in view the minimum bending radius of cables.

Cable ends shall be carefully pulled through the conduits, to prevent damage to the cable. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following grade of the pipe fill shall be used for sizing the pipe size:

a)	1 cable in pipe	-	53% full
b)	2 cables in pipe	-	31% full
c)	3 or more cables	-	43% full
d)	Multiple cables	-	40% full

6.2.7 Where cables are required to cross roads, railways tracks and surface drains they shall be taken through reinforced concrete spun pipes at a minimum depth of 1000 mm. For crossing water oil, gas or sewage pipes etc. cables shall be taken above the pipes where minimum 500 mm clearance is available from top of pipes. Where 500 mm clearance is not available, the cables shall cross these pipes through RC pipes at minimum depth of 750 mm from finalized ground level keeping distance of 300 mm between the utility and cable pipes.

6.2.8 In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made in case the cable develops fault at a latter date. Also when group of cable are laid together the cable length shall be adjusted to stagger the straight through joints.

6.2.9 Directly buried underground cable shall be generally laid by the utility alley along the roads and cable routing shall follow the road layout. However, in special cases to keep the cable lengths minimum the cables may be laid by the shortest route and the same shall be taken through RC pipe where required.

6.2.10 Galvanised iron cable markers and identification tags shall be provided at each joint, entry to building/tunnels, each turn, either side of the road crossings and at 30 m intervals for straight cable runs. The markers shall be conspicuous and fixed in concrete block in a durable manner.

6.2.11 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protective pipe or cover, until such times the final termination to the equipment is connected. Minimum bending radii of cable shall be as specified in IS: 1255.

6.2.12 Cables shall be laid in trenches at depth as shown in the drawing with protective GI earth conductor (runs

along the cable). Before cables are placed, the trenches bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall then be laid flat. The remainder of the trench shall then be back-filled with soil, rammed and leveled.

6.2.13 As each row of cables is laid in place and before covering with sand every cable shall be given an insulation test in the presence of Engineer-in-Charge / Owner. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.

6.2.14 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/ lined trench.

6.2.15 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/ `PUTTI' for sealing purpose. The cost for the same shall be deemed to have been included in the installation of G.I. Pipe and no separate payment shall be allowed.

6.2.16 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Engineer-in-Charge before cutting is done.

6.2.17 Individual cables or small groups which run along structures/walls etc. will be clamped by means of 10 SWG GI saddles on 25x6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. Alternatively small group of cables can be taken through 100 mm slotted channel/ISMC 100.

6.2.18 They shall be rightly supported on structural steel and masonary, individual or in groups as required, if drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result.

6.2.19 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm diameter.

6.2.20 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. Saddles/Clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

6.2.21 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

7 TERMINATION

7.1 All PVC cables upto 1.1 KV grade shall be terminated at the equipments by means of double compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

All Cable entries shall be through bottom only and top entry terminations are made only after getting approval of Engineer-in-Charge.

7.2 Power cables wherever colour coding is not available shall be identified with red, yellow and blue PVC

tapes. Where copper to aluminum connections are made, necessary bimetallic washers shall be used for trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

7.3 In case of control cables, all cables shall be identified at both ends by their terminal numbers by means of PVC ferrules or self-sticking cable markers. Wire numbers shall be as per schematic/ wiring /inter-connection diagram. Bidders shall have the samples of PVC ferrules/cable markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends.

7.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type, at no extra cost. All switchgear and control panels shall have un-drilled gland plate.

Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables.

7.5 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

7.6 In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the center line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

7.7 Cable leads shall be terminated at the equipment terminals, by means of crimped type solderless connectors.

7.8 Crimping shall be done by hand crimping hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

7.9 Termination and jointing of aluminium conductor power cables shall be by means of compression type aluminium lugs. Alternatively, tinned copper compression type lugs may also be used with application of corrosion inhibiting compound. Copper conductor control cables shall be terminated directly into screwed type terminals provided in the equipment.

7.10 The jointing and end sealing kits shall be complete with stress relief system and all accessories, straight through joint for direct burial installations shall be provided with cast resin enclosure for protection against water and corrosion.

7.11 Straight-through joints for 1100 V grade PVC insulated cables shall be with epoxy resin compound for direct burial cables. Cable glands for terminating PVC insulated, armoured/ unarmoured cables shall be made of brass or aluminium alloy.

7.12 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all XLPE/PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed

cables shall be plumbed with lead alloy.

7.13 Cable accessories for H.V. Systems

7.13.1 The 11, 6.6 and 3.3 KV cables terminations joints shall be done by skilled and experienced jointers duly approved by the Engineer-in-Charge. Termination including supplying of jointing kit shall be in the scope of contractor unless specified otherwise.

7.13.2 The termination and straight through joint kit for use on high voltage system shall be suitable for the type of cables or the type of cables issued by owner for installation. Supply of termination kit shall be in the scope of contractor. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fitting and consumables items. An installation instruction shall be included in each sheet.

7.13.3 The termination kits shall be suitable for termination of the cables to indoor switchgear/panels or outdoor weatherproof cable box or outdoor transformer & motors or Double/Four pole structure. The terminating kits shall preferably be of the following types:

a) Heat-shrinkable power cable termination/joint kit of M/s. Raychem or equivalent.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

7.13.4 The straight through jointing kits shall be suitable for underground-buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a) Heat-shrinkable sleeve type of M/s. Raychem or equivalent.

7.13.5 Makes of kits other than those specified above may be considered, provided the Contractor furnishes type test certificates, along with the offer for approval of the same.

7.13.6 Type tests are to be carried out at manufacturer's works to prove the general qualities and design of a given type of termination/jointing system. The type tests shall include the following tests conforming to the latest IEC 502.2, 466 and VDE 0278 specifications. The type test certificates shall be submitted by the Contractor along with the offer for indicating the jointing system considered.

a. A.C. Voltage withstand dry test for 1 minute
b. Partial discharge test - Discharge magnitude shall be less than 20 p.c.
c. Impulse voltage withstand test with 10 impulses of each polarity.
d. A.C. high voltage test following load cycling test with conductor temperature at 95˚C.
e. Thermal short circuit test of 250˚C for 1 second.
f. DC Voltage withstand test for 30 minutes.
g. Humidity test.
h. Dynamic short circuit test.

i. Salt log test

j. Impact test

8 TESTING

8.1 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground.

8.2 Where splices or termination are required in circuits rated above 600 volts, measure insulation resistance of each length of cable before splicing and or/ terminating. Repeat measurement after splices and/or terminations are completed.

8.3 Measure the insulation resistance of directly buried cable circuits before cable trenches are back-filled. Repeat measurement after back- filling.

Rating of IR tester for cables of different voltage rating as follows-

Cable Voltage grade	IR Tester Voltage Rating
1.1kV	500V
3.3kV	1000V
6.6kV	1000V
11kV	1000V

8.4 Cables after jointing & termination are subjected to DC high voltage test. The recommended values of test voltage are given below.

Uo/U	Test Voltage Between: Any conductor and metallic Sheath/ Screen /Armour	Conductor to Conductor (For Unscreened Cable)	Duration (Min.)
0.65/1.1	3	3	
1.9/3.3	5	9	
3.3/3.3	9	9	
3.8/6.6	10.5	18	15
6.6/6.6	18	18	
6.35/11	18	30	
11/11	30	30	

8.5 All cables shall be tested as per standard test Performa available with site engineer.

8.6 Cable schedule and layout drawings must be marked for AS BUILT conditions during the installation work and shall be approved by Site Engineer.

9 DOCUMENTATION

After commissioning & testing of all power & control cables, contractor shall submit the following document to Client/BGL for As-Built status in hard copy (5 set) plus one soft copy.

i) Complete commissioning report of cables

ii) Drawing showing Cable rout of all laid cables in trenches/trays including respective cable numbers.

SPECIFICATION FOR

EARTHING AND LIGHTNING PROTECTION

CONTENTS

1.0 SCOPE

The intent of this specification is to define the requirements for the supply, installation, testing, and commissioning of the complete Earthing & lightning protection System.

2.0 STANDARDS

The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specifications/codes of practice of Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instructions of Engineer-in-Charge shall be binding.

IEC 62305 Protection against Lightning

IS 2309 Protection of building and allied structure against lightning IS

3043 Code of practice for earthing

NBC 2016 National Building code

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 TAGGING

All components, equipment and installations shall receive the respective tagging plates, labels, etc., which have to be of extremely durable material resistant against the environmental conditions. For further requirements, reference is made to the specification “Design Basis- Electrical”.

4.0 EARTHING SYSTEM

General

Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations/ IS code of practice IS 3043-1987 and Indian Electricity Rules, so that the values of the step and contact potentials in case of faults are kept within safe

permissible limits.Parts of all electrical equipment and machinery not intended to be alive shall have two separate and distinct earth connections each to conform to the stipulation of the Indian Electricity Rules and apparatus rated 240V and below may have single earth connections.

The stations shall be equipped with an equipotentially meshed grounding network. All exposed conductive parts or elements of the station systems will be connected to this network. The earthing systems of the various stations are part of the protection systems for electrical power supply, instrumentation, control and supervisory system. The earthing system consists of the main grounding grid, the grounding rods, the building foundation grounding and the equipment grounding.

Supply of all other erection/consumable required to complete the installation shall be the responsibility of the contractor. All hardware used for earthing shall be hot dip galvanized.

Any other items not specifically mentioned here but necessary for completeness of job shall be in the scope of contractor & shall be supplied by contractor without any extra cost.

All shops and buildings as well as the electrical sub-stations and electrical rooms shall be provided with a ring main earthing system each. Individual ring main earthing systems shall again be interconnected as a network.

For stations, which are to be extended, the existing earthing system shall be considered. The layout of new earthing system shall match to the existing installations. The new and the existing grounding network must be interconnected at two (2) locations, at least.

The ring earthing system around each building shall be laid at a distance of approximately 1.5 m from the building and at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structures, reinforcement of building columns and also to pipes, wherever they are crossing. The earth ring shall further be connected at intervals to deep earthing electrodes to achieve a combined earth resistance of less than one ohm.

The grounding network system will be installed in different locations have different soil characteristics according to the location of the stations. Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements by the contractor & submit for review & approval.

Station earthing should have low earth resistance, low touch & step potential.

5.0 EARTHING CONDUCTOR

The main grid conductor shall be hot dip galvanized G.I. Flat or PVC insulated copper conductor. Size & type of conductor shall be as marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns.

6.0 DESIGN REQUIREMENTS

6.1 The earth resistance of the overall interconnected station grounding network shall not exceed 1 Ω.

6.2 For the purpose of dimensioning the earthing lines/conductors, the duration of the earth fault current shall be taken as 0.3 seconds.

6.3 All exposed metal part such as HT/LT switchgear, DP/FP structure, distribution board, metal clad switchgear enclosure, lamp brackets, lamp holder, plug sockets, lighting poles, junction boxes, high mast etc shall be properly earthed by connecting these to the earth electrode by means of GI wire/Flat or PVC insulated Cu conductor of approved size to pass the fault current safely to earth in case of any fault.

6.4 For different floors in a building, localized ground mats shall be formed and connected to the ground earthing ring through vertical risers. The earthing mat shall be common to both power and lighting installations.

6.5 For the UPS, the SCADA and telecommunication systems with their equipment a separate grounding network with sufficient cross-section to avoid interference shall be installed. This grounding network shall be connected to the common station grounding network on one (1) separable and indicated connection point, within the electrical building or equipment container/enclosure.

6.6 Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements.

6.7 The required conductor spacing, the total length of the grounding grid and the required grounding material cross-section shall be calculated under consideration of the maximum earth fault current, to maintain touch and step voltages within reasonable limits. The impedance of the fault current path and protective devices shall be chosen that the faulted circuit will be disconnected from the supply within the required time. A respective grounding calculation with report shall be performed for each station and is to be submitted to the Client/BGL for approval.

6.8 Multiple connections of grounding conductors shall only be carried out above ground. For these connections the respective grounding bars are to be installed. Extensions of single grounding conductors can be permitted below ground under use of compression connectors or welding connections, with repair painting and coating of the connection point.

6.9 All connections of conductors on equipment shall be performed with pressure type lugs or connectors and threaded bolts, screws, spring-washers and washers. Special care must be taken to avoid the arising of a chemical element. Connections between bare copper and iron parts must be protected in a special manner and shall only be executed on above-ground connection points (grounding bars) or inside of pits.

6.10 The power supply cables (LT) from the sub-station and the distribution cables to individual motors shall have 4/3.5 cores. LT power supply cables shall have four cores and the fourth core shall have cross-sectional area of 50% of the other cores generally. The fourth core of the main supply lines shall be connected to the solidly earthed neutral bar in the substation switchgear as well as at the earth bars in MCC/distribution boards.

6.11 Separate electonic earthing system shall be provided for all electronic equipment like PLC"s, weighing panel, computer etc.

7.0 EARTHING NETWORK

7.1 The earthing installation shall be done in accordance with the earthing drawings and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and Rules. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location on the equipment shall be determined in field, in consultation with the Engineer-in-Charge or his authorized representative. Any changes in the methods, routing, size of conductors etc shall be subject to approval of the Owner/ Engineer-in-Charge before execution.

7.2 Excavation and refilling of earth, necessary for laying underground earth bus loops shall be the responsibility of the contractor.

7.3 The main earth grid shall be laid at a depth of minimum 700 mm below grade level. Wherever RCC cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleared to the walls of concrete lined trenches. The earthing strip shall be protected against mechanical damage.

7.4 A common grounding system network (Main earthing grid) will be made underground by using 50 mm x 6 mm GI earthing strip connected to earth electrodes in loop-in & loop-out system and connecting the electrical equipment to network. In RCC cable trench one number earth strip of size 50 x 6 mm shall be run throughout the length of the trench.

7.5 Earthing system around each building shall be laid at distance approximately 1.5 meter from the building & at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structure, reinforcement of building columns & pipes wherever they are crossing. The earth ring shall further be connected to deep earthing electrodes to achieve a combined earth resistance of less than One or Two ohm as specified earlier.

7.6 In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals.

7.7 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below ground shall be welded and suitably protected by giving two coats of bitumen and covering with Hessian tape. All joints above ground shall be by means of connectors/ lugs as far as practicable. Tee connectors shall be used for tapping, earth leads from the main earth loop wherever it is installed above ground. Earthing plates shall be provided for earthing of two or more equipment at a place from earth grid. Where aluminium cable risers are to be connected to the underground GI earth bus, the aluminium cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable, then G.I. risers shall be brought above grade and a bolted joint shall be made between this GI riser and the aluminium cable termination. This G.I. Riser shall be protected applying two coats of bituminous paint/bitumen on the
exposed portion.

7.8 Conduits in which cables have been installed shall be effectively bonded and earthed. Cable armours shall be earthed at both ends.

8.0 INSTALLATION OF EARTH ELECTRODES

8.1 Earth pipe electrodes shall be installed as shown in the earthing layout drawings shall be in accordance with the standard drawings, specification and IS: 3043. Their location shall be marked to enable accurate location by permanent markers.

8.2 All earth electrodes shall preferably be driven to sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.

8.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months. If necessary, a number of electrodes shall be connected in parallel to reduce the earth resistance, shall be in the scope of contractor. The distance between two electrodes shall not be less than twice the length of electrode.

8.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of

poor conductivity.

8.5 Tentative no of earth pits shown in drawing are only for reference to the contractor. The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/Engineer-in- Charge, depending on the soil strata and resistivity, to meet the ohmic values prescribed in clause 6.1. The contactor shall design the earthing system accordingly & submit for review & approval.

8.6 Earth Electrodes shall be located avoiding interference with road, building foundation, column etc. Individual earth electrode shall be provided for each lightning arrestor and lightning mast. The electrodes shall be so placed that all lightning protective earths may be brought to earth electrode by a short and straight a path as possible to minimize surge impedance.

8.7 The disconnect facility shall be provided for the individual earth pits to check their earth resistance periodically. All the earth electrodes shall be suitably numbered and this should be indicated in as built drawings.

9.0 CONNECTION

9.1 All electrical equipment is to be doubly earthed by connecting two points on equipment to a main earthing ring. The earthing ring will be connected via links to several earth electrodes. The earth grid formed shall be a closed loop as shown in the drawing with earth electrodes connected to the grid with double strip connection. The cable armour will be earthed through the cable glands.

9.2 In hazardous areas all major process equipments shall be connected to the earthing ring by means of anti-loosening connections and all pipelines will be bonded and earthed on entering the battery limit of the process area.

9.3 The following shall be earthed.

1. Transformer neutrals & body
2. Double Pole & Four Pole structures
3. CT/PT neutrals
4. Neutral Grounding Resistors
5. Lightning Arrestors
6. All switchgear and their earth buses, bus duct
7. Motor Frames
8. UPS, Telecommunication system, RTU's, Control panels & other instruments etc.
9. Non-current carrying metallic parts of electrical equipment such as switchgear, switch racks, panel boards, motor control centres, lighting, power and instrument panels, push button stations, cable trays, pipes, conduits, terminal boxes, etc.
10. All fences, gates/enclosures, housing electrical equipment
11. All steel structures, rails etc. including bonding between sections
12. Shield Wire
13. Structural steel and Columns
14. Loading racks
15. Lighting Mast, poles
16. Lighting rods (Mast)
17. Tanks and vessels containing flammable materials.

18. Rotating parts of the agitators, pumps etc. through spring loaded brushes of suitable grade.
19. Earth continuity conductor shall be provided for flanges.

Conductor size for connection to various equipments shall be as indicated on Earthing Layout Drawings.

9.4 Two distinct conductors directly connected to independent earth electrodes, which in turn shall be connected to the earth and earth system. The earth connection shall be properly made. A small flexible aluminium cable loops to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is a Lightning surge, high voltage surge or failure of the bushings.

9.5 The shield wire shall be connected with the main grid solidly and not through supporting steel structures.

9.6 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

9.7 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground. In case of G.I. Earth Loop all underground "T" connections shall be of the same size as main loop however in case of PVC insulated aluminium conductor loops underground joints shall be completely avoided. Connections to motors from earth plate or main loop conductor brought above ground shall not be less than following:

Equipments		**Earthing Conductor size (Indicative)**
Grid & equipment such as Main Electrical Distribution Board, LT Switchboard, PDB, MLDB, Silent D. G. Set	:	50 x 6 mm GI Flat
Motors and starters over 45 kW and HT motors, Cable trays	:	50 x 6 mm GI Flat
Mechanical equipment / Vessels,Tanks, Pipe/cable racks, structure, fencing	:	50 x 6 mm GI Flat
Utility building PDB, LDB, Switch Socket DB, UPSDB, Lighting DB etc	:	25 x 5 mm GI
Motors and starters above 15 kW, and upto and including 45 kW	:	25 x 5 mm GI
RTU, Telecom, UPS	:	25 x 5 mm copper
Motors and starters above 3.7 kW and upto and including 15 kW.		

: 16 sq mm stranded GI Wire

Product pipe line : 16 sq mm flexible copper wires

Motors and starters upto and including 2.2kW, Light fitting, JBs, etc. 6 sq mm stranded GI Wire

FLP – WP lights/control station : 6 sq mm stranded GI Wire

Instruments and miscellaneous small items protected by fuses of ratings not exceeding 15A. : 6 sq mm stranded GI Wire

Field Instruments	:	2.5 sq mm PVC Cu Wire
Jumper for flanges	:	50 x 2 mm Copper Strip

Anchor bolts or fixing bolts shall not be used for earthing connection.

9.8 All hardware used for earthing installations shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment.

9.9 Lighting fixtures shall be earthed through the extra core provided in the lighting cable for this purpose.

10.0 TESTING OF EARTHING SYSTEM

Earthing systems/connections shall be tested as follows:

10.1 Resistance of individual electrodes shall be measured after disconnecting it from the grid.

10.2 Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

10.3 The resistance to earth shall be measured at the following:

1) At each electrical system earth or system neutral earth.
2) At each earth provided for structure lightning protections.
3) At one point on each earthing system used to earth electrical equipment enclosure.
4) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armour.
5) At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

11.0 LIGHTNING PROTECTION

11.1 Lightning protection system shall generally comprise air termination system (lightning finials, air terminals or collector rods, roof conductors or collector lines), down conductor system (down conductors & test links) and earth termination system (earth electrodes along with pits and strips). These individual elements of an LPS should be connected together using appropriate lightning protection components to ensure that in the event of a lightning current discharge to the structure, the correct design and choice of components will minimize any potential damage.

11.2 The number, types, materials and sizes shall be in accordance with the drawings. All lightning arrestor earth leads of the buildings and plant units shall be connected to the cage ring.

11.3 All buildings and plant structures vulnerable to lightning strokes owing to their height or exposed situation shall be protected against atmospheric flash-overs and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein.

11.4 Lightning affecting a structure can cause damage to the structure itself and to its occupants and contents, including failure of internal systems. The damages and failures may also extend to the surroundings of the structure and even involve the local environment. The scale of this extension depends on the characteristics of the structure and on the characteristics of the lightning flash.

11.5 IEC 62305 consists of the following parts, under the general title Protection against lightning:
Part 1: General principles Part 2:
Risk management
Part 3: Physical damage to structures and life hazard Part 4:
Electrical and electronic systems within structures

11.6 The lightning current is the source of damage. The following situations shall be taken into account, depending on the position of the point of strike relative to the structure considered:
- S1: flashes to the structure;
- S2: flashes near the structure;
- S3: flashes to the services connected to the structure;
- S4: flashes near the services connected to the structure.

11.7 Each source of damage may result in one or more of three types of damage:
- D1 Injury of living beings due to step and touch voltages
- D2 Physical damage (fire, explosion, mechanical destruction, chemical release) due to lightning current effects including sparking
- D3 Failure of internal systems due to Lightning Electromagnetic Impulse (LEMP)

11.8 The following types of loss may result from damage due to lightning:
- L1 Loss of human life
- L2 Loss of service to the public
- L3 Loss of cultural heritage
- L4 Loss of economic value

11.9 Damages & loss in a structure according to different points of strike of lightning:

Point of strike	*Source of damage*	*Type of damage*	*Type of loss*
Structure	S1	D1 D2 D3	L1,L4 L1,L2,L3,L4 L1,L2,L4
Near a structure	S2	D3	L1,L2,L4
Service connected to the structure	S3	D1 D2 D3	L1,L4 L1,L2,L3,L4 L1,L2,L4
Near a service	S4	D3	L1,L2,L4

11.10 In order to evaluate whether or not lightning protection of an object is needed, a risk assessment in

accordance with the procedures contained in IEC 62305-2 shall be made. The following risks shall be taken into account, corresponding to the types of loss:

−R1: risk of loss of human life;
−R2: risk of loss of services to the public;
−R3: risk of loss of cultural heritage.

Protection against lightning is needed if the risk R(R1 to R3) is higher than the tolerable level RT

$R > RT$

In this case, protection measures shall be adopted in order reduce the risk R(R1 to R3) to the tolerable level

$R \leq RT$

11.11 The role of an air termination system is to capture the lightning discharge current and dissipate it harmlessly to earth via the down conductor and earth termination system. Therefore it is vitally important to use a correctly designed air termination system. BS EN/IEC 62305-3 advocates the following, in any combination, for the design of the air termination:

- Air rods (or finials) whether they are free standing masts or linked with conductors to form a mesh on the roof
- Catenary (or suspended) conductors, whether they are supported by free standing masts or linked with conductors to form a mesh on the roof
- Meshed conductor network that may lie in direct contact with the roof or be suspended above it (in the event that it is of paramount importance that the roof is not exposed to a direct lightning discharge)

11.12 Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors, pipes, hands rails or any other metallic projection above the roofs shall also be bonded to the roof conductors. All metallic chimneys, ducts and the like above the roof of the structure shall be bonded to and form part of the air termination network. Vertical air termination points shall project at least 30 cm above the object on which it is fixed.

11.13 The three basic methods recommended for determining the position of the air termination systems are:

- The rolling sphere method
- The protective angle method
- The mesh method

11.14 Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends.

11.15 Four protection levels have been determined based on certain parameters and each level has a fixed set of maximum and minimum lightning current parameters.

LPL	*I*	*II*	*III*	*IV*
Maximum current (kA)	200	150	100	100
Minimum Current (kA)	3	5	10	16

11.16 Each Lightning Arrestor shall be connected to a separate electrode located as close as possible to it and within the fenced area for each set of arrestors. The two nos. electrodes for each set of arrestors shall be spaced about 5 meters apart so that they are all within the enclosing fence. Each of these electrodes shall be connected to the main earth grid.

11.17 All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system.

11.18 In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.

11.19 The layout and design of lightning protection systems for building extensions or new buildings and structures provided within existing station areas shall match the existing design.

11.20 All connections between the different parts of lightning protection systems and the connections to the earthing system must be performed in a manner such that the arising of chemical elements will be avoided.

11.21 Natural Components Of Collectors

Metal cladding, metal roof structures, metal components of roof Structures, gutters and railings may be considered as natural components of collectors.

The requirements of the standards, such as the following, have to be considered:

- Parts must be permanently conductively connected,
- Minimum thickness of the metal involved,
- Cross-sections of the parts.

Installations with metal casings need not to be fitted with collectors taking into consideration the above-mentioned minimum requirements.

Protective coatings or insulation between metal parts shall be electrically bridged.

11.22 Mesh Type Collectors

Buildings shall be provided with mesh-type collector lines. Protruding roof superstructures, such as ladders, chimney stacks, pipes, antenna mounting brackets, etc. and other metallic parts of buildings which are located near the roof (e.g. louvers of ventilation openings) must be directly connected to the collector lines.

This method is suitable where plain surfaces require protection if the following conditions are met:

- Air termination conductors must be positioned at roof edges, on roof overhangs and on the ridges of roof with a pitch in excess of 1 in 10 (5.7º).
- No metal installation protrudes above the air termination system.

Modern research on lightning inflicted damage has shown that the edges and corners of roofs are most susceptible to damage. The air rods should be spaced not more than 10 m apart and if strike plates are used as an alternative, these should be strategically placed over the roof area not more than 5 m apart.

Class of LPS	Mesh size (m)
I	5 x 5
II	10 x 10
III	15 x 15
IV	20 x 20

11.23 Collector Rods

Collector rods shall be used for roof superstructures featuring mechanically or electrically operated equipment, such as ventilators and non-conductive parts projecting from the mesh plane by 0.3 m. The angle of protection and a certain minimum distance have to be observed.

Outdoor electrical facilities for HVAC or other purposes not located in the protective area of earthed structures, installations or buildings, including exposed electrical equipment shall be protected by collectors.

Buildings with sheet metal roofs where the thickness of the sheet is smaller as the required value, the collector mesh must be equipped with collector rods of sufficient quantity and length to avoid lightning strokes in the sheet metal.

11.24 Down Conductors

Down conductors shall be selected in a manner such that there are several parallel current paths between the collector and the earthing system. The length of each down conductor is to be kept as short as possible.

Steel structures and steel columns of buildings may be used as down conductor, if the minimum sizes according to the standards are guaranteed. In each case the connections with the earthing system and collectors respectively must be visible and removable.

Starting from the corners of the structure involved, conductors should be distributed around the exterior as evenly as possible. They must be configured in such a way as to constitute the direct continuation of the collector. The minimum distance between conductors and doors,

windows and other apertures must be 0.5 m.

If not already connected with the collectors or with the internal potential equalisation, larger metal parts mounted in/on the building outer walls (e.g. frames of doors, ventilation louvers) shall be terminated on the down conductors.

The down conductor spacing should correspond with the relevant class of LPS :

Class of LPS	Typical Distances (m)
I	10
II	10
III	15
IV	20

All down conductors which are connected to the earthing system must be provided with an accessible isolating point for measuring purposes. For termination the grounding bars of grounding loops shall be used, preferably. No conductors are required for outdoor metal structures of adequate size.

11.25 Inadmissibly Short Distances

Inadmissibly short distances between the lightning protection system and metal installations or electrical equipment shall be prevented. In the event of potential hazard due to flash-over or disruptive discharge caused by lightning, appropriate measures shall be taken.

Admissible distances between lightning protection systems and metal installations, electrical wiring and equipment shall be determined in compliance with the standards. This also applies to the use of special roof-mounted collectors.

11.26 Lightning Equipotential bonding

Equipotential bonding is simply the electrical interconnection of all appropriate metallic installations/parts, such that in the event of lightning currents flowing, no metallic part is at a different voltage potential with respect to one another. If the metallic parts are essentially at the same potential then the risk of sparking or flashover is nullified. Bonding can also be accomplished by the use of surge protective devices (SPDs) where the direct connection with bonding conductors is not suitable.

12.0 TESTS OF LIGHTNING PROTECTION SYSTEM

After erection of the earthing and lightning protection system all installations shall be tested in accordance with applicable regulations

The following tests shall be carried out, at least:

- Measures against corrosion protection and arising of chemical elements,

- Check of all connections,
- Measurements of earthing system resistance,
- Measurements of lightning protection system conductivity,
- Check of mechanical details,
- Compliance with specifications.

The aim of the tests is to ensure the proper function of the complete scope. The measuring results and the locations of the measuring points have to be indicated in respective drawings as a basis for future measurements.

13.0 DOCUMENTATION

Complete documentation shall be provided for the design, construction, testing, maintenance and repair of the earthing and lightning protection systems and their components.

The documentation shall be in English language.

The following drawings/documents shall be submitted for approval within 3 weeks of award of contract.

a) Soil resistivity survey report
b) Technical data sheets
c) Earthing design calculations
d) Lightning protection design calculations
e) Earthing grid layouts
f) Construction drawings
g) Spare parts list
h) Operation and maintenance manuals
i) Test reports

The documents listed above shall be handed over for approval. Special attention has to be given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing / assembly. The documentation has to be prepared in accordance with the relevant ISO standards. The final documentation shall be delivered on paper in sufficient number and with exception of the signed protocols in electronic form, also. The type of the electronic files and the number of copies shall be agreed with the Client.

After commissioning & testing of earthing system contractor shall submit the following document to Client/BGL for As-Built status in hard copy (5 set) plus one soft copy.

a) Soil resistivity survey report
b) As built earthing grid layouts & earth electrode installations
c) Construction drawings

Specification for Electrical Equipment Installation

1.0 CODES AND STANDARDS

The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS 5 Colours for ready mixed paints and enamels SP	
30 (BIS)	National Electrical Code 2011
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 1239	Steel tubes, tubulars and other wrought steel fittings
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS 1364	Hexagon head bolts, screws and nuts of product grades A and B IS 1573
	Electroplated coatings of zinc on iron and steel
IS 2309	Code of practice for the protection of buildings and allied structures against lightning
IS 2629	Recommended practice for hot dip galvanizing of iron and steel IS 2633
	Methods for testing uniformity of coating of zinc coated articles IS 3043
	Code of practice for earthing
IS 3618	Phosphate treatment of iron and steel for protection against corrosion IS 4759
Hot-dip zinc coatings on structural steel and other allied products	
IS 6005	Code of practice for phosphating of iron and steel
IS 7689	Guide for the control of undesirable static electricity
IS 7816	Guide for testing Insulation resistance of rotating machines
IS 10028 : Part 2	Code of practice for selection, installation and maintenance of Transformers: Part 2 - Installation
IS 10118 : Part 3	Code of practice for selection, installation and maintenance of switchgear and control gear : Part 3 - Installation
OISD-RP-110	Recommended practices on static electricity
OISD-STD-137	Inspection of Electrical Equipment
OISD-RP-147	Inspection and safe practices during electrical installations

In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

a) Indian Electricity Act and Rules.
b) Regulations laid down by CEA/Electrical Inspectorate.
c) Regulations laid down by PESO/ DGMS (as applicable).
d) The petroleum rules (ministry of Industry Government of India).

e) Any other regulations laid down by central/state/local authorities and Insurance agencies.

In case of any contradiction between various referred standards, specifications and statutory regulations the following order of priority shall govern:

- Statutory regulations
- This specification
- Codes and standards

However the Contractor shall bring any such contradiction to the notice of Purchaser for prior approval.

2.0 EQUIPMENT INSTALLATION

Prior to start of installation of the electrical equipment contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation, testing and commissioning of all electrical equipment shall be done by vendor/contractor with utmost care as per the scope matrix between the site installation contractor and respective equipment vendor attached in the each tender. Manufacturer's instructions and the requirements given in their technical manuals shall be strictly adhered. The substation/switchgear room wherein the equipment shall be installed shall be kept clean, dry and free from all debris. Panel floor cutouts not in immediate use shall be suitably covered to avoid any mishap. When handling the switchboard panels, care shall be taken to observe the correct lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting points. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

The lifting position mark indicated on packing casing shall be adhered to strictly, for keeping it in required vertical position.

Contractor shall check and report to the Purchaser about any damaged item and / or missing component for getting the same replaced as per specifications. During installation, all accessories and loose items shall also be inspected by the contractor before their assembly/mounting.

In case of any modifications/replacement of existing equipments or Tie-ins with existing Electrical systems, approvals shall be obtained from Purchaser before any work to be implemented. The tie-in and shutdown philosophy shall be developed by Contractor in coordination with production, operation and maintenance department. Detailed Task Risk Assessment (TRA) shall be developed by the Contractor for all modifications/replacement or tie-ins activities and shall be approved by all concerned authorities.

The following philosophies provide the frame work for modifications/replacement or tie-in approach:

a) The existing facilities shall continue to operate normally. Contractor shall verify the requirements for modifications, replacement and interface or tie-in with existing / new electrical systems.

In general, a planned construction campaign shall be scheduled to facilitate the modifications/replacement or tie-in work. However, preparation for modifications/replacement or tie-in work can be proceed on an opportunistic or scheduled shutdown prior to the planned construction campaign in consultation with Purchaser. Associated shutdown co-ordination shall be carried out by the Contractor as per Purchaser procedure to complete the modifications/replacement of existing electrical equipments or tie-in hook up for all electrical systems.

Switchboards and Bus Ducts

The term switchboard here includes all HV / MV/ LV switchboard panels, motor control centres, power and

lighting distribution boards, UPS panels, ACDB, charger panels, DCDB etc. The switchboard panels shall be handled with care, avoiding any impact to the equipment. Dragging of the panels directly on floor shall be avoided. Roller bars may be used for shifting of panels: Use of a crane and trailer shall be made for handling of equipment. The switchboard panels shall be properly supported on the truck or trailer by means of ropes to avoid any chance of tilting. The switchboards shall be lifted after ensuring that panel supports, nuts and bolts are all intact and tightened. While lifting the panels in packed conditions utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment. The panels shall be preferably kept inside the packing cases till foundations are ready.

The switchboard panels shall be installed on prepared foundations or floor cutouts. Steel base channels shall be welded to inserts provided in floor slab. Cross members shall be provided at the junctions of each shipping section and other places as required. Alternatively when the floor is being-laid, base channel frame of panels supplied by the vendor shall be grouted and levelled in cement concrete. It shall be ensured that the base plate level of HV switchboard shall match with the finished floor level. The foundation pockets and the grouted bolts shall be cured for a minimum period of 48 hours.

The switchboard panels shall be taken out from the packed cases and shifted one by one to its proper place. All the panels shall be assembled, aligned and levelled: Alignment of panels shall be checked in both longitudinal and lateral directions. It shall be ensured that panel to panel coupling bolts, bus bar links etc. fit properly without any strain on any part. No new holes for jointing of the panels other than those recommended by the vendor shall be drilled. No gaps shall be left between the panels. The lifting, racking in and out operation of the breaker and all other motions shall be free from any obstruction.

The panels shall be checked for correct vertical position using pendulum weight and spirit levels. The switchboard panels shall be tack welded at suitable intervals at base channel.

After erection of switchboard panels, all uncovered portions of floor cutouts shall be covered with 6 mm thick removable chequered plates finished with floor level. The design of the chequered plates shall be such that the maximum allowable deflection is L/200 (where L is the span of the chequered plates in metres) for a live load of 500 kg./sq. meters. Suitable lifting arrangements shall be provided for chequered plates: The chequered plates shall be painted with a coat of red oxide zinc chromate primer after proper surface preparation as per specifications. Where specified, panels cutouts provided for future use shall be filled with lean concrete.

After completion of erection of switchboards, all the cubicles, switchboard components such as switches, starters, C.T. and P.T. chambers, busbar chamber shall be cleaned and checked for tightness of all the components. Vacuum circuit breakers shall be checked for integrity of bottle seals. All loosely supplied items shall be fitted up. Bus bar sections or links shall be inserted and where specified, of high voltage equipment shall be insulated. Interconnection wiring between shipping sections shall be made by vendor. All the wiring connections shall also be checked. Phase sequence and polarity of PTs and CTs shall be checked. Contact resistance of all busbar joints and contactors shall be checked. Insulator shall be checked for any damage. All the starters, switches, contacts shall be cleaned with C.T.C. where required. All the moving parts shall be checked for easy and free movement. Hinges of panel doors shall be lubricated to give free and noise free movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

Functional scheme verification of individual feeder shall be carried out and minor wiring modifications in the panel wiring, if required shall be done as per the directions of Purchaser. Special attention shall be paid to CT circuits polarity, wiring continuity and correctness in the protection as well as measurement circuits. Auto transfer scheme shall be simulated and verified. During the course of scheme verification tests, defective components if any shall be taken out, after bringing to the notice of Purchaser. The same shall be replaced by component supplied by Purchaser.

Where switchboard is damp or having a low IR value due to damaged insulators/ bushings/any other

insulated parts, or any other reason, the entire switchboard shall be dried. up according to the instruction of the Purchaser for the I.R value to improve to a sate level for commissioning. Care shall be taken to protect the surrounding insulation from direct local heating during the drying up process.

All the metering instruments, protective relays and other relays and contactors shall be tested as per manufacturer's recommendations and according to the instructions of the Purchaser. Protection relays shall be inserted and connected and settings adjusted as required by the Purchaser.

All moving parts, of closing/tripping mechanism, racking in and racking out mechanism, spouts and shutter closing mechanism shall be checked for proper operation. All the auxiliary contacts of breaker shall be checked-up, cleaned and contact pressure measured.

All the control wiring, PTs, bushings, bus bars, other live parts of switchgear, incoming and outgoing cables shall be meggered.

Electrical simulation tests shall be carried out for all the protective, alarm and annunciation relays and external interfaces to ascertain properfunctioning.

Safety insulation mats of approved make and of required voltage grade shall be provided in the sub- Station and electrical rooms. i.e. min. 2mm thickness.

Pre-Commissioning Check List:

Before commissioning any switchboard, following points shall be checked and ensured for safe energizing of the switchboard:
That the installation of equipment to be commissioned is complete in all respects with its auxiliaries and all other mounting including earthing. Openings in floor within and outside panels have been sealed off. All cover and door gaskets are intact to make the enclosure vermin proof.

a) All the metering instruments have been checked and found in working order. Indicating lamps are healthy and are in correct position. All power and control fuses are of proper rating.

b) That the polarity test and ratio test of all the P.T.s and C.T.s is complete and phase sequence of C.T.s conforms to the correct vector group connections. Wiring continuity and correctness are ensured in the protection and measurement circuits. Polarity of D.C. supply for all the circuits is correct.

c) That the high voltage tests of incoming and outgoing cables have been conducted and results are satisfactory.

d) That all the protective relays including both conventional and microprocessor based numerical relays and thermal overload relays have been tested for secondary injection tests. (Primary injection tests shall be carried out for differential protection, Restricted Earth fault protection at full / reduced current to ensure correctness of complete wiring). Relay settings, status indications, fault annunciations, data logging, display of switchboard SLDs shall be verified from MMI in case the same isprovided.

e) That I.R. Value has been recorded for bus bars, circuit breaker, incoming and outgoing cables, control wiring and potential transformers. Where required joint resistance of bus bars have been recorded and found to be satisfactory. All the surroundings and panels have been cleaned and temporary earth leads have been removed.

Bus Ducts:

The bus ducts as per issued drawings will be supplied in parts and all the parts shall be assembled and the bus bar connections shall be made at site. The insulators in bus ducts shall be inspected for any possible damage during transit and the defective ones shall be replaced. The insulators shall be cleaned. Contact surface of bus bars, bus bar bolts and nuts shall be thoroughly cleaned. Petroleum jelly shall then be applied and bolted connection made. The bus duct enclosure shall be checked for earth continuity and then earthed

at two places. The bus duct shall be properly supported between switchgear and transformer. The opening in the wall where the bus duct enters the switchgear room shall be completely sealed to avoid rain water entry. Expansion joints, flexible connections etc. supplied by the manufacturer of the bus duct shall be properly connected. The bus duct levelling shall be checked with spirit level and pendulum weight.

Transformers

Transformers on receipt at site shall be unloaded by means of crane or lifting devices of adequate capacity. All lifting lugs shall be used to avoid unbalanced lifting and undue stresses on lugs. Lifting lugs if any provided for partial lifting (e.g. for active part, conservator) etc. shall not be used for lifting complete transformer. Parts other than those identified for lifting of the transformer shall not be used for lifting. While slinging, care shall be taken to avoid slings touching other parts.

Before lifting transformer, it shall be ensured that all cover bolts are tightened fully. In case when it is necessary to use jacks for lifting, projections provided for the purposes of jacking shall be used. Lifting jacks shall not be used under the valves or radiator tubes. For transporting transformers from stores to site, the transformers shall be loaded on a suitable capacity truck or trailer. The transformers shall be properly supported by steel ropes and stoppers on the trailer to avoid tilting of the transformers in transit due to jerks and vibrations. At no instance the transformer shall be kept on bare ground. Where it is not possible to unload the transformer directly on a foundation, it shall be unloaded on a properly built wooden sleeper platform. A transformer shall never be left without putting stoppers to the wheels.

Transformer shall be examined, for any sign of damage in transit. Particular attention shall be given to the following in this regard:

a) Dents on tank wall or cooling tubes.

b) Damage to protruding parts like valves, sight glass etc.

c) Loosening of bolts due to vibration in transit.

d) Cracked or broken bushings.

e) Oil leakage particularly along welds.

If anything adverse is noted the same shall be brought to the notice of Purchaser.

Contractor shall examine the transformer base, oil pit, tire walls and foundations laid by the civil contractor. It shall be ensured that oil spills cannot propagate along cable trenches. Any discrepancy noted will be brought to the notice of Purchaser. Transformers shall be placed on channels or rails over concrete foundations. The transformers shall be levelled, aligned and checked for free movement on the channels or rails. Stoppers shall be provided to the transformers immediately to prevent any movement. Normally transformers upto 1000kVA rating shall be received duly fitted with radiator tubes, conservator tanks, valves, wheels and other accessories. While the transformers of above 1000kVA rating may be supplied with loose accessories. All the accessories like radiators, cooling fans, valves, conservator tanks, explosion vent pipe, bushings and other devices which are supplied in different packages shall be checked for any transit damage and cleaned thoroughly before fixing on the transformer. All loosely supplied parts shall be assembled as per manufacturer's instruction manuals/ drawings and documents. All the connections for C.T.s bushings and other wiring shall be checked for tightness and correctness before replacing the lid or tightening all the bolts.

Topping of transformer with oil:

Before topping up with oil, transformer shall be fitted with all accessories such as valves, gauges, thermometers etc. Oil samples shall be taken from each drum and tested for determination of dielectric strength. Any sign of leakage of the barrel or of its having been opened shall be recorded and reported. It is necessary to filter the oil before the transformers are filled. It shall be ensured in oil filling operation that

no air pockets are left in the tank and that no dust or moisture enters the oil. All air vents shall be opened. Oil shall be filled through a streamline oil filter using metal hose. To prevent aeration or the oil, the transformer tank shall be filled through the bottom drain valve. In a transformer with conservator tank, the rate of oil flow shall be reduced when the level is almost upto the bottom of the main cover to prevent internal pressure from rupturing the pressure relief-pipe diaphragm. Sufficient time shall be allowed for the oil to permeate the transformers and also for the locked -up air bubbles to escape. Any air accumulation in the buchholz relay shall be released.

Transformer Oil

a) Sample of oil from the transformer shall be taken from the bottom of the tank.

b) Testing of Oil:

For dielectric test, the oil shall be tested as described in IS 335. The oil shall also be tested for acidity in accordance with the methods prescribed.

Drying out of the transformers, if required, shall be carried out and record maintained in accordance with IS 10028. Normally a streamline filter shall be used for drying-up. I.R. value versus time of both windings shall be recorded during the drying-up process.

Precautions when drying

a) The maximum sustained temperature to which transformer oil may be subjected shall be limited to 80^0C.

b) The transformer shall be carefully monitored throughout the drying out process and all observations shall be carefully recorded.

c) Drying out shall be continued so that the insulation resistance as prescribed in the standard code of practice is attained and the value remains constant for more than 12 hours. However, a minimum number of cycles shall be done for each transformer as found necessary by the Purchaser. Generally a megger reading of 2 megohms / kV at 60^0 C temp with a 5kV Megger may be a rough indication for stopping the dehydration.

The following work on transformers shall be performed by the vendor if specifically called for:

a) Before finally commissioning the transformer it may sometimes be desired to run it for a few hours on short-circuit, applying a low voltage, approximately equal to the impedance voltage of the transformer. During this process, regular readings of the insulation resistance of the winding to earth and winding to winding and temperature against time shall be recorded.

b) Testing of radiator tubes for any leakage and rectifying these by welding / brazing.

Pre-commissioning Check List:

Before commissioning of any transformer, the following points shall be checked for safe energisation of the transformer:

a) That all the accessories have been fixed properly and transformer body and neutral are properly earthed. The transformer dehydration is over and results are satisfactory and approved by the Purchaser. In case transformers are idle for more than one month after dehydration, transformer oil has been givenat least two circulations.

b) That the oil level, in the transformer conservator tank and all the bushings is upto the marked point and the oil has been tested for dielectric strength and acidity.

c) That the silicagel is in reactivated condition. The breather pipe is clear from any blocking and contains oil upto the proper level.

d) The explosion vent diaphragm does not have any dents. Accumulation of any oil and air had been released.

e) That the operation of off-load and on-load tap changers on all the tap positions is satisfactory. The mechanical parts of the on-load tap changer are lubricated. Motor IR value has taken and found satisfactory. Tap position mechanical indicator on the transformer and tap position indication meter on the control panel are reading the same tap positions. Tap changer limit switches are operating satisfactorily on the maximum and minimum tap positions. On-load tap changer contact pressure and resistance is as per manufacturers recommendations. Oil level of tap changer tank is upto the required level and oil has been tested for dielectric strength. The tap setting on which the off load tap switch is locked shall be recorded. Generally the off-load tap switch shall be kept on nominaltap.

f) That the buchholz relay has been tested and checked up for any friction in the movement, and floats are free, all the other protective relays, alarm and annunciation relays have been tested.

g) That all the metering equipment have been tested and polarity test of P.T's and transformer winding is satisfactory. Phase sequence and connections have been checked for proper vector group.

h) That the ratio test and winding resistance on all the tap positions is satisfactory.

i) That gaps of arcing horns for the bushings where provided are in order and earth connections for the surge diverters have been checked

j) That the winding and oil temperature thermometer pockets contain oil and the winding and oil temperature settings on dial gauges are in order.

k) That the transformers fitted with fans for forced air cooling have been checked up for automatic starting and stopping of the fans and air-displacement has been verified (If applicable).

l) That the simulation tests for all external interface connection alarm, annunciation and trip circuits have been checked and are inorder.

m) That the insulation resistance of all the control circuits and IR value of the transformer windings and all the incoming and outgoing cables have beenchecked.

n) That all the valves in the cooling system and valve between the buchholz relay and the conservator tanks are in open position.

o) That the setting of all the protective relays is at the desired value and D.C. Trip supply is healthy.

Observations after Commissioning

After switching on the transformer the following points shall be observed and recorded.

a) The inrush magnetizing current and no-load current.

b) Alarm, if any, or if any relay flag hasoperated.

c) Voltage and current on all the three phases.

d) Transformer hum or abnormal noise.

e) Circulation of oil and leakages.

f) Record current, voltage, cooling air temperature, winding temperature and oil temperature

readings, hourly for 24 hours.

g) Cable end boxes, for any over -heating.

EARTHING INSTALLATION

This consist of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a common earth for electrical device and metallic structures. From each earth electrode two distinct connections shall be made of the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipment.
The earth conductors shall be laid in ground, along cable trays / cable trench / pipe rack etc as indicated on the earthing layout drawings. The location shown on the earthing layout drawings are indicative. The exact location of earth conductors in the filed shall be determined by Contractor in consultation with the Purchaser. Earth conductors shall be located avoiding interferences with other services such as piping, instrumentation, civil,structural, mechanical etc.

Where lined cable trenches are available, the earth conductor shall be laid in the trenches and shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run along one of the cable trays along a cable route. The earthing conductor shall be suitably cleated and electrically bonded to all the other cable trays on the same cable route at regular interval of 25 to 30 metre. The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure. Earth conductor when laid underground shall be at a depth of 600mm below finished grade level.

Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with Hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be jointed by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides shall be continuously welded. All joints at tappings above ground shall be means of connector/ lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

Installation of Earth Electrodes

Earth electrodes shall be installed as shown on earthing layout drawings and installation details. The location shown on the earthing layout drawings are indicative. The exact location of earth electrodes in the filed shall be determined by Contractor in consultation with the Purchaser, depending on the soil strata and resistivity. Earth electrodes shall be located avoiding interferences with other services such as road, building foundation, column, pipelines etc. The civil area drawings shall be referred for this. The distance between two earth electrodes shall not be less than twice the depth of electrode.

Earth electrodes shall preferably be located in a moist soil which has a fine texture, grain size and distribution. Wherever practicable the soil be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes and soil packed by watering and ramming as tight as possible.

The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell.

The disconnect facility shall be provided for the individual earth electrode to check its earth resistance

periodically.

Location of earth electrodes shall be marked by permanent markers for easy identification. All earth Electrodes shall be serial numbered and also marked on 'As Built' drawing for future reference.

Individual earth electrodes shall be provided for each lighting arrestor and flood light mast.

Earthing system provided for concrete paved area by other agency where applicable; shall be connected to the plant earthing system below ground by minimum two earth connections.

Connection

The earth system connections shall generally cover the following:
- Equipment earthing for personnel safety
- System neutral earthing
- Static and lighting protection

The following shall be earthed.
- System neutral
- Current and potential transformer secondary neutral
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus duct, motors, neutral earthing resistors, capacitors, UPS , battery charger panels, welding receptacles, power sockets, lighting / power panels, control stations, lighting fixtures etc.
- Steel structures/ columns, rail loadings platforms etc.
- Cable trays and racks, lighting mast and poles.
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Fance and gate for electrical equipment (e.g. transformer, yard etc.)
- Cable shields and armour
- Flexible earth provision for Wagon, Truck
- Shield wire

Conductor size for branch connection to various equipment shall be as per Installation details unless otherwise stated on earthing layout drawings.

All process pipelines shall be bonded and earthed at the entry and exist points of battery limit of hazardous area. Earth continuity conductors across pipe flanges shall not be provided as per OISD 110.
Steel pipe racks in the process units and offsite area shall be earthed at every 24 metres.

Equipment / street light pole etc. located remote from main network may be earthed by means of individual earth electrode and earth conductor unless otherwise stated in specifications.

The main earthing network shall be used for earthing of equipment to protect against static electricity.

All medium and high voltage equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

Plant instrument system clean earthing, UPS system clean / safety earth shall be separate from the electrical earthing system.

All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing connection.

Earth connections shall be made through compression type cable welded lugs.

All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers

shall be used for all earthing connections and all connections adequately locked against loosening.

Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/ cable for this purpose.

The reinforcement of sub-station building and the sub-station floor shall be connected to main earth grid.

LIGHTNING PROTECTION INSTALLATION

Lightning protection shall be provided for the equipment, structure and buildings as shown on lightning protection layout drawings. Self conducting structures shall not require separate aerial rod and down conductors. These shall however be connected to the earthing system at two or more points as shown on earthing layout drawing. An independent earthing network shall be provided for lightning protection and this shall be bonded at least at two points with the main earthing network below ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimize surge impedance. Aerial and down conductors shall be located avoiding interferences with other services such as ducts, pipes, equipment, supports etc.

SPECIFICATION FOR

HV & LV CABLES

CONTENTS

1.0 SCOPE

a. This specification is intended to detail the selection criteria of HV power & LV Power and control cables besides covering general requirements, testing at manufacturer's works, packing, transportation and receipt at site.

b. **Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / requirements as part of the project needs:**

1. **Voltage grade, Conductor material, type of insulation and size of cables.**
2. **Schedule of quantities of cables**

Any other item / component / equipment / accessories / services as necessary for satisfactory completion of the project shall also be covered in separate Technical specification (TS) / SOR item.

2.0 CODES & STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.
The cables shall comply in design, material, testing and performance to the following codes and standards. The latest revision of the publication referred to shall apply.

IS-1554	:	PVC insulated (heavy duty) electric cables.
IS-3961	:	Recommended current ratings for cables; PVC insulated and PVC sheathed heavy duty cables.
IS-3975	:	Mild steel wires, straps and tapes for armouring of cables. IS-
5831	:	PVC insulation and sheath of electric cables.
IS-7098	:	Cross-linked poly ethylene XLPE insulated PVC sheathed cables. IS-
8130	:	Conductors for insulated electric cables and flexible cords.
IS-10418	:	Drum for electric cables.
IS- 10810	:	Method of test for cables
IS-13573	:	Joints and terminations for polymeric cables for working voltages from 6.6 KV & including 33KV; performance requirements & type tests.

The cables and accessories shall conform to the provisions of Indian Electricity Rules and other statutory regulations as applicable.

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards,

the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The cables shall be designed and calculated for continuous operation at full load under the climatic and environmental conditions as described in the "Design Requirements and Cable technical specifications".

4.0 DESIGN REQUIREMENTS

The cross section of all power cables shall be determined in accordance with the current demand of the linked power consumer, the maximum permissible voltage drop, the operating temperature, thermal short-circuit capacity, maximum cable loop impedance for earth faults and laying conditions.

Cable cross-sections shall be determined using the manufacturer's published data and the respective reduction factors according to installation conditions. The current-carrying capacities of power cables shall be calculated according to the type of operation, the conditions of installation and the ambient condition. The factors/parameters influencing cable sizing/ selection are as follows:

- Above ground or underground
- Installation / arrangement - e.g. for underground cables, is it directly buried or buried in conduit? For above ground cables, is it installed on cable tray / ladder, against a wall, in air, etc.
- Ambient or soil temperature of the installation site
- Cable bunching, i.e. the number of cables that are bunched together
- Cable spacing, i.e. whether cables are installed touching or spaced
- Soil thermal resistivity (for underground cables)
- Depth of laying (for underground cables)

Following points shall be taken into consideration during selection of cables:

- All LT power cables shall be 3.5 / 4 cores XLPE/PVC.
- Minimum size of the cables used in LT power feeders shall be 6 sq.mm for aluminium conductor and 4 sq.mm for copper conductor.
- Maximum cable size shall be 240 sq.mm for incomers to MCCs, PCCs etc.
- The minimum cable size selected for applications in the power circuits of cranes and other moving mechanisms shall be 6sq.mm with copper conductor.
- Flexible copper cables shall be used for power supply to vibrating mechanisms,

- For hoists, cranes, conveyors etc. shall be provided with flexible / festoon cable system, through butyl rubber / EPR insulated PCP/CSP sheathed flexible cables.

- Cables used for circuits of tacho generators, brakes, solenoids, field windings and secondary windings of measuring transformers shall be copper conductor with cross- sectional area not less than 2.5sq.mm.
- For control circuits, PVC insulated and PVC sheathed multicore cables with copper conductors having a minimum cross-sectional area of 2.5sq.mm shall be used. The number of cores may be standardized as 3, 5, 7, 10, 14, 19, and 24.
- Special screened/shielded cables shall be used for mA and mV signals.
- 20% spare cores shall be provided with minimum 1 spare core in multi-core control and signal cables
- For calculating the current rating of LT power cables de-rating factor of 0.65 shall be considered.

HT Cable sizes for LT sub-station transformers

- The cable size shall be calculated based on the short circuit calculation considering breaker opening time of 0.25 seconds

Cable for Incomer of MCC / PDB / MLDB

- Cable size for incomer of MCC & PDB shall be selected on the basis of current rating corresponding to MD and voltage drop.
- Cable size for incomer of MLDB shall be selected on the basis of current rating corresponding to lighting transformer and voltage drop.

Cables for LT & HT Motors

- Cable size for LT motors shall be selected on the basis of rated nameplate current and starting & running voltage drop as per specification.
- Cable size for HT motors shall be selected on the basis of rated nameplate current, starting & running voltage drop as per specification and short circuit capacity of the system. The cable size shall be calculated based on the breaker opening time of 0.25 seconds.

Cables for Illumination System

- The minimum size of the cable for feeding power to SLDB or MCBDB having 32A incomer shall be 4x25sq.mm
- Cable size for SLDB (or MCBDB) to light fittings shall be 3x2.5sq.mm. or 4x2.5sq.mm as per the configuration of fittings.
- In case of concealed wiring, single core, PVC insulated, stranded copper conductor wire of size 2.5 sq mm in MS conduit shall be used. For utility sockets, cable size shall be 4sq.mm.

Cables for Automation System

- All Cables connecting I/Os from field to PLC or remote I/O panel shall be of stranded copper conductor of type YRY as per IS: 1554 and of size 2.5/1.5 sq.mm.

- Communication bus shall be laid in GI pipe. The route for redundant communication bus shall be different.

5.0 CABLES SPECIFICATION

5.1 HT Power Cables for Voltage up to 33kV.

Sl.No.	Parameter	Description
1.0	Voltage Grade	33 kV (UE)/ 11 kV (UE)/ 6.6 kV (UE) / 3.3 kV (UE) as applicable
2.0	Duty type	Heavy duty
3.0	No. of cores	3 cores
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Conductor type	Compact circular stranded (rm/V) aluminum conductor, with extruded conductor shielding of semi conducting material. Conductor construction as per IS 8130-1984.
6.0	Insulation type	XLPE insulated, with insulation shielding over individual cores, consisting of extruded semi conducting compound , followed by lapped semi conducting material and copper tape (non magnetic) metallic screen , cores stranded together with a holding tape provided with a common covering of extruded inner sheath of type ST2 compound . The cable shall conform to IS:7098(Part-2)-1985.
7.0	Armour	Galvanized steel wire armoured. For multi core cables, armouring shall be applied over the inner sheath of flat steel wires (strips) . Round steel wire armouring can also be offered. For single core armoured cables non-magnetic armour consisting of hard drawn flat or round aluminium wires shall be provided.
8.0	Outer sheath	PVC outer sheathed of type ST2 compound. Black in colour. Suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
9.0	Miscellaneous	Copper screen shall be suitable to carry 1 KA E/F current for one second.
10.0	Temp. rise on continuous load	90 deg.C
11.0	Oxygen index of outer sheath material for XLPE Cable	Shall not be less than 29 at 27 □ 2 deg. C.
12.0	Temperature index	Not below 250□C.

13.0	Max. conductor withstand temperature during short circuit.	250□C

5.2 LT Power Cables of 1.1kV Voltage grade.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	- 3.5 / 4 core cables shall be used for motor feeders. - For other consumers or for power supply to other panel 4 core (upto conductor size of 50 sq.mm) or 3.5 core (for conductor size beyond 50 sq.mm) cables shall be used.
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 – 1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Conductor type	- Plain aluminium conductor. - All power cables of size 10 sq.mm and above shall have standard sector shaped (sm) or compact circular stranded (rm/V) or circular stranded (rm) aluminum conductors as applicable. - The conductors will be H2 or H4 grade. - The solid conductor shall be class - 1 and the stranded conductor will be class - 2. - The conductors shall be solid for conductor of nominal area upto and including 6 sq. mm. and stranded beyond 6 sq. mm. Conductors of nominal area less than 25 sq. mm. shall be circular or shaped. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS 1554 (Part-1) -1988.
6.0	Insulation type	- XLPE insulation - The insulation compound shall be conforming to IS:7098 (Part I) - 1988.
7.0	Inner sheath	- For armoured / unarmoured cables a tough inner sheath of heat resisting PVC compound

		(wrapped / extruded as per size),Type ST2 as per IS 5831 . - Black in colour.

8.0	Armour	- Galvanised steel wire armour shall be used for 3Cx10 sq.mm / 4Cx6 sq.mm cable. - Galvanised flat steel wires (strips) armour shall be used for bigger size cables. - Single core armoured cables are provided with non-magnetic armour consisting of hard drawn flat or round aluminium wires.
9.0	Outer sheath	- For armoured / unarmoured cables a tough outer sheath of heat resisting PVC compound (Type ST2 as per IS 5831) . - Black in colour .
10.0	Miscellaneous	- Minimum cross - sectional area of the power cable shall be 6 sq.mm in case of aluminium conductor and 2.5 sq.mm in case of copper conductor. - Power cables shall be selected from core sizes of 6, 10, 16, 25, 50, 70, 120, 150, 240 & 300 sq.mm (Aluminium conductor).
11.0	Temp. rise	Shall be limited to 90 deg.C.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: • Manufacturer's name & trade mark • Voltage grade • Year of manufacture • Type of insulation • R,Y,B for phases . • Black for neutral (fourth core)

5.3 LT Control Cables of 1.1kV Voltage grade.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	As per requirement .
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IEC-60502
5.0	Cross sectional area	Shall be 1.5 / 2.5 sq.mm.
6.0	Conductor type	Solid annealed circular stranded copper conductor.
7.0	Insulation type	PVC Type- C insulated
8.0	Inner and outer sheath	- Type ST-2 PVC shall be used for inner sheath . - Type ST-2 PVC shall be used for outer sheath .
		- Both inner and outer sheath shall be extruded type upto 7 core and after 7 core inner sheath shall be wrapped ..

9.0	Armour	- Galvanised steel wire armour / galvanised steel strip
10.0	Spare Cores	- 3, 5 and 7 cores cables shall have at least one spare core, cables with 10 core and above shall have at least 2 spare cores.
11.0	Miscellaneous	- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop. - Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: • Manufacturer's name & trade mark • Voltage grade • Year of manufacture • Type of insulation - Cores of the cables upto 5 cores shall be identified by colouring of insulation. - For cables having more than 5 cores, core identification shall be done by numbering insulation of core sequentially. - All the numbers shall be of same colour, which shall contrast with the colour of insulation. - Numbers shall be written in figures and words both - The numerals shall be legible and indelible. - The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. - When number is a single numeral a dash shall be blacked underneath. - If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. - The spacing between consecutive numbers shall not exceed 100 mm.

5.4 LT Power Screened/special cables.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	As per requirement .
4.0	Cross sectional area of conductor & Armouring	- Shall be 1.5 sq.mm & Armoured . - For weighing system 1.0 sq mm un-armoured

		cables in GI conduit from field to controller panel shall be provided.

5.0	Conductor type	- Solid annealed circular stranded copper conductor. - For twisted pair cables , the conductors shall be of stranded tinned copper having proper flexibility to provide limpness and extended flex-life as required for these small diameter cables.
6.0	Insulation type	- PVC insulated, Type A - Type ST-1 PVC shall be used for inner sheath. - Both inner and outer sheath shall be extruded type. - Outer sheath made of PCP (Chloroprene rubber), abrasion resistant, oil resistant and flame retardant conforming to IS:434 –1964 (Part - I), as amended upto date.
7.0	Screen	- Tinned annealed copper mesh over metallised tape , in a close woven braid .
8.0	Shielding	- Special aluminium foil to provide 100% shield coverage for optimum protection against radiated interference and ingress of audio and radio frequencies. - It shall have shorting fold for metal to metal contact and isolation fold to prevent adjacent shields from shorting to one another, so as to improve the voltage breakdown characteristics. The drain wire shall be of stranded tinned copper wire of 0.518 sq. mm. (20 AWG) cross-section.
9.0	Spare Cores	- 20% spare cores but not less than 2 spares shall be provided in all the multi core cables .
10.0	Reference standard	As per relevant IS with latest amendments
11.0	Miscellaneous	- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop. - Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm. - The special twisted paired cables shall be of the type to provide balanced signal transmission and shall have good noise immunity.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: • Manufacturer's name & trade mark • Voltage grade • Year of manufacture • Type of insulation - Cores of the cables upto 5 cores shall be identified by colouring of insulation. - For cables having more than 5 cores, core

		identification shall be done by numbering insulation of core sequentially. - All the numbers shall be of same colour, which shall contrast with the colour of insulation. - Numbers shall be written in figures and words both - The numerals shall be legible and indelible. - The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. - When number is a single numeral a dash shall be blacked underneath. - If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. - The spacing between consecutive numbers shall not exceed 100 mm.

5.5 Flame retardant low smoke (FRLS) cables.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Reference standard	Category AF as per IS : 10810 ASTM-D 2863 (Critical Oxygen Index) ASTM-D 2863 (Temperature Index) ASTM-D 2843 (Smoke density) IEC 754-1 (Acid gas generation) IEEE-383 (Flammability test on group of cables) Swedish chimney test SS 424175, class F3. (Flammability test) IEC 332-1 (Flammability test) IEC 332-3 (Flammability test) IS 5831 (Fire resistant test)
3.0	Duty type	Heavy duty
4.0	No. of cores	Single or multicore as per requirement
5.0	Cross sectional area	As per requirement .
6.0	Conductor type	Annealed tinned copper conductor
8.0	Insulation type	XLPE insulation
11.0	Sheath	Specially designed with thermoplastic or thermosetting materials , superior resistance to ignition and flame propagation with smoke emission and toxicity or corrosive characteristics Flame retarded Oil resistant
12.0	Armouring	GI wire / strip armoured as per requirement and size (as specified in respective TS)
13.0	Test values	Critical Oxygen Index : Minimum 29 Temperature Index : Minimum 250 deg. C Smoke density : Minimum average light

		transmission of 40% Acid gas generation maximum : HCl gas released 20% Flammability test on group of cables : As per standards mentioned Flammability test : As per standards mentioned Fire resistant test : As per standards mentioned

5.6 Details to be furnished in datasheet of HT & LT Cables:

i) Name of manufacturer
ii) Type
iii) Applicable standards
iv) Voltage grade
v) Maximum temperature of conductor
- Continuous rating
- Short circuit withstand rating

vi) Conductor
- Material & type
- Type & shape of conductor
- Cross sectional area
- Number and diameter of wire in each conductor

vii) Insulation
- Material & type
- Nominal thickness
- Identification of cores

viii) Laying up
- Direction of lay

ix) Inner sheath
- Material & type
- Minimum thickness

x) Armour
- Material & type

xi) Outer sheath
- Material & type
- Colour
- Minimum thickness
- Embossing/printing
- Diameter of cable
- Sequential length marking

xii) General
- Total quantity
- Packing length
- Net weight

xiii) Acceptance and routine tests
- Tensile strength of insulation & sheath
- Elongation at break of insulation & sheath

- Volume resistivity
- DC Resistance of conductor at 20°C
- High voltage at room temperature

xiv) Other parameters
- Short circuit rating of conductor for 1 sec
- Minimum permissible bending radius

xv) Current rating
- Direct in ground
- In air
- In Duct

6.0 GENERAL REQUIREMENT

The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installations.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables shall withstand without damage a 3 phase fault current for 1 second as specified in "Design Basis" at rated conductor temperature (70˚ C for PVC insulated cables and 90˚C for XLPE insulated cables).

The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects.

Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

When armouring is specified for single core cables, the same shall consist of aluminium wires/strips.

7.0 TRANSPORTATION AND UNLOADING

All cables shall be shipped and transported on cable drums of adequate size. Drums shall be lifted by means of a crane or by means of a loading ramp. Throwing and dropping down of cable drums shall be strictly avoided. In order to prevent drums moving during transportation, these must be securely wedged to prevent movement. Before unloading it is necessary to verify that the drum is received in proper condition. The directional arrow of the drums has to be observed during rolling. Empty cable drums have to be stored on a suitable central store place. Retransport to the cable manufacturer of returnable drums is the Contractor's responsibility.

8.0 DRAWINGS AND DOCUMENTS

Following minimum information shall be furnished with bid:

a) Data sheet for cables
b) Type Test Reports of cables
c) Catalogues of cables

The following drawings (in three sets) shall be submitted for approval/review within 3 weeks of award of contract.

a) Data sheet for cables
b) Type Test Reports of cables

10.0 INSPECTION

Inspection and testing of equipment shall be carried out by the owner/ consultant at the manufacturer's works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approval drags. and reference national/ international standards.

The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he shall have the power to reject any material which appears to be unsuitable description or of unsatisfactory quality. The vendor shall give at least 2 weeks advance notice to the purchaser regarding the date of testing to enable them or their representative to witness the tests.

All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out on cables as per IS:1554 Part 1 and IS:7098 Part – 2 and international standards as may be applicable.

Routine test and type test certificate shall be furnished for review. Acceptance

test shall be witnessed by owner/consultant.

The following special tests may be performed on the cables as per sampling plan and as may be applicable as per approved QAP. These tests will be witnessed by Purchaser / Consultant before despatch of cables.

a. Accelerated water absorption test for insulation as per NEMA – WC – 5. (For PVC insulated cables) and as per NEMA WC – 7 (for XLPE insulated cables). Sampling for this test to be done randomly and once for each size per order wise provided outer sheath remains same.

b. Dielectric Retention Test: The dielectric strength of the cable insulation tested in accordance with NEMA WC – 5 at 75 +/- 1 deg C will not be less than 50% of the original dielectric strength (For PVC insulated cables.) Test certificates with respect to this test from recognized testing laboratory to be furnished for review by purchaser/ consultant before inspection of cables. In case test certificates are not available, test to be conducted by the manufacturer at his own cost in any recognized test laboratory before inspection of cables.

c. Oxygen index test: The test will be carried out as per ASTMD 2863 or applicable Indian Standard. Sampling to be done for every offered lot / size as per sampling plan.

d. Flammability test: The test will be carried out on finished cable as per IS-10810 (Part 61 & 62). Sampling for these tests to be done randomly once for each size per lot provided outer sheath remains same.

e. Test for rodent and termite repulsion property: The vendors will furnish the test details to analyse the property by chemical method. Sampling will be done for every offered lot / size as per sampling plan.

1. TYPICAL CALCULATIONS: (For sizing and design)

a) Selection criteria for HV/MV cable size for primary distribution:

i) Temperature of conductor just prior to short circuit:
   1) With XLPE insulation - 90 Deg. C
   2) With PVC insulation - 70 Deg. C

ii) Maximum permissible conductor temperature during short circuit:
   1) With XLPE insulation - 250 Deg. C
   2) With PVC insulation - 160 Deg. C

iii) Volumetric specific heat of the conductor:
   1) With Aluminium conductor - 2.5 x 10 J/Deg. C/MM
   2) With Copper conductor - 3.45 x 10 J/Deg. C/MM

iv) Reciprocal of temperature co-efficient of resistance at 9 Deg. C:
   1) With Aluminium conductor - 228
   2) With Copper conductor - 234.5

Short circuit current rating at different duration may be calculated as – Ish (for

t duration) = Ish (for 1Sec.) Ish for 1 Sec. Duration (kA)

t = Time duration required to be calculated of short circuit in Sec

Formula for calculating HT Cable size:

With Aluiminium cond./XLPE insulated cable = Ish X√ t / 0.094 With

Copper cond./XLPE insulated cable = Ish X√ t / 0.143

b) Calculation for number of runs of incoming cable: Maximum demand (MD) on MCC = (Total working load x LF)/DF Where

LF – Load factor
DF – Demand factor

Current based on maximum demand (I_M)= (KWX1000)/(1.732 X V X pf) Current rating as per catalogue (In air) for selected size of cable - I_C Derated current rating (I_{CD}) = Derating factor X I_C

Minimum no. of runs (n) = I_M / I_{CD}

c) Voltage drop calculation:

Voltage drop of cable = ($\sqrt{3}$ x I_M x Z_{cab} x L) / n Volts. Where

I_M - Current based on maximum demand Z_{cab} –
Impedence of cable
L – Route length of cable N –
no. of runs

SPECIFICATION FOR

PDB PANEL

C O N T E N T S

1.0 INTENT

a. The intent of this standard specification is to define the general requirements for design, manufacture, assembly and testing at manufacturer's works, packing, transportation and receipt at site with all materials and accessories of PDB Panel with 16 SWG CRCA sheets 2.5 mm thickness.

b. **Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / requirements as part of the project needs:**

1. **Details of PDB – Single /double front, Draw out/ Non-drawout, Busbar details – Alumimium/copper etc.**
2. **Single incomer/ double incomer with buscoupler along with ratings.**
3. **Outgoing feeder details (Ratings & Quantity)**
4. **Make list of PDB and its components**
5. **Quantity & location of PDB**

Any other item / component / equipment / accessories / services as necessary for satisfactory completion of the project shall also be covered in separate Technical specification (TS) / SOR item.

2.0 CODES & STANDARDS

IS: 375	-	Marking and arrangement for switchgear busbars, main connections and auxiliary wiring
IS: 722	-	AC Electric meters
IS: 2147	-	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS: 2705	-	Current transformers
IS: 3156	-	Voltage transformers
IS: 3231	-	Electrical relays for power system protection
IS: 4237	-	General requirements for switchgear and controlgear for voltages not exceeding 1 000 volts ac or 1 200 volts dc

IS: 8623	-	Specification of low voltage switchgear and controlgear assemblies
IS: 10118	-	Code of Practice for selection, installation & maintenance of switchgear & controlgear.
IS: 13947	-	Specification of low voltage switchgear and controlgear
IEEE	-	Recommended practice for electrical power distribution (Std. 141) for industrial plants

3.0 TECHNICAL REQUIREMENTS

3.1 Construction features

- 415V, 3 phase, 4 wire, 50 kA (short time rating for 1 sec.) indoor type.
- Single front/ double front design(as per TS), Draw –out / Non-draw out (as per TS), free standing, compartmentalized, floor mounting type suitable for both front and rear access.
- The panel shall be extendable on both sides at site through provision of coupling holes at bus end & removable type side end covers.
- Unless specified in TS, the PDB shall have one incomer.
- Incoming Circuit breakers (ACBs – 800A & above / MCCBs from 500A upto 630A with contactor) shall be mounted on fully draw-out truck with service, test and isolated positions and complete with following safety interlocks and safety shutters with padlock facility;
    - It shall not be possible to move the truck in or out of cubicle when the breaker is closed.
    - CB compartment door shall be mechanically interlocked so that it will not be possible to close the CB in plug position when the door is open.
    - It shall not be possible to push the truck in close position if either of the safety shutter is not free and not in close position.
- Incomer MCCB below 500A rating shall be a non-drawout panel.
- Outgoing feeders shall be drawout / non-drawout type as per TS.
- Shall have an integral base channel.
- A transport section shall not exceed 3 vertical panels (Limited to 2400 mm).
- Rear face of each panel cubicle shall be openable and accessible for maintenance purpose. Panel shall have removable type bolted door on the rear side.
- Lifting facility shall be provided for each section.
- Dust & vermin proof design.
- Degree of protection for enclosure kept in a premise shall be IP 52 as per IS: 13947 – 1993 Part – 1.
- Incomer shall have analogue type of Voltmeter & Ammeter with selector switches. All feeders shall

have ON/OFF/TRIP lamps. Each Incomer panel shall have 3 nos lamps for R/Y/B and 6 nos lamps for Breaker ON/OFF/TRIP and for breaker fault conditions.

- Shall have isolated busbar chamber for main busbar at the top, running through out the length of the board. Chamber shall have removable cover.
- Cable alley shall have sufficient space for aluminium power cables and bottom cable chamber shall be left free completely isolated from the vertical busbars.
- Busbars shall have same cross section throughout the length. Rating of the neutral busbar shall be 50% of the main busbar. Earth bus bar shall run in bottom chamber throughout the length of the panel.
- Polyurethene/ Neoprene gaskets shall be used for cable alley doors, busbar chamber covers to ensure tightness and making it dust proof.
- Feeder module doors and cable alley doors shall open in opposite direction for providing more working area for maintenance purpose.
- Each feeder module shall have door interlock, defeat interlock and padlocking facility.
- All outgoing feeders from PDB's shall be TPN MCCB with miminum 2 NO+2NC auxiliary contacts.

3.2 Busbars & Supports

- Main busbars shall be made of high conductivity EC grade aluminium alloy equivalent to E91E WP (IS-5082/198l) or electrolytic copper as per IS-1897-1983.
- Three phase, neutral (with atleast 50% rating of main buses) and continuous earth bus. Bus bar shall be provided with proper grade &colour of heat shrinkable sleeve.
- Rating of horizontal buses shall be same as that of incomer circuit breakers and vertical run shall be same as that of outgoing breaker rating.
- Temperature rise of bus bars shall not be more than 40 deg. C above an ambient of 50 deg. C.
- Three phase and Neutral bus shall have facility for connection with earth bus.
- Shall be heat shrinkable PVC shrouded except at the points of tap-off. The bus bars shall be colour coded for phase identification.
- All incoming and outgoing bus bars shall be TP&N type and shall be sleeved.
- Busbars shall be housed in totally enclosed compartments (Bus bar chambers) having removable type covers for easy maintenance.
- Power and control bus bars shall be segregated.
- Main bus bars shall run throughout the length of transport section and vertical bus bars throughout the height of PDB.
- Busbar joints shall be of bolted type with suitable spring washers to ensure tight fittings. Bolts and washer shall be galvanized or cadmium plated.
- GI earth strip of size 50 x 6 mm or equivalent shall be run at the bottom of PDB with a provision of a link for connecting to neutral bus bar.
- Provision shall also be made for terminating the 4th core of incoming & outgoing cables.
- Bus bars shall be sized for the current rating specified (with temperature derating) to withstand

a short circuit current of 50kA for 1 sec.

- Bus bar supports shall have adequate mechanical strength, high dielectric strength, and low moisture absorption characteristics.
- Bus bar supports shall be rigidly held to the frame work of PDB and shall be so spaced as to ensure rigid support for bus bars.
- Bus bar supports shall be designed to withstand thermal and dynamic stresses resulting from specified short circuit current.
- Min. clearance between live parts shall be 25 mm and live to earth 19mm.
- All core type CTs mounted on bus bars shall be supported separately and not supported on bus bars. CT secondary-connecting cables shall be properly dressed and clamped such that these do not hang loose / pass directly over bus bars.

3.1 Circuit Breaker

3.3.1 Electrical Features

- Air break triple pole (4 pole in case of DG power incomer) drawout type conforming to IS 13947 for incomers & buscoupler for ratings of 800A & above.
- MCCB TPN, air break type with independent manual quick make and quick break type for incomer ratings of upto 630A and all outgoing feeders. MCCB shall withstand the fault current envisaged for 415V system.MCCB shall have set point adjustable feature for instantaneous thermal overload & shall have trip coil.
- Under voltage release provision shall be kept in ACB.
- Electrically operated mechanism for incomers & Bus-couplers. Manual operated mechanism for outgoing feeders or as specified
- Incomer shall have analogue type of Voltmeter & Ammeter (144 X 144 sq.mm) with selector switches. All outgoing feeders shall have ON/OFF/TRIP lamps with ammeters of 96 X 96 sq.mm.
- All outgoing feeders shall have TPN.
- Rated continuous current as specified:
  - Symmetrical breaking capacity and 1 second rating of the breaker not less than the system short circuit level specified.
  - Making capacity 2.55 times breaking capacity.

 Auxiliary contacts : 4 NO + 4 NC minimum, convertible from NO to NC and vice versa at site.

Ratings :

Continuous	10 amps
AC 11	4 amps at 240 V
DC 11	0.5 amps at 110 V

3.3.2 Moulded Case Circuit Breaker (MCCB)

MCCB shall conforms to IS/IEC 60947-2 and the rating shall be as per SLD with ICS=ICU=100% for the complete range. MCCBs must be suitable for "Positive Isolation" as per IEC 60947-2 and should have Class-II Front Facia as per IEC 60441. MCCB rated upto 250 A shall have Thermal Magnetic release or Microprocessor based release with variable O/L, S/C& E/F settings. Accessories should be continuously rated with Shunt Trip Coils and shall be snap fit type and should be common throughout the range. MCCB shall have Cross Bolted Termination to withstand higher short circuit Levels.

Operating handle, door interlock and padlocking at ON/OFF position shall be provided. At least 1 NO and 1 NC auxiliary contacts shall be provided.

3.3.3 Air Circuit Breaker (ACB)

3.3.3.1 Electrical Features

- Air break TPN (4 pole in case of DG power incomer) drawout type conforming to IS 13947.
- Motor operated spring charge mechanism
- Rated continuous current as specified.
- Symmetrical breaking capacity and 1 second rating of the breaker not less than the system short circuit level specified.
- Making capacity 2.55 times breaking capacity.
- Performance category : P2
- Auxiliary contacts : 4 NO + 4 NC minimum, convertible from NO to NC and vice versa at site.

Ratings :

Continuous	10 amps
AC 11	4 amps at 240 V
DC 11	0.5 amps at 110 V

3.3.3.2 Operating Mechanism

- Electrically operated mechanism for incomers & Bus-couplers
- Manual operated mechanism for outgoing feeders or as specifiedwith MCCB + Contactor as per SLD/TS.
- Spring charged stored energy mechanism to ensure high speed closing and tripping independent of the operating forces.
- Anti pumping and trip free feature
- Emergency tripping by mechanically operated trip push button (shrouded to prevent accidental closing) acting directly on the trip bar.
- Closing operation of the breaker to charge the tripping spring, ready for tripping.
- Mechanical indication to show :
- Closing spring charged
- Breaker ON/OFF/TRIP
- Breaker to close only when spring fully charged
- Non-reset type operation counter
- For manually operated breakers (if specified).
  - Independent manual charging of closing spring and closing by handle.
  - Alternatively, closing by mechanical push button with spring previously charged by handle.
- For electrically operated breakers :
  - Charging of closing spring by motor
  - closing by closing coil
  - spring charging motor and closing coil suitable for rated control voltage (240 AC unless otherwise specified).
  - One opening and one closing operation without control supply.
  - Provision also for manual closing with spring charging motor automatically decoupled as soon as charging handle is inserted.

3.3.3.3 Drawout Features

- 3 distinct positions viz. service, test, and isolated with the door closed.
- Mechanical position indication and locking/latching facility for all 3 positions.
- Power connections -self aligning, plug-in type.
- Control connections - sliding or plug socket type, mechanically coded, to prevent wrong insertion.
- Automatic safety shutters to prevent accidental contact with live parts when the breaker is withdrawn.

3.3.3.4 Safety Interlocks

- It shall not be possible to close the breaker in any intermediate position other than the 3 fixed positions.
- With the breaker closed, it shall not be possible to rack it in from any of the 3 position to another.
- Mechanical stopper to prevent accidental falling while withdrawing.

- It shall not be possible to rack in the breaker from isolated to 'test' position with the door open together with provision for defeat of this interlocking, however, it shall be possible to close the door only when the breaker is brought back to 'isolated' position.
- It shall be possible to open the door only when breaker is OFF andis in 'Isolated' position.
- Remote closing of breaker is not permitted with door open.
- Insertion of breaker into 'Service' position shall not be possible if the shutters are not free.

3.3.3.5 Microprocessor based releases

General

- The control unit shall be interchangeable on site for adaptation to changes in the installation.
- Sensors shall be non-magnetic or of the Rogowsky type for accurate current measurements.
- The control unit shall measure the true RMS value of the current.
- The control unit shall comprise a thermal memory to store temperature-rise data in the event of repeated overloads or earth faults. It shall be possible to disable this function if necessary.

Protection

- The control unit shall offer the following protection functions as standard:
  1. Long-time (LT) protection with an adjustable current setting and time delay;
  2. Short-time (ST) protection with an adjustable pick-up and time delay;
  3. Instantaneous (INST) protection with an adjustable pick-up and an OFF position.

- Digital Microprocessor based relay shall be used to obtain data processing regarding protection.
- It shall display the phase current with highest load.
- It shall also express the true energy content of the current.
- Current and time-delay settings shall be indicated in amperes and seconds respectively on a digital display. Acknowledgement that the setting change should translate to the trip threshold.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the single-line diagram.

3.3.3.6 Communication

- The circuit breaker shall be capable of communicating the following data via a bus:

  - Circuit-breaker status (open/closed, service/test/isolated, tripped on a fault, ready to close);
  - Control-unit settings;
  - Tripping causes;
  - The measurements processed by the control unit: current, voltage, frequency, power

- It shall be possible to remotely control the circuit breaker. All Protection parameters are adjustable from Remote.
- RS-485 Standard serial interface shall be provided for communication of microprocessor based relay

- It shall be possible to remotely modify circuit-breaker settings:
  - Settings within the range defined by the switches on the front panel of the control unit;
  - Settings of the protectionfunctions and the alarms.
  - Communications functions shall be independent of the control unit

3.2 Internal Panel Wiring & Terminal Blocks

- Suitable provision shall be made to terminate control / power connections near the respective module. The terminals selected shall be suitable for the termination of armoured cables, as per the details of cable required. Adequate space shall be kept for cabling.
- Feeders up to 100A shall be terminated to terminal block located in cabling chamber and feeders above 100A rating shall be terminated directly to suitably staggered taped bus bars.
- PDB shall be completely factory wired, ready for connecting to equipment.
- Power circuit wiring shall be with 1100 V grade single core stranded, PVC insulated copper cable of minimum 4 sq. mm or aluminium cable of 6 sq.mm..
- Control circuit wiring shall be with 1100 V grade multi strand, PVC insulated copper cable of 2.5 sq. mm.
- Internal control wiring shall be laid in PVC ducts with detachable snap - on covers and there shall be enough length to avoid the necessity to stretch the cables for door movement/connection, disconnection or changing.
- Wires identified at each end in accordance with schematic diagrams by interlocked type ferrules.
- Necessary cable clamping arrangement shall also be provided in the cable alley/chamber inside compartment on perforated sheet steel section.
- All connections external to a feeder, all the auxiliary contacts of the LT breaker, and all spare contacts of the relays shall be wired on to the terminal blocks.
- Interconnection between panels of adjacent shipping sections to be brought out to a separateterminal block, wires for interconnection properly labeled, looped and bunched inside the panel for connection at site.
- All terminals, as well as terminations, at various control devices inside the compartment shall be provided with interlocking type ferrules having engraved numbers. Terminals having connections from other modules shall be marked with red ferrules.
- There shall be no joints or tappings between two terminations. No more Than two connections shall be made to any terminal.

- 20% spare terminals shall be provided in each control terminal block.
- The wiring shall be terminated in the respective terminal with suitable crimp type sockets.
- Interlocking type ferrules for identification shall be provided.
- All spare contacts to be wired to terminal block.
- Interpanel wiring shall be through horizontal bus bar chamber.
- All holes or tubes for wiring runs shall be bushed and shall have room for reasonable additions.
- All power cable terminal blocks / boards shall be stud and nut type with phase barriers.
- For higher rated feeders, suitable staggered extension links shall be provided to permit direct termination of cables.
- Cable supports / clamps shall be provided in cable alley.
- Removable cable gland plate shall be provided.
- All cable termination nut / bolts and washers (for all cables at panel bus bar /link inside all the supplied panels must be supplied as part of Tenderer's panel supplier's scope.
- Double compression type GI / brass glands, accessories including tinned copper lugs to outgoing cable sizes to be supplied loose.
- The color-codes for the wires shall be as follows:

415V, 3phases	Red, yellow & blue
Neutral	Black
Earth	Green
Single phase - line	Red
110V AC - line	Brown
24V DC +ve	Orange
-ve	Black

3.3 Control Transformers

415V/230V Control transformers of adequate rating (Minimum 2.5 kVA each) shall be provided for 230 V AC control supply for each PDB. Higher rating shall be selected based on actual requirement with 50% margin and voltage drop in control transformer shall be less than 3% at peak KVA requirement during coil pickup.

MCB& fuse shall be provided for primary side of control transformers. MCB of suitable rating shall

be provided on the secondary side.

Voltmeter class 1.5 and scale 0-250 V.

Control transformer shall be horizontally mounted in one of the bottom compartments with adequate ventilation.

The transformer shall be double wound, dry type with class E insulating materials. The control

supply for the motor feeders shall be fed through suitable rated MCBs.

Control transformers shall be provided with +/- 5% and +/-10% voltage taps on 415 V side.

The control bus of the PDB shall be electrolytic grade aluminium/copper only and will be designed to carry the transformer rated secondary current as well as withstand the available short circuit level. Control buses of two sections shall be connected through sectionalising switch.

Indication lamps shall be connected to 240V AC supply.

Isolation arrangement shall be provided on each panel to facilitate fault location and testing. Separate fuses shall be provided for spring charging motors, for indication lamps and for closing/tripping circuits of each cubicle.

3.4 Inscriptions

Identification labels shall be provided for each PDB as well as for each compartment, control device and other components.

PDB designation at the top of central panel with letters of 25 mm (min.) height.

Anodised Al. Plates (Black background and white lettering) for each feeder inscriptions with letters of mm. 6 mm height for each module on door.

Each component shall be identified as per schematics by good quality polyester film stickers on components and by painting in a conspicuous place on the panel body.

Terminal blocks shall be identified as per schematics with stickers / stenciling by black paint.

Danger boards as per IS on front & rear end of PDB in English, Hindi & local language.

3.5 Earthing

A continuous earth bus shall be provided for the PDB at the bottom with an earthing bolt at each end. Bolted joints with tooth spring washers shall be provided for good earth continuity.

Provision shall be made for connecting 4th core incoming and outgoing cables.

The earth bus shall be of aluminium having the same size as that of neutral bus bar at the top.

Neutral and earth busbars shall be connected through a link.

Electrical equipment shall be interconnected with earth grid using minimum size 50 x 6 GI strip or equivalent.

Earthing shall confirm IS: 3043 - 1987, IE rules and statutory regulations.

Internal earthing network shall be connected at two places minimum to the external- earthing network.

5.0 Feeder Types

The PDB'S shall be generally used to feed all items such as Sockets /starters / MCBs/ Other PDB_ supply panels / mobile sockets / non-UPS supply etc.

The following types of feeders shall be envisaged in PDB.

Type 'A' Incomers

- Draw out design
- Air circuit breaker of 800 / 1200 A / 1600 A rating with Microprocessor based trip release for O/L, S/C& E/F.
- Incomer from transformer or incomers from DG set can be switched on one at a time.
- 415V, 3 Ph, 250/400/630 Amps, rated Moulded case circuit breaker with Microprocessor based trip release for O/L, S/C& E/Fwith AC3 duty contactor.
- Current transformers to read phase currents as per PDB rating.
- Relay as per SLD
- Voltmeter with 3-position selector switch
- Digital Ammeters
- Phase (R, Y, B) Indication lamps with fuses.
- ON/OFF/Trip indication lamps (LED type).
- Current transformers for protection and measurement

Type 'B' Control Section

- Dry type control transformer, 415 / 240V with + 2.5 and + 5% tappings on primary, of required rating (minimum 2.5 kVA).
- MCB on primary side and secondary side of transformer.
- Control supply healthy (lamp) indication.

Type 'C' (Power supply Feeder module)

- Heavy duty fuse switch unit of AC 23 duty or MCCB as per SLD.
- Mechanical ON/OFF indication
- Door interlock ,defeat interlock and padlocking facility.
- Rating 32/63/100/125/250/400 A as specified / as per SLD.

Type 'D' (Spare Feeders)

- Each PMCC shall be provided with atleast 20% spare feeders or minimum of 1 no. of spare feeder of each rating whichever is maximum.

Type 'F' (Capacitor Feeders)

- Heavy duty fuse switch unit of AC 23 duty
- Mechanical ON/OFF indication
- Door interlock, defeat interlock and padlocking facility.
- Rating 32/63/125/250 A as specified / as per SLD.
- APFC relay for PF correction.
- Capacitor Bank as per SLD
- PF meter with lagging and leading indication

6.0 Special tools

A set of special tools required for the normal operation and maintenance shall be supplied with each PDB. The tenderer shall include, along with each PMCC, one height adjustable circuit breaker trolley for removal and replacement of the withdrawable circuit breaker carriage.

7.0 Painting

All sheet metal work shall undergo a process of

- Degreasing

- Pickling in acid
- Cold rinsing &Phosphating
- Two primer coats of Epoxy based primer suitable for corrosive (seashore) atmosphere.
- Two finish coats of painting of light grey or approved colour shade and quality.
- The interior of panel shall have eggshell white paint.

8.0 Inspection & testing

The owner or his authorized representatives may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within three weeks of award of contract. Owner's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings and reference national/ international standards.

QAP shall be prepared and furnished by the contractor in BGL Form No.11.20 (4.4) F- 10.Test certificates including test records and performance data etc. shall be furnished by the vendor.

Inspection will be carried out on the basis of the purchaser's drawings/ manufacturer's approved drawings and instructions contained in the QAP.

QAP shall generally cover the following tests:

- Visual
- Dimensional
- Fitment & alignment
- Measurement of IR Value – Before HV test & after HV test
- High voltage test/ dielectric test
- Routine test as per relevant IS/other standard
- Type test as per relevant IS/other standard

- Test certificates of bought out items
- Paint shade verification
- Operational & functional check
- Verification of BOM

Tests at works and tests at site shall include the following:

a. One minute PF withstand voltage between phases, phase to earth and between open poles as well as for the auxiliary/control circuit.

b. Insulation resistance test for power, auxiliary and control circuits.

c. Milli volts drop across incoming and outgoing jumper connections with breaker closed and in service position.

d. Physical inspection

e. Operational tests

f. Temperature rise test on main and vertical busbars

g. Tests to prove inter changeability of breakers with same current rating.

h. Calibration of meters (if supplier is to commission the equipment, this can be done at site)

i. Check of control circuits

j. Test to prove operating voltage range of spring charging motor, closing coil, trip coil and relays.

k. Heat run test

10.0 Drawings

The following drawings shall be submitted for approval as per agreed schedule.

a) Dimensional GA drawing of PDB indicating busbar arrangement, foundation details, gland plate location,Front view of PDB indicating component locations.

b) Single line schematic diagram indicating feeder details.

c) Control schemes of feeders.

d) Component specification details.

e) List of inscriptions.

f) Internal wiring diagrams

g) Terminal plan and external connection diagrams.

h) Cross sectional drawings of cubicle indicating details of busbar chamber, cable chamber, breaker chamber etc.

i) Catalogues of relays, breakers.

j) Operation and Maintenance Manual
   - Recommended procedure for routine maintenance
   - Tests for checking of proper functioning
   - Diagnostic trouble shooting/ fault location charts

k) Storage, conservation and re-commissioning Manual

l) Safety Manual

m) List of special tools and tackles

11.0 PACKING

The equipment shall be properly packed. Special notations such as fragile, this side up, centre of gravity, etc. shall be clearly marked on the package.

12.0 COMPLETENESS OF EQUIPMENT

All fittings, accessories or apparatus which may not have been specially mentioned in this specification but which are otherwise necessary for satisfactory working of PDBshall be deemed to have been included in the scope of supply.

SPECIFICATION FOR

CAPACITOR BANK

C O N T E N T S

1.0 INTENT

a) The intent of this standard specification is to define the general requirements for design, manufacture, assembly and testing at manufacturer's works, packing, transportation and receipt at site with all materials and accessories of Capacitor Bank.

b) Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / requirements as part of the project needs:

1. **Requirement of Capacitor bank and its rating & voltage level.**
2. **Number of Steps/Switching Conditions/ Capacitor Units and its corresponding ratings.**
3. **Incoming feeder rating/ switchgear details etc. or other project specific details, if any.**

Any other item / component / equipment / accessories / services as necessary for satisfactory completion of the project shall also be covered in separateTechnical specification (TS) / SOR item.

2.0 CODES & STANDARDS

The Capacitor bank shall comply with the latest edition of the following and other relevant Indian standards. Incase equipment is supplied by foreign manufacturers relevant international standards shall be applicable.

IS: 2834:1986	-	Specification for Shunt Capacitors for power systems. IS –
13340: 2012	-	Specification for Shunt Power Capacitors of Self-healing type for AC Systemsupto rated voltage of 1100V
IS: -13925:2012	-	Specification of Shunt Capacitors for AC power systems for Voltages above 1000V
IEEE	-	Recommendedpractice for electrical power distribution (Std. 141) for industrial plants.

3.0 TECHNICAL FEATURES

AUTOMATIC POWER FACTOR CORRECTION EQUIPMENT

The capacitor banks rating shall be selected in such a way so that the power factor shall be maintained to 0.95 or higher at 415 V at all load conditions.

The actual rating of the capacitor bank shall be finalised during drawing approval stage and it shall be provided without any price variation. The rating of the capacitor feeding cables shall be 30% higher than the normal rating

The capacitor bank shall be sheet steel enclosed, free standing, dust & vermin proof and suitable for indoor service. The banks shall be complete with capacitors, busbars chamber and busbars, suitable discharge resistor and fuse for individual capacitor, arrangement for cable entry and termination, earthing terminal, nameplate etc.

The control panel shall be complete with all relays, contactors, switches, lamps etc. Both manual and automatic correction shall be provided. The panel shall be sheet steel enclosed, free standing, dust & vermin proof and suitable for indoor service. The panel shall be complete with busbars chamber and busbars and arrangement for cable entry and termination, earthing terminal, nameplate etc.

The minimum voltage rating of capacitors shall be 460V (phase to phase). CFS unit and contactors shall be suitable for capacitor switching duty. Capacitor shall have higher voltage rating to account for series reactor and 10% system over voltage.

LT capacitors shall be controlled by contactors. The total bank isolation, from the MCC bus, shall be achieved by suitably rated CFS unit having capacitor switching capability. Current rating of CFS unit shall be 30% higher than the normal rating of capacitor bank.

Capacitor bank shall have generally use of different capacity ratings such as of 12.5KVAr , 25KVAr , 50 KVAr , 100 KVAr and so on , that shall be used such that control of desired power factor by proper selection of capacitor rating switching requirements can be more accurately achieved.

Each capacitor bank shall be of 3 Nos. of each individual capacitor rating units connected in delta & should have external fuses for protection. Each capacitor feeder shall have under voltage and over voltage protection by using relay.

Each capacitor shall have series reactor/ choke inductance to control the inrush current. The tenderer shall furnish the rating of capacitor bank and the series reactor/ choke inductance along with calculations in the offer based on data indicated in SLD.

Necessary CT requirement for automatic power factor correction in the incomer breaker panel shall be provided for automatic intelligent power factor controller. Automatic measurement system of the running load / power factor shall be provided to calculate the desired capacitor bank loading through use of automatic correction / capacitor bank switching command.

3.1 Capacitor units

Each capacitor unit shall be fully enclosed in sheet steel on plastic container of adequate thickness suitable for mounting inside the capacitor cubicle. The unit shall be supplied with necessary accessories for forming bank of specified rating.

Capacitors shall be of polypropylene dielectric with self-healing properties. Each unit shall have built-in discharge resistor, series reactor and unit protection fuses and two terminal bushings. The fuses shall not deteriorate or operate due to repeated switching at rated voltage.

The minimum voltage rating of capacitors shall be 440V (phase to phase). Capacitor shall have higher voltage rating to account for series reactor and 10% system over voltage.

The unit shall conform to IS-2834-1981 / IS-13925 and shall be suitable for an ambient of 50 degrees C.

PARAMETER		SPECIFICATION
Rated voltage	-	460V AC
Rated frequency	-	50 Hz
Max. over-current	-	1.3 times rated current
Max. over-voltage	-	1.1 times rated voltage
Max. over load	-	1.3 times rated output

Fuse (capacitor unit)	- External fuse connected before capacitor
Mounting	- IP54 enclosure mounted in a panel / box
Discharge device	- Directly connected discharge device across the capacitor (in the same enclosure) to limit the residual voltage
Connection	- By PVC copper / Aluminium cable suitable for bottom entry
Earth connection	- Distinct earth terminals clearly marked . Specify terminal size
Bank connection	- Delta connected
Max. permissible withstand capacity	- As per IS13340
Peak inrush current	- As per IS13340
Over voltage / long duration voltage withstand capacity	- As per IS13340
Temperature class	- Suitable for 45 deg C ambient (as per IS 2834). - Specify class selected.
Capacitance tolerance	- Pl specify
Terminals	- Specify size with cable gland details
Bushing type	- Pl specify
Insulation level	- 2.5 KV

3.2 Capacitor banks

Each LT switchboard section shall have specified number and rating of capacitor banks. The capacitor banks shall be delta connected using singlephase units rated for 440 V. Where capacitor banks of different ratings are specified, the same shall be built-up from a single standard capacitor unit. The capacitor bank formation inside the cubicle shall be formed

considering easy accessibility for each unit and better air clearances. All bus work shall be adequately supported for maximum fault level specified.

Each bank shall be independently controlled. All the banks shall be controlled automatically based on bus power factor. The control scheme shall be such that maximum numberof steps are achieved for smooth control of power factor.

3.3 Control equipment

Each capacitor bank shall have independent control equipment comprising fuse switch unit, power contactor with auxiliary contacts, line CTs with taut band ammeter and selector switch to read phase currents of capacitor bank feeder, ON/OFF indicating lamps, auto/manual selector switch, auxiliary relays and any other equipment required for satisfactory operation, maintenance and control. Local/remote selector switches where specified shall be provided for switching ON/OFF capacitor banks from remote location.

Each bus section shall have a multistage (12 stage) microprocessor based PF relay with associated contactors, bus PF meter for group control of the banks connected to respective bus section. The power factor controller shall have LCD display with indication of inductive/capacitive power factor, active outputs, demand for switching on/off of a capacitor step, alarm conditions, overtemperature conditions, phase shift, C/K ratio, type of switching sequence etc.It shall also have optional RS-485 Modbus adaptor for allowing communication with a monitoring system.

All switching equipment shall have capacitor switching rating of 150%of rated current of capacitor bank. All equipment shall be suitable for 240 V AC control supply. Necessary protection through HRC fuses shall be provided for control circuits. Control supply shall be drawn preferably through control transformer. Necessary interlock shall be provided to ensure switching-on of capacitor banks after it is fully discharged.

3.4 Details to be furnished in datasheet of APFC Panel:

i) Name of manufacturer
ii) kVAR rating
iii) Rated voltage
iv) Rated Frequency
v) Number of phases
vi) Type of connection
vii) Enclosure details
viii) Material of construction and its thickness
ix) Dimensions
x) IP Protection class
xi) Application

xii) Cable entry details
xiii) Paint shade
xiv) Busbar details – Material,cross section, busbar supports etc.
xv) Capacitor type
xvi) Number of steps
xvii) Configuration details
xviii) Switchgear details – Incomers, outgoing, APFC Relays etc.
xix) Bill of material

4.0 DRAWINGS AND DOCUMENTS

4.1 Vendor shall furnish all data/drawings/documents specified in the vendor data requirement.Approval of the drawing shall not relieve the manufacturer of his responsibility to equipment conforming to the relevant specification and standards or for any mistakes, errors or omissions in the drawing.

4.2 Following Drawings & Documents shall be submitted after award of contract for approval:

i) List of drawings
   a) Overall General arrangement drawing
   b) Capacitor bank details
   c) Capacitor sizing calculation
   d) Technical Datasheet
   e) Bill of material
   f) QAP, Internal Test Certificates and Inspection Certificates
ii) Instruction manuals for erection, testing and commissioning.
   a) Instruction manual shall give step by step procedure for:
      - Erection, testing and commissioning
      - Operation
      - Maintenance and
      - Repair
   b) Operation and Maintenance Manual
      - Recommended procedure for routine maintenance
      - Tests for checking of proper functioning
iii) List of special tools and tackles

5.0 TESTS AND ACCEPTANCE

Tests shall be carried out at manufacturer's works under his care and expense.

The manufacturer shall submit a QAP inline with the format enclosed for approval of BGL. All tests and documents of inspection documents shall be shall be done based on this.

All routine tests as specified by the applicable standard code shall be conducted. Type test

certificates for the Capacitor bank from a recognized testing organization shall be furnished with the bids. The vendor shall also submit a list of guaranteed technical particulars with the bids.

In addition, specific tests shall be conducted to check mechanical and electrical operation/wiring etc. and panel wiring conforming to the specification and approved schematic drawings.

All routine tests on capacitor banks shall be conducted as per relevant standards (Refer IS: 13118 – latest revision).

Above tests shall be provisionally conducted at manufacturer's works by providing temporary connection to switchgear units in order to simulate the actual conditions.

QAP shall generally cover the following tests:

- Visual
- Dimensional
- Fitment & alignment
- Measurement of IR Value – Before HV test & after HV test
- High voltage test/ dielectric test
- Routine test as per relevant IS/other standard
- Type test as per relevant IS/other standard
- Impulse test HT
- Test certificates of bought out items
- Paint shade verification
- Operational & functional check
- Verification of BOM

Type tests:

- Thermal stability test
- Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature
- Voltage test between terminals
- Voltage test between terminals and container
- Lightning impulse voltage test between terminals and container
- Discharge test
- Ageing test
- Self-healing test
- Destruction test

Routine tests:

- Capacitance measurement and output calculation
- Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature
- Voltage test between terminals
- Voltage test between terminals and container
- Test of the internal discharge device
- Self-healing test

All the capacitor banks shall be subjected to the routine tests as per IS 13340 at manufacturer's works. Type test certificates for similar design have to be submitted for approval. Test procedures as specified in IS-13340 shall be adopted.

6.0 CAPACITOR SIZING CALCULATION (To be submitted by the vendor)

i) Required kVAr = kW [tan $\cos^{-1}$(initial pf) – tan $\cos^{-1}$(final pf)]

ii) kVAr of capacitor bank = $\frac{2 \times \pi \times f \times C}{100}$

iii) kVAr of series reactor = kVAr of capacitor bank x % of reactor

iv) Current of series reactor = $\frac{\text{kVAr of capacitor bank}}{\text{kV} \times \sqrt{3}}$

v) Inrush current = $\frac{U \sqrt{2}}{\sqrt{X_C \times X_L}}$

SECTION – 8

SPECIAL CONDITIONS OF CONTRACT (SCC)

The following Special Conditions of Contract shall supplement the General Conditions of Contract. Whenever there is a conflict, the provisions herein shall prevail over those in the General Conditions of the Contract. The corresponding clause number of the GCC is indicated in parentheses.

1. Definitions

The Purchaser is: (C&P Department), Bhagyanagar gas Limited having their office at 2nd floor TSIDC buildings, Parishrma bhavan, Basheerbagh, Hyderabad-500004

FOT shall mean sum of Ex-works price including packing and forwarding, TPIA, GST, Transit insurance, transportation, and unloading at site.

2. Price Reduction Schedule (Prs)

In case supplier fails to complete the supply within stipulated period then unless such failure is due to force majeure as defined in Bid document, there will be reduction in order value @ 0.5% of the total order value for every week or part thereof of the delay, subject to maximum of 5% of the total order value. Owner may without prejudice to any methods of recovery, deduct the amount of such PRS from any money due or which may at any time become due to supplier from its obligations or liabilities under the contract or by recovery against the performance bank guarantee. Both owner and supplier agree that the above percentage of price reduction are genuine pre-estimates of the loss/ damage which Owner would have suffered on account of delay/ breach on the part of supplier and the said amount will be payable on demand without there being any proof of the actual loss/ damage caused by such delay/ breach. Owner decision in the matter of applicability of price reduction shall be final and binding.

Value considered for PRS as per above clause shall be excluding taxes and duties.

All sums payable by way of compensation shall be considered as reasonable compensation without reference to the actual loss or damage which shall have been sustained.

3.0 Delivery and Documents

Bidder to note that delivery shall be as per followings:

For Part -: The basis of delivery for all items shall be FOT, BGL Site/OMC site/ Store at Hyderabad GA

Upon delivery of the Goods to the transporters/ carriers, the Supplier shall notify the Purchaser/ Consultant and fax/ mail the following documents to the Purchaser/ Consultant:

LR or GR

Packing List showing weight and dimension of each package

Manufacturer's factory inspection complying the technical specification as per tender.

Inspection release note issued by Purchaser/ Consultant/ TPIA

Dispatch clearance issued by Purchaser/ Consultant.

Likely date of arrival.

Invoice

The above documents shall be received by the Purchaser before arrival of the Goods and, if not received, the Supplier will be responsible for any consequent expenses.

Final original documents for release of payment shall be submitted at BGL, Hyderabad Head Office and transport copy shall be submitted at the time of delivery at BGL designated store/ office.

4. Shipment

The Bidder shall make shipment only after obtaining dispatch clearance from Purchaser. For getting dispatch clearance, bidder has to submit inspection release note issued by Third Party Inspection agency/ Purchaser‟s authorized representative to the Purchaser.

The bidder shall provide details of adequate coverage of transit insurance along with dispatch documents.

5. Payment Terms

Supply :

a) 80% payment shall be released after:

Completion of supply, erection, and installation of Physical verification of material received at site and Submission of invoice with all required supporting documents.

Document Requirement

Inspection release note by issued by inspection Agency appointed by owner / consultant.
GR / LR.
Packing List
Insurance cover note covering transit insurance
Dispatch Clearance by Owner / Consultant.
Documents as specified in the Technical Specifications.
Copy of valid Performance Bank Guarantee as per tender terms & conditions
Invoice in triplicate (as per GST Act/ Rules)
A certificate from manufacturer that all items/ equipment under supply including its component or raw material used with manufacturing are new and conform to the tender requirement. In case manufacturer is not the contractor this certificate will duly be endorsed by the contractor owning overall responsibility.
Indemnity Bond

b) 15% shall be released after successful completion of load enhancement works.

Works :

A) 95% shall be released after:

a) Successful testing and commissioning of the system
b) Submission of all statutory approvals including CEIG clearance and TGSPDCL energization letter
c) Handing over of As-Built Drawings, test reports, and warranty certificate.

5% balance shall be released after:
Defective liability period and contract closure
General Notes
All efforts shall be made to release the payment within 30 days after receipt of relevant documents complete in all respects.
All bank charges incurred in connection with payments shall be to vendor‟s accounts.
Unless otherwise specifically stated in bid document, all payments shall be made in the currency quoted.
No interest charges for delay in payments, if any, shall be payable by Owner.
Bidder shall ensure payment of minimum wages, as per respective State Govt., to its people engaged in the site activities/ AMC.
Penalty/ deductions for non-performance, if any, shall be applicable as per provisions stipulated in technical volume (Vol.-II).

6. Dispatch Instructions

Seller shall obtain dispatch clearance from the Purchaser prior to each dispatch.
Copy of Inspection Release Certificate, Dispatch Clearance and Statement showing the name of the vessel / transporter, description and weight of material and shipping marks etc. to be submitted along with the documents.

7. Rejection

Any materials/goods covered under scope of supply, which during the process of inspection by appointed third party, at any stage of manufacture/fabrication and subsequent stages, prior to dispatch is found not conforming to the requirements/specifications of the Purchase Requisition/Order, shall be liable for immediate rejection.
Supplier shall be responsible and liable for immediate replacement of such material with acceptable material at no extra cost or impact on the delivery schedule to OWNER.

8. Limitation of Liability

Notwithstanding anything contrary contained herein, the aggregate total liability of Supplier under the Contract or otherwise shall be limited to 100% of contract value. However, neither party shall be liable to the other party for any indirect and consequential damages, loss of profits or loss of production.

9. Quality Assurance/Quality Control

The Bidder shall prepare a detailed quality assurance plan for the execution of Contract for the various supplies for

approval of BGL/ BGL PMC Consultant.
The Bidder shall establish document and maintain an effective quality assurance system outlined in recognized codes.
The Purchaser, while agreeing to a quality assurance plan shall mark the stages for witness of Tests, review at any or all stages of work at shop/site as deemed necessary for quality assurance.

10. Inspections and Tests

Inspection and tests prior to shipment of Goods and at final acceptance shall be as per Technical Specifications, Quality Control Table and approved Inspection & Test Procedure. However, without prejudice to the provisions of technical specifications following shall hold good:
The Purchaser or its representative shall have the right to inspect and/ or to test the material to confirm their conformity to the specifications.
The inspections and tests may be conducted on the premises of the Seller or his subcontractor
(s) at point of Delivery and/or at the destination. When conducted on the premises of the Seller or his subcontractor(s), all reasonable facilities and assistance including access to the production data shall be furnished to the Purchaser's representatives at no charge to the Purchaser.
The Purchaser's right to inspect, test and wherever necessary reject the material after the material‟s arrival in the Purchaser‟s country shall in no way be limited to or waived by reason of the material having previously been inspected, tested and passed by the Purchaser or their representative prior to the material shipment from the country of origin.
Supplier shall hire Third Party Inspection Agency (TPIA) for carrying out the inspection at supplier‟s works as per approved ITP. TPIA charges shall be borne by Supplier. Approved TPIA are Moody International (India) Pvt. Ltd., Dr. Amin Controllers Pvt. Ltd., Certification Engineers International Ltd., International Certification Service Pvt. Ltd., Bureau Veritas (India) Pvt. Ltd., Hertz Inspection & Services Pvt. Ltd., Meenar Global Consultant, Quality Evaluation and Systems Team Pvt. Ltd. TUV SUD South Asia, Vincotte International India Assessment Service Pvt. Ltd., TUV India Pvt. Ltd., SGS India Pvt. Ltd. Supplier shall obtain BGL /BGL‟s Consultant’s approval before finalizing the TPIA.

11. Repeat order

deleted.

12. Mode of payment

Payment will be released through E-payment as detailed in ITB Taxes & duties (GST) shall be paid in Indian Rupees only.
The payment shall be released within 30 days from the date of receipt of invoice , if found to be in order and duly certified by PMC/BGL -EIC. The Payment shall be released through RTGS only.

13. Deduction at Source

Purchaser will release the payment to the Seller after effecting deductions as per applicable law in force.
Purchaser will release payments to the Bidder after offsetting all dues to the Purchaser payable by the Bidder under the Contract.
Notes: - All Invoices shall be raised in line with the GST Act/rules in vogue.

14. Guarantee/ Warranty

Warranty shall remain valid for twelve (12) months from the date of successful commissioning of supplied material or Eighteen (18) Months after the date of receipt of last shipment whichever is earlier. However, if these 18 months‟ period exceeds due to any defect observed in the supplied material at site in that case supplier to replace the material without any extra cost to owner and the warranty will stand extended for another 12 months from the date of supply of replaced material.

15. Packing

The SCC provisions shall supplement GCC Clause 11.0 as detailed below.
Packing shall be capable of withstanding rough sea weather for a minimum period of 2 to 3 months and shall be commensurate with the best commercial export practice in case of sea freight.
Fragile articles shall be packed with special precaution and shall bear the marking like 'Fragile Handle with Care' and' or 'This side Up' etc. Items shipped in bundle must be securely tied with steel wire or straps at suitable intervals.

All delicate surface on equipment' materials shall be carefully protected and painted with protective paint compound and wrapped to prevent rusting and damage.
Attachments and parts of equipment and small pieces shall be packed in wooden cases with adequate protection inside the case and wherever possible should be sent along with the major equipment. Each item shall be tagged so as to identify it with the main equipment and part number and reference number shall be indicated.
All protrusions shall be suitably protected, and openings shall be blocked by wooden covers.
Wherever required, equipment' material shall be packed in polythene bags and silica gel or similar dehydrating compound shall be put inside the bags for protecting them.

16. Contract Duration and Completion

The contractor shall complete the entire scope—including supply, installation, testing, commissioning, and statutory approvals—within 60 calendar days from the date of issuance of the Purchase Order (PO).
Delays due to reasons within the contractor's control (e.g., manpower shortage, procurement delays, poor planning) will not be considered for any schedule extension.

17. Approvals and Liasioning

The contractor shall coordinate with DISCOM (TSSPDCL/TGSPDCL) and CEIG authorities to obtain necessary approvals such as:
Approval of drawings and single-line diagrams (SLD)
Site inspections and testing clearances
Final CEIG safety certificate and DISCOM energization approval
BGL will reimburse All statutory fees upon submission of receipts/ paid challan copies (if any) or BGL will directly pay the fees/ charges.
In case of rejection by CEIG due to documentation, workmanship, or specification non-compliance, the contractor must rectify and resubmit at their own cost.

18. Inspection and Testing

Pre-dispatch inspection of panels, MCCBs, and cables may be conducted at the contractor's premises or OEM works.
Site-level testing and inspection shall include but not be limited to:
Insulation Resistance (IR) Test
High Voltage (HV) Test
Earth Resistance Test
Relay calibration and protection testing
Functional checks of APFC panel, MCCBs, and metering system
TPIA inspection and certification is in the scope of contractor
All test reports must be submitted in original to the BGL Engineer-in-Charge prior to commissioning.

19. Warranty and Guarantee

All equipment, components, and workmanship shall be under warranty for 12 months from the date of commissioning or 18 months from the date of delivery, whichever occurs first.
During the warranty period:
Contractor shall attend any fault within 24 hours of intimation.
Replacement of defective parts shall be done at no extra cost, including transportation, labor, and reinstallation.

20. Liquidated Damages (LD) / Price Reduction Schedule (PRS)

For delays beyond 60 days, LD shall be applicable at the rate of:
0.5% of the pending works value per week of delay (or part thereof)
Subject to a maximum of 5% of total contract value (excluding GST)
BGL reserves the right to deduct this amount from the bills or recover from the Performance Bank Guarantee (PBG).

21. Performance Bank Guarantee (PBG)

Contractor shall furnish a PBG equal to 10% of the total contract value (excluding taxes and duties) within 15 working days from PO issue date.

The PBG shall be valid for a period of:
12 months (warranty period) + 90 days claim period
PBG must be issued by a scheduled commercial bank in the prescribed format approved by BGL.

22. Safety, Security & Statutory Compliance
Contractor shall:
Ensure usage of proper Personal Protective Equipment (PPE) by all deployed personnel.
Follow all site safety rules, especially as work is in HT electrical and potentially energized zones.
Ensure workers are covered under ESIC/Workmen Compensation and comply with relevant labor laws.
Any accident or injury shall be the sole responsibility of the contractor. BGL shall not be held liable.

22. Termination Clause
BGL reserves the right to terminate the contract under the following conditions:
Non-performance or breach of contract terms
Safety violations or delays beyond acceptable limits
Insolvency or unethical conduct
Termination will be preceded by a 30-day written notice, during which the contractor must rectify the issue or demobilize gracefully.

23. Taxation, Invoicing, and Duties
GST and other statutory taxes shall be paid extra as per prevailing laws.
All invoices must:
Be submitted in triplicate
Include GSTIN of both parties
Comply with GST invoicing norms
TDS will be deducted as per Income Tax Act and relevant GST provisions.

24. Ownership and Handover
- Upon completion, the system (panels, CTPTs, earthing, cables) becomes the property of BGL.
- Contractor shall submit:

As-Built Drawings in hard and soft copy
Manufacturer test certificates
Warranty documents
O&M manuals
- Final handover shall be signed off jointly by contractor and Engineer-in-Charges.

25. Corresponding Address Purchaser:
- C&P Department
  Bhagyanagar Gas Limited
  2nd floor, TSIDC buildings,
  Parishrma Bhavan, Basheerbagh,
  Hyderabad-500004

SECTION 09

SCHEDULE OF RATES (SOR)

BGL Bhagyanagar Gas Ltd.	**Procurement of 250 KVA & 650 KVA transformer along with Installation & Commissioning at BGL Mother Station Shamirpet and TSRTC DEPO Medchal for Hyderabad GA** **Bid Document No. BGL/659/2024-25**	Volume II of II

BHAGYANAGAR GAS LIMITED

SCHDULE OF RATES

Tender No.- BGL/659/2025-26

Procurement of 250 KVA & 650 KVA transformer along with Installation & Commissioning at BGL Mother Station Shamirpet and TSRTC DEPO Medchal for Hyderabad GA

A. Supply(S), transportation(T), Erection(E), installation(I) and commissioning(C) of 630 kVA Transformer, at MS - Shamirept

Sr. No	Description	Unit	Qty	Unit Rate (Rs.)	GST %	Total GST Amount in Rs.	Total amount including GST Rs.
1	S/T/I/C of 630kVA 11/0.433KV On load tap changer, RTCC Panel, 3 Phase, 50Hz, Dynn11 Vector Group, Copper wound, CRGO Core, Oil Immersed Distribution Transformer with standard fittings confirming to IS1180 Level-I Standard.	Nos	1			₹ -	₹ -
2	Buy Back of 630 kVA Transformer	Nos	1			₹ -	₹ -

A.1. Electricity load enhancement works excluding Govt charges, at MS - Shamirpet

Sr. No	Description	Unit	Qty				
1	S/T/I/C of 11KV CT PT and Energy Meter Replacement Work Including Old CTPT Removing, handing over at Dept Stores, Drawing new CTPT, Installation, Commissioning of new CTPT and Energy Meter	Lump sum	1			₹ -	₹ -
2	S/T/I/C of Meter Box with GI Piping and Wiring	Lump sum	1			₹ -	₹ -
3	S/T/I/C of 11KV LAS	Nos	3			₹ -	₹ -
4	S/T/I/C of 50X6mm GI Flat for Earthing for HT Yard	Mtrs	20			₹ -	₹ -
5	S/T/I/C of 50X6mm Copper Flat for TF Neutral Earthing	Mtrs	5			₹ -	₹ -
6	S/T/I/C of Hardware Items, Monoplast, Silver Paints, 8SWG Copper Wire Etc	Lump sum	1			₹ -	₹ -
7	S/T/I/C of APFC 180kVAR Capacitor Bank with Panel	Nos	1			₹ -	₹ -
8	Liasoning Work with EB Department including inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lump sum	1			₹ -	₹ -
9	CEIG Approvals inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lump sum	1			₹ -	₹ -

B. Supply(S), transportation(T), Erection(E), installation(I) and commissioning(C) of 250 kVA Transformer at Medchal, RTC Depot.

Sr. No	Description	Unit	Qty				
1	S/T/I/C of 250kVA 11/0.433KV On load tap changer, RTCC Panel, 3 Phase, 50Hz, Dynn11 Vector Group, Copper wound, CRGO Core, Oil Immersed Distribution Transformer with standard fittings confirming to IS1180 Level-I Standard.	Nos	1			₹ -	₹ -
2	Buy Back of 100 kVA Transformer	Nos	1			₹ -	₹ -

B.1. Electricity load enhancement works excluding Govt charge, at Medchal, RTC Depot.

Sr. No	Description	Unit	Qty				

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1	S/T/I/C of 11KV CT PT and Energy Meter Replacement Work Including Old CTPT Removing, handing over at Dept Stores, Drawing new CTPT, Installation, Commissioning of new CTPT and Energy Meter	Lumpsum	1			₹ -	₹ -
2	S/T/I/C of Meter Box with GI Piping and Wiring	Lumpsum	1			₹ -	₹ -
3	S/T/I/C of Extension Plinths both CTPT and Meter Box, LT Cable Trench and Yard Metal Cleaning and Spreading	Lumpsum	1			₹ -	₹ -
4	S/T/I/C of 11KV XLPE 70Sqmm X 3 Core Cable	Mtrs	10			₹ -	₹ -
5	S/T/I/C of 11KV XLPE 70Sqmm X 3 Core Cable straight through Joint Kit	Nos	1			₹ -	₹ -
6	S/T/I/C of 11KV XLPE 70Sqmm X 3 Core Cable End Joint Kit	Nos	1			₹ -	₹ -
7	S/T/I/C of 11KV Breaker Servicing and Fuses Replacement	Lumpsum	1			₹ -	₹ -
8	S/T/I/C of 50X6mm GI Flat for Earthing for HT Yard	Mtrs	50			₹ -	₹ -
9	S/T/I/C of 50X6mm Copper Flat for TF Neutral Earthing	Mtrs	5			₹ -	₹ -
10	S/T/I/C of Hardware Items, Monoplast, Silver Paints, 8SWG Copper Wire Etc	LS	1			₹ -	₹ -
11	S/T/I/C of 400Amps LT Main Incoming MCCB with Outdoor type Panel	Nos	1			₹ -	₹ -
12	S/T/I/C of LT XLPE 185Sqmm X 3.5 Core Cable (2 Runs TF to MCCB to Main Panel to Capacitor Bank)	Mtrs	60			₹ -	₹ -
13	Cable Terminations with DC Glands and Lugs	Nos	12			₹ -	₹ -
14	S/T/I/C of LT PCC Panel with 400Amps Incomer, 160Amps Outgoings - 4 Nos	Nos	1			₹ -	₹ -
15	S/T/I/C of APFC 120kVAR Capacitor Bank with Panel	Nos	1			₹ -	₹ -
16	S/T/I/C of GI Earth pits 50mm 3 Mtrs Long with Chambers	Nos	4			₹ -	₹ -
17	Liasoning Work with EB Department including inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lumpsum	1			₹ -	₹ -
18	CEIG Approvals inclusive of preparation of drawings, load details, coordination, inspection, certification, agreement, liasoning, etc if any	Lumpsum	1			₹ -	₹ -
19	Buy Back of 250 kVA Transformer	Nos	1			₹ -	₹ -
						Total Amount Rs.	₹ -

Note- The Bidder is advised to visit and examine the site of works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the Bid and entering into a Contract for the required job. The costs of visiting the site shall be borne by the Bidder

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