

Part 2 (B): Employer's Requirements

Technical Specifications for Equipment

All materials required to complete the work as per given specifications & drawings etc. must be manufactured and supplied using fresh raw material. Re-moulded, re-circulated materials are not acceptable. The procurement of materials must be made by the contractor directly from manufacturer or through authorized dealer/distributors. Documentary evidence to this effect is to be made available to Employer for necessary checks/verification of source of supply of materials. Secondhand materials/ partial used materials/ used materials would not acceptable.

Climatic condition details are given with various materials specifications however, bidder shall note that materials covered under project specific RDSS works shall be utilized in that particular project only. Hence, the geographical location of that particular project site and its associated climatic condition shall be applicable for all the materials of that particular project.

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1. Power Transformers

20 MVA 33/11 KV POWER TRANSFORMERS

1 SCOPE: -

- 1.1 This Specification provides for design, engineering, manufacture, assembly, stage inspection, final inspection and testing before dispatch, packing and delivery at destination Sub-station by road transport, transit insurance, unloading at site /stores of Oil immersed, Oil Natural Air Natural (ONAN)/(ONAF) Outdoor Type, 50 Hz,20 MVA 33/11 KV Power Transformers with On Load Tap Changer (OLTC) and Remote Tap Change Control (R.T.C.C.) panel, AVR complete with all fittings, accessories, associated equipment's, spares, 10% extra Transformer Oil, required for its satisfactory operation in any of the sub-stations of the Purchaser.
- 1.2 The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO)silicon steel laminations conforming to HIB grade of BIS certified with lamination thickness not more than 0.23mm to 0.27mm or better (Quoted grade and type shall be used). The Supplier shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.
- 1.3 The scope of supply includes the provision of type test. The equipment offered should have been successfully type tested within five years from date of tender and the designs should have been in satisfactory operation for a period not less than three years as on the date of order. Compliance shall be demonstrated by submitting, (i) authenticated copies of the type test reports and (ii) performance certificates from the users, specifically from Central Govt./State Govt. or their undertakings.
- 1.4 The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification, and the latest revisions of relevant standards at the time of offer and the employer shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The Engineer reserves the right to reject the transformers if on testing the losses exceed the declared losses beyond tolerance limit as per IS or the temperature rise in oil and / or winding exceeds the value, specified in technical particular or impedance value differ from the guaranteed value including tolerance as per this specification and if any of the test results do not match with the values, given in the guaranteed technical particulars and as per technical specification.

2 SPECIFIC TECHNICAL REQUIREMENTS

1	Rated MVA (ONAN/ONAF rating)	16/20 MVA
2	No. of phases	3
3	Type of installation	Outdoor
4	Frequency	50 Hz (± 5%)
5	Cooling medium	Insulating Oil (ONAN-16 MVA)(ONAF-20 MVA)
6	Type of mounting	On Wheels, Mounted on rails.
7	Rated voltage	
	a) High voltage winding	33KV
	b) Low voltage winding	11KV

Technical Specification

8	Highest continuous system voltage		
	a) Maximum system voltage ratio (HV / LV)		36KV / 12 KV
	b) Rated voltage ratio (HV / LV)		33KV /11 KV
9	No. of windings		Two winding Transformers
10	Type of cooling		ONAN/ONAF
11	MVA Rating corresponding to ONAN		100%
	Cooling system		
12	Method of connection:		
	HV :		Delta
	LV :		Star
13	Connection symbol		Dyn 11
14	System earthing		Neutral of LV side to be solidly earthed.
15	Intended regular cyclic overloading of windings		As per IEC –76-1, Clause 4.2
16	a) Anticipated unbalanced loading		Around 10%
	b) Anticipated continuous loading of windings (HV / LV)		110 % of rated current
17	a) Type of tap changer (For 20 MVA only)		ON-load tap changer.
	b) Range of tapping winding (17 Positions)		+ 5% to – 15% in 16 equal steps of 1.25% each on HV
18	Neutral terminal to be brought out		On LV side only
19	Over Voltage operating capability and duration		112.5 % of rated voltage (continuous)
20	Maximum Flux Density in any part of the core and yoke at rated MVA with +12.5 % combined voltage and frequency variation from rated voltage & frequency		1.9 Tesla
21	Transient Condition voltage and frequency		-20% or + 10% Combined variation of
22	Radio Influence Voltage		Maximum 250 Microvolts.
23	System fault level for 33 KV		1500 MVA
24	System fault level for 11 KV		500 MVA
25	Harmonic Current 5 th , 7 th Harmonic		Designed for suppression of 3 rd , voltages and high frequency disturbances.
26	Insulation levels for windings:-		33KV 11KV
	a) 1.2 / 50 microsecond wave shape Impulse withstand (KVP)		170 75
	b) Power frequency voltage withstand (KVrms)		70 28
27	Type of winding insulation		
	a) HV winding		Uniform
	b) LV winding		Uniform

- 28 Withstand time for three phase short circuit 2 Seconds
- 29 Noise level at rated voltage and frequency as per NEMA Publication No. TR-1.
- 30 Permissible Temperature Rise over ambient temperature of 45/50°C as per IS 2026

31	Minimum clearances in air (mm) :-	Phase to Phase	Phase to earth
a)	HV	400	320
b)	LV	280	140

32 Terminals

- a) HV winding line end 36 KV oil filled communicating type porcelain bushings (Anti-fog type)
- b) LV winding 12 KV porcelain type of bushing (Anti-fog type) – for outdoor 11 KV breakers

(11KV Power cables shall be used for extending supply to 11KV breakers in case of indoor circuit breakers. The termination of 11 KV cables on LV bushing shall be through extended copper bus bars suitable to hold power cables termination. A metallic cable termination box, completely sealed, shall be installed on LV side of the transformer in which cables shall enter from bottom gland plates.)

33	Insulation level of bushing	HV	LV
a)	Lightning Impulse withstand (KVP)	170	75
b)	1 Minute Power Frequency withstand voltage (KV –rms)	70	28
c)	Creepage distance (mm) (minimum)	900	300

34 Material of HV & LV Conductor Electrolytic Copper

35 Maximum current density for HV and LV winding for rated current As per best practice

36 Polarisation index IR Test = 1 minute value/15 secs.
 value will not be less than 1.5
 (HV to LV, HV & HV to Earth & LV to earth) IR Test = 10 minute value/1
 minute. value will not be more than 5 and
 less than 1.5

37 Core Assembly Boltless type

38 Temperature Indicator
 a) Oil One number
 b) Winding One number

39.

Minimum Weight of Material, Thickness of tank and Maximum losses for GTP of Power Transformers

Capacity	Minimum Weight of Material	Max. Losses (Kilo Watts)	Minimum Thickness of Tank (mm)
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	Core (Kg)	Conductor (Kg)	Oil (Kg)	No Load Losses (KW)	Load Losses (KW)	Top & Bottom	Side
33/11KV, 20MVA	20700	8500	12	69	12	10	

3 Specific Technical Requirements for Mineral Oil filled Power Transformer:

3.1 Standard MVA Ratings:- 20 MVA (Continuous capacity).

3.2 Rated Voltage :

- i. Primary Voltage - 33 kV
- ii. Secondary voltage - 11 kV

3.3 Temperature Rise:

- i The temperature rise for top oil over an ambient temperature of 50 °C should be 45 °C maximum (measured by thermometer in accordance with IS 2026 or relevant International Standard).
- ii Temperature rise for winding over an ambient temperature of 50 °C should be 50 °C maximum (measured by resistance in accordance with IS 2026 or relevant International Standard).

3.4 No Load voltage ratio:-

The No Load Voltage ratio corresponding to the principal tapping shall be 33,000/11,000 Volts.

3.5 Flux density:-

- (i) Flux density should not be more than **1.69** Tesla Transformer core should be designed in such a way that it will not get saturated for any value of V/f (Voltage/frequency) ratio.
- (ii) Maximum Flux Density in any part of the core and yoke at rated MVA with +12.5 % combined voltage and frequency variation from rated voltage & frequency should not be more than 1.9 Tesla (over fluxing without saturation).

3.6 Current density:

The current density for HV & LV windings should not exceed 2.5 A / mm² for copper conductor at normal tap.

3.7 Magnetizing Current:-

- i The magnetizing current at normal voltage & frequency shall be limited to 1% of full load current.
- ii The magnetizing current at maximum voltage & frequency shall be limited to 3% of full load current.

3.8 Impedance Values :

Percentage impedance voltage on normal taps & rated MVA at 75° C.

Base MVA	% impedance	IS Tolerance
20	12.0%	+/- 10%

3.9 Minimum clearances:

Following minimum clearances in air and oil shall be maintained :

Voltage	Phase to phase (in mm)	Phase to Earth out of Oil (in mm)	Phase to Earth in Oil (in mm)
11 KV	280	140	25
33 KV	400	320	40

3.10 Losses:

The Maximum No Load & Full Load Losses at normal tap of 20 MVA Power Transformer(with IS tolerance) are specified as below:

Voltage Ratio	No load Losses(KW)	Load Losses (kW at 75 ° C)
33/11	12	69

3.11 Vector Group : Dyn 11

3.12 Cooling : ONAN / ONAF

4 MARSHALLING BOX

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch etc. shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have degree of protection of IP 55 or better as per IS: 2147 (Refer Clause 3.12).

4.1 Marshalling Box Cubicle :

- 1) **Material for construction of marshalling box :** Construction of marshallingbox should be stainless steel more than 316 grade with powder coating of 1.6mm with specified color shed.
- 2) Door hinges of marshalling box should be from inner side and should not beexposed to rain. Gland plate mounting should be from inside only. Digital temperature scanner. TTB with LED for all TRIP & ALARM signals.
- 3) **Major equipment required for marshalling box :**
 - a) One PECON scanner TR-7557C for (OTI alarm, HV WTI alarm Fan ON+ 4-20mA for OTI & WTI).
 - b) Dial type Gauge with alarm & TRIP contacts for LV WTI.
 - c) Other panel accessories as listed as listed in spec.
- 4) Gland plate Min.3mm thick detachable with knockout 6X1 inch.
- 5) Contact wired terminal block connect well TTB with LED shall be used for allTRIP & alarm terminals (TTB No. DDFL4ULR) TTB shall be of “Solid Link” type & TTB with “Glass fuse “ type will not be acceptable. POLYAMIDE Minimum 8 mm width 2nos DDFL4ULR with brass link & end plate for each alarm and tripping (One spare for each).Disconnecting type for WTI CT stud type with screwdriver operated for others separated terminal blocks for protection and Fan control are essential.
 - a) WTI alarm and TRIP.
 - b) OTI alarm and Trip.
 - c) Buchholz relay alarm and trip.
 - d) OSR trip contacts
 - e) MOG low level alarm.

- f) MOG on OLTC low level alarm.
 - g) PRV main tank trip.
 - h) PRV OLTC trip.
 - i) Sudden pressure relay trip.
 - j) WTI and OTI relay contacts of the temperature scanner.
 - k) Contacts in addition to above as required by customer during drawing approvals.
To be provided by supplier.
- 6) Signals to be wired to terminal block :
- a) WTI CT.
 - b) NCT.
 - c) Sensor for temperature scanner.
 - d) Capillaries for WTI and OTI.
 - e) 4 to 20mA signals for WTI and OTI repeater located elsewhere.
- 7) IP55 Ingress protection plus additional rain canopy to be provided. Continuous welding on joints, welding at regular intervals on joints and filling of gaps with use of M seal not accepted. Cable entry from bottom for all cables. Panel internal access from front only through front door double leaf with antitheft hinges. Panel back access not accepted. Separate mounting for marshalling box. Panel supply 240V AC, Single Phase, 50Hz.
- 8) Panel accessories :
- a) Cubicle lamp with door switch and separate fuse/ MCB.
 - b) Approved space heaters controlled by thermostat and separate fuse / MCB
 - c) Incoming fuse switch/ MCB for the incoming supply.
 - d) Panel wiring diagram fixed on back of panel door on aluminum plate engraved fixed by rivet.
 - e) Stainless steel door handle with lock & additional facility for padlock.
 - f) Single phase power plug industrial type 15/5Amp. with MCB.
 - g) TTB for all trip commands.
- 9) Fan motor control if installed in marshalling box or separate fan control cubicle. Fan shall have wire guard on both the sides.
- a) 2X50% fans.
 - b) Complete fan control with fuse switch, contactor, Bimetallic relay, in starter circuit with type 2 coordinated rating as per IS.
 - c) Automatic control from WTI contact.
 - d) Provision for manual controls both from local/remote.
 - e) Fan control cubicle should be separately mounted.
 - f) 2RC/2RS type bearings shall be used instead of ball bearings.

- g) Fan enclosure shall have perforated sheet with holes at motor side.
 - h) Fan shall have wire guard on both sides.
 - i) Fan support enclosure shall be ground mounted & not take any support from transformer radiators.
- 10) Fan control shall be Scanner operated auto manual scheme required single contactor for common control. MPCB shall be suitable rating range for each fan with auxiliary contact. Fan identification numbers on both at MPCB and fan end. Standby fan logic in a day, standby fan shall run for 15 minutes.
- 11) Wires & Cables (FRLSH) :
- a) AC control wiring- 1.5sq.mm black.
 - b) AC fan wiring -2.5 Sq.mm R/Y/B.
 - c) DC wiring – 1.5 Sq.mm : For protection & alarm schemes.
2.5 sq,mm- For Fans.
 - d) Screened cable for PT100 sensor.
- 12) Illumination & Socket Shall be of LED type with 5/15A domestic socket with MCB for control & protection.

5. Hardware :

M 16 size & below stainless steel and above M 16 Hot dip galvanized steel hardware shall be used for external purpose. Cadmium plated except special hardware frame parts and core assembly as per manufacturer's design hardware shall be used for internal purpose.

5.1 All oil Surge relays, Buchholz And Pressure release valve shall be fully enclosed with Aluminum hoods / Canopy for protection against water ingress.

5.2 Gasket : RC 70 c Nitrile Cork / NBR 70 C shall be used for Transformer, OLTC chamber, PT chamber, surfaces interfacing with oil inspection cover etc and also for Cable boxes, Marshaling box, OLTC drive mechanism etc.

5.3 Valves :

- b) Material : Brass.
- c) Type : Both end flanged gate valve / butterfly valve depending on application.
- d) Size : As per manufacture standard.
- e) Position indicator, locking rod, padlocking facility, valve guard and cover late shall be provided to valves.

6. PERFORMANCE

i) Transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit MVA available at the terminals.

ii) The maximum flux density in any part of the core and yoke at rated Voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla.

iii) Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.

iv) The transformer may be operated continuously without danger on any particular tapping at the

rated

MVA \pm 1.25% of the voltage corresponding to the tapping.

v) The thermal ability to withstand short circuit shall be demonstrated by calculation.

any
vi) Transformer shall be capable of withstanding thermal and mechanical stress caused by symmetrical and asymmetrical faults on any winding.

7. DRAWINGS/ DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID

- a) General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.
- b) Assembly drawings of core, windings etc. and weights of main components / parts.
- c) Height of center line on HV and LV connectors of transformers from the rail top level.
- d) Dimensions of the largest part to be transported.
- e) GA drawings / details of various types of bushing
- f) Tap changing and Name Plate diagram
- g) Type test certificates of similar transformers.
- h) Illustrative & descriptive literature of the Transformer.
- i) Maintenance and Operating Instructions.

8. Minimum Protective devices on Power Transformer:

- 1) Spring loaded with detachable diaphragm type Pressure Relief Valve (PRV) with two trip contacts for Main Tank of LSM model with limit switch design, IP : 65 with raindood.
- 2) Spring loaded with detachable diaphragm type Pressure Relief Valve (PRV) with two trip contacts for OLTC of LSM model with limit switch design, IP : 65 with raindood.
- 3) Double Float Buchholz alarm Relay with alarm and trip contacts, service and test position with cock for the Main Tank. Terminal box shall be IP : 65 with drain plug for water draining. Additional rain hood shall be provided.
- 4) Oil Surge Relay with alarm and trip contacts, service and test position with cock for the OLTC. Terminal box shall be IP : 65 with drain plug for water draining. Additional rain hood shall be provided.

Oil temperature indicator metallic bulb type 150 mm diameter with maximum reading pointer, potential free independent adjustable alarm and trip contacts, resetting device with temperature sensing element.

- 5) Winding temperature indicator 150 mm diameter with maximum reading pointer, two sets of potential free independent adjustable alarm and trip contacts, resetting device with temperature sensing element, thermal image coil.

- 6) 2 Nos. Pt 100 sensors / RTDs for winding temperature indication wired up to TBs in marshalling box for external connection.

9. Nitrogen injection Fire Protection System (NIFPS) ;

Nitrogen injection Fire Protection System (NIFPS) shall use nitrogen as fire quenching medium. The protective system shall prevent Transformer/Reactor's oil tank explosion and possible fire in case of internal faults. In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipment's etc, it shall act as fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water and/or carbon dioxide. Fire shall be extinguished within 3 minutes (Maximum) of system activation and within 3 seconds (Maximum) of commencement of nitrogen injection. The scope of work also includes supply, installation, and commissioning of NIFPS System.

10. ~~Water Sprinkler System:~~

~~The water spray system belongs to the category of fixed fire fighting installations. The purpose of providing water spray system is to guarantee exposure protection to equipment containing hazardous substances, flammable liquids by means of cooling their surfaces using devices like water spray nozzles, to reduce heat input from adjacent fire and limit the spread flames.~~

~~High velocity water spray system is provided to extinguish fires involving combustible liquids that constitute the hazard with flash point of 65 deg C or higher. As per IS 3034, Transformers handling cooling oil capacity of 2000 liters & above shall be protected by the system.~~

~~Procurement of raw material, manufacturing, inspection, painting, insulation, supply, erection (including civil, mechanical, electrical and instrumentation), commissioning, commissioning and GTR of complete unit of velocity waters spray system of 20 MVA transformer and associated equipment for high velocity water spray systems.~~

11. Fittings and Accessories on Power Transformer :

SR.No.	Rating and Diagram Plate	
1	a) Material	Anodized aluminum 16 SWG
	b) Background	Satin Silver
	c) Letters, diagram and border	Black
	d) Process	Etching
	e) Name Plate Details	Following details shall be provided on rating and diagram plate as a minimum : 1) Type / kind of transformer with winding material. 2) Standard of manufacturing. 3) Manufacture Name. 4) Transformer serial number. 5) Month and year of manufacturing. 6) Rated frequency in Hz. 7) Rated voltage in kV. 8) Number of phases. 9) Rated power in kVA. 10) Type of cooling. 11) Rated current in Amp.

		<ol style="list-style-type: none"> 12) Vector group symbol. 13) 1.2 / 50"s wave impulse voltage withstand level in kV. 14) Power frequency withstand in kV. 15) Impedance voltage at rated current and frequency in percentages at Principle, Minimum and maximum tap. 16) Load losses at rated current. 17) No load losses at rated voltage and frequency. 18) Auxiliary loss. 19) Continuous ambient temperature at which rating applies in deg. C. 20) Top oil and winding temperature rise over an ambient temperature at rated current in deg. C. 21) Temperature gradient of HV and LV winding. 22) Winding connection diagram. 23) Weight of radiator. 24) Volume and weight of oil in radiator. 25) Transport weight of transformer. 26) Weight of core. 27) Weight of winding. 28) Weight of core and winding with assembly. 29) Weight of tank and fitting. 30) Weight of oil in transformer tank. 31) Volume of oil in transformer tank. 32) Total weight of transformer excluding total weight of OLTC. 33) Type of OLTC. 34) Total weight of OLTC. 35) Weight of oil in OLTC. 36) Volume of oil in OLTC. 37) Total weight of transformer including total weight of OLTC. 38) Tapping details. 39) NCT,WCT details. 40) Name of Purchaser. 41) PO no. and date. 42) Guarantee Period.
2.	Instruction Plate for OLTC	Anodized aluminum black lettering on satin silver background fixed by rivet.

3.	Instruction Plate for Oil filling	Anodized aluminum black lettering on satin silver background fixed by rivet.
4.	Valve Plate	Anodized aluminum black lettering on satin silver background fixed by rivet.
5.	Instruction Plate for Valve	Anodized aluminum black lettering on satin silver background fixed by rivet.
6.	Terminal marking plate for Bushing, WTI, OTI and RTD	Anodized aluminum black lettering on satin silver background fixed by rivet.
7.	Company Monogram Plate	Suitable plate.
8.	Lifting lugs	With antiskid head to lift complete transformer.
9.	Lashing lug	Required.
10.	Jacking Pad	With Haulage hole to raise or lower complete transformer. Design in such a way that jacking of complete transformer with oil shall be possible with 3 nos. jacking pads out of 4 nos. jacking pads provided as minimum.
11.	Detachable bi-directional roller	Detachable bi-directional roller assembly with corrosion resistant bearing, fitting / ripple for lubrication or with permanently lubricated bearing, anti earthquake locking device. The wheels shall be capable of swiveling when transformer is lifted with provision for locking the swivel movement. Roller shall be suitable for 90lb rail. Suitable anti rolling clamp for 90lb rail minimum 4 nos. shall be provided.
12.	Pockets	Pockets for OTI, WTI and RTD on tank. Pockets for ordinary thermometer on tank cover, top and bottom header of radiator, top of each radiator.
13.	Ordinary thermometer	4 Nos.
14.	Drain valve(Gate valve) for Main tank	80 mm.
15.	Drain valve(Gate valve) for OLTC	50 mm.
16.	Drain valve (Gate valve) for all headers	50 mm.
17.	Filter valve (Gate valve) at top and bottom of the Main tank	50 mm
18.	Sampling valve (Gate valve) at top and bottom of the Main tank	15 mm
19.	Vacuum breaking valve (Gate valve)	25 mm
20.	Drain plug	On tank base.
21.	Air Release Plug	On various fittings and accessories.
22.	Earthing Pad	On tank of transformer, complete earthing with non ferrous nut, bolt, washers and spring washers etc.
23.	Vacuum Pulling Pipe	Vacuum Pulling Pipe with blanking plate on Main conservator pipe work.
24.	Rainhood / Canopy	For Buchholz Relay, PRV on Main transformer and OLTC's Buchholz Relay, OSR relay of OLTC. Vertical gasketed joints in cable boxes.

25.	Oil level gauge	On tank for transformer shipment.
26.	Earthing bridge	Earthing bridge by tinned copper strip jumpers on all gasketed joints at least two points for electrical continuity.
27.	Aluminum Ladder	Aluminum Ladder with anticlimbing device and safety flap, with lockable hinged plate at least 1.5 meters from ground level. Ladder shall be located in such a way that it avoids any hindrance to operation of nearby electrical / mechanical accessories etc.
28.	OLTC panel	OLTC panel is required.
29.	Skid base	Welded type.
30.	Core frame to tank earthing	Core frame to tank earthing required.
31.	Danger Plate	Anodized aluminum white lettering on red background fixed by rivet.
32.	Identification plate for all accessories, protective devices, instruments, thermometer, RTD pockets, earthing terminals, all inspection covers, cable boxes, marshalling boxes etc.	Anodized aluminum black lettering on silver background fixed by rivet.
33.	OLTC	a) External on tank / Internal in tank.
		b) Type : Mineral oil / Synthetic Organic Esters / Natural Esters/Vacuum type.
		c) On line filter unit : On line filter unit shall be required for Mineral oil filled OLTC. On line filter shall be capable to remove both carbon and moisture content from oil.
		d) OLTC Location : External to tank type OLTC- Side mounted on conservator side not in front of HV bushing and OLTC gear shall be covered with protective gear shaft around it.
		e) Type of OLTC gear : The taping shall be controlled by a high speed resistor transition type gear in which tap change is carried out virtually under „No volt“ “ No ampere” condition. The selector switches do not make and break any current, main current is never interrupted and a resistor is provided to limit the arcing at diverted contacts to minimum suitable for outdoor mounting and continuously rated for operating at all positions including position in the middle of tap change.

		f) Tapings: The transformers with on load taps shall have taps ranging from +5% to -15% in 16 equal steps of 1.25% each on HV winding (17 position) for HV variation for constant voltage on LV side.
		g) Operation of OLTC gear: Selection of Local / Remote operation of OLTC gear of by selector switch on OLTC drive mechanism
		h) Local operation: Local operation from OLTC drive mechanism through pistol grip rotary switch as well as emergency mechanical hand operation.
		i) Remote operation : Remote operation from Digital RTCC provided by MSEDCL or SCADA depending on the selection of control on Digital RTCC panel.
		<p>j) Safety interlocks : Following minimum safety interlocks to be provided in OLTC :</p> <ol style="list-style-type: none"> 1) Positive completion of tap changing step once initiated. 2) Blocking of reverse tap change command during a forward tap change already in progress until the mechanism resets and vice-versa. 3) Cutting of electrical circuits during mechanical operation. 4) Mechanical stop to prevent overrunning of the mechanism at the end taps. 5) Raise / Lower command in OLTC and Digital RTCC shall be positively interlocked.
		<p>k) OLTC features :</p> <p>OLTC mechanism and associated controls shall be housed in an outdoor with IP 55, weatherproof, vermin proof and dust proof cabinet.</p> <p>It shall be ensured that oil in compartments containing contacts making and breaking current and Main transformer tank does not mix.</p> <p>The hand cranking arrangement shall be such that it can be operated at standing height from ground level.</p>

		<p>d) Bill of Material for OLTC mechanism : Drive Mechanism shall be of MA 9 with stainless steel enclosure</p> <ol style="list-style-type: none"> 1) Control circuit transformer 433/55,0-55 V, adequate capacity. 2) Local / Remote selector switch 1 phase, 2 way, 6 Amp, Pistol grip. 3) Retaining switch Raise / Lower. 4) Handle interlock switch. 5) Raise / Lower switch 1 phase, 2 way, 6 Amp, Pistol grip. 6) Lower limit switch. 7) Raise limit switch. 8) Tap Changer Motor 433 V AC, 3 phase, adequate rating. 9) Motor protection relay with single phasing preventer. 10) Motor control contactors Raise / Lower. 11) Stepping relay. 12) Out of step switch. 13) Tap position indicator. 14) Operation counter. 15) Emergency stop Push Button. 16) Pressure relief valve and Oil surge relay should be provided to OLTC. 17) Drive Mechanism box shall be either Stainless steel 314 or better or Aluminium pressure diecasted only. 18) OLTC timer scheme to trip MPCB for continuous tap operation. 19) Potential free contacts for OLTC supply Healthy, OLTC control supply Healthy, Tap change in progress and OLTC timer trip. 20) All disconnecting type terminals shall be of POLYAMIDE stud type and screwdriver operated minimum 8 mm width.
34.	Drive Mechanism accessories	<ol style="list-style-type: none"> a) Cubicle lamp with door switch and separate fuse / MCB with external ON / OFF switch on front of cover of OLTC drive mechanism. b) Approved space heaters controlled by thermostat and separate fuse / MCB. c) Incoming Fuse / MCB for incoming supply. d) Panel wiring diagram fixed on back of panel door Aluminum engraved plate fixed with rivet. e) Nylon 66 Terminal block minimum 4 sq. mm screw type with 10 % spare terminals. f) Stainless steel door handle with lock and additional facility for padlock. g) Earthing boss.
35.	Hardware, gasket, cables, terminal block, cable gland cable lugs etc.	As per specification.
36.	OLTC and drive mechanism paint	As per specification.

12. MISCELLANEOUS

- i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever locking arrangement is provided.
- ii) Foundation bolts for wheel locking devices of Transformer shall be supplied by the Contractor.

13. DELIVERY

The full quantity of the equipments shall be delivered as per the delivery schedule appended to this specification.

14. SCHEDULES

All Schedules annexed to the specification shall be duly filled by the bidder separately.

15. ALTITUDE FACTOR

If the equipment is to be installed in the hilly area, necessary correction factors as given in the Indian Standard for oil temperature rise, insulation level etc. shall be applied to the Standard Technical Parameters given above.

16. NAME PLATE

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (part-I). The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription of Employer’s name. The name plate shall also include (i) The short circuit rating , (ii) Measured no load current and no load losses at rated voltage and rated frequency, (iii) measured load losses at 75° C (normal tap only), (iv) D.C resistance of each winding at 75° C.

17. SERVICE CONDITIONS

The service conditions shall be as follows: (To be confirmed by PIA as per locality of project)

	Plane area	Hilly area
maximum altitude above sea level	1000m	5000m
maximum ambient air temperature	50° C	50° C
maximum daily average ambient air temperature	35° C	40° C
minimum ambient air temperature	-5° C	-30° C
maximum temperature attainable by an object exposed to the sun	60° C	60° C
maximum yearly weighted average ambient temperature	32° C	32° C
maximum relative humidity	100%	100%
average number of thunderstorm days per annum (isokeraunic level)	70	70
average number of rainy days per annum	120	120
average annual rainfall	1500 mm	1500 mm
maximum wind pressure	260Kg/m ²	260Kg/m ²

Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators. Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

18. SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics.

Frequency	50 Hz± 5%
Nominal system voltages	33 KV 11 KV

Maximum system voltages	33KV System 11 KV System	36.3 KV 12 KV
Nominal short circuit level (Basing on apparent power)	33KV System 11 KV System	31.5KA 13.1KA
Insulation levels : 1.2/50 μ sec impulse withstand voltage	33KV System 11 KV System	170KV (peak) 75 KV (peak)
Power frequency one minute withstand (wet and dry) voltage	33KV System 11 KV System	70KV (rms) 28KV (rms)
Neutral earthing arrangements	11 KV System	Solidly earthed

19. CODES & STANDARDS

19.1 (i) The design, material, fabrication, manufacture, inspection, testing before dispatch and performance of power transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

19.2 The equipment and materials covered by this specification shall conform to the latest applicable provision of the following standards.

IS:5	Colour for ready mixed paints
IS:325	Three Phase Induction Motors
IS:335	New insulating oil for transformers, switch gears
IS:1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services
IS:2026(Part I to IV)	Power Transformer
IS:2071	Method of high voltage testing
IS:2099	High voltage porcelain bushings
IS:2147	Degree of protection
IS:2705	Current Transformers
IS:3202	Code of practice for climate proofing of electrical equipment
IS:3347	Dimensions for porcelain Transformer Bushings
IS:3637	Gas operated relays
IS:3639	Fittings and accessories for power Transformers
IS:5561	Electric Power Connectors
IS:6600/BS:CP“10:0	Guide for loading of oil immersed Transformers
IS:8468	On Load Tape changer
IS:13947	LV Switchgear & Control gear-Part:1
IS:6272	Industrial cooling fans.
IS:16227(Part 1 & 2) 2016	Current Transformer
IS:4201	Application guide for Current Transformer
IS:3034	High velocity water spray system.
IS:1239	Heavy seamless Carbon steel pipe.
IS:14846	Sluice/Gate valve.
IS:10028	Code of practice for selection, installation and maintenance of transformers, Part I. II and III
C.B.I.P. Publication	Manual on Transformers

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item.

The equipment complying other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

19.3 DRAWINGS

- a) The contractor shall furnish, within fifteen days after issuing of Letter of Award. Six copies each of the following drawings/documents incorporating the transformer rating for approval.
 - i) Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimensions, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for un-tanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and L.V terminals and ground, quantity of insulating oil etc.
 - ii) Assembly drawings of core and winging and weights of main components / parts
 - iii) Foundation plan showing loading on each wheel land jacking points with respect to centre line of transformer.
 - iv) GA drawings details of bushing and terminal connectors.
 - v) Name plate drawing with terminal marking and connection diagrams.
 - vi) Wheel locking arrangement drawing.
 - vii) Transportation dimensions drawings.
 - Viii) Magnetization characteristic curves of PS class neutral and phase side current transformers, if applicable.
 - ix) Interconnection diagrams.
 - x) Over fluxing withstand time characteristic of transformer.
 - xi) GA drawing of marshalling box.
 - xii) Control scheme/wiring diagram of marshalling box.
 - xiii) Technical leaflets of major components and fittings.
 - xiiiv) As built drawings of schematics, wiring diagram etc.
 - xv) Setting of oil temperature indicator, winding temperature indicator.
 - xvi) Completed technical data sheets. xvii) Details including write-up of tap changing gear.
 - xviii) HV and LV bushing.
 - xix) Bushing Assembly.
 - xx) Bi-metallic connector suitable for connection to 100 mm² up to 232 mm² AAAC Conductor.
 - xxi) GA of LV cable Box.
 - xxii) Radiator type assembly.
- b) All drawings, documents, technical data sheets and test certificates, results calculations shall be furnished.

19.4 Any approval given to the detailed drawings by the Employer's shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the employer shall be general with overall responsibility with contractor.

20. GENERAL CONSTRUCTIONAL FEATURES

- 20.1** All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.
- 20.2** Similar parts particularly removable ones shall be interchangeable.
- 20.3** Pipes and pipe fittings, screws, studs, nuts and bolts used for external connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.
- 20.4** Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washer or locknuts.
- 20.5** Exposed parts shall not have pockets where water can collect.
- 20.6** Internal design of transformer shall ensure that air is not trapped in any location.
- 20.7** Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated
- 20.8** Labels, indelibly marked, shall be provided for all identifiable accessories like Relays, switches current transformers etc. All label plates shall be of in corrodible material.
- 20.9** All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified stands without injury.
- 20.10** Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
- 20.11** No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
- 20.12** Schematic Drawing of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

21. Painting

- 21.1** All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following:
- a) Proper storage to avoid exposure as well as extremes of temperature.
 - b) Surface preparation prior to painting.
 - c) Mixing and thinning
 - d) Application of paints and the recommended limit on time intervals between coats.
 - e) Shelf life for storage.
- 21.2** All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 21.3** All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of Employer.
- 21.4** The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

21.5 Cleaning and Surface Preparation

- 21.6** After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.
- 21.7** Steel surfaces shall be prepared by Sand/Shot blast cleaning or Chemical cleaning by Seven tank process including Phosphating to the appropriate quality.
- 21.8** The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting. 6.13.2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.
- 21.9** Protective Coating As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

22. Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- i) Heat resistant paint (Hot oil proof) for inside surface.
- ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of POLYURETHANE . The color of the finishing coats shall be dark admiral grey conforming to No.632 or IS 5:1961.

23. Painting Procedure

- 23.1** All painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All paints in any one particular system. Whether shop or site applied, shall originate from one paint manufacturer.
- 23.2** Particular attention shall be paid to the manufacture's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.
- 23.3** All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.
- 23.4** Where the quality of film is impaired by excess film thickness,(wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25% . In all instances, where two or more coats of the same paints are specified, such coatings may or may not be of contrasting colors.
- 23.5** Paint applied to items that are not be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

24. Damages to Paints Work

- 24.1** Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.
- 24.2** Any damaged paint work shall be made as follows:

- a) The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.
- b) A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

24.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

25. Dry Film Thickness

25.1 To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be same color.

25.2 Each coat of paint shall allowed to hardened before the next is applied as per manufacture"s recommendations.

25.3 Particular attention must be paid to full film thickness at edges.

25.4 The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

Sl.No	Paint Type	Area to be painted	No of Coats	Total Dry film thickness(Min)
1	Liquid paint			
	a) Zinc Chromate(Primer)	Out side	02	45 micron
	b) POLYURETHANE Paint (Finish Coat)	Out side	02	35 micron
	c) Hot Oil paint	Inside	01	35 micron

26. DETAILED DESCRIPTION

26.1 Tank

26.2 The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the shall be of welded construction.

26.3 Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filed with oil. Suitable lugs and bossed shall be provided for this purpose.

26.4 All breams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.

26.5 The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760mm of Hg.

26.6 Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.

26.7 Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness. All gaskets shall be closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange type connections of the various oil compartments, shall be laid in grooves or in groove-equivalent sections on bolt sides of the gasket, throughout their total length. Care shall be taken to secure uniformly distributed mechanical strength over the gaskets and retains throughout the total length. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.

26.8 Suitable guides shall be provided for positioning the various parts during assemble or

dismantling.

Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

- 26.9** (a) The main tank body excluding tap changing compartments and radiators shall be capable of withstanding a vacuum of **100.64 kN/m²** (760 mm of Hg.).
- f) The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding on plates or rails in any direction without injury.
 - g) Suitable guides shall be provided in the tank for positioning the core and coil assembly.
 - h) All Control cabinets and marshaling kiosks being supplied as transformer accessories, except OLTC. Remote control panel shall be preferably mounted on the transformer body. No cabinet or marshaling kiosk shall be mounted on radiators.
 - i) Top of the tank cover shall be sloped towards HV side by approximately upto 10° to prevent retention of rainwater.
 - j) The thermometer pockets shall be fitted with captive screwed top to prevent the ingress of water.
 - k) The thermometer pockets shall be located in the position of maximum oil temperature at continuous and it shall be possible to remove the instrument bulbs without lowering the oil in the tank.
 - l) Inspection covers (Manhole) shall be rectangular in shape and flanged adequately. The tank cover and the inspection covers (Manhole) shall be provided with suitable lifting arrangements. Inspection covers (Manhole) shall not weigh more than 25 Kg each. Sufficient size of Inspection covers (Manhole) shall be provided for inspection of core and winding. Overall design shall be in such a way that there shall not be any hindrance / overlapping of some other component in front of the Inspection covers (Manhole).
 - m) Tank to be design for oil filling under vacuum.
 - n) Core, frame and tank earthing links shall be provided on tank top with the help of epoxy housing and shorted with links in normal operating condition.

27.1 Tank Cover

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitable sloped so that it does not retain rain water.

28. UNDER CARRIAGE

- 28.1** The transformer tank filled with oil shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of roller with transformer shall be space accordingly, rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication.

29. CORE

- 29.1** Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- 29.2** The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better(Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not be more than 1.69 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s)_ and different thickness (s) are not allowed to be used in any manner or under any circumstances.

CRGO steel for core shall be purchased only from the approved vendors, list of which is available at [http:// apps.powergridindia.com/ims/componentlist/Power-former%20upto20420%20kV-CM%20List.pdf](http://apps.powergridindia.com/ims/componentlist/Power-former%20upto20420%20kV-CM%20List.pdf)

- 29.3** The bidder should offer the core for inspection starting from the destination port to enable Employer for deputing inspecting officers for detail verification as given below and approval by the Employer during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following

documents as applicable as a proof towards use of prime core material: The core coils, if found suitable, are to be sealed with proper seals which shall be opened in presence of the inspecting officers during core-cutting at the manufacturer's or its sub-vendor's premises as per approved design drawing.

- a) Purchase Order No. & Date.
- b) Invoice of the supplier
- c) Mills test certificate
- d) Packing list
- e) Bill of lading
- f) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through any agent.

Please refer to "Checklist for inspection of prime quality CRGO for Transformers" attached at Annexure-A. It is mandatory to follow the procedure given in this annexure.

- 29.4** The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.
- 29.5** The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 V DC voltage for one minute.
- 29.6** The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assemble shall not deviate from the vertical plane by more than 25mm.
- 29.7** All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
- 29.8** The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
- 29.9** The core clamping structure shall be designed to minimize eddy current loss.
- 29.10** The framework and clamping arrangements shall be securely earthed.
- 29.11** The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- 29.12** Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.
- 29.13** The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.
- 29.14** The construction is to be of boltless core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assemble shall be so fixed in the tank that shifting will not occur during transport or short circuits.
- 29.15** The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procurement to be mutually agreed) or by calculation.

30. INTERNAL EARTHING

- 30.1** All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.

- 30.2** The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more the following methods:
- a) By connection through vertical tie-rods to the top structure.
 - b) By direct metal to metal contact with the tank base.
 - c) By a connection to the structure on the same side of the core as the main earth connection to the tank.
- 30.3** The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.
- 30.4** Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connections.
- 31. WINDING**
- 31.1** Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service. 7.6.2 All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.
- 31.2** Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.
- 31.3** Materials used in the insulation and assembly of the windings shall be insoluble, non catalytic and chemically inactive in the hot transformer oil and shall not soften or the otherwise affected under the operating conditions.
- 31.4** Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.
- 31.5** Winding and connections shall be braced to withstand shocks during transport or short circuit.
- 31.6** Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil steel bolts, if used, shall be suitably treated.
- 31.7** Terminals of all windings shall be brought out of the tank through bushings for external connections.
- 31.8** The completed core and coil assemble shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.
- 31.9** The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.
- 31.10** Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.

- 31.11** Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.
- 31.12** The insulation of winding shall be designed to withstand voltage stress arising from surge in transmission lines due to atmospheric or transient conditions caused by switching etc.

31.13 Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.

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31.14 Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to BILL of LV winding.

32. INSULATING OIL

32.1 The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.

32.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. transformer shall supplied complete with all fittings, accessories and new transformer oil required for first filling plus 10% extra oil. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.

32.3 The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

32.4 The contractor shall warrant that oil furnished is in accordance with the following specifications.

S.No.	Characteristic	Requirement	Method of Test
1	Appearance	Appearance & transparent & free From Suspended matter or sediment	A representative sample of oil shall be examined in a 100 mm thick layer at ambient temp.
2	Density at 20°C	0.89 g/cm ³ Max.	IS:1448
3	Kinematic Viscosity at 27 deg. C Max	27 CST	IS:1448
4	Interfacial tension at 27 °C Min.	0.03 N/m	IS:6104
5	Flash Point	136 °C	IS:1448
6	Flash Point	72.5 KV	IS:1448
7	Neutralisation Value (Total Acidity) Max	0.03 mg KOH/gm	IS:335
8	Electric strength Breakdown (voltage) Min.	72.5 KV	IS:6792
9	Dielectric dissipation factor tan delta at 90°C	0.03 Max	IS:6262
10	Min specific resistance (resistively) at 90°C	35X10 ¹² ohm cm (min.)	IS:6103
11	Oxidation stability		
12	Neutralization value after oxidation	0.40mg KOH/g	
13	Total sludge after oxidation	0.10% by weight max.	
14	Presence of oxidation Inhibitor	The oil shall not contain anti-oxidant Additives.	IS:335

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15	Presence of oxidation Inhibitor	The oil shall not contain anti-oxidant Additives	IS:335
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33. VALVES

- i) Valves shall be of forged carbon steel upto 50mm size and of gun metal or of cast iron bodies with metal fittings for sizes above 50mm. They shall be of full way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.
- ii) Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.
- iii) All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements, Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required the contractor shall supply the same.
- iv) Each transformer shall be provided with following valves on the tank:
- a) Drain valve so located as to completely drain the tank & to be provided with locking arrangement.
 - b) Two filter valves on diagonally opposite corners of 50mm size & to be provided with locking arrangement.
 - c) Oil sampling valves not less than 8mm at top and bottom of main tank & to be provided with locking arrangement.
 - d) One 15mm air release plug.
 - e) Valves between radiators and tank. Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

34. ACCESSORIES**34.1 Bushing**

- i) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
- ii) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.

- iii) Bushing shall be designed and tested to comply with the applicable standards.
- iv) Bushing rated for 400A and above shall have non-ferrous flanges and hardware.
- v) Fittings made of steel or malleable iron shall be galvanized.
- vi) Bushing shall be so located on the transformers that full flashover strength will be utilized.
- Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.
- vii) All applicable routine and type tests certificates of the bushings shall be furnished for approval.
- viii) Bushing shall be supplied with bi-metallic terminal connector/ clamp/ washers suitable for fixing to bushing terminal and the Employers specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550 C over an ambient of 500 C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
- ix) Bushing of identical voltage rating shall be interchangeable.
- x) The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltage winding.
- xi) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.
- xii) The extended bushing bus bars shall be used for termination of 11 KV cables. LV busing shall be housed in completely sealed metallic enclosure.
- xiii) Sheet steel, weather, vermin and dust proof cable box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate 11 KV cables etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55 or better. To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust. All incoming cables shall enter the kiosk from the bottom and the minimum 4mm thick, non-magnetic, gland plate shall not be less than 600 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench – **for those transformers which are used in partly indoor substation,**

34.2 Protection & Measuring Devices

i) Oil Conservator Tank

- a) The Conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment.
- b) The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.
- c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.
- d) Plain conservator fitted with silica gel breather.
- e) Conservator should be volumetric capacity of at least 10 % of total volume of oil in the tank. Moreover the oil in conservator up to the minimum level mark on the oil level gauge should be at least 3 % of the total volume of oil in the transformer excluding oil in the OLTC. Conservator having a capacity between the highest and the lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from the minimum ambient temperature i.e. -5°C to 98°C .
- f) Flexible rubber bag (Air cell) should be provided inside of conservator tank for oil preservation system. Air cell material shall be special type of fabric coated with special grade nitrile rubber whose outer surface is oil resistant and inner surface is ozone resistant. It shall be possible to remove or replace the Air cell if required.
- g) Conservator shall be bolted into position so that it can be removed for easy cleaning and other maintenance work. Main pipe from tank shall be projected about 20 mm above conservator bottom for creating a sump for collection of impurities. Minimum oil level in conservator corresponding to minimum temperature shall be well above the sump level.
- h) Conservator shall be supported at minimum two points to Main tank.
- i) Conservator shall be mounted in such a way that the top cover of the transformer can be lifted without disturbing the conservator.
- j) Following fittings and accessories shall be provided on Main tank conservator:
 - i) Prismatic oil gauge with three position Normal, Minimum and Maximum marking.
 - ii) End cover.
 - iii) Oil feeling hole with cap.
 - iv) Magnetic Oil gauge with LOW LEVEL alarm.
 - v) Silica Gel Dehydrating Breather with oil seal and filter. Container and oil cup should be polycarbonate single piece clearly transparent cover and resistant to UV rays.
 - vi) Drain cum filling valve (Gate valve with locking rod and position indicator, made of Brass 25 mm with cover plate.
 - vii) Shut off valve (Gate valve) with position indicator made of Brass 80 mm located before and after Buchholz relay.
 - viii) Flange for Breather connection.
 - ix) Air release valve on conservator made of Brass 25 mm with cover plate.
- k) Breather body should be Aluminum pressure die cast, shot blasted and powder coated. Container and oil cup should be 143R grade UV resistant polycarbonate. All gaskets should be of nitrile cork (RC 70C) rubber. Breather should be flanged type. Breather piping shall not have any valve placed in between conservator and breather. Breather shall be removable type mounted at suitable height from ground level. Breather shall be tested for 0.35 kg/cm for all joints. Silica Gel used in breather should be 2.5 mm diameter ROUND BALL type and should be bio-degradable, non-carcinogenic.

ii) Pressure Relief Device.

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contact shall be provided for alarm and tripping.

iii) Buchholz Relay

A double float type Buchholz relay shall be provided., Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent potential free contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

iv) Temperature Indicator

a) Oil Temperature Indicator (OTI)

The transformers shall be provided with a mercury contact type thermometer with 150 mm dial for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be $\pm 1\%$ or better. One No electrical contact capable of operating at 5 A ac at 230 volt supply.

b) Winding Temperature indicator(WTI)

A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following.

i) Temperature sensing element.

ii) Image Coil.

iii) Mercury contacts.

iv) Auxiliary CTS, If required to match the image coil, shall be furnished and mounted in the local control panel.

v) 150mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, one for high winding temperature alarm and on for trip.

vi) Calibration device.

- vii) Two number electrical contact each capable of operating at 5 A ac at 230 Volt supply.

7.9.3 Oil Preservation Equipment

7.9.3.1 Oil Sealing

The oil preservation shall be diaphragm type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

- i) Passage of air is through a dust filter & Silica gel.
- ii) Silica gel is isolate from atmosphere by an oil seal.
- iii) Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
- iv) Breather is mounted not more than 1400 mm above rail top level.

34.3 MARSHALLING BOX

- i) Sheet steel, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55 or better.
- ii) The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a prospone sheet.
- iii) The marshalling box shall accommodate the following equipment:
 - a) Temperature indicators.
 - b) Space for accommodating Control & Protection equipment in future for the cooling fan (for ONAF type cooling, may be provided in future).
 - c) Terminal blocks and gland plates for incoming and outgoing cables.

All the above equipments except c) shall be mounted on panels and back of panel wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door (s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet above ground level.

- iv) To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater

shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

- v) 450 All incoming cables shall enter the kiosk from the bottom and the gland plate shall not be less than mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

34.4 On Load Tap Changer:

General Requirement:

External to tank or ~~In-tank type~~ OLTC accepted.

Each transformer shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load.

- a) **Type:** External to tank or ~~In-tank type~~ OLTC, Mineral oil / ~~ester filled or vacuum type~~ OLTC as per requirement.
- b) **On line Filter Unit:** On line filter unit shall be required for Mineral oil filled OLTC. On line filter shall be capable to remove both carbon and moisture content from oil.
- c) **OLTC Location:** External to tank type OLTC- Side mounted on conservator side not in front of HV bushing and OLTC gear shall be covered with protective gear shaft around it.
- d) **Operation of OLTC gear :** The tapping shall be controlled by a high speed resistor transition type gear in which tap change is carried out virtually under „No volt“ “ No ampere” condition. The selector switches do not make and break any current, main current is never interrupted and a resistor is provided to limit the arcing at diverted contacts to minimum suitable for outdoor mounting and continuously rated for operating at all positions including position in the middle of tap change.

Selection of Local / Remote operation of OLTC gear is by selector switch on OLTC drive mechanism.

Local operation from OLTC drives mechanism through pistol grip rotary switch as well as emergency mechanical hand operation.

Remote operation from Digital RTCC provided by MSEDCL or SCADA depending on the selection of control on Digital RTCC panel.

Safety interlocks: Following minimum safety interlocks to be provided in OLTC:

- 1) Positive completion of tap changing step once initiated.
 - 2) Blocking of reverse tap change command during a forward tap change already in progress until the mechanism resets and vice-versa.
 - 3) Cutting of electrical circuits during mechanical operation.
 - 4) Mechanical stop to prevent overrunning of the mechanism at the end taps.
 - 5) Raise / Lower command in OLTC and Digital RTCC shall be positively interlocked.
- e) OLTC gear shall be motor operated suitable for local as well as remote operation. An external hand wheel/ handle shall be provided for local manual operation. This hand wheel/ handle shall be easily operable by a man standing at ground level.
 - f) Arrangement shall be made for securing and padlocking the tap changer wheel in any of the working positions and it shall not be possible for setting or padlocking the wheel in any

intermediate position. The arrangement shall be such that no padlock key can be inserted unless all contacts are correctly engaged and switch set in a position where no open or short circuit is possible. An indicating device shall be provided to show the tapin use.

- g) The details of the method of diversion of the load current during tap changing, the mechanical construction of the gear and the control features for OLTC gear along with detailed drawings on the inner view and the arrangement of connections, shall be submitted with the bid. Information regarding the service experience on the gear and a list of important users shall be furnished. The tap changer shall change the effective transformation ratio without producing phase displacement.
- h) The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer.
- i) **Tapings :** The transformers with on load taps shall have taps ranging from +5% to -15% in 16 equal steps of 1.25% each on HV winding (17 position) for HV variation for constant voltage on LV side. The transformer shall be capable of being operated without danger on any tapping at the rated 20 MVA with voltage variation of $\pm 10\%$ corresponding to the voltage of that tapping. 9ap, + 3.6 to -7.2 @ 1.2.+5.4 to -10.8 @1.8.
- j) In-tank vacuum type OLTC shall be connected through 630 Amp vacuum bottle.
- k) **OLTC features :**
 OLTC mechanism and associated controls shall be housed in an outdoor with IP 55, weatherproof, vermin proof and dust proof cabinet.
 It shall be ensured that oil in compartments containing contacts making and breaking current and Main transformer tank should not mix.
 The hand cranking arrangement shall be such that it can be operated at standing height from ground level.
- l) **Bill of Material for OLTC mechanism :** Drive Mechanism shall be of MA 9 with stainless steel enclosure.
- 1) Control circuit transformer 433/55,0-55 V, adequate capacity.
 - 2) Local / Remote selector switch 1 phase, 2 way, 6 Amp, Pistol grip.
 - 3) Retaining switch Raise / Lower.
 - 4) Handle interlock switch.
 - 5) Raise / Lower switch 1 phase, 2 way, 6 Amp, Pistol grip.
 - 6) Lower limit switch.
 - 7) Raise limit switch.
 - 8) Tap Changer Motor 433 V AC, 3 phase, adequate rating.
 - 9) Motor protection relay with single phasing preventer.
 - 10) Motor control contactors Raise / Lower.
 - 11) Stepping relay.
 - 12) Out of step switch.
 - 13) Tap position indicator.
 - 14) Operation counter.
 - 15) Emergency stop Push Button.
 - 16) Pressure relief valve and Oil surge relay should be provided to OLTC.
 - 17) Drive Mechanism box shall be either Stainless steel 314 or better or Aluminum pressure diecasted only.
 - 18) OLTC timer scheme to trip MPCB for continuous tap operation.
 - 19) Potential free contacts for OLTC supply Healthy, OLTC control supply Healthy, Tap change in progress and OLTC timer trip.
 - 20) All disconnecting type terminals shall be of POLYAMIDE stud type and screwdriver operated minimum 8 mm width.
 - 21) Drive Mechanism accessories :
 - a) Cubicle lamp with door switch and separate fuse / MCB with external ON /OFF switch on front of cover of OLTC drive mechanism.
 - b) Approved space heaters controlled by thermostat and separate fuse / MCB.
 - c) Incoming Fuse / MCB for incoming supply.

- d) Panel wiring diagram fixed on back of panel door Aluminum engraved plate fixed with rivet.
 - e) Nylon 66 Terminal block minimum 4 sq. mm screw type with 10 % spare terminals.
 - f) Stainless steel door handle with lock and additional facility for padlock.
 - g) Earthing boss.
- m) Separate conservator should be there for OLTC. Main tank conservator should not be used for OLTC.
 - n) The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.
 - o) The Contractor shall indicate the safeguards in order to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under over-load conditions of the transformer. Necessary tools and tackles shall be provided along with main supply for maintenance of OLTC gear.
 - p) The OLTC oil chamber shall have oil filling and drain plug, oil sampling valve, relief vent and level glass. It shall also be fitted with an oil surge relay the outlet to which shall be connected to separate conservator tank.
 - q) The diverter switch or arcing switch shall be so designed as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment.
 - r) Drive mechanism chamber shall be mounted on the tank in accessible position. It should be adequately ventilated and provided with anti condensation metal clad heaters. All contractors, relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.
 - s) The control feature shall provide the following Equipment for local and remote electrical and local manual operation shall be provided and shall comply with the following conditions:
 - 1) Local-remote selector switch mounted in the local control cubicle (tap change driving unit) shall switch control of OLTC for lower/raise functions in local or remote mode as selected.
 - 2) The LOCAL-REMOTE selector switch shall have at least two spare contacts per position which are closed in that position but open in the other position.
 - 3) A RAISE-LOWER CONTROL SWITCH shall be provided in the Local Control Cubicle. The switch shall be spring loaded to return to the Centre „OFF“ position and shall require movement to the RIGHT to raise the voltage of the transformer. Movement to the left shall lower the voltage. Alternatively push button type arrangement of standard design may be provided. This switch shall be operative only when 'local remote', selector switch is in „local“ position.
 - 4) An OFF-ON tap changer control switch shall be provided in the OLTC local control cabinet for transformer. The tap changer shall be inoperative in the OFF position. Also the OFF-ON switch shall have at least one spare contact per position which is closed in that position but open in the other position.
 - 5) Operating mechanism for on load tap changer shall be designed to go through one step or tap change per command. Subsequent tap changes shall be initiated only by a new or repeat command.
 - 6) On load tap changer shall be equipped with a time delay in-complete STEP alarm consisting of a normally open contact which closes, if the tap changer fails to make a complete tap change. The alarm shall not operate for momentary loss of auxiliary power.
 - 7) The selsyn units or approved equivalents shall be installed in the local OLTC control cabinet to provide tap position indication for the transformer. Complete mounting details shall be included with approved diagram.
 - 8) Transformer load tap changer shall be equipped with a fixed resistor network capable of providing discrete voltage steps for input to the supervisory system.
 - 9) Limit switches shall be provided to prevent overrunning of the mechanism and in addition, a technical stop shall be provided to prevent over-running of the mechanism under any condition.

- 10) Limit switches may be connected in the control circuit of the operating motor provided that a mechanical-de-clutching mechanism is incorporated.
- 11) Thermal device or other means shall be provided to protect the motor and control circuit. All relays switches, fuses etc. shall be mounted in the drive mechanism chamber and shall be clearly marked for the purpose of identification. They shall withstand the vibrations associated with tap changer gear operation.
- 12) A permanently legible lubrication chart shall be fitted within the driving mechanism chamber.
- 13) Any 'DROP DOWN' tank associated with the tap changing apparatus shall be fitted with guide rod to control the movements during lifting or lowering.
- 14) The guide rods shall be so designed as to take support of the associated tank when in the fully lowered position with oil. Lifting gear fitted to „DROP DOWN“ tanks shall include suitable device to prevent run- away during lifting and lowering operations. They shall be provided with adequate breathing arrangement.
- 15) If specified the tap changer shall be mounted in such a way that the cover of the transformer can be lifted without removing connections between windings and tap changer.
- 16) A five digit counter shall be fitted to the tap changing equipment to indicate the number of operations completed. Suitable apparatus shall be provided for each transformer to give indications as follows. To give an indication at the remote control point that a tap change is in progress by means of an illuminated lamp.
- 17) All relays and operating devices shall operate correctly at any voltage between the limits specified.
- 18) It shall not be possible to operate the electric drive when the manual operating gear is in use. It shall not be possible for any two controls to be in operation at the same time.
- 19) The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position. This switch shall be provided in addition to any other switch/switches which may be required for remote tap position
- 20) Operation from the local or remote control switch shall cause one tap movement only until the control switch is returned to the off position between successive operations.
- 21) All electrical control switches and the local operating gear shall be clearly labeled in a suitable manner to indicate the direction of tap changing.
- 22) Transfer of source failure of one AC supply shall not affect tap changing operation.
- 23) The equipment shall be so arranged as to ensure that when a tap change has been commenced it shall be completed independently of the operation of the control relays or switches. If a failure of the auxiliary supply during a tap change or any other contingency such as tap changer getting stuck would result in that movement not being completed, adequate means shall be provided to safeguard the transformer and its auxiliary equipment. The tap changing switches and mechanism shall be mounted in oil tanks or compartments mounted in an accessible position on the transformer tank.
 Any enclosed compartment not oil filled shall be adequately ventilated, metal clad thermostatically controlled heaters shall be provided in the driving mechanism chamber and in the marshalling box, all contactors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi, etc.
 The tap changer contacts which are not used for making or breaking current like separate selector switch contacts can be located inside main transformer tank where tap changer construction permits such an arrangement. On load tap changers having separate compartment for selector contacts, the oil in such compartment shall be maintained under conservator head by means of pipe connection from the highest point of the chamber to the conservator. Such connection shall be controlled by suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate surge relay may be provided for this compartment.
 It shall not be possible for the oil in these compartments of the tap change equipment, which contain contacts used for making or breaking current, to mix with the oil in the compartments containing contacts not used for making or braking current

34.5 Manual Control :

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing on ground level.

The mechanism shall be complete with the following:

- 1) Mechanical tap position indicator which shall be clearly visible to the person operating tap changer manually at the transformer.
- 2) A mechanical operation counter.
- 3) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.
- 4) The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor start-up during manual operation. The manual operating mechanism shall be labeled to show the direction of operation for raising the voltage and vice versa.

34.6 Electrical Control :

This includes the following:

- 1) Local Electrical control
- 2) Electrical remote control from remote control panel. The control circuits shall have the following features:
 - a) An interlock to cut off electrical control automatically upon recourse being taken to the manual control in emergency
 - b) Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated to the next (higher or lower) tap.
 - c) Step-by-step Operation ensuring only one tap change from each tap changing impulse and a lock-out of the mechanism if the control switch (or push button) remains in the "operate" position
 - d) An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.
 - e) An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change and until the mechanism comes to rest and resets circuits for a fresh position.
 - f) Tap change in progress by means of an indicating lamp at the remote panel. Necessary contacts for this and for remote tap position indicator at remote panel shall be provided by the Contractor.
 - g) Protection apparatus, considered essential by the Contractor according to specialties.
 - h) Remote Electrical Group Control.

The OLTC control scheme offered shall have provision of remote electrical group control during parallel operation of transformers. This is in addition to independent control of OLTC.

- i) A four position selector switch having MASTER, Follower, Independent and OFF position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in Master, Follower or Independent mode.
- ii) Out of step relays with timer contacts shall also be provided to give alarm and indication in case of tap positions in all the transformers under group control being not in same position. An out-of-step device shall be provided for each transformer which shall be arranged to prevent further tap changing when transformers in a group operating in „Parallel control“ are one tap out-of-step.
- iii) Master Position: -
If the selector switch is in MASTER position, it shall be possible to control the OLTC units in the FOLLOWER mode by operating the controls of the MASTER unit Independent operation of the units under FOLLOWER mode shall have to be prevented.
However, the units under independent mode will be controlled independently
- iv) Follower Position:
If the selector switch is in FOLLOWER mode, control of OLTC shall be possible only from MASTER panel
- v) Independent Position: In this position of Selector Switch, Control of OLTC of individual unit only shall be possible.
- vi) An out of step device shall be provided for each transformer which shall be arranged prevent

further tap changing when transformers in a group operating in parallel control are one tap out of step.

34.7 Tapping method :

- a) The switch position no.1 shall correspond to the maximum plus tap.
- b) The primary winding shall be connected delta and secondary winding star as per vector group Dyn 11 (IS 2026 latest version.) so as to produce a positive displacement of 30 deg. from the primary to the secondary vector of the same phase (vector rotation assumed counter clockwise).
- c) The neutral point of the secondary winding shall be solidly earthed and should be brought out to separate insulated terminal through an earthing current transformer for an earth leakage relay to be connected whenever required.

34.7.1 Local OLTC Control Cabinet :

The auxiliary devices for electrical control of the OLTC shall be housed in a weatherproof cabinet. It shall be complete with the following:

- a) A circuit breaker / contactor with thermal overload devices for controlling the AC auxiliary supply to the OLTC motor.
- b) Cubicle light with door switch.
- c) Space heaters to prevent condensation of moisture
- d) Padlocking arrangement for hinged door of cabinet.
- e) Cable terminal glands for power and control cables to the OLTC gear.

34.7.2 Remote Tap Changer Control (RTCC) Panel :

- A) The auxiliary devices for remote electrical control of the OLTC and Cooler shall be housed in a separate panel to be placed in the Control room. The panel shall be made of sheet steel of thickness not less than **14 SWG** and it shall be duly finished with Stoved Enamel paint. The size and color of the control cubicle to be supplied by the supplier shall be **750 mm** depth and **2312 mm** height and Olive Green (shade no.220, IS : 5) respectively. The width of the cubicle may be as per the suppliers practice. The cabinet sealing system shall have a degree of protection not less than IP-42.

The Control and signal devices required to be mounted in the RTCC Panel shall comprise of the following :

- a) Relays in the control circuit for the operation of the transformers in parallel.
- b) Remote Tap position indicator.
- c) (i) Tap changer in progress.
(ii) Tap changer out of step.
- d) Lamps (white) showing healthy auxiliary supply from 240/110 Volts Center point earthing transformer.
- e) Time delay contactors 1-5 Seconds with 5 Amps. Contacts for tripping when a follower fails to go into steps with the master together with indication.
- f) Oil temperature alarm with suitable cancellation device.
- g) Winding Temperature alarm with suitable cancellation device for 20 MVA Transformer.
- h) Signaling apparatus for out-of-step alarm.
- i) Time delay contactors 1-5 Seconds for tripping due to incorrect coupling in.
- j) Master position (out of step tripping). The desired time delay for tripping will be to 50 Seconds.
- k) Remote Push Button for Lower & Raise Tap.
- l) Alarm cancellation Push Button.
- m) Tap Changer Supply Isolating Switch.
- n) Sequence Selector Switch.
- o) Out of Step Alarm with Cancellation Push Button.
- p) Panel Strip Heater with Switch.
- q) Panel Lamp with Door Switch.
- r) Surge relay trip.
- s) Upper limit & lower limit reached.
- t) Two spare windows.

- u) Buchholz relay alarm.
- v) Buchholz relay trip.
- w) Pressure relief device trip.
- x) MOLG low oil level alarm.

B) Terminal Block (for RTCC Panel and Cooler Control Cabinet) :

- 1) **The terminal block shall be stud type.** The terminal blocks should be as per **IEC 60947/7-1. The insulating material should be polyamide and all the metal parts should be non ferrous.** The screws should be captive and terminal be shock protected. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.
- 2) All internal wiring to be connected to the external equipment shall be terminated on terminal blocks, preferably **vertically mounted** on the side of each panel. The terminal blocks shall be **1100 V grade and have 10 amps continuous rating**, molded piece, complete with insulated barriers, **non-disconnecting stud type terminals**, washers, nuts and lock nuts. Terminal block design shall include a white fiber-marking strip with clear plastic, slip-on/clip-on terminal cover. Markings on the terminal strips shall correspond to wire number and terminal numbers on the wiring diagrams.
- 3) Terminal blocks for current transformer secondary leads shall be provided with test links and isolating facilities. Also current transformer secondary leads shall be provided with short-circuiting and earthing facilities.
- 4) At least 20% spare terminals shall be provided on each cubicle and these spare terminals shall be uniformly distributed on all terminal blocks.
- 5) Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side.
 - a) For all circuits except current transformer circuits: minimum of two nos. of 2.5mm² copper.
 - b) For all CT circuits: minimum two nos. of 4 mm² copper.
- 6) There shall be a minimum edge to edge clearance of 250 mm between the first row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be minimum 150 mm.
- 7) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run parallel and in close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the owner's external cable connection. All adjacent terminal blocks shall also share this field wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450 mm intervals for support of incoming cables.

34.7.3 OLTC and Diverter chamber Conservator tank :-

- a) Conservator should be volumetric capacity of at least 10 % of total volume of oil in the OLTC tank. Moreover the oil in conservator up to the minimum level mark on the oil level gauge should be at least 3 % of the total volume of oil in the OLTC. Conservator having a capacity between the highest and the lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from the minimum ambient temperature i.e. -5 Deg. C to 98 Deg. C. Conservator for OLTC and Diverter chamber shall be single with partition inside and with clear visible indication for both OLTC and Diverter chamber.
- b) Flexible rubber bag (Air cell) should be provided inside of conservator tank for oil preservation system. Air cell material shall be special type of fabric coated with special grade nitrile rubber which outer surface is oil resistant and inner surface is ozone resistant. It shall be possible to remove or replace the Air cell if required.
- c) Conservator shall be bolted into position so that it can be removed for easy cleaning and other maintenance work. Main pipe from tank shall be projected about 20 mm above conservator bottom for creating a sump for collection of impurities. Conservator minimum oil level corresponding to minimum temperature shall be well above the sum level.

- d) Conservator shall be supported at minimum two points to OLTC tank.
- e) Conservator shall be mounted in such a way that the OLTC can be inspected / maintained without disturbing the conservator.
- f) Following fittings and accessories shall be provided on OLTC tank conservator:
 - i) Prismatic oil gauge with three position Normal, Minimum and Maximum marking.
 - ii) End cover.
 - iii) Oil feeling hole with cap.
 - iv) Magnetic Oil gauge with LOW LEVEL alarm
 - v) Silica Gel Dehydrating Breather with oil seal and filter . Container and oil cup should be polycarbonate single piece clearly transparent cover and resistant to UV rays
 - vi) Drain cum filling valve (Gate valve with locking rod and position indicator, made of Brass 25 mm with cover plate.
 - vii) Shut off valve (Gate valve) with position indicator made of Brass 80 mm located before and after OLTC Bucchohz relay.
 - viii) Flange for Breather connection.
 - ix) Air release valve on conservator made of Brass 25 mm with cover plate.
- g) Breather body should be Aluminum pressure die cast, shot blasted and powder coated. Container and oil cup should be 143R grade UV resistant polycarbonate. All gaskets should be of nitrile cork (RC 70C) rubber. Breather should be flanged type . Breather piping shall not any valve placed in between conservator and breather. Breather shall be removable type mounted at suitable height from ground level. Breather shall be tested for 0.35 kg / cm for all joints. Silica Gel used in breather should be 2.5 mm diameter ROUND BALL type and should be bio-degradable , non- carcinogenic.

34.7.4 Oil :

A) Insulation Oil :

As per annexure – I attached.

The quantity of transformer oil excluding OLTC shall not be less than 6700 Ltrs for 20 MVA Transformer. One sample of oil drawn from every lot of Power Transformer offered for inspection should be tested at NABL accredited lab for tests as listed under Table-1 of IS : 1866(2000). The cost of this testing should be included within the cost of Power Transformer.

34.7.5 FITTINGS AND ACCESSORIES

The following fittings and accessories shall be provided on the transformers:

- i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.
- ii) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.
- iii) Prismatic/ toughened glass oil level gauge.
- iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.
- v) A double float type Buchholz relay with isolating valve. Bleeding pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation). A 5mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired upto transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
- vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.
- vii) Air release plugs in the top cover.
- viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.
- ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have two set of contacts to operate at different settings :
 - a) To provide winding temperature high alarm
 - b) To provide temperature too high trip
- x) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.
- xi) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.
- xii) Jacking pads
- xiii) Haulage lugs.
- xiv) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.
- xv) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
- xvi) Top and bottom sampling valves.
- xvii) Drain valve with pad locking arrangement
- xviii) Rating and connection diagram plate.
- xix) Two numbers tank earthing terminals with associated nuts and bolts for connections to Employer's grounding strip.

- xx) Marshalling Box (MB)
- xxi) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxii) Cooling Accessories :
 - a) Requisite number of radiators provided with :-
 - One shut off valve on top
 - One shut off valve at bottom
 - Air release device on top
 - Drain and sampling device at bottom
 - Lifting lugs.
 - b) Air release device and oil drain plug on oil pipe connectors:
- xxiii) Terminal marking plates for Current Transformer and Main Transformer
- xxiv) Off- Load Tap Changer
- xxv) Oil Preservation Equipment
- xxvi) Oil Temperature indicator
- xxvii) Transformer shall be supplied with all control cable, WTI & OTI, sensing cable, glands, lugs etc (complete control).

Note :

1. The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.
2. The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

34.7.6 Radiator Arrangement:

- A) Radiators shall be so designed as to avoid pockets in which moisture may collect and shall withstand the pressure tests B. Unless the pipe work is shielded by adequate earthed metal the clearance between all pipe work and live parts shall be more than the clearance for live parts to earth. Material for radiators shall be Pressed steel or Stainless steel and thickness of material shall be 1.25 mm minimum.
 - i. Each radiator block shall have shut off valves, lifting lugs, top and bottom oil filling valves, air release plug, a drain valve (25 mm) and fitted with captive screw cap on the inlet and outlet.
 - ii. Each radiator shall be provided with:
 - a) One shut off valve at the top (80 mm size)
 - b) One shut-off valve at the bottom (80 mm size)
 - c) Air release device at the top
 - d) Drain plug at bottom
 - e) Lifting lugs.
 - f) Expansion bellows to be provided in pipes between main tank and radiator headers. Top plate of tank cover shall be easily removable at site hence radiator header pipe shall not originate from top cover of transformer.
 - g) Radiator support from ground if required.
- B) Radiator accessories:
 - 2 No's of radiators with top and bottom shut-off-valves, air release plug and drain plug Fans with protective guards: Air release device The no. of radiators/fins and heat dissipation calculation to justify the no. of radiators shall be submitted along with the offer.

34.7.7 CONTROL CONNECTIONS AND INSTRUMENT AND WIRING TERMINAL BOARD AND FUSES

- i) Normally no fuses shall be used anywhere instead of fuses MCB's (both in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.
- ii) All wiring connections, terminal boards, fuses MCB's and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.
- iii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.
- iv) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.
- v) When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue wires shall be followed.
- vi) All box wiring shall be in accordance with relevant ISS. All wiring shall be of stranded copper (48 strands) of 1100 Volt grade and size not less than 2.5 sq.mm
- vii) All wires on panels and all multi-core cables shall have ferrules, for easy identifications, which bear the same number at both ends, as indicated in the relevant drawing.
- viii) At those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.
- ix) The same ferrule number shall not be used on wires in different circuits on the same panels.
- x) Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.
- xi) Stranded wires shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.
- xii) All circuits in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.
- xiii) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq. mm where strip is used, the joints shall be sweated. The copper wire shall have green coloured insulation for earth connections.
- xiv) All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
- xv) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
- xvi) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails .

- xvii) Terminal blocks shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal boards. CT terminals shall have shorting facilities. The terminals for CTs should have provision to insert banana plugs and with isolating links.
- xviii) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.
- xix) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.
- xx) To avoid condensation in the Marshalling Box, a space heater shall be provided with an MCB and thermostat.
- xxi) Suitable MV, CFL light shall be provided in the Marshalling Box for lightning purpose.

34.7.8 RADIO INTERFERENCE AND NOISE LEVEL

Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimize interference with communication circuits. Transformer noise level when energized at normal voltage and frequency shall be as per NEMA stipulations.

35. INSPECTION AND TESTING

- (i) The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the transformer. This is, however, not intended to form a comprehensive programme as it is contractor’s responsibility to draw up and carry out such a programme duly approved by the Employer.
- (ii) Transformer of each rating will be as per pre-type tested design.
- (iii) The pre-shipment checks shall also be carried out by the contractor.
- (iv) The requirements on site tests are as listed in the specifications.
- (v) Certified test report and oscillograms shall be furnished to the Employer Consultants for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the Employers evaluations of the tests without any extra charges to the Employer. Manufacturer’s Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
- (vi) The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity.

35.1 INSPECTION

Transformers not manufactured as per Type- Tested design shall be rejected.

i) Tank and Conservator

- a) Inspection of major weld.
- b) Crack detection of major strength weld seams by dye penetration test.
- c) Check correct dimensions between wheels, demonstrate turning of wheels, through 900 and further dimensional check.
- d) Leakage test of the conservator.

ii) Core

- a) Sample testing of core materials for checking specific loss, properties, magnetization characteristics and thickness.
- b) Check on the quality of varnish if used on the stampings.
- c) Check on the amount of burrs.
- d) Visual and dimensional check during assembly stage.
- e) Check on completed core for measurement of iron loss, determination of maximum flux density,
- f) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- g) High voltage DC test (2 KV for one minute) between core and clamps.

Please refer to “ Checklist for inspection of prime quality CRGO for Transformers” attached at Annexure-A. It is mandatory to follow the procedure given in this annexure

iii) Insulating Material

- a) Sample check for physical properties of materials.
- b) Check for dielectric strength
- c) Check for the reaction of hot oil on insulating materials.

iv) Winding

- a) Sample check on winding conductor for mechanical and electrical conductivity.
- b) Visual and dimensional checks on conductor for scratches, dent mark etc.
- c) Sample check on insulating paper for PH value, electric strength.
- d) Check for the bonding of the insulating paper with conductor.
- e) Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- f) Check for absence of short circuit between parallel strands.

v) Checks Before Drying Process

- a) Check condition of insulation on the conductor and between the windings.
- b) Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
- c) Check insulating distances between low voltage connections and earth and other parts.
- d) Insulating test for core earthing.

vi) Check During Drying Process

- a) Measurement and recording of temperature and drying time during vacuum treatment.
- b) Check for completeness of drying

vii) Assembled Transformer

- a) Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- b) Jacking test on the assembled Transformer.
- viii) Oil All standard tests in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.
- ix) Test Report for bought out items The contractor shall submit the test reports for all bought out / sub contracted items for approval.
 - a) Buchholz relay
 - b) Sudden pressure rise relay on Main Tank
 - c) Winding temperature indicators (for TX capacity 20 MVA)
 - d) Oil temperature indicators
 - e) Bushings
 - f) Bushing current transformers in neutral (If Provided)
 - g) Marshalling box
 - h) On Load Tap changer

- i) Any other item required to complete the works.
- j) Porcelain, bushings, bushing current transformers, wherever provided, winding coolers, control devices, insulating oil and other associated equipment shall be tested by the contractor in accordance with relevant IS . If such requirement is purchased by the contractor on a sub-contract, he shall have them tested to comply with these requirements.

35.2 FACTORY TESTS

- i) All standards routine tests in accordance IS: 2026 with dielectric tests corresponding as per latest amendments to IS: 2026 shall be carried out.
- ii) All auxiliary equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items.
- iii) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.
- iv) Following additional routine tests shall also be carried out on each transformer:
 - a) Magnetic Circuit Test Each core shall be tested for 1 minute at 2000 Volt AC
 - b) Oil leakage test on transformer

35.2.1 Type Test

35.2.1.1 The measurements and tests should be carried out in accordance with the standard specified in each case as indicated in the following table if the same tests were not conducted earlier at CPRI or any NABL accredited Laboratory on the transformers of the offered design without any cost implication and employer.

Table 6: Transformer type tests	
Type Test Standard	
Temperature Rise Test	IEC 76/IS 2026/IS660
Impulse Voltage Withstand Test, including Full Waves and Chopped Waves as listed below	IEC 76/IS 202
Noise Level Measurement	IEC 551
Short Circuit Test	IEC 76 / IS 2026

In accordance with IEC 76-3 the following sequence of impulses should have been/ should be applied;

- One full wave at 50% BIL;
- One full wave at 100% BIL;
- One chopped wave at 50% BIL
- Two chopped waves at 100% BIL and
- Two full waves at 100% BIL.

35.2.1.2 If the type test report(s) submitted by the bidder do not fulfil the criteria, as stipulated in this technical specification/ Bidder’s offer, the relevant type test(s) has/ have to be conducted by the Bidder at his own cost in CPRI/NABL accredited Laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.

35.2.1.3 The offered transformer must be manufactured as per type tested design. A copy of type test certificate must be submitted by manufacturer to Engineer/Employer. Transformers offered without type tested however design shall not be accepted. In case manufacturer agrees for type testing of transformers, testing shall be conducted on manufacturer's cost. No claim shall be acceptable towards type testing. The transformers shall be accepted only on acceptance of type testing results by employer.

35.2.1.4 The supplier shall furnish calculations in accordance with IS: 2026 to demonstrate the Thermal ability of the transformers to withstand Short Circuit forces.

35.2.1 (a) Special Test

The short circuit test shall be a mandatory test for each design shall be supplied by the manufacturer and no exception shall be allowed. The test shall be conducted as per latest standard tabled below:

Short circuit test	IEC 76/IS 2026
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Type test report for above test from CPRI shall be required.

35.2.2 STAGE INSPECTION

The supplier shall offer the core, windings and tank of each transformer for inspection by the Employer's representative(s). During stage inspection, all the measurements like diameter, window height, leg centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken / determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage inspection report by the Employer.

35.2.3 Routine Tests

Transformer routine tests shall include tests stated in latest issue of IS: 2026 (Part –1). These tests shall also include but shall not be limited to the following :

- (i) Measurement of winding DC resistance.
- (ii) Voltage ratio on each tapping and check of voltage vector relationship.
- (iii) Impedance voltage at all tapings.
- (iv) Magnetic circuit test as per relevant ISS or CBIP manual or latest standard being followed.
- (v) Measurement of Load losses at normal tap and extreme taps.
- (vi) No load losses and no load current at rated voltage and rated frequency, also at 25% to 120 % of rated voltage in steps.
- (vii) Absorption index i.e insulation resistance for 15 seconds and 60 seconds (R 60/ R 15) and polarization index i.e Insulation Resistance for 10 minutes and one minute (R 10 mt / R 1 mt).
- (viii) Induced over voltage withstand test.
- (ix) Separate source voltage withstand test.
- (x) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.
- (xi) Measurement of zero sequence impedance
- (xii) Tests on On- load tap changer (fully assembled on transformer) as per IS 2026, IS 8468.

- (xiii) Auxiliary circuit tests
- (xiv) Oil BDV tests
- (xv) Measurement of neutral unbalance current which shall not exceed 2% of the full rated current of the transformer.
- (xvi) Magnetic balance test
- (xvii) Leakage test.

Six (6) set of certified test reports and oscillographs shall be submitted for evaluation prior to dispatch of the equipment. The contractor shall also evaluate the test results and shall correct any defect indicated by his and Employers evaluation of the tests without charge to the Employer.

35.2.4 TANK TESTS

a) Oil leakage Test :

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of viscosity not greater than that of insulating oil conforming to IS : 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/ m² measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours of oil and one hour for air and during that time no leak shall occur.

b) Pressure Test

Where required by the Employer, one transformer tank of each size together with its radiator, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN / m² whichever is lower, measured at the base of the tank and maintained for one hour.

c) Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 60 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m² (25 mm of mercury) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999) without affecting the performance of the transformer.

35.2.5 PRE-SHIPMENT CHECK AT MANUFACTURERS WORKS

- i) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes and conservator etc.
- ii) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
- iii) Gas tightness test to conform tightness.

35.2.6 INSPECTION AND TESTING AT SITE

On receipt of transformer at site, shall be performed detailed inspection covering areas right from the receipt of material up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

35.2.7 Receipt and Storage Checks

- i) Check and record conditions of each package visible parts of the transformers etc for any damage.
- ii) Check and record the gas pressure in the transformer tank as well as in the gas cylinder.
- iii) Visual check of core and coils before filling up with oil and also check condition of core and winding in general.

35.2.8 Installation Checks

- i) Inspection and performance testing of accessories like tap changers etc.
- ii) Check choking of the tubes of radiators
- iii) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has been allowed to settle for 24 hours.
- iv) Check the whole assembly for tightness, general appearance etc.
- v) Oil leakage tests.

35.2.9 Pre-Commissioning Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

- i) Megger Test
- ii) Ratio test on all taps
- iii) Phase relationship test (Vector grouping test)
- iv) Buchholz relay alarm & surge operation test
- v) Temperature Indicators
- vi) Marshalling kiosk

35.2.10 The following additional checks shall be made :

- i) All oil valves are incorrect position closed or opened as required
- ii) All air pocket are cleared.
- iii) Thermometer pockets are filled with oil
- iv) Oil is at correct level in the bushing, conservator, diverter switch & tank etc.
- v) Earthing connections are made.
- vi) Colour of Silica gel is blue.
- vii) Bushing arcing horn is set correctly and gap distance is recorded.
- Viii) C T polarity and ratio is correct.

35.2.11 PERFORMANCE

The performance of the transformer shall be measured on the following aspects.

- i) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variations and $\pm 10\%$ corresponding to the voltage of the tapping
- ii) Radio interference and Noise Level
- iii) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.

35.2.12 FAULT CONDITIONS

- a) The transformer shall be capable of withstanding for two(2) seconds without damages any external short circuit to earth
- b) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS : 2026.
- c) Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140% for 5 seconds.

35.2.13 WITNESSING OF TESTS AND EXCESSIVE LOSSES

- i) The Employer reserves the right to reject the Transformer if losses exceed the maximum specified as per Clause No 2. SPECIFIC TECHNICAL REQUIREMENTS (STANDARD CONDITIONS), item-35of this specification or if temperature rise of oil and winding exceed the values specified at item -26 of the above clause.

36. LIQUIDATED DAMAGES FOR EXCESSIVE LOSSES

There is no positive tolerance on the guaranteed losses offered by the bidder. However, the transformer(s) shall be rejected out rightly, if any of the losses i.e. no load loss or load loss or both exceed (s) the guaranteed maximum permissible loss figures quoted by the bidder in the Technical Data Schedule with the bid.

37 SPARE PARTS

In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra cost to the Employer to fabricate or procure spare parts from other sources.

Mandatory Spare Parts

The suppliers shall provide the following mandatory spare s for each of Transformer supplied

1. H.V. & L.V. Bushing & Studs –Each 2 Nos
2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets

37.1 INSTRUCTION MANUAL

Eight sets of the instruction manuals shall be supplied at least four (4) weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other, the following particular:

- a) Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- b) Detailed dimensions, assembly and description of all auxiliaries.
- c) Detailed views of the core and winding assembly, winding connections and tapings tap changer construction etc. These drawings are required for carrying out overhauling operation at site.

- d) Salient technical particulars of the transformer.
- e) Copies of all final approved drawings.
- f) Detailed O&M instructions with periodical check lists and Performa etc.

37.2 COMPLETENESS OF EQUIPMENT

All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the transformer, shall be deemed to be included in the specification and shall be furnished by the supplier without extra charges. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to the Employer under any circumstances.

38.0 GUARANTEE PERIOD

- For 5 MVA/10 MVA/20 MVA or above Power Transformers:

The material will be guaranteed for a period of atleast 120 calendar months from the date of installation at the site or 126 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the "maintenance period." If the material is damaged within the guarantee period, it shall be replaced/repared by the supplier free of cost within three months of receipt of intimation.

If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 12 months. The total guarantee period will now be 132/138 months as applicable."

Both stage and final inspection of 100 percent repaired transformer will be carried out at the manufacturer's works.

In case, the repair work/replacement of transformer is not affected within six months of the abovenotice/intimation, the consignees will ensure deduction of the amount equal to the price of new transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

The outage period i.e., period from the date of failure till unit is repaired/replaced shall not be counted for arriving at the guarantee period.

In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

Further, installation of 100 percent Power Transformers (both new and repaired) shall be carried out in the supervision of manufacturer's representative.

39 COMMISSIONING

The utility will give a 10 days' notice to the supplier of transformer before commissioning. The manufacturer will depute his representative to supervise the commissioning. In case, the manufacturer fails to depute his representative, the utility will go ahead with the commissioning and under these circumstances, it would be deemed that commissioning is done as per recommendations of manufacturer.

Annexure-A

Check-list for Inspection of prime quality CRGO for Transformers

During inspection of PRIME CRGO, the following points needs to be checked by the Transformer manufacturer. Utility’s inspection shall verify all these points during inspection:-

A) In case PRIME cutting is at works of Transformer Manufacturer:

1 Review of documents:

- Purchase Order (unpriced) to PRIME CRGO supplier/ Authorized Agency
- Manufacturer’s test certificate
- Invoice of the Supplier
- Packing list
- Bill of Lading
- Bill of Entry Certificate by Customs Deptt.
- Reconciliation Statement as per format below
- Certificate of Origin
- BIS Certificate

Format for Reconciliation/Traceability records

Packing List No. / Date /Quantity of PRIME CRGO received

Name of Manufacturer

Manufacturer test certificate No. / date

Serial No.	Details of Package/Job	Drawing Reference	Quantity involved	Cumulative Quantity Consumed	Balance in Stock
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2.1 Inspection of PRIME CRGO Coils:

- a) PRIME CRGO-Manufacturer’s identification Slip on PRIME CRGO Coils
- b) Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
- c) Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
- d) ISI logo Sticker on packed mother coil and ISI logo in Material TC.

2.2 During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report Would Be issued after this inspection

3 Inspection of PRIME CRGO laminations: Transformer manufacturer will maintain records for traceability of lamination to PRIME CRGO coils and burr/bow on lamination shall be measured.

4. Inspection at the time of core building:

Visual Inspection of PRIME CRGO lamination. In case of suspected mix-up/ rusting/ decoloration, Samples may be taken for testing on surveillance basis mentioned in A.2.2 above.

Above tests shall be witnessed by utility. In case testing facilities are not available at Manufacturer’s work, the sample(s) sealed by utility to be sent to approved labs for testing.

Inspection Clearance Report would be issued after this inspection

B) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

1 Review of documents:

- Purchase Order (unpriced) to PRIME CRGO supplier/ Authorized Agency
- Purchase Order (unpriced) to Core Cutter
- Manufacturer test certificate
- Invoice of the Supplier
- Packing List
- Bill of Lading
- Bill Of Entry Certificate by Customs Deptt.
- Reconciliation Statement as per format below
- Certificate of Origin
- BIS Certificate

Format for Traceability records as below:-

Packing List No./date/quantity of PRIME CRGO received

Name of Manufacturer

Manufacturer test certificate No. / date

Serial No.	Name Of Customer	Details of Package/Job	Drawing Reference	Quantity involved	Cumulative Quantity Consumed	Balance in Stock	Dispatch Details
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2.1 Inspection of PRIME CRGO Coils:

- a) PRIME CRGO-Manufacturer's identification Slip on PRIME CRGO Coils
- b) Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
- c) Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
- d) ISI logo Sticker on packed mother coil and ISI logo in Material TC.

2.2 During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla, Thickness depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/IEC standard, Tech.Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations:

Transformer manufacturer representative will inspect laminations and issue their internal Inspection Clearance Report. Inspection will comprise of review of traceability to prime CRGO coils, visual Inspection of PRIME CRGO laminations and record of burr/bow. After clearance given by the transformer manufacturer, utility will issue an Inspection Clearance Report after record review. If so desired by Utility, their representative may also join transformer manufacturer representative during this inspection.

Inspection Clearance Report would be issued after this inspection

4 Inspection at the time of core building

Visual inspection of PRIME CRGO laminations. In case of suspected mix-up/rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in B.2.2.

Inspection Clearance Report would be issued after this inspection

NOTE:-

- a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.
- b) Transformer Manufacturer should also involve themselves for ensuring the quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

C) General

If a surveillance sample is drawn and sent to TPL (if testing facility not available with the manufacturer), the transformer manufacturer can continue manufacturing

at their own risk and cost pending TPL test report on PRIME CRGO sample drawn. Decision for acceptance of PRIME CRGO shall be based upon report of sample drawn.

These checks shall be read in –conjunction with approved quality plan, specification as a whole and conditions of contract.

Sampling Plan (PRIME CRGO)

33/11 kV -1st transformer and subsequently at random 10% of Transformers (min.1) offered for inspection.

DTs and other ratings -1st transformer and subsequently at random 10% of Transformers (min.1) offered for inspection.

NOTE:- One sample for each lot of CRGO shall be drawn on surveillance basis.

CRGO has to be procured only from POWERGRID approved vendors. List of such vendors is available at the following website. Since the list is dynamic in nature, the site may be checked from time to time to see the list of approved vendors.

<http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf>

SL. NO	ITEM	VENDOR NAME
1	CRGO STEEL	M/S NIPPON STEEL & SUMITOMO METAL CORP, JAPAN
	CRGO STEEL	M/S KAWASAKI CORPORATION/JFE,JAPAN
	CRGO STEEL	M/S A.K.STEEL, USA
	CRGO STEEL	M/S POSCO KOREA
	CRGO STEEL	M/S AST ITALY
	CRGO STEEL	M/S TKES GERMANY
	CRGO STEEL	M/S UGINE DIVISION DUSINOR SACLAR, S.A., FRANCE
	CRGO STEEL	M/S ORB ELECTRICALS STEELS, UK
	CRGO STEEL	M/S PREUSSAG HANDEL, GERMANY
	CRGO STEEL	M/S ACESITA, BRAZIL
	CRGO STEEL	M/S VIZ STEEL, RUSSIA valid upto 05.02.2018
	CRGO STEEL WITH FINAL PROCESS OF COATING & ANNEALING OF SEMIPROCESSED CRGO MOTHER COIL (SOURCED FROM TKES, GERMANY)	M/S TKES INDIA PVT. LTD. NASIK, (approval valid up to 20.08.2016) and subject to condition

TECHNICAL SPECIFICATION FOR NITROGEN INJECTION FIRE PROTECTION SYSTEM

1 Scope:-

Nitrogen injection Fire Protection System (NIFPS) shall use nitrogen as fire quenching medium. The protective system shall prevent Transformer/Reactor's oil tank explosion and possible fire in case of internal faults. In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipments etc, it shall act as fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water and/or carbon dioxide. Fire shall be extinguished within 3 minutes (Maximum) of system activation and within 30 seconds (Maximum) of commencement of nitrogen injection.

2 System Particulars:-

2.1	Nominal System Voltage	:	33 kV	11kV
2.2	Voltage variation on supply side	:	$\pm 10 \%$	
2.3	Corresponding Highest System Voltage	:	36 kV	12kV
2.4	Frequency	:	50 Hz with $\pm 3 \%$ tolerance	
2.5	Transient condition	:	-20 % or + 10 % combined variation of voltage and frequency.	

3. Applicable Standards:

The design and installation of the complete fire protection system shall comply with the latest applicable Indian Standards. Wherever Indian Standards are not available relevant British/I.E.C. codes shall be followed. The following standards /codes shall be followed in particular.

- a) Approval certificate from Loss Prevention Association.
- b) National fire Codes 1993 of National Fire protection Association (NFPA) USA.

The entire fire protection system shall be designed, erected and commissioned in accordance with the regulation of Tariff Advisory Committee (TAC). In absence of TAC regulations NFPA regulation shall be adhered to.

4. Activation of the Fire Protective System:

Mal-functioning of fire prevention/extinguishing system could lead to interruption in power supply. The supplier shall ensure that the probability of chances of malfunctioning of the fire protective system is particularly Zero. To achieve this objective, the supplier shall [plan out his scheme of activating signals which should not be complicated to make the fire protective system inoperative in case of actual need. The system shall be provided with automatic control for fire prevention fire extinction. Besides

automatic control, remote electrical push button control at control box and local manual control in the fire extinguishing cubicle shall also be provided. The following electrical signals shall be required for activating the fire protective system under prevention mode /fire extinction mode.

- **Auto mode :**

- For prevention of fire :

- Differential relay operation.
 - Buchholz relay paralleled with pressure relief valve or RPRR(Rapid pressure RiseRelay).
 - Tripping of all circuit breakers (On HV& LV side) associated with transformer

/reactor is the pre-requisite for activation of system.

- For extinguishing fire :

i) Fire detector.

ii) Buchholz relay paralleled with pressure relief valve(PRV) or Sudden PressureRelay (SPR).

iii) Tripping of all circuit breakers (On HV& LV side) associated with transformer /reactor is the pre-requisite for activation of system.

- **Manual Mode (Local/Remote) :**

Tripping of all circuit breakers (On HV & LV side) associated with transformer/reactor is the pre –requisite for activation of system.

- **Manual Mode (Mechanical) :**

Tripping of all circuit breakers (On HV & LV side) associated with transformer/reactor is the pre –requisite for activation of system.

The system shall be designed to be operated manually in case of failure of power supply to fire protection system.

5.0 General description:

Nitrogen injection fire protection system should be a dedicated system for each oil filled transformer/reactor .It should have a Fire Extinguishing Cubicle (FEC) placed on a plinth at a suitable distance away from transformer/reactor. The FEC shall be connected to the top of transformer reactor oil tank for depressurization of tank and to the oil pit (capacity is approximately equal to 10 %of total volume of oil in transformer/reactor tank) from its bottom

through oil pipes. The fire extinguishing cubicle should housed a pressurized nitrogen cylinder(s) which is connected to the oil tank of transformer/reactor oil tank at bottom. The Transformer Conservator Isolation Valve (TCIV) is fitted between the conservator tank and Buchholz relay.

Cable connections are to be provided from signal box to the control box in the control room, from control box to the extinguishing cubicle and from TCIV to the signal box. Fire detectors placed on the top of transformer/reactor tank are to be connected in parallel to the signal box by Fire survival cables. Control box is also to be connected to relay panel in control room for receiving system activation signals.

6.0 Operation:

On receipt of all activating signals ,the system shall drain pre-determined volume of hot oil from the top of tank(i.e top oil layer),through outlet valve, to reduce tank pressure by removing top oil and simultaneously injecting nitrogen gas at high pressure for stirring the oil at pre-fixed rate and thus bringing the temperature of top oil layer down. Transformer conservator isolation valve blocks the flow of oil from conservator tank in the case of tank rupture / explosion or bushing bursting. Nitrogen occupies the space created by oil drained out and acts as an insulating layer over oil in the tank and thus preventing aggravation of fire.

7.0 System components :

Nitrogen injection fire protection system shall broadly consist of the following components. However, all other components which are necessary for fast reliable and effective working of the fire protective system shall deemed to be included in the scope of the supply.

a) Fire Extinguishing Cubicle (FEC) :

The FEC shall be made of CRCA sheet of 3 mm (minimum) thick complete with the base frame, painted inside and outside with post office red color (shade 538 of IS -5). It shall have hinged split doors fitted with high quality tamper proof lock. The degree of protection shall be IP55. The following items shall be provided in the FEC.

- a) Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer.
- b) Oil drain pipe with mechanical quick drain valve.
- c) Control equipment for draining of oil of pre-determined volume and injecting regulated volume of nitrogen gas.
- d) Pressure monitoring switch for back-up protection for nitrogen release.
- e) Limit switches for monitoring of the system.
- f) Butterfly valve with flanges on the top of panel for connecting oil drain pipe and nitrogen injection pipes for transformer/reactors.
- g) Panel lighting (CFL Type).
- h) Oil drainpipe extension of suitable sizes for connecting pipes to oil pit.

b) Control box :

Control box is to be placed in the control room for monitoring system operation, automatic control and remote operation. The following alarms, indications, switches, push buttons, audio signal etc. shall be provided.

- a) System on
- b) TCIV open
- c) Oil drain valve closed
- d) Gas inlet valve closed
- e) TCIV closed*
- f) Fire detector trip*
- g) Buchholz relay trip
- h) Oil drain valve open*
- i) Extinction in progress*

- j) Cylinder pressure low*
- k) Differential relay trip
- l) PRV / SPR trip
- m) Transformer/reactor trip
- n) System out of service *
- o) Fault in cable connecting fault fire detector
- p) Fault in cable connecting differential relay
- q) Fault in cable connecting Buchholz relay
- r) Fault in cable connecting PRV / SPR
- s) Fault in cable connecting Transformer / reactor trip.
- t) Fault in cable connecting TCIV
- u) Auto/ Manual/ Off
- v) Extinction release on/off
- w) Lamp test
- x) Visual/ Audio alarm*
- y) Visual/ Audio alarm for DC supply fall*

* Suitable provision shall be made in the control box , for monitoring of the system from remote substation using the substation automation system.

c) Transformer Conservator Isolation Valve :

Transformer conservator isolation valve(TCIV) to be fitted in the conservator pipe line, between conservator and Buchholz relay which shall operate for isolating the conservator during abnormal flow of oil due to rupture / explosion of tank or bursting of bushing. The valve shall not isolate conservator during normal flow of oil during filtration or filling or refilling, locking plates to be provided with handle for pad locking. It shall have proximity switch for remote alarm, indication with visual position indicator.

The TCIV should be of the best quality as malfunctioning of TCIV could lead to serious consequence. The closing of TCIV means stoppage of breathing of transformer / reactor. Locking plates shall be provided for pad locking.

d) Fire detectors :

The system shall be complete with adequate number of fire detectors (quartz bulb) fitted on the top cover of the transformer / reactor oil tank.

e) Signal box :

It shall be mounted away from transformer / reactor main tank, preferably near the transformer marshaling box, for terminating cable connections from TCIV & fire detectors and for further connection to the control box. The degree of protection shall be IP55.

f) Cables :

Fire survival cables (capable to withstand 750 deg. C) of 4 core x 1.5 sq. mm size for connection of fire detectors in parallel shall be used. The fire survival cable shall conform to BS 7629-1, BS 8434-1, BS 7629-1 and BS 5839-1, BS EN 50267-2-1 or relevant Indian standards.

Fire Retardant Low Smoke(FRLS) cable of 12 core x 1.5 sq. mm size shall be used for connection of signal box / marshaling box near transformer / reactor and FEC mounted near transformer / reactor with control box mounted in control room.

Fire Retardant Low Smoke(FRLS) cable of 4 core x 1.5 sq. mm size shall be used for connection between control box to DC and AC supply source, fire extinguishing cubicle to AC supply source, signal box / marshaling to transformer conservator isolation valve connection on transformer.

g) Pipes :

Pipes complete with connections, flanges, bends and tees etc. shall be supplied along with the system. Pipes and welding shall be sufficiently passivated and environment protected.

8. Others Items :

- a) Oil drain and nitrogen injection openings with gate valves on transformer / reactor tank at suitable locations.
- b) Flanges with dummy piece in conservator pipe between Buchholz relay and conservator tank for fixing TCIV.
- c) Fire detector brackets on transformer / reactor tank top cover.
- d) Spare potential free contacts for activating the system i.e differential relay, Buchholz relay, Pressure relief device /RPRR, circuit breaker of transformer / reactor.
- e) Pipe connections between transformer / reactor and FEC and between FEC and oil pit required for collection top oil.
- f) Cabling for fire detectors mounted on transformer / reactor top cover.
- g) Inter cabling between signal box , control box and Fire Extinguishing Cubicle(FEC).
All external cables from / to the system i.e signal box to control box and control box to FEC shall be provided by the purchaser. All internal cables within the system i.e between detectors /signal box /marshaling box/FEC/TCIV shall be in the scope of NIFPS supplier .
- h) Butterfly valves / Gate valves on oil drain pipe and nitrogen injection pipe which should be able to withstand full vacuum.
- i) Supports valves, signal box etc. which are to be painted with enameled paint.

9.0 Technical Particulars :

Sr. No.	Particulars	Details
1.	Fire extinction period from commencement of Nitrogen Injection	30 Sec(Max)
2.	Fire extinction period from the moment of system activation.	3 minutes.(Max)
3.	Fire detectors heat sensing temperature	Vendor to specify
4.	Heat sensing area per detector	Vendor to specify
5.	Transformer conservator isolation valve setting-min	Vendor to specify
6.	Capacity of nitrogen cylinder	Vendor to specify
7.	Power supply	
	a) For control	30/110 DC, variation -15%,+10 %
	b) For service/lighting	250 V AC , Variation +/- 10 %

The doors, removable covers and panels shall be gasketed all round with neoprene gaskets.

10.0 Mandatory Spares :

- i. Cylinder filled with Nitrogen of required capacity per substation :- 1.No.
- ii. Fire detectors per transformer :- 3 No.
- iii. Regulator assembly per substation :- 1 No.

11.0 Tests :

Reports of all type tests conducted as per relevant IS/IEC standards in respect of various bought out items including test reports for degree of protection for FEC/control box/signal box shall be submitted by the supplier.

The supplier should demonstrate the functional test associated with the following

- 11.1.1 Fire extinguishing cubicle, control box.
- 11.1.2 Fire detector.
- 11.1.3 Transformer Conservator Isolation Valve.

The performance test of the complete system shall be carried out after erection of the system with transformer at site.

12.0 Documentation:

- 12.1.1 To be submitted along with offer : General outline of the system.

Detailed write-up on operation of the offered protection system including maintenance and testing aspects / schedules.

Technical Data Particulars (GTP).

Data regarding previous supplies, date of commissioning, performance feedback etc.

- 12.1.2 To be submitted after award of contract :

Detailed dimensional layout drawing of the system with complete bill of materials, clearances from ground and other live points, details of detectors ,equipment layout, drawings ,detailed drawings pertaining to signal box, control box, FEC equipment, wiring and schemes,4 sets of testing, commissioning, Operation and Maintenance manual along with soft copies (in CDs) shall be submitted by supplier.

GUARANTEED TECHNICAL PARTICULARS (NIFPS)

NOTE: This schedule of guaranteed technical particulars for Nitrogen Fire Protection System is to be submitted by the Bidder. It may be carefully noted that filling / reply of each and every clause described below is must.

S. No.	Description	Details to be filled in by the Bidder
1	Name of Manufacture and country of origin	
2	Reference standards	
3	Details of system equipments	
4	Fire Extinguishing Cubicle (FEC)	
4.1	Dimensions (LXBXH) mm	
4.2	Weight	
4.3	Capacity of Nitrogen cylinder	
4.4	Number of cylinders	
4.5	Pressure of Nitrogen filing	
4.6	Minimum distance of FE cubicle from the transformer	
4.7	Method of mounting	
4.8	Whether the following items are provided in FE cubicle. If so furnish make, type & other details.	
4.9	Contact manometer	
4.10	Pressure Regulator	
4.11	Oil Release Unit make and suitable to operate without power	
4.12	Gas release unit make and suitable to operate without power	
4.13	Oil drain assembly	
4.14	Pressure monitoring switch as backup for nitrogen release	
4.15	Limit switches with No of contacts & spare contacts (NO&NC)	
4.16	Oil drain valve (above FEC)	
4.17	Make	
4.18	Type	
4.19	Size	
4.20	Type of metal	
4.21	Nitrogen Injection Valve (above FEC)	
4.22	Make	
4.23	Type	
4.24	Size	
4.25	Oil drain pipe	
4.26	Size	
4.27	Length	
4.28	Number of openings in the transformer tank	
4.29	Material	
5	Control Box	
5.1	Dimensions (LXBXH) mm	
5.2	Weight	
5.3	Type & Thickness of sheet steel	
5.4	Details of components provided in the control box	

S. No.	Description	Details to be filled in by the Bidder
5.5	Control voltage	
5.6	Method of mounting	
5.7	Whether audio and visual alarms provided?	
6	Transformer Conservator Isolation Valve	
6.1	Make	
6.2	Type	
6.3	Location	
6.4	Whether suitable for pipe of size 80mm dia	
6.5	No of contacts & spare contacts (NO&NC)	
6.6	Padlocking provision for service , filtration/refilling/filling	
6.7	Visual position indicator for inspection	
7	Fire Detectors	
7.1	Make	
7.2	Type	
7.3	Quantity required	
7.4	Method of fixing	
7.5	Heat sensing temperature	
7.6	Number of contacts NO/NC	
7.7	Necessity and Condition of Refilling	
8	Whether approved by Tariff Advisory Committee of India	
9	Power Supply	
9.1	Control box	
9.2	FEC (lighting)	
10	Extinction period	
10.1	On commencement of Nitrogen injection	
10.2	On system activation	
11	FEC suitable for capacity	
11.1	Dimensions (LXBXH) mm	
11.2	Weight	
11.3	Nitrogen cylinder capacity	
12	Control Box	
12.1	Dimensions (LXBXH) mm	
12.2	Weight	
13	Any other technical details not covered above	

2 SCOPE

- 2.1 This specification is provided for information for design, engineering, manufacture, assembly, stage inspection, final inspection and testing before dispatch, packing and delivery at destination stores by road transport, transit insurance of 3.15/5/6.3/8/10/12.5 MVA, 33/11 KV Power Transformer(s), complete with all fittings, accessories, associated equipment's, spares, 10% extra Transformer Oil, required for its

satisfactory operation in any of the sub-stations of the purchaser.

- 2.2 The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade of BIS certified with lamination thickness not more than 0.23mm to 0.27mm or better (Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that it should under 10% overvoltage condition should not be more than 1.9 Tesla. The supplier shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.
- 2.3 The scope of supply includes the provision of type test. The equipment offered should have been successfully type tested within five years from date of tender and the designs should have been in satisfactory operation for a period not less than three years as on the date of order. Compliance shall be demonstrated by submitting, (i) authenticated copies of the type test reports and (ii) performance certificates from the users, specifically from Central Govt./State Govt. or their undertakings.
- 2.4 The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the employer shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The Employer reserves the right to reject the transformers if on testing the losses exceed the declared losses beyond tolerance limit as per IS or the temperature rise in oil and / or winding exceeds the value, specified in technical particular or impedance value differ from the

guaranteed value including tolerance as per this specification and if any of the test results do not match with the values, given in the guaranteed technical particulars and as per technical specification.

3 SPECIFIC TECHNICAL REQUIREMENTS

1	Rated MVA (ONAN rating)		3.15/5/6.3/8/10/12.5MVA
2	No. of phases		3
3	Type of installation		Outdoor
4	Frequency		50 Hz ($\pm 5\%$)
5	Cooling medium		Insulating Oil (ONAN)
6	Type of mounting		On Wheels, Mounted on rails.
7	Rated voltage		
	a) High voltage winding		33KV
	b) Low voltage winding		11KV
8	Highest continuous system voltage		
	a) Maximum system voltage ratio (HV / LV)		36KV / 12 KV
	b) Rated voltage ratio (HV / LV)		33KV /11 KV
9	No. of windings		Two winding Transformers
10	Type of cooling		ONAN (Oil natural / Air natural)
11	MVA Rating corresponding to ONAN Cooling system		100%
	Method of connection:		
12	HV	:	Delta
	LV	:	Star
13	Connection symbol		Dyn 11
14	System earthing		Neutral of LV side to be solidly earthed.
15	Intended regular cyclic overloading of windings	of	As per IEC –76-1, Clause 4.2
16	a) Anticipated unbalanced loading		Around 10%
	b) Anticipated continuous loading of windings (HV / LV)	of	110 % of rated current

17	a) Type of tap changer	(For 3.15, 5, 6.3, 8, 10 & 12.5 MVA only)		
	b) Range of taping	On or Off load tap changer as per BOQ		
		+ 5% to – 15% in 9 equal steps of 2.5% each for Off-load tap and in 17 equal steps of 1.25% each for On-load tap changer on HV winding		
18	Neutral terminals to be brought out	On LV side only		
19	Over Voltage operating capability and duration	112.5 % of rated voltage (Cont.)		
20	Maximum Flux Density in any part of the core and yoke at rated MVA with +12.5% combined voltage and frequency variation from rated voltage and frequency.	1.9 Tesla		
21	Insulation levels for windings: -	33kV	11kV	
	a) 1.2 / 50 microsecond wave shape Impulse withstand (KVP)	170	75	
	b) Power frequency voltage withstand (KVrms)	70	28	
22	Type of winding insulation			
	a) HV winding	Uniform		
	b) LV winding	Uniform		
23	Withstand time for three phase short circuit	2 Seconds		
24	Noise level at rated voltage and frequency	As per NEMA Publication No. TR-1.		
	Permissible Temperature rise over ambient temperature shall be as per IS-2026*			
	* Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091 Dated 25.08.2017.			
25	Minimum clearances in air (mm) :-	Phase to Phase	Phase to Ground	
	a) HV	400	320	
	b) LV	280	140	
26	Terminals			

a. HV winding line end 36 KV oil filled communicating type porcelain bushings

(Anti-fog type)

b. LV winding 12 KV porcelain type of bushing (Anti-fog type) – for outdoor 11 KV breakers

(11KV Power cables shall be used for extending supply to 11KV breakers in case of indoor circuit breakers. The termination of 11 KV cables on LV bushing shall be through extended copper bus bars suitable to hold power cables termination. A metallic cable termination box, completely sealed, shall be installed on LV side of the transformer in which cables shall enter from bottom gland plates.)

27 Insulation level of bushing

	LV	HV
a) Lightning Impulse withstand (KVP)	170	75
b) 1 Minute Power Frequency withstand voltage (KV –rms)	70	28
c) Creepage distance (mm) (minimum)	900	300

28 Material of HV & LV Conductor Electrolytic Copper

29 Maximum current density for HV and LV winding for rated current As per best practice

30 Polarization index

(HV to LV, HV to Earth & LV to earth)

IR Test = 1 minute value/ 15 secs. value will not be less than 1.5

IR Test = 10 minutes value / 1 minute value will not be more than 5 and less than 1.5

31 Core Assembly Boltless type

32 Temperature Indicator

a. Oil One number

b. Winding One number

35. **Losses:** - The losses shall not exceed the value given below

MVA Rating	No-load losses (Fixed loss) KW	Load losses at 75°C KW	Percentage impedance voltage on normal tap and MVA base at 75° C
3.15	3	16	7.15
5	4	23	7.15
6.3	4.6	36	7.15
8	5.5	40	8.35
10	7	50	8.35
12.5	7.5	65	10

3.1 MARSHALLING BOX

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with

switch, illumination lamp with switch etc. shall be provided with each

transformer to accommodate temperature indicators, terminal blocks etc. It shall have degree of protection of IP 55 or better as per IS: 2147 (Refer Clause 3.12 of IS).

3.2 CAPITALIZATION OF LOSSES AND LIQUIDATED DAMAGES

Capitalization of losses will be as per Annexure B which is attached herewith. No (+) ve tolerance shall be allowed at any point of time, on the quoted losses after the award. In case, the losses during type testing, routine testing etc. are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

3.3 PERFORMANCE

- a. Transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit MVA available at the terminals.
- b. The maximum flux density in any part of the core and yoke at rated Voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla.
- c. Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.
- d. The transformer may be operated continuously without danger on any particular tapping at the rated MVA \pm 1.25% of the voltage corresponding to the tapping.
- e. The thermal ability to withstand short circuit shall be demonstrated by calculation.
- f. Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding.

3.4 DRAWINGS/ DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID

- a. General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.
- b. Assembly drawings of core, windings etc. and weights of main components / parts.
- c. Height of center line on HV and LV connectors of transformers from the rail top level.
- d. Dimensions of the largest part to be transported.
- e. GA drawings / details of various types of bushing
- f. Tap changing and Name Plate diagram
- g. Type test certificates of similar transformers.

h. Illustrative & descriptive literature of the Transformer.

- i. Maintenance and Operating Instructions.

3.5 MISCELLANEOUS

- i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever locking arrangement is provided.
- ii) Foundation bolts for wheel locking devices of Transformer shall be supplied by the Contractor.

3.6 DELIVERY

The full quantity of the equipments shall be delivered as per the delivery schedule appended to this specification.

3.7 SCHEDULES

All Schedules annexed to the specification shall be duly filled by the bidder separately.

3.8 ALTITUDE FACTOR

If the equipment is to be installed in the hilly area, necessary correction factors as given in the Indian Standard for oil temperature rise, insulation level etc. shall be applied to the Standard Technical Parameters given above.

3.9 NAME PLATE

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (part-I). The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription of Employer's name. The name plate shall also include (i) The short circuit rating, (ii) Measured no load current and no load losses at rated voltage and rated frequency, (iii) measured load losses at 75° C (normal tap only), (iv) D.C resistance of each winding at 75° C.

3. SERVICE CONDITIONS

The service conditions shall be as follows: (To be confirmed by PIA as per locality of project)		
	Plain area	Hilly area
Maximum altitude above sea level	1000m	5000m
Maximum ambient air temperature	50° C	50° C

Maximum daily average ambient air Temperature	35° C	40° C
Minimum ambient air temperature	-5° C	-30° C
Maximum temperature attainable by an object exposed to the sun	60 ° C	60 ° C
Maximum yearly weighted average ambient temperature	32° C	32° C
maximum relative humidity	100%	100%
average number of thunderstorm days per annum (isokeraunic level)	70	70
average number of rainy days per annum	120	120
average annual rainfall	1500 mm	1500 mm
maximum wind pressure	260Kg/m ²	260Kg/m ²

* HP, J&K, Uttarakhand, Sikkim, Assam, Meghalaya, Manipur, Nagaland, Tripura and Mizoram will be considered as Hilly Area.

Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators. Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics.

Frequency		50 Hz± 5%
Nominal system voltages		33 KV 11 KV
Maximum system voltages	33KV System	36.3 KV
	11 KV System	12 KV
Nominal short circuit level (Basing on apparent power)	33KV System	31.5KA
	11 KV System	13.1KA

Insulation levels: 1.2/50 μ sec impulse withstand voltage	33KV System	170KV (peak)
	11 KV System	75 KV (peak)
Power frequency one minute withstand (wet and dry) voltage	33KV System	70KV (rms)
	11 KV System	28KV (rms)
Neutral earthing arrangements	11 KV System	Solidly earthed

CODES & STANDARDS

- 4.1 The design, material, fabrication, manufacture, inspection, testing before dispatch and performance of power transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the contractor of this responsibility.
- 4.2 The equipment and materials covered by this specification shall conform to the latest applicable provision of the following standards.

IS:5	Colour for ready mixed paints
IS:325	Three Phase Induction Motors
IS:335	New insulating oil for transformers, switch gears
IS:1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services
IS:2026(Part I to IV)	Power Transformer
IS:2071	Method of high voltage testing
IS:2099	High voltage porcelain bushings
IS:2147	Degree of protection
IS:2705	Current Transformers
IS:3202	Code of practice for climate proofing of electrical equipment
IS:3347	Dimensions for porcelain Transformer Bushings

IS:3637	Gas operated relays
IS:3639	Fittings and accessories for power Transformers
IS:5561	Electric Power Connectors
IS:6600/BS: CP**10:0	Guide for loading of oil immersed Transformers
IS:10028	Code of practice for selection, installation and maintenance of transformers, Part I. II and III
C.B.I.P. Publication	Manual on Transformers

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item.

The equipment complying other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

4.3 DRAWINGS

- a) The contractor shall furnish, within fifteen days after issuing of Letter of Award. Six copies each of the following drawings/documents incorporating the transformer rating for approval.
 - i) Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimensions, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for un-tanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and L.V terminals and ground, quantity of insulating oil etc.
 - ii) Assembly drawings of core and winging and weights of main components / parts
 - iii) Foundation plan showing loading on each wheel land jacking points with respect to centre line of transformer.
 - iv) GA drawings details of bushing and terminal connectors.
 - v) Name plate drawing with terminal marking and connection diagrams.
 - vi) Wheel locking arrangement drawing.
 - vii) Transportation dimensions drawings.
 - viii) Magnetization characteristic curves of PS class neutral and phase side current transformers, if applicable.
 - ix) Interconnection diagrams.

- x) Over fluxing withstand time characteristic of transformer.
 - xi) GA drawing of marshalling box.
 - xii) Control scheme/wiring diagram of marshalling box.
 - xiii) Technical leaflets of major components and fittings.
 - xiv) As built drawings of schematics, wiring diagram etc.
 - xv) Setting of oil temperature indicator, winding temperature indicator.
 - xvi) Completed technical data sheets.
 - xvii) Details including write-up of tap changing gear.
 - xviii) HV & LV bushing.
 - xix) Bushing Assembly.
 - xx) Bi-metallic connector suitable for connection to 100 mm² up to 232 mm² AAAC Conductor.
 - xxi) GA of LV cable Box.
 - xxii) Radiator type assembly.
- b) All drawings, documents, technical data sheets and test certificates, results calculations shall be furnished.

4.4 Any approval given to the detailed drawings by the Employer's shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the employer shall be general with overall responsibility with contractor.

GENERAL CONSTRUCTIONAL FEATURES

6.1 All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.

- 6.2 Similar parts particularly removable ones shall be interchangeable.
- 6.3 Pipes and pipe fittings, screws, studs, nuts and bolts used for external connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.
- 6.4 Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washer or locknuts.
- 6.5 Exposed parts shall not have pockets where water can collect.
- 6.6 Internal design of transformer shall ensure that air is not trapped in any location.
- 6.7 Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated
- 6.8 Labels, indelibly marked, shall be provided for all identifiable accessories like Relays, switches current transformers etc. All label plates shall be of in corrodible material.
- 6.9 All internal connections and fastenings shall be capable of operating under overloads and over- excitation, allowed as per specified stands without injury.
- 6.10 Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
- 6.11 No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
- 6.12 Schematic Drawing of the wiring, including external cables shall be put under the pros pane sheet on the inside door of the transformer marshalling box.
- 6.13 Painting
 - 6.13.1 All paints shall be applied in accordance with the paint manufacturer's recommendations.

Particular attention shall be paid to the following:

 - a. Proper storage to avoid exposure as well as extremes of temperature.
 - b. Surface preparation prior to painting.
 - c. Mixing and thinning
 - d. Application of paints and the recommended limit on time intervals between coats.
 - e. Shelf life for storage.

- 6.13.1.1 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 6.13.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of Employer.
- 6.13.1.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

6.13.2 Cleaning and Surface Preparation

6.13.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

6.13.2.2 Steel surfaces shall be prepared by Sand/Shot blast cleaning or Chemical cleaning by Seven tank process including Phosphate to the appropriate quality.

6.13.2.3 The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting. 6.13.2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

6.13.3 Protective Coating As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

6.13.4 Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- a. Heat resistant paint (Hot oil proof) for inside surface.
- b. For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of POLYURETHANE. The color of the finishing coats shall be dark admiral grey conforming to No.632 or IS 5:1961.

6.13.5 Painting Procedure

6.13.5.1 All painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All

paints in any one particular system. Whether shop or site applied, shall originate from one paint manufacturer.

6.13.5.2 Particular attention shall be paid to the manufacture's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.

6.13.5.3 All prepared steel surfaces should be primed before visible rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.

6.13.5.4 Where the quality of film is impaired by excess film thickness, (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%. In all instances, where two or more coats of the same paints are specified, such coatings may or may not be of contrasting colors.

6.13.5.5 Paint applied to items that are not be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

6.13.6 Damages to Paints Work

6.13.6.1 Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.

6.13.6.2 Any damaged paint work shall be made as follows:

- a) The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.
- b) A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

6.13.6.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

6.13.7 Dry Film Thickness

6.13.7.1 To the maximum extent practicable, the coats shall be applied as a

continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be same color.

6.13.7.2 Each coat of paint shall allowed to hardened before the next is applied as per manufacture’s recommendations.

6.13.7.3 Particular attention must be paid to full film thickness at edges.

6.13.7.4 The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

Sl.No	Paint Type	Area to be painted	No of Coats	Total Dry film thickness(Min)
1	Liquid paint			
	a) Zinc Chromate(Primer)	Out side	02	45 micron
	b) POLYURET HANE Paint (Finish Coat)	Out side	02	35 micron
	c) Hot Oil paint	inside	01	35 micron

7.1 DETAILED DESCRIPTION

7.2 Tank

7.2.1 The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the shall be of welded construction.

7.2.2 Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filed with oil. Suitable lugs and bossed shall be provided for this purpose.

7.2.3 All breams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.

7.2.4 The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760mm of Hg.

7.2.5 Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals

etc.

7.2.6 Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness. All gaskets shall be closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange type connections of the various oil compartments, shall be laid in grooves or in groove- equivalent sections on bolt sides of the gasket, throughout their total length. Care shall be taken to secure uniformly distributed mechanical strength over the gaskets and retains throughout the total length. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.

7.2.7 Suitable guides shall be provided for positioning the various parts during assemble or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

7.3 Tank Cover

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitable sloped so that it does not retain rain water.

7.4 UNDER CARRIAGE

7.4.1 The transformer tank filled with oil shall be supported on steel structure with detachable plain rollers. Suitable channels for movement of roller with transformer shall be space accordingly, rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication.

7.5 CORE

7.5.1 Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.

7.5.2 The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better(Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not be more than 1.69 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s)_ and different thickness (s) are not allowed to be used in any

manner or under any circumstances.

CRGO steel for core shall be purchased only from the approved vendors,

- 7.5.3 The bidder should offer the core for inspection starting from the destination port to enable Employer for deputing inspecting officers for detail verification as given below and approval by the Employer during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material: The core coils, if found suitable, are to be sealed with proper seals which shall be opened in presence of the inspecting officers during core-cutting at the manufacturer's or its sub-vendor's premises as per approved design drawing.
- a) Purchase Order No. & Date.
 - b) Invoice of the supplier
 - c) Mills test certificate
 - d) Packing list
 - e) Bill of lading
 - f) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through any agent.

Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers**" attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

- 7.5.4 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.
- 7.5.5 The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 V DC voltage for one minute.
- 7.5.6 The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assemble shall not deviate from the vertical plane by more than 25mm.
- 7.5.7 All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
- 7.5.8 The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
- 7.5.9 The core clamping structure shall be designed to minimize eddy current loss.
- 7.5.10 The framework and clamping arrangements shall be securely earthed.

- 7.5.11 The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- 7.5.12 Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.
- 7.5.13 The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.
- 7.5.14 The construction is to be of boltless core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assemble shall be so fixed in the tank that shifting will not occur during transport or short circuits.
- 7.5.15 The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procurement to be mutually agreed) or by calculation.

7.6 INTERNAL EARTHING

- 7.6.1 All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.
- 7.6.2 The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more the following methods:
- a) By connection through vertical tie-rods to the top structure.
 - b) By direct metal to metal contact with the tank base.
 - c) By a connection to the structure on the same side of the core as the main earth connection to the tank.
- 7.6.3 The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.
- 7.6.4 Coil clamping rings of metal at earth potential shall be connected to the

adjacent core clamping structure on the same side as the main earth connections.

7.7 WINDING

- 7.7.1 Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service. 7.6.2 All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.
- 7.7.2 Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness. The conductors shall be of electrolytic grade copper free from scales and burrs. The conductor insulation shall be made from high-density (at least 0.75 gm/cc) paper having high mechanical strength. The barrier insulation including spacers shall be made from high-density pre-compressed pressboard (1.1 gm/cc minimum for load bearing and 1 to 1.3 gm/cc minimum for non-load bearing) to minimize dimensional changes.
- 7.7.3 Materials used in the insulation and assembly of the windings shall be insoluble, non catalytic and chemically inactive in the hot transformer oil and shall not soften or be otherwise affected under the operating conditions.
- 7.7.4 Winding and connections shall be braced to withstand shocks during transport or short circuit.
- 7.7.5 Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.
- 7.7.6 Terminals of all windings shall be brought out of the tank through bushings for external connections.
- 7.6.6.1 The completed core and coil assemble shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.
- 7.6.6.2 The winding shall be so designed that all coil assembles of identical

voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.

- 7.6.6.3 Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.
- 7.6.6.4 Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.
- 7.6.6.5 The insulation of winding shall be designed to withstand voltage stress arising from surge in transmission lines due to atmospheric or transient conditions caused by switching etc.
- 7.6.6.6 Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.
- 7.6.6.7 Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to BILL of LV winding.

7.7 INSULATING OIL

- 7.7.1 The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.
- 7.7.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. transformer shall supplied complete with all fittings, accessories and new transformer oil required for first filling plus 10% extra oil. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.
- 7.7.3 The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.
- 7.7.4 The oil parameters shall be as per Table-1 of IS 335.

7.8 VALVES

- i) Valves shall be of forged carbon steel upto 50mm size and of gun mental or of cast iron bodies with gun metal fittings for sizes above

50mm. They shall be of full way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

- ii) All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements, Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required the contractor shall supply the same.
- iii) Each transformer shall be provided with following valves on the tank:
 - a) Drain valve so located as to completely drain the tank & to be provided with locking arrangement.
 - b) Two filter valves on diagonally opposite corners of 50mm size & to be provided with locking arrangement.
 - c) Oil sampling valves not less than 8mm at top and bottom of main tank & to be provided with locking arrangement.
 - d) One 15mm air release plug.
 - e) Valves between radiators and tank. Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

7.9 ACCESSORIES

7.9.1 Bushing

- i) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
- ii) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
- iii) Bushing shall be designed and tested to comply with the applicable standards.
- iv) Bushing rated for 400A and above shall have non-ferrous flanges and hardware.

- v) Fittings made of steel or malleable iron shall be galvanized
- vi) Bushing shall be so located on the transformers that full flashover strength will be utilized. Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.
- vii) All applicable routine and type tests certificates of the bushings shall be furnished for approval.
- viii) Bushing shall be supplied with bi-metallic terminal connector/ clamp/ washers suitable for fixing to bushing terminal and the Employers specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550 Co ver an ambient of 500 C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
- ix) Bushing of identical voltage rating shall be interchangeable.
- x) The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltage winding.
- xi) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.
- xii) The extended bushing bus bars shall be used for termination of 11 KV cables. LV busing shall be housed in completely sealed metallic enclosure.
- xiii) Sheet steel, weather, vermin and dust proof cable box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate 11 KV cables etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshaling box. The degree of protection shall be IP-55 or better. To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust. All incoming cables shall enter the kiosk from the bottom and the minimum 4mm thick, non-magnetic, gland plate shall not be less than 600 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable

trench – **for those transformers which are used in partly indoor substation**, *If required as per BOQ, a cable box for LV bushings shall be provided.*

7.9.2 Protection & Measuring Devices

i) **Oil Conservator Tank**

- a) The Conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment.
- b) The conservator tank shall be bolted into position so that it can be remove for cleaning purposes.
- c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.
- d) Plain conservator fitted with silica gel breather.

Pressure Relief Device.

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contract shall be provided for alarm and tripping.

Buchholz Relay

A double float type Buchholz relay shall be provided. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent potential free contracts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

Temperature Indicator

a) Oil Temperature Indicator (OTI)

The transformers shall be provided with a micro switch contact type thermometer with 150 mm dial for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be $\pm 1\%$ or better. One No electrical contact capable of operating at 5 A ac at 230 volt supply.

Winding Temperature indicator (WTI)

A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following.

- i) Temperature sensing element.
- ii) Image Coil.
- iii) Micro switch contacts.
- iv) Auxiliary CTS, If required to match the image coil, shall be furnished and mounted in the local control panel.
- v) 150mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, one for high winding temperature alarm and on for trip.
- vi) Two number electrical contact each capable of operating at 5 A ac at 230 Volt supply.

7.9.3 Oil Preservation Equipment**7.9.3.1 Oil Sealing**

The oil preservation shall be diaphragm type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

- i) Passage of air is through a dust filter & Silica gel.

- ii) Silica gel is isolate from atmosphere by an oil seal.
- iii) Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
- iv) Breather is mounted not more than 1400 mm above rail top level.

7.10 MARSHALLING BOX

- i) Sheet steel, weather, vermin and dust proof marshaling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshaling box. The degree of protection shall be IP-55 or better.
- ii) The schematic diagram of the circuitry inside the marshaling box be prepared and fixed inside the door under a propone sheet.
- iii) The marshaling box shall accommodate the following equipment:
 - a) Temperature indicators.
 - b) Space for accommodating Control & Protection equipment in future for the cooling fan (for ONAF type cooling, may be provided in future).
 - c) Terminal blocks and gland plates for incoming and outgoing cables.

All the above equipment except c) shall be mounted on panels and back of panel wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door (s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet above ground level.

- iv) To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

- v) All incoming cables shall enter the kiosk from the bottom and the gland plate shall not be less than 450 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

7.11 TAPCHANGER

7.11.1 ON-LOAD TAP-CHANGERS

- i) The 3.15/5/6.3/8/10 MVA transformers shall be provided with Off-load Taps & 12.5 MVA and above rated Transformers shall be provided with On- load Taps. Specification of OLTC is attached herewith as Annexure.
- ii) The Transformer with off-load tap changing gear shall have taps ranging from +5% to -15% in 9 equal steps of 2.5% each for Off Load Tap.
- iii) The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle shall be provided with locking arrangement along with tap position indication, thus enabling the switch to be locked in position

7.12 FITTINGS AND ACCESSORIES

The following fittings and accessories shall be provided on the transformers:

- i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.
- ii) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.
- iii) Prismatic/ toughened glass oil level gauge.
- iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.
- v) A double float type Buchholz relay with isolating valve. Bleeding pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation). A 5mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas

accumulation and the other for tripping on sudden oil surge. These

contacts shall be wired upto transformer marshaling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.

- vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.
- vii) Air release plugs in the top cover.
- viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.
- ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have two set of contacts to operate at different settings :
 - a) To provide winding temperature high alarm
 - b) To provide temperature too high trip
- x) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.
- xi) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.
- xii) Jacking pads
- xiii) Haulage lugs.
- xiv) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.
- xv) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
- xvi) Top and bottom sampling valves.
- xvii) Drain valve with pad locking arrangement
- xviii) Rating and connection diagram plate.
- xix) Two numbers tank earthing terminals with associated nuts and bolts for connections to Employer's grounding strip.

- xx) Marshaling Box (MB)
- xxi) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxii) Cooling Accessories :
 - a) Requisite number of radiators provided with :-
 - One shut off valve on top
 - One shut off valve at bottom
 - Air release device on top
 - Drain and sampling device at bottom
 - Lifting lugs.
 - b) Air release device and oil drain plug on oil pipe connectors:
- xxiii) Terminal marking plates for Current Transformer and Main Transformer
- xxiv) On/Off Load Tap changer as per BOQ
- xxv) Oil Preservation Equipment
- xxvi) Oil Temperature indicator
- xxvii) Transformer shall be supplied with all control cable, WTI & OTI, sensing cable, glands, lugs etc (complete control).

Note :

1. The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.
2. The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

7.13 CONTROL CONNECTIONS AND INSTRUMENT AND WIRING TERMINAL BOARD AND FUSES

- i) Normally no fuses shall be used anywhere instead of fuses MCB's (both in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.
- ii) All wiring connections, terminal boards, fuses MCB's and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.
- iii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.
- iv) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.
- v) When 400 volt connections are taken through junction boxes or marshaling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshaling box. Proper colour code for Red, Yellow, Blue wires shall be followed.
- vi) All box wiring shall be in accordance with relevant ISS. All wiring shall be of stranded copper (48 strands) of 1100 Volt grade and size not less than 2.5 sq.mm
- vii) All wires on panels and all multi-core cables shall have ferrules, for easy identifications, which bear the same number at both ends, as indicated in the relevant drawing.
- viii) At those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.
- ix) The same ferrule number shall not be used on wires in different circuits on the same panels.
- x) Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.

- xi) Stranded wires shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.
- xii) All circuits in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.
- xiii) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq. mm where strip is used, the joints shall be sweated. The copper wire shall have green coloured insulation for earth connections.
- xiv) All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
- xv) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
- xvi) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails .
- xvii) Terminal blocks shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal boards. CT terminals shall have shorting facilities. The terminals for CTs should have provision to insert banana plugs and with isolating links.
- xviii) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshaling box is included in the scope of this specification and shall be done by the Transformer supplier.
- xix) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshaling box cover.

- xx) To avoid condensation in the Marshaling Box, a space heater shall be provided with an MCB and thermostat.
- xxi) Suitable MV, CFL light shall be provided in the Marshaling Box for lightning purpose.

7.14 RADIO INTERFERENCE AND NOISE LEVEL

Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimize interference with communication circuits. Transformer noise level when energized at normal voltage and frequency shall be as per NEMA stipulations.

8 INSPECTION AND TESTING

- (i) The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the transformer. This is, however, not intended to form a comprehensive programme as it is contractor's responsibility to draw up and carry out such a programme duly approved by the Employer.
- (ii) Transformer of each rating will be as per pre-type tested design.
- (iii) The pre-shipment checks shall also be carried out by the contractor.
- (iv) The requirements on site tests are as listed in the specifications.
- (v) Certified test report and oscillograms shall be furnished to the Employer Consultants for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the Employers evaluations of the tests without any extra charges to the Employer. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
- (vi) The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity.

8.1 INSPECTION

Transformers not manufactured as per Type- Tested design shall be rejected.

i) Tank and Conservator

- a) Inspection of major weld.
- b) Crack detection of major strength weld seams by dye penetration test.
- c) Check correct dimensions between wheels, demonstrate turning of wheels, through 900 and further dimensional check.
- d) Leakage test of the conservator.

ii) Core

- a) Sample testing of core materials for checking specific loss, properties, magnetization characteristics and thickness.
- b) Check on the quality of varnish if used on the stampings.
- c) Check on the amount of burrs.
- d) Visual and dimensional check during assembly stage.
- e) Check on completed core for measurement of iron loss, determination of maximum flux density,
- f) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- g) High voltage DC test (2 KV for one minute) between core and clamps.

Please refer to “**Check-list for Inspection of Prime quality CRGO for Transformers**” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

iii) Insulating Material

- a) Sample check for physical properties of materials.
- b) Check for dielectric strength
- c) Check for the reaction of hot oil on insulating materials.

iv) Winding

- a) Sample check on winding conductor for mechanical and electrical conductivity.
- b) Visual and dimensional checks on conductor for scratches, dent mark etc.
- c) Sample check on insulating paper for PH value, electric strength.

- d) Check for the bonding of the insulating paper with conductor.
- e) Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- f) Check for absence of short circuit between parallel strands.

v) **Checks Before Drying Process**

- a) Check condition of insulation on the conductor and between the windings.
- b) Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
- c) Check insulating distances between low voltage connections and earth and other parts.
- d) Insulating test for core earthing.

vi) **Check During Drying Process**

- a) Measurement and recording of temperature and drying time during vacuum treatment.
- b) Check for completeness of drying

vii) **Assembled Transformer**

- a) Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- b) Jacking test on the assembled Transformer.

viii) Oil All standard tests in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.

ix) Test Report for bought out items The contractor shall submit the test reports for all bought out / sub contracted items for approval.

- a) Buchholz relay
- b) Sudden pressure rise relay on Main Tank
- c) Winding temperature indicators (for TX capacity 5 MVA)
- d) Oil temperature indicators
- e) Bushings
- f) Bushing current transformers in neutral (If Provided)
- g) Marshaling box
- h) On/Off Load Tap changer as per BOQ
- i) Any other item required to complete the works.
- j) Porcelain, bushings, bushing current transformers, wherever provided, winding coolers, control devices, insulating oil and

other associated equipment shall be tested by the contractor in accordance with relevant IS . If such requirement is purchased by the contractor on a sub-contract, he shall have them tested to comply with these requirements.

8.2 FACTORY TESTS

- i) All standards routine tests in accordance IS: 2026 with dielectric tests corresponding as per latest amendments to IS: 2026 shall be carried out.
- ii) All auxiliary equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items.
- iii) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.
- iv) Following additional routine tests shall also be carried out on each transformer:
 - a) Magnetic Circuit Test Each core shall be tested for 1 minute at 2000 Volt AC
 - b) Oil leakage test on transformer

8.2.1 Type Test

8.2.1.1 The measurements and tests should be carried out in accordance with the standard specified in each case as indicated in the following table if the same tests were not conducted earlier at CPRI or any NABL accredited Laboratory on the transformers of the offered design without any cost implication on employer.

Table 6: Transformer type tests

Type Test Standard	
Temperature Rise Test	IEC 76/IS
Impulse Volt age Withstand Test, including Full	IEC 76/IS 2026
Noise Level Measurement	IEC 551

In accordance with IEC 76-3 the following sequence of impulses should have been/ should be applied;

- One full wave at 50% BIL;
- One full wave at 100% BIL;
- One chopped wave at 50% BIL
- Two chopped waves at 100% BIL and
- Two full waves at 100% BIL.

8.2.1.2 If the type test report(s) submitted by the bidder do not fulfill the

criteria, as stipulated in this technical specification/ Bidder's offer, the relevant type test(s) has/ have to be conducted by the Bidder at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.

8.2.1.3 The offered transformer must be manufactured as per type tested design. A copy of type test certificate must be submitted by manufacturer to Engineer/Employer. Transformers offered without type tested however design shall not be accepted. In case manufacturer agrees for type testing of transformers, testing shall be conducted on manufacturer's cost. No claim shall be acceptable towards type testing. The transformers shall be accepted only on acceptance of type testing results by employer.

8.2.1.4 The supplier shall furnish calculations in accordance with IS: 2026 to demonstrate the Thermal ability of the transformers to withstand Short Circuit forces.

8.2.1(A) Special Test

The short circuit test shall be a mandatory test for each design shall be supplied by the manufacturer and no exception shall be allowed. The test

Short Circuit Test	IEC 76 / IS 2026
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shall be conducted as per latest standard tabled below:

8.2.2 STAGE INSPECTION

The supplier shall offer the core, windings and tank of each transformer for inspection by the Employers representative(s). During stage Inspection, all the measurements like diameter, window height, leg Centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken / determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage Inspection report by the Employer.

8.2.3 Routine Tests

Transformer routine tests shall include tests stated in latest issue of IS: 2026 (Part –1). These tests shall also include but shall not be limited to the following :

- (i) Measurement of winding DC resistance.
- (ii) Voltage ratio on each tapping and check of voltage vector relationship.
- (iii) Impedance voltage at all tappings.
- (iv) Magnetic circuit test as per relevant ISS or CBIP manual or latest standard being followed.
- (v) Measurement of Load losses at normal tap and extreme taps.
- (vi) No load losses and no load current at rated voltage and rated frequency, also at 25% to 120 % of rated voltage in steps.
- (vii) Absorption index i.e insulation resistance for 15 seconds and 60 seconds (R 60/ R 15) and polarization index i.e Insulation Resistance for 10 minutes and one minute (R 10 mt / R 1 mt).
- (viii) Induced over voltage withstand test.
- (ix) Separate source voltage withstand test.
- (x) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.
- (xi) Measurement of zero sequence impedance
- (xii) Tests on On/Off Load Tap changer as per BOQ (fully assembled on transformer) as per IS 2026
- (xiii) Auxiliary circuit tests
- (xiv) Oil BDV tests
- (xv) Measurement of neutral unbalance current which shall not exceed 2% of the full rated current of the transformer.
- (xvi) Magnetic balance test
- (xvii) Leakage test.

Six (6) set of certified test reports and oscillographs shall be submitted for evaluation prior to dispatch of the equipment. The contractor shall also evaluate the test results and shall correct any defect indicated by his and Employers evaluation of the tests without charge to the Employer.

8.4 TANK TESTS

a) Oil leakage Test :

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of viscosity not greater than that of insulating oil conforming to IS : 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/ m² measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours of oil and one hour for air and during that time no leak shall occur.

b) Pressure Test

Where required by the Employer, one transformer tank of each size together with its radiator, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN / m² whichever is lower, measured at the base of the tank and maintained for one hour.

c) Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 60 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m² (25 mm of mercury) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999) without affecting the performance of the transformer.

8.5 PRE-SHIPMENT CHECK AT MANUFACTURERS WORKS

- i) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes and conservator etc.
- ii) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
- iii) Gas tightness test to conform tightness.

8.6 INSPECTION AND TESTING AT SITE

On receipt of transformer at site, shall be performed detailed inspection covering areas right from the receipt of material up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

8.6.1 Receipt and Storage Checks

- i) Check and record conditions of each package visible parts of the transformers etc for any damage.
- ii) Check and record the gas pressure in the transformer tank as well as in the gas cylinder.
- iii) Visual check of core and coils before filling up with oil and also check condition of core and winding in general.

8.6.2 Installation Checks

- i) Inspection and performance testing of accessories like tap changers etc.
- ii) Check choking of the tubes of radiators
- iii) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has been allowed to settle for 24 hours.
- iv) Check the whole assembly for tightness, general appearance etc.
- v) Oil leakage tests.

8.6.3 Pre-Commissioning Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

- i) Megger Test
- ii) Phase relationship test (Vector group test)
- iii) Buchholz relay alarm & surge operation test (Physical)
- iv) Ratio test on all taps
- v) Low oil level (in conservator) alarm
- vi) Temperature Indicators (Physical)

vii) Marshaling kiosk (Physical)

8.6.4 The following additional checks shall be made :

- i) All oil valves are incorrect position closed or opened as required
- ii) All air pocket are cleared.
- iii) Thermometer pockets are filled with oil
- iv) Oil is at correct level in the bushing, conservator, diverter switch & tank etc.
- v) Earthing connections are made.
- vi) Bushing arcing horn is set correctly and gap distance is recorded.
- vii) C T polarity and ratio is correct.

8.7 PERFORMANCE

The performance of the transformer shall be measured on the following aspects.

- i) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variations and $\pm 10\%$ corresponding to the voltage of the tapping
- ii) Radio interference and Noise Level
- iii) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.

8.8 FAULT CONDITIONS

- a) The transformer shall be capable of withstanding for two(2) seconds without damages any external short circuit to earth
- b) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS : 2026.
- c) Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140% for 5 seconds.

8.9 WITNESSING OF TESTS AND EXCESSIVE LOSSES

- i) The Employer reserves the right to reject the Transformer if losses exceed the maximum specified as per Clause No 2. SPECIFIC TECHNICAL REQUIREMENTS (STANDARD CONDITIONS), item-35 of this specification or if temperature rise of oil and winding exceed the values specified at item -26 of the above clause.

9 LIQUIDATED DAMAGES FOR EXCESSIVE LOSSES

There is no positive tolerance on the guaranteed losses offered by the bidder. However, the transformer(s) shall be rejected out rightly, if any of the losses i.e. no load loss or load loss or both exceed (s) the guaranteed maximum permissible loss figures quoted by the bidder in the Technical Data Schedule with the bid.

10 SPARE PARTS

In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra cost to the Employer to fabricate or procure spare parts from other sources.

Mandatory Spare Parts

The suppliers shall provide the following mandatory spare s for each of Transformer supplied

1. H.V. & L.V. Bushing & Studs –Each 2 Nos
2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets

10.1 INSTRUCTION MANUAL

Eight sets of the instruction manuals shall be supplied at least four (4) weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other, the following particular:

- a) Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- b) Detailed dimensions, assembly and description of all auxiliaries.
- c) Detailed views of the core and winding assembly, winding connections and tapings tap changer construction etc. These drawings are required

for carrying out overhauling operation at site.

- d) Salient technical particulars of the transformer.
- e) Copies of all final approved drawings.
- f) Detailed O&M instructions with periodical check lists and Performa etc.

10.2 COMPLETENESS OF EQUIPMENT

All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the transformer, shall be deemed to be included in the specification and shall be furnished by the supplier without extra charges. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to the Employer under any circumstances.

11.0 COMMISSIONING

The utility will give a 10 days' notice to the supplier of transformer before commissioning. The manufacturer will depute his representative to supervise the commissioning. In case, the manufacturer fails to depute his representative, the utility will go ahead with the commissioning and under these circumstances, it would be deemed that commissioning is done as per recommendations of manufacturer.

12.0 GUARANTEE

The material will be guaranteed for a period of at least 120 calendar months from the date of installation at the site or 126 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the "maintenance period." If the material is damaged within the guarantee period, it shall be replaced/repared by the supplier free of cost within three months of receipt of intimation.

If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 12 months. The total guarantee period will now be 132/138 months as applicable."

Both stage and final inspection of 100 percent repaired transformer will be carried out at the manufacturer's works.

In case, the repair work/replacement of transformer is not affected within six months of the above notice/intimation, the consignees will ensure deduction of the amount equal to the price of new transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

The outage period i.e., period from the date of failure till unit is repaired/replaced shall not be counted for arriving at the guarantee period.

In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

Further, installation of 100 percent Power Transformers (both new and repaired) shall be carried out in the supervision of manufacturer's representative.

Annexure-B

Methodology for computing total owning cost for

Power Transformer

$TOC = IC + (A \times W_i) + (B \times W_c)$; Losses in KW	
Where,	
TOC	= Total Owning Cost
IC	= Initial cost of transformer quoted by the manufacturer including taxes
A factor	= Cost of no load losses in Rs/KW (A = 334447)
B factor	= Cost of load losses in Rs/KW (B = 151616)
W_i	= No load losses quoted by the manufacturer in KW
W_c	= Load losses quoted by the manufacturer in KW

ON LOAD TAP CHANGER FOR 33/11KV POWER TRANSFORMER

The tapping range of On Load Tap Changer shall be +5% to -15% in steps of 1.25% each. The no of taps shall be 17. The On Load Tap Changer shall be supplied with RTCC panel and AVR (Automatic Voltage Regulating Relay)

The Continuous current rating of the tap changer shall be based on connected winding rating and shall have liberal and ample margin. Lower rated tap changers connected in parallel are not acceptable.

The on-load tap changing equipment shall have the provision for mechanical and electrical control from a local position and electrical control from a remote position. For local mechanical operation, the operating handle shall be brought outside the tank for operation from floor level with provision to lock the handle in each tap position. Remote electrical operation shall have an AUTO-MANUAL selection at the remote location. When selected AUTO, the tap changing gear shall maintain steady voltage within practical limit on the transformers secondary bus from which the reference shall not respond to transient variation of voltage due to grid disturbance and system fault.

The required voltage relay shall not be sensitive to frequency variation and shall be suitable for sensing voltage from the secondary of potential transformers mounted on the 66KV, 33KV, or 11KV bus.

The tap changer shall be provided with over-current protection in order to prevent the tap-change operation during a short circuit, which would to greatly stress the contacts of the diverter switch. The function of protection shall be arranged as follows;

- (i) Whenever over current occurs, the control circuit for commanding OLTC motor operation shall be blocked by the normally close contacts of the over current relays.
- (ii) If during tap change over current occurs, the OLTC motor circuit shall be blocked through the mechanical cam switch, which is close from the very beginning to the very end of every tap change operation and to the normally open contacts of the over current relays. The stop action of the motor shall be made through the motor brake contactor.

The design of the tap changing equipment shall be such that the mechanism will not stop in any intermediate position; however, if the mechanism through faulty operation does stop in an intermediate position, the full load must be carried by the transformer without injury to the equipment. The mechanical position indicator shall be equipped in the motor drive cubicle. The motor shall be designed to be of step control. In any case the operation shall be of step by step.

The **voltage regulating relay** shall be supplied together with the timer and under voltage relay. The signal order from the voltage regulating relay to execute the tap changer operation, when the regulating voltage is out of the voltage regulating level shall be designed to be delayed by the adjustable timer. If the control voltage abnormally falls, the movement of the tap changer shall be locked by the contact of the under voltage relay, even if the contacts of the voltage regulating relay are working.

The control circuit of the transformer shall be completely designed and provisions shall be made for parallel operation with another transformer.

The following accessories, control and selector switches and other necessary accessories shall be furnished.

Remote tap changer control board

(Placed in the control room)

- Voltmeter
- “AUTO-MANUAL” control switch
- “RAISE-LOWER” control switch
- Tap position indicator
- Tap changer operation program indicator.

Transformer Tap Changer driving mechanism control cubicle

- “REMOTE-LOCAL-TEST” selector switch
- “AUTOMATIC-MANUAL” control switch
- “RAISE-LOWER” control switch
- Tap position indicator
- Tap changer operation program indicator
- Voltmeter
- Tap change operation counter
- Means for manual operation when power supply is lost

Check-list for Inspection of Prime quality CRGO for Transformers

During inspection of PRIME CRGO, the following points needs to be checked by the Transformer manufacturer. Utility’s inspector shall verify all these points during inspection:-

i) In case PRIME CRGO cutting is at works of Transformer Manufacturer:

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/Authorised Agency
 Manufacturer’s test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below
 Certificate of Origin
 BIS Certification

Format for Reconciliation/Traceability records

Packing List No./date /Quantity of PRIME CRGO received
 Name of Manufacturer
 Manufacturer test certificate No./date

Serial No.	Deatails of Package/Job	Drawing Reference	Quantity Invoved	Commulative Quantity Consumed	Balance Stock
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(i) .1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer’s Identification Slip on PRIME CRGO Coils
 Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
 Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
 ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be

carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

4 Inspection of PRIME CRGO laminations: Transformer manufacturer will maintain records for traceability of laminations to prime CRGO coils and burr/bow on laminations shall be measured. Utility can review these records on surveillance basis.

4. Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/ rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in A.2.2 above.

Above tests shall be witnessed by Utility. In case testing facilities are not available at Manufacturer's work, the sample(s) sealed by Utility to be sent to approved labs for testing.

Inspection Clearance Report would be issued after this inspection

(i) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/ Authorised Agency

Purchase Order (unpriced) to Core Cutter

Manufacturer test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below

Certificate of origin

BIS Certification

Format for Traceability records as below:-

Packing List No./date /Quantity of PRIME CRGO received

Name of Manufacturer

Manufacturer test certificate No./date

Serial No.	Name of Customer	Deatails of Package/Job	Drawing Reference	Quantity Invoved	Commulative Quantity Consumed	Balance Stock	Dispatch details

(ii) 1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils
 Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
 Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
 ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla, thickness depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations:

Transformer manufacturer representative will inspect laminations and issue their internal Inspection Clearance Report. Inspection will comprise of review of traceability to prime CRGO coils, visual Inspection of PRIME CRGO laminations and record of burr/bow. After clearance given by transformer manufacturer, Utility will issue an Inspection Clearance Report after record review. If so desired by Utility, their representative may also join transformer manufacturer representative during this inspection.

Inspection Clearance Report would be issued after this inspection

vi) Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in B.2.2.

Inspection Clearance Report would be issued after this inspection

NOTE :-

a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.

14.1 Transformer Manufacturer should also involve themselves for ensuring the

quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

a) General

If a surveillance sample is drawn and sent to TPL (if testing facility not available with the manufacturer), the Transformer manufacturer can continue manufacturing at their own risk and cost pending TPL test report on PRIME CRGO sample drawn. Decision for acceptance of PRIME CRGO shall be based upon report of the sample drawn.

These checks shall be read in-conjunction with approved Quality Plan, specification as a whole and conditions of contract.

Sampling Plan (PRIME CRGO)

33 / 11 kV - 1st transformer and subsequently at random 10% of Transformers (min. 1) offered for inspection.

DTs and other ratings -1st transformer and subsequently at random 2% of Transformers (min. 1) offered for inspection.

NOTE: - One sample for each lot of CRGO shall be drawn on surveillance basis. CRGO has to be procured only from Discom/POWERGRID approved vendors. List of such vendors is available at the following website. Since the list is dynamic in nature, the site may be checked from time to time to see the list of approved vendors.
<http://apps.powergridindia.com/ims/ComponentList/Power->

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS : (To be furnished and signed by the tenderer for each category of Transformer).

GUARANTEED TECHNICAL PARTICULARS			
Sl. No.	Particulars		
1.	Name and address of the manufacturer	:	
2.	Country of origin	:	
3.	Applicable standard	:	
4.	Maximum continuous rating (in MVA)	:	
5.	No load voltage ratio at Principal (Nominal) tap (in KV/KV)	:	
6.	Rated frequency (in Hz)	:	
7.	Number of phases	:	
8.	Type of Cooling	:	
9.	Connections	:	
	(i) H.V. Winding	:	
	(ii) L.V. Winding	:	
10.	Vector Symbol	:	
11.	Tappings	:	
	(a) Range	:	
	(b) Number of steps	:	
	(c) Variation of voltage in each step (in KV)	:	
	(d) No load voltage ratio in each tap (in KV/KV) for 6.3 & 10 MVA 33/11KV TR.	:	

GUARANTEED TECHNICAL PARTICULARS					
	Tap Number	Voltage ratio in KV/KV		Tap Number	Voltage ratio in KV/KV
	1.			10.	
	2.			11.	
	3.			12.	
	4.			13.	
	5.			14.	
	6.			15.	
	7.			16.	
	8.			17.	
	9.				

12.	(i) Temperature rise under normal operating condition above ambient temperature	:	
	(a) Top oil (in Degree C)	:	
	(b) Windings (in Degree C)	:	
	(ii) Maximum hot spot temperature of Copper windings (in Degree C)	:	
13.	Magnetising current referred to H.V. at rated frequency	:	
	(a) at 90% rated voltage : (in Amps)	:	
	(b) at 100% rated voltage : (in Amps)	:	
	(c) at 110% rated voltage (in Amps)	:	
14.	Power factor of magnetizing current at 100% rated voltage & frequency	:	
15.	No load current at rated voltage and Rated frequency (in Arms)	:	
16.	No load loss in KW at rated frequency and voltage	:	
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	(c) at highest tap	:	
17.	Load loss in KW at 75 Deg. C. at Rated output and frequency	:	

GUARANTEED TECHNICAL PARTICULARS			
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	(c) at highest tap	:	
18.	Percentage Regulation at full load at 75 Deg.C	:	
	(a) at unity power factor	:	
	(b) at 0.8 power factor lagging	:	
19.	Efficiencies at 75 Deg.C (in percentage)	:	
	a) at full load (i) at unity power factor	:	
	(ii) at 0.8 power factor lagging	:	
	(b) at 3/4 full load (i) at unity power factor	:	
	(ii) at 0.8 power factor lagging	:	
	(c) at 1/2 full load (i) at unity power factor	:	
	(ii) at 0.8 power factor lagging	:	
20.	Impedance voltage on rated MVA base at rated Current and frequency for the Principal tapping 75 Deg.C. (in percentage)	:	

21.	a) Reactance voltage at rated current and frequency for the principal tapping at 75 Deg.C. (in percentage)	:	
	b) Resistance voltage at rated current and frequency for the principal tapping at 75 Deg.C. (in percentage)	:	
22.	Resistance at H.V. base at 75 Deg.C.		
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	(c) at highest tap	:	
23.	Reactance at H.V. base at 75 Deg.C.		
	(a) at Lowest tap	:	
	(b) at principal tap	:	
	© at highest tap	:	
24.	Withstand time without injury for three phase dead short circuit at terminal (in seconds)	:	
25.	Short time current rating for short circuit with duration	:	
	a) H.V. winding (in K. Amps)	:	
	b) L.V. winding (in K Amps)	:	
	c) Duration (in seconds)	:	
26.	Permissible overloading with time	:	
27.	Core :		
	i) Type	:	
	ii) Flux density of Core and yoke at principal tap	:	
	a) at 100% rated voltage at 50 Hz (in lines/sq.cm	:	
	b) at 110% rated voltage at 50 Hz (in lines/sq.cm.)	:	
	iii) Thickness of Stamping (in mm)	:	
	iv) Type of insulation between core laminations	:	
	v) Core bolt withstand Insulation (in KV rms for 1 min)	:	
	vi) Approximate area of Cross Section of Core and yoke (in sq.mm.)	:	
	vii) Material of Core clamping plate	:	
	viii) Thickness of Core clamping plate (in mm)	:	
	ix) Insulation of Core clamping plate	:	
	x) Describe location/Method of Core grounding	:	
28	Terminal Arrangement	:	
	i) High Voltage	:	
	ii) Low Voltage	:	
29	Positive Sequence Impedance between HV & L.V. winding on rated MVA base at rated Current and frequency at 75 Deg.C. winding temperature	:	

	i) At principal tapping (in percent)	:		
	ii) At lowest tapping (in percent)	:		
	iii) At highest tapping (in percent)	:		
30	Zero Sequence Impedance at reference temperature of 75 Deg.C at principal tap (in percent)	:		
31	Details of windings	:		
	i) Type of Winding	:		
	(a) High Voltage	:		
	(b) Low Voltage	:		
32	Winding conductor	:		
i)	Material of the winding conductor	:		
	(a) High Voltage	:		
	(b) Low Voltage	:		
ii)	Conductor Area :	:		
	(a) High Voltage (in sq.cm)	:		
	(b) Low Voltage (in sq.cm)	:		
iii)	Current density of windings at rated MVA	At principal tapping 1	At lowest tapping 2	At highest tapping 3
(a)	High voltage (Amp.per <u>sq.cm</u>)			
(b)	Low voltage (Amp.per <u>sq.mm</u>)			
iv)	Insulating material used for			
	(a) High voltage winding	:		
	(b) Low voltage winding	:		
v)	Insulating material used between	:		
	(a) High voltage and low voltage winding	:		
	(b) Low voltage winding and core	:		
vi)	Whether adjustable coil clamps are			
38.	Bushing :	High voltage	Low voltage	
i)	Make			
ii)	Type			
iii)	Applicable standard			
iv)	Insulation withstand test Voltage			
a)	Lightning Impulse withstand test voltage (1.2 x 50 micro seconds in KV peak)			
b)	Power frequency withstand test voltage (in KV rms for 1 min)			
	1)Dry			
	2)Wet			
v)	Creepage distance			
	a) Total (in mm)			
	b) Protected (in mm)			

vi)	Minimum height of the bushing				
39.	Minimum clearance (in mm)				
		In Oil		In Air	
		Between Phases	Phase to Ground	Between Phases	Phase to Ground
	i) H.V.				
	ii) L.V.				
40.	Particulars of Bushing & Neutral C.T.				
	i) Type				
	ii) Ratio				
	iii) Accuracy Class				
	iv) Knee Point Voltage				
	v) RCT at 75 Deg.C				
	vi) Magnetising Current at Knee Point Voltage				
	vii) Additional winding particulars of testing on the C.T.	:			
	viii) Short Time Rating				
	ix) Reference Standard				
41	Approximate weight of Transformer (in Kgs)				
	i) Core with clamping				
	ii) Coil with insulation				
	iii) Core and winding				
42.	Tank and fitting with accessories				
	v) Untanking weight				
	vi) Oil required for first filling				
	vii) Total weight with Core, Winding, Oil Fittings				
43.	Details of Tank				
i)	Type of tank				
ii)	Approximate thickness of Sheet (in mm)				
	a) Sides				
	b) Bottom				
	c) Cover				
	d) Radiators				
iii)	Vacuum recommended for hot oil circulation (in torr.)				

iv)	Vacuum to which the tank can be subjected without distortion (in torr.)	
v)	Under carriage dimensions	
	a) No. of bidirectional wheels provided	
	b) Track gauge required for the wheels	Axis
		Transverse Longitudinal
	Dimension of base channel (in mm x mm)	
	vi) Type of Pressure relief device / Explosion Vent and pressure at which it operates	
44.	Conservator	
	i) Total volume (in Litres)	
	ii) Volume between the highest and Lowest visible oil level (in litres)	
45.	Oil Quality	
	i) Applicable standard	
	ii) Total quantity of oil (in Litres)	
46.	Radiator	
	i) Number of Radiator Bank	
	ii) Number of tubes/fins in each radiator Bank	
	iii) Thickness of tubes/fins (in mm)	
	iv) Overall dimensions (in mm)	
	a) Length	
	b) Breadth	
	c) Height	
	v) Type of mounting	
	viii) Vacuum withstand capability	
47	Gas And Oil Actuated Relay	
	i) Make	
	ii) Type	
	iii) Number of float contacts	

48	Temperature Indicators	Oil Temperature Indicator	Winding Temperature Indicator
i)	Make		
ii)	Type		
iii)	Permissible setting ranges for alarm and trip		
iv)	Number of contacts		
v)	Current rating of each contact		
49.	Approximate overall Dimensions (in mm)		
	a) Length		
	b) Breadth		
	c) Height		
	d) Minimum height of bottom most portion of bushing from bottom of base channel		
50.	Minimum clearance height for lifting tank cover (in mm)		
51.	Make of OLTC		
52.	Whether OLTC is Type tested		
53.	whether OLTC is in line with the specification		
54.	Make of RTCC		
	whether RTCC is in line with the specification		
55.	Whether agreeable to carry out Type Tests, in line with specification at your Cost ?		
56.	Whether all particulars as specified above are furnished?		

2. Single Phase Oil Immersed Distribution Transformers (Outdoor Type)

1 SCOPE:

- 1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed naturally cooled 11 kV/240 V, $11/\sqrt{3}$ kV/240 V single phase distribution transformers for outdoor use.
- 1.2 The equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and/or the commercial order or not.
- 1.3 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in the operation and maintenance of equipment.
- 1.4 All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

1.5 STANDARD RATINGS

- 1.5.1 Standard ratings of single-phase transformers shall be 5, 10, 16 and 25 kVA.

2 STANDARDS:

- 2.1 The materials shall conform in all respects to the relevant Indian Standard, with latest amendments thereof unless otherwise specified herein; some of them are listed below.
- 2.2 Material conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above would also be acceptable. In case the bidder who wishes to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

3 SERVICE CONDITIONS:

Indian Standards	Title	International Standards
IS -2026	Specification for Power Transformers	IEC 76
IS 1180 (Part-I): 2014	Outdoor Type Oil Immersed Distribution Transformers up to and including 2500kVA, 33kV- Specification	
IS 12444	Specification for Copper wire rod	ASTM B-49
IS-335	Specification for Transformer/Mineral Oil	IEC Pub 296
IS-5	Specification for colors for ready mixed paints	
IS -104	Ready mixed paint, brushing zinc chromate, priming	
IS-2099	Specification for high voltage porcelain bushing	
IS-649	Testing for steel sheets and strips and magnetic circuits	
IS- 3024	Cold rolled grain oriented electrical sheets and strips	
IS - 4257	Dimensions for clamping arrangements for bushings	
IS - 7421	Specification for Low Voltage bushings	
IS - 3347	Specification for Outdoor Bushings	DIN 42531 to 33
IS - 5484	Specification for Al Wire rods	ASTM B - 233
IS - 9335	Specification for Insulating Kraft Paper	IEC 554
IS - 1576	Specification for Insulating Press Board	IEC 641
IS - 6600	Guide for loading of oil Immersed Transformers	IEC 76
IS - 2362	Determination of water content in oil for porcelain bushing of transformer	
IS - 6162	Paper covered Aluminum conductor	
IS - 6160	Rectangular Electrical conductor for electrical machines	
IS - 5561	Electrical power connector	
IS - 6103	Testing of specific resistance of electrical insulating liquids	

IS - 6262	Method of test for power factor and dielectric constant of electrical insulating liquids	
IS - 6792	Determination of electrical strength of insulating oil	
IS - 10028	Installation and maintenance of transformers.	

3.1 The distribution transformers to be supplied against this specification shall be suitable for satisfactory continuous operation under the following climatic conditions as per IS 2026 (Part-I).

- i) Location : At various locations in the country
- ii) Max ambient air temperature ($^{\circ}\text{C}$) : 50
- iii) Minimum ambient air temperature ($^{\circ}\text{C}$) : -5
- iv) Maximum Average daily ambient air temperature ($^{\circ}\text{C}$) : 40
- v) Maximum Yearly weighted average ambient temperature ($^{\circ}\text{C}$) : 32
- vi) Maximum altitude above 5000 meters mean sea level (metres) :
- For HP, J&K, Uttarakhand, Sikkim, Assam, Meghalaya, Manipur, Nagaland, Tripura, Arunachal Pradesh and Mizoram

Note:

1. The climatic conditions specified above are indicative and can be changed by the user as per requirements.
2. The equipment shall generally be for use in moderately hot and

humid tropical climate, conducive to rust and fungus growth unless otherwise specified.

4 PRINCIPAL PARAMETERS:

4.1 The Transformer shall be suitable for outdoor installation with single phase, 50 Hz, 11 kV

systems in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 12.5% to minus 12.5%.

4.2 The transformer shall conform to the following specific parameters. Rated HV side value (11 kV or $11/\sqrt{3}$ kV) shall be specified in the detailed bill of quantity by purchaser.

Sl.No	ITEM	SPECIFICATION
1.	System voltage(max)	7/ 12 kV
2.	Rated voltage HV Rated voltage LV	$11/\sqrt{3}$ or 11 kV 240 V*
3.	Frequency	50 Hz +/- 5%
4.	No. of Phases	Single
5.	Type of cooling	ONAN

4.3 INSULATION LEVELS

Voltage (Volts)	Impulse Voltage (kV Peak)	Power (kV)	Frequency
433	-	3	
11000	75	28	
$11000/\sqrt{3}$	60	20	

5 TECHNICAL REQUIREMENTS:

5.1 CORE MATERIAL:

5.1.1 Transformer core shall be wound core type construction using new and high quality cold rolled grain oriented (CRGO) steel with heat resistant insulating coating or Amorphous metal.

5.1.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage. CRGO steel for core shall be purchased only from the approved vendors, list of which is available at <http://apps.powergridindia.com/ims/ComponentList/Power->

former%20upto%20420%20kV-CM%20List.pdf

- 5.1.3 The transformer shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto 12.5% without injurious heating. The operating flux density shall be such that there is a clear safe margin over the over fluxing limit of 12.5%.
- 5.1.4 No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 6% of full load current.
- 5.1.5 Please refer to “**Check-list for Inspection of Prime quality CRGO for Transformers**” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.
- 5.2 WINDINGS MATERIALS:
- 5.2.1 HV and LV windings shall be wound from Aluminum/Copper conductors covered with double paper/enamel. The inter layer insulation shall be of nomex/epoxy resin dotted kraft paper.
- 5.2.2 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength to be conducted.
- 5.2.3 The core coil assembly shall be dried in an oven. The type of winding shall be indicated in the tender. Whether LV windings are of conventional type or foil wound shall be indicated.
- 5.2.4 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in guaranteed technical particulars (GTP).
- 5.2.5 The core coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 5.2.6 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.
- 5.3 WINDING CONNECTION AND TERMINAL ARRANGEMENTS:
- 5.3.1 For 11 kV transformers both ends of primary winding shall be brought out through HV

bushings. For $11/\sqrt{3}$ kV transformers, neutral end of the primary HV

winding shall be brought out for connecting to 'Neutral' supply wire through 1 kV bushings. There shall be provision for connecting 'Neutral' terminal, to local 'Earth' by way of a tinned Copper strip of adequate size and dimension. The secondary winding shall be connected to two LV bushings.

5.4 OIL:

5.4.1 The insulating oil shall comply with the requirements of IS 335. Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than 2.5×10^{12} ohm-cm at 27 °C when tested as per IS 6103.

5.4.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling

5.4.3 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

6 LOSSES:

6.1 The bidder shall guarantee individually the no-load loss and load loss without any positive tolerance. The bidder shall also guarantee the total losses (no load + load losses at 75 °C) at the 50% of rated load and total losses at 100% of rated shall not exceed the maximum total loss values given in Table-9 of IS 1180(Part-1):2014.

6.2 The maximum allowable losses at rated voltage and rated frequency permitted at 75°C for 11/0.433 KVA transformers can be chosen by the utility as per table 3 upto 200 KVA and table 6 for rating above 200 KVA as per Energy Efficiency Level-1 Specified in IS 1180 (Part-1):2014 (amendment-4) for all KVA rating of distribution transformers.

6.2 The above losses are maximum allowable and there would not be any positive tolerance. Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above stated values. The utility can evaluate offers with losses lower than the maximum allowable losses on total owning cost basis in accordance with methodology given in Annex-I.

7 PERCENTAGE IMPEDANCE:

7.1 The percentage impedance of single-phase transformers at 75 °C for different ratings upto 25 kVA shall be as per Table 9 of IS 1180(Part-1):2014.

8 TEMPERATURE RISE:

- 8.1 The permissible temperature rise shall be as per IS: 1180
- 8.2 Bids not conforming to the above limits of temperature rise will be treated as non-responsive.
- 9 PENALTY FOR NON PERFORMANCE
- 9.1 During testing at supplier's works if it is found that the actual measured losses are more than the values quoted by the bidder, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.
- 9.2 Purchaser shall reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.
- 9.3 Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance and if they do not meet the requirements of clause 7.1
- 10 BUSHINGS:
- 10.1 The bushings shall be either porcelain or epoxy type and shall conform to the relevant standards specified. Polymer insulator bushings conforming with relevant IEC can also be used.
- 10.2 For HV, 12 kV class bushings shall be used and for LV, 1 kV class bushings shall be used.
- 10.3 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.
- 10.4 The HV bushings shall be fixed to the top cover of the transformer and the LV bushings shall be fixed to transformer on sides and in the same plane.
- 10.5 The bushing rods and nuts shall be of brass/stainless steel.
- 10.6 Arcing horns will be provided on HV bushings shall not have arcing horns and 1 clamp for LA shall also be provided for each HT bushing. Supply of LA is not included in DT supplier's scope.
- 10.7 Bushings shall be marked with manufacturer's name, month and year of manufacture.

11 BUSHING TERMINALS:

- 11.1 HV terminal shall be designed to directly receive ACSR conductor upto 7/2.59 mm (without requiring the use of lug) and the LV terminals shall be suitable for directly receiving LT cables (aluminum) ranging from 10 Sq mm to 25 Sq mm both in vertical and horizontal position and the arrangements should be such as to avoid bimetallic corrosion. Terminal connectors must be type tested as per IS 5561.
- 12 TANK:
- 12.1 The oil volume inside the tank shall be such that even under the extreme operating conditions, the pressure generated inside the tank does not exceed 0.4 kg/sq. cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion.
- 12.2 The tank cover shall have plasticized surface at the top to guard against bird faults. Alternately, suitable insulating shrouds shall be provided on the bushing terminals.
- 12.3 The Transformer tank shall be of robust construction round/rectangular in shape and shall be built up of tested CRCA/Mild Steel Sheet.
- 12.4 The tank shall be capable of withstanding a pressure of 1 kg/cm^2 (g) and a vacuum of 760 mm of Hg for 30 minutes without any permanent deflection (Air pressure test shall be conducted as per IS -1180(Part-I):2014.
- 12.5 The L - seam joint, C - seam joint and all fittings and accessories shall be oil tight and no deflection / bulging should occur during service.
- 12.6 Manufacturer should carry out the all the welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the Purchaser.
- 12.7 The circular bottom plate edges of the tank should be folded upward, for at least 25 mm, to have sufficient overlap with vertical sidewall of the transformer.
- 12.8 The Transformer tank and the top cover shall be designed in such a manner as to leave no external pockets in which water can lodge.
- 12.9 Tank shall have permanent lugs for lifting the transformer bodily and there shall be facilities for lifting the core coil assembly separately.
- 12.10 The transformer shall be provided with two mounting lugs suitable for

fixing the transformer to a single pole by means of 2 bolts of 20 mm diameter as per ANSI C 57.12.20-1988.

- 12.11 Both mounting lugs are made with steel of minimum 5 mm thickness.
- 12.12 Jump proof lips shall be provided for upper mounting lug.
- 12.13 Mounting lug faces shall be in one plane.
- 12.14 Minimum Oil level mark shall be embossed inside the tank (at 25⁰ C).
- 12.15 The top cover shall be fixed to the tank through clamping only.
- 12.16 HV bushing pocket shall be embossed to top side of the top cover so as to eliminate ingress of moisture and water.
- 12.17 The edges of the top cover shall be formed, so as to cover the top end of the tank and gasket.
- 12.18 Nitrile/ polyurethane /neoprene rubber gaskets' conforming to latest IS 4253 part-II shall be provided between tank and top cover.
- 12.19 The gaskets shall be continuous i.e. without any joint.

13 TANK SEALING:

- 13.1 The space on the top of the oil shall be filled with dry air or nitrogen. The nitrogen plus oil volume inside the tank shall be such that even under extreme operating conditions, the pressure generated inside the tank does not exceed 0.4 kg/sq. cm positive or negative. The nitrogen shall conform to commercial grade of the relevant standards.

14 SURFACE PREPARATION AND PAINTING:

14.1 GENERAL

- 14.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 14.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations.

14.2 CLEANING AND SURFACE PREPARATION:

14.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting. Steel surfaces shall be prepared by Shot blast cleaning (IS 9954) to grade Sa. 2.5 of ISO 8501-1 or chemical cleaning including phosphating (IS 3618).

14.2.2 The pressure and volume of the compressed air supply for blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination to ensure that the cleaning process is not impaired.

14.2.3 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where shot blast cleaning is impractical. Manufacturer shall indicate such location, for purchaser's information, in his offer.

14.3 PROTECTIVE COATING:

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

14.4 PAINT MATERIAL:

Following are the types of paint that may be suitably used for the items to be painted at shop and supply of matching paint to site:

14.4.1 The painting shall be as per Annexure-Paint which is attached herewith.

14.4.2 For external surfaces one coat of Thermo Setting paint or 1 coat of epoxy primer followed by 2 coats of polyurethane base paint. These paints can be either air-drying or stoving.

14.4.3 In case of highly polluted area, chemical atmosphere or at a place very near the sea coast, paint as above with one intermediate coat of high build MIO (Micaceous iron oxide) as an intermediate coat may be used to give a total dry film thickness of 150 to 180 microns.

14.5 PAINTING PROCEDURE:

14.5.1 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.

14.5.2 Where the quality of film is impaired by excess film thickness (wrinkling,

mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another. In all instances where two or more coats of the same paint are specified, such coatings may or may not be of contrasting colours.

14.5.3 DAMAGED PAINTWORK:

14.5.4 Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally employed.

14.5.5 Any damaged paint work shall be made good as follows:

14.5.6 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.

14.5.7 A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage.

14.5.8 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

14.6 DRY FILM THICKNESS:

14.6.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Over spray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour.

14.6.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.

14.6.3 Particular attention must be paid to full film thickness at edges.

14.7 TESTS:

- The painted surface shall be tested for paint thickness.
- The painted surface shall pass the cross hatch adhesion test and impact test as routine test, Salt spray and Hardness test as type test as per the relevant ASTM standards.

14.8 The paint shade shall be as per Annexure-Paint which is attached herewith.

Note: Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

15 RATING AND TERMINAL PLATES:

15.1 Each transformer shall be provided with rating plate made of anodized aluminum/stainless steel material securely fixed on the outer body, easily accessible, showing the information given in Fig.2 of IS 1180(Part-1):2014 for single phase transformers. The entries on the rating plates shall be indelibly marked by engraving.

15.2 Each transformer shall be provided with a terminal marking plate in accordance with Fig.5 of IS 1180(Part-1):2014. The rating and terminal marking plates may be combined into one plate at the option of manufacturer.

15.3 The distribution transformer be marked with the Standard Mark and the use of Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and regulations made thereunder. As per Quality Control Order for Electrical Transformers- 2015, issued by Dept. of Heavy Industries, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1: (2014).

16 PRESSURE AND VACCUM REQUIREMENTS:

16.1 Single phase transformers up to 25kVA, the transformer tank shall be of robust construction, round in shape shall be capable of withstanding a pressure of 100kPa and a vacuum of 760 mm of mercury.

17 FITTINGS:

17.1 The following standard fittings shall be provided :

17.1.1 Two earthing terminals with earthing symbol.

17.1.2 Lifting lugs for the complete transformer as well as for core and winding assembly.

17.1.3 HV side neutral grounding strip(where one of the bushing terminal is connected to earth).

17.1.4 Rating and terminal marking plates.(Non detachable type)

17.1.5 Pressure relief device or self-ventilating cover

17.1.6 HV bushings.

17.1.7 LV bushings.

17.1.8 HV and LV terminal connectors.

17.1.9 Top cover fixing clamps.

17.1.10 Mounting lugs - 2 Nos.

17.1.11 Bird guard.

17.1.12 LV earthing arrangement.

17.1.13 Any other fitting required as per IS: 1180 (Part 1)

18 FASTENERS:

18.1 All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.

18.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.

18.3 All nuts and pins shall be adequately locked.

18.4 Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

18.5 All All bolts/nuts/washers exposed to atmosphere should be as follows.

a) Size 12 mm or below – Stainless steel

b) Above 12 mm- steel with suitable finish like electro galvanized with passivation or hot dip galvanized.

18.6 Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.

18.7 The length of the screwed portion of the bolts shall be such that no

screw thread may form part of a shear plane between members.

18.8 Taper washers shall be provided where necessary. Protective washers of suitable material shall be provided front and back or the securing screws.

19 OVER LOAD CAPACITY:

19.1 The transformer shall be suitable for loading as per latest IS 6600.

20 TESTS:

All the equipment offered shall be fully type tested by the bidder as per the relevant standards including the additional type tests mentioned at clause 23. The type test must have been conducted on a transformer of same design during the last five years at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer. **In case, the offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type tests at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.**

20.1 Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards

20.2 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted with the bid. However, if the same are not available at the time of bidding, the same may be submitted after order but before commencement of supply.

20.3 The procedure for testing shall be in accordance with IS 1180(Part-1): 2014/2026 as the case may be except for temperature rise.

20.4 Before dispatch each of the completely assembled transformer shall be subjected to the routine tests at the manufacturers works.

21 ROUTINE TESTS:

21.1 Ratio, polarity tests.

21.2 No load current and losses at service voltage and normal frequency.

21.3 Load losses at rated current and normal frequency.

- 21.4 Impedance Voltage test.
- 21.5 Resistance of windings cold (at or near the test bed temperature).
- 21.6 Insulation resistance.
- 21.7 Induced over voltage withstand test.
- 21.8 Separate source voltage withstand test. This test will not be applicable for single phase DTs with $11/\sqrt{3}$ kV as primary voltage.
- 21.9 Oil sample test (one sample per lot) to comply with IS 1866.
- 21.10 Air pressure test on empty tank as per IS 1180
- 22 TYPE TESTS TO BE CONDUCTED ON ONE UNIT:
- In addition to the tests mentioned above following tests shall be conducted:
- 22.1 Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.
- 22.2 Impulse voltage withstand test: As per IS 2026 part-III. Basic insulation level (BIL) for 11 kV shall be 75 kV peak while for $11/\sqrt{3}$ kV, it will be 60KVp
- 22.3 Air pressure test: As per IS 1180 (Part-I):2014.
- 22.4 Short circuit withstand test: Thermal and dynamic ability.
- 22.5 Oil samples (Post short circuit and temperature rise test) - Only DGA & BDV test shall be conducted.
- 22.6 Noise level measurement.
- 22.7 Permissible flux density and over fluxing withstand test.
- 22.8 Type test certificates for the tests carried out on prototype of same specifications shall be Submitted along with the bid.
- 22.9 The purchaser may select the transformer for type tests randomly.
- 23.10 Short Circuit Test and Impulse Voltage Withstand Test:** The purchaser intends to procure transformers designed and successfully tested for short circuit and impulse test. In case the transformers

proposed for supply against the order are not exactly as per the tested design, the supplier shall be required to carry out the short circuit test and impulse voltage withstand test at their own cost in the presence of the representative of the purchaser.

- 23.11 The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un- tanking after a short circuit test.
- 23.12 Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.
- 23.13 It may also be noted that the purchaser reserved the right to conduct short circuit test and impulse voltage test in accordance with the IS, afresh on each ordered rating at purchaser's cost, even if the transformers of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the purchaser either at their works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's Stores. The findings and conclusions of these tests shall be binding on the supplier.

24 TESTS AT SITE:

- 24.1 The purchaser reserves the right to conduct all tests on transformer after arrival at site and the manufacturer shall guarantee test certificate figures under actual service conditions.

25 ACCEPTANCE TESTS:

- 25.1 The transformers shall be subjected to the following routine/ acceptance test in the presence of purchaser's representative at the place of manufacture before despatch without any extra charges. The testing shall be carried out in accordance with IS 1180, Part-1 (2014) and IS 2026. Checking of mass, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP/QA plan and contract drawings.
- 25.2 Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report.
- 25.3 All tests as specified in clause 22.

26 INSPECTION:

26.1 In respect of raw material such as core stampings, winding conductors, insulating paper and oil, supplier shall use materials manufactured/supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from the manufacturers (excise gate pass) for information of the purchaser. The bidder shall furnish following documents along with their offer in respect to the raw materials :

26.1.1 Invoice of supplier.

26.1.2 Mill's certificate.

26.1.3 Packing List.

26.1.4 Bill of landing.

26.1.5 Bill of entry certificate by custom.

Please refer to “**Check-list for Inspection of Prime quality CRGO for Transformers**” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

26.2 To ensure about the quality of transformers, the inspection shall be carried out by the purchaser's representative at following stages:

26.2.1 Online anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.

26.2.2 When the raw material is received, and the assembly is in process in the shop floor.

26.2.3 At finished stage i.e. transformers are fully assembled and are ready for despatch.

26.3 After the main raw-materials i.e. core and coil materials and tanks are arranged and transformers are taken for production on shop floor and a few assembly have been completed, the firm shall intimate the purchaser in this regard, so that an officer for carrying out such inspection could be deputed, as far as possible within seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled (only in case of CRGO material) to ensure that the CRGO laminations used are of good quality. Further, as and when the transformers are ready for despatch, an offer intimating

about the readiness of transformers, for final inspection for carrying out tests as per relevant IS and as in clauses above, shall be sent by the firm along with routine test certificates. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection.

- 26.4 In case of any defect/defective workmanship observed at any stage by the purchaser's inspecting officer; the same shall be pointed out to the firm in writing for taking remedial measures. Further processing should only be done after clearance from the Inspecting officer/purchaser.
- 26.5 All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall offer the inspector representing the purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include stage inspection during manufacturing stage as well as active part inspection during acceptance tests.
- 26.6 The manufacturer shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical/electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.
- 26.7 Along with the bid the manufacturer shall prepare Quality Assurance Plan (QAP) identifying the various stages of manufacture, quality checks performed at each stage and the customer hold points. The document shall also furnish details of method of checking, inspection and acceptance standards/values and get the approval of purchaser or his representative before proceeding with manufacturing. However, purchaser or his representative shall have the right to review the inspection reports, quality checks and results of manufacturer's in house inspection department which are not customer hold points and the manufacturer shall comply with the remarks made by purchaser or his representative on such reviews with regards to further testing, rectification or rejection etc. Manufacturer should submit the list of equipment for testing along with latest calibration certificates to the purchaser.
- 26.8 Purchaser shall have every right to appoint a third party inspection to carry out the inspection

process. The purchaser has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality of supply. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation purchaser has every right to reject the entire lot or penalise the manufacturer, which may lead to blacklisting among other things.

27 QUALITY ASSURANCE PLAN:

- 27.1 The bidder shall invariably furnish following information along with his bid, failing which his bid shall be liable for rejection. Information shall be separately given for individual type of material offered.
- 27.2 Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials in presence of bidder's representative and copies of test certificates.
- 27.3 Information and copies of test certificates as above in respect of bought out accessories.
- 27.4 List of manufacturing facilities available.
- 27.5 Level of automation achieved and list of areas where manual processing exists.
- 27.6 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- 27.7 List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports shall be furnished with the bid. Manufacturer shall possess 0.1 accuracy class instruments for measurement of losses.
- 27.8 Quality assurance plan with hold points for purchaser's inspection.
- 27.9 The successful bidder shall within 30 days of placement of order, submit following information to the purchaser.
 - 27.9.1 List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
 - 27.9.2 Type test certificates of the raw materials and bought out accessories.

- 27.10 The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing.
- 27.11 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformers- 2015, issued by Dept. of Heavy Industries, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1:(2014).

28 DOCUMENTATION:

- 28.1 Completely dimensioned drawings indicating general arrangement and details of fittings, clearances and winding details shall accompany the tender.
- 28.2 Drawings of internal constructional details and fixing details of coils should also be indicated. Tank dimensions, position of fittings, clearances between leads within the transformer, core grade of laminations, distance of core centers, area of conductor bare and with insulation. No. of coils, No. of turns per coil material of bushing metal parts etc., shall also be furnished with tender.

29 PACKING and FORWARDING:

- 29.1 The packing shall be done as per the manufacturer's standard practice. However, he should ensure the packing is such that, the material should not get damaged during transit by rail/road.
- 29.2 The marking on each package shall be as per the relevant IS.

30 GUARANTEE:

The material will be guaranteed for a period of at least 60 calendar months from the date of installation at the site or 66 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the "maintenance period." If the material is damaged within the guaranteed period, it shall be replaced/repared by the supplier free of cost within one month of receipt of intimation. If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 24 months. The total guarantee period will now be 84/90 months as applicable."

Both stage and final inspection of at least 10-20 percent of the quantity of repaired transformer will be carried out at the manufacturer's works/local repairing center. The manufacturer has to inform the address of the local repairer in advance. In case, the repair work/replacement of transformer is not effected within three months of the above notice/intimation the consignees will ensure deduction of the amount equal to the price of new transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

The outage period i.e., from the date of failure till unit is repaired/replaces shall not be counted for arriving at the guarantee period. In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period. Further, installation of 10 percent Distribution Transformers (both new and repaired) shall be carried out in the supervision of manufacturer's representative.

Methodology for computing total owning cost*

Annex-I

TOC = IC + (A xWi) + (B xWc) ; Losses in KW		
Where,		
TOC	=	Total Owing Cost
IC	=	Initial cost ta o transfor a quo b the manufacturer
A factor	=	Cost of no load losses in Rs/KW (A = 288239)
B factor	=	Cost of load losses in Rs/KW (B = 93678)
Wi	=	No load losses quoted by the manufacturer in KW
Wc	=	Load losses quoted by the manufacturer in KW

Note:

No (+)ve tolerance shall be allowed at any point of time on the quoted losses after the award. In case, the losses during type testing ,routine testing etc. are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

* Amendment issued vide letter No. REC/DDUGJY/SBD/DTR-TS/969 Dated 29.09.2016

Annexure-Paint

Painting-Transformer Main tank, pipes, Conservator Tank, Radiator etc.-

	Surface Preparation	primer coat	intermediate under coat	finish coat	total DFT	Colour shade
Main tank, pipes, conservator tank, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer 30-40 micron	Epoxy base Zinc primer 30-40 micron	Aliphatic Polyurethane (PU Paint) (min 50 micron)	Min 110 micron	541 shade of IS:5
Main tank, pipes (above 80 NB), conservator tank, etc (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint	--	--	Min 30 micron	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer 30-40 micron	Epoxy base Zinc primer Min 30-40 micron	Aliphatic Polyurethane (PU Paint) (min)50 micron	Min 110 micron	541 shade of IS:5
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning if required	Hot oil proof low viscosity varnish or hot oil resistant non corrosive paint	--	--	--	Glossy white for paint

GUARANTEED TECHNICAL PARTICULARS FOR COMPLETELY SELF PROTECTED DISTRIBUTION TRANSFORMERS

Sl.No.	Description	6.3 kVA	10 kVA	16 kVA	25 kVA
1.	Name of the manufacturer and place of manufacture				
2.	Continuous maximum rating as per this specification.				
3.	Normal ratio of transformer				
4.	Method of connection HV/LV				
5.	Maximum current density in Windings : 1. HV (A/sq mm) 2. LV (A/sq mm)				
6.	Maximum hot spot temperature $^{\circ}\text{C}$. (Ambient air temperature on which above is based) $^{\circ}\text{C}$.				
7.	Maximum temperature : $^{\circ}\text{C}$ (a) Maximum observable oil temperature (ambient air temperature on which above is based) b) Maximum winding temperature at an ambient temperature of				
8.	No-load losses at rated voltage (watt)				
9.	Full load losses at 75°C (watt)				
10.	Total losses at 100% load (watt)				
11.	Total losses at 50% load (watt)				
12.	Efficiency at normal voltage :				

- (i) Unity Power Factor
 - (a) At 50% load
 - (b) At 75% load
 - (c) At full load
- (ii) 0.8 Power Factor
 - (a) At 50% load
 - (b) At 75% load
 - (c) At full load
- 13. Regulation as percentage of normal voltage :
 - (a) At unity power factor
 - (b) At 0.8 power factor lagging
- 14. Percentage impedance voltage at normal ratio between HV and LV windings
- 15. Type of transformers, CRGO/ amorphous type
- 16. Type of Insulation used in
 - HV Windings
 - LV Windings
- 17. Type of insulation used in
 - Core bolts
 - Core bolt washers
 - End plates
 - Core lamination
- 18. Impulse withstand test voltage level (kV)
 - HV Windings
 - LV Windings
- 19. Characteristics of transformer oil
- 20. Total content of oil in litres
- 21. Whether transformer will be transported with oil?
- 22. Type of transformer tank
- 23. Approximate overall dimensions
 - a Height m
 - b Length m
 - c Width m

Tank dimensions

 - a Diameter m
 - b Height m

- 24. Mass of insulated conductor
 - HV (minimum) kg
 - LV (minimum) kg
- 25. Mass of core (minimum) kg (CRGO or amorphous metal)
- 26. Mass of complete transformer arranged for transport (kg)

ADDITIONAL DETAILS

Sl. No.	Description	
1.	Core grade	
2.	Core dimensions	mm
3.	Gross core area	cm ²
4.	Net Core area	cm ²
5.	Flux density	Tesla
6.	Mass of Core	kg
7.	Loss per kg of core at the specified flux density	watt
8.	Core window height	mm
9.	Center to center distance of the core	mm
10.	No. of LV Turns	
11.	No. of HV turns	
12.	Size of LV Conductor bare/ covered (dia)	mm
13.	Size of HV conductor bare/covered (dia)	mm
14.	No. of parallels	
15.	Current density of LV winding	A/sq mm
16.	Current density of HV winding	A/sq mm
17.	Mass of the LV winding for Transformer	kg
18.	Mass of the HV winding for Transformer	kg
19.	No. of of LV Coils/phase	
20.	No. of HV coils . phase	
21.	Height of LV Windings	mm
22.	Height of HV winding	mm
23.	ID/OD of LV winding HV	mm
24.	ID/OD of LV winding	mm
25.	Size of the duct in LV winding	mm
26.	Size of the duct in HV winding	mm
27.	Size of the duct between HV and LV	mm
28.	HV winding to LV clearance	mm
29.	HV winding to tank clearance	mm

30.	Calculated impedance	%
31.	HV to earth creepage distance	mm
32.	LV to earth creepage distance	mm

SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION

Sl. No.	Item	Source of Material	Place of Manufacture	Place of testing and inspection
1.	Laminations			
2.	Aluminium/Copper			
3.	Insulated winding wires			
4.	Oil			
5.	Press boards			
6.	Kraft paper			
7.	MS plates/Angles/Channels			
8.	Gaskets			
9.	Bushing HV/LV			
10.	Paints			

Annexure - A**Check-list for Inspection of Prime quality CRGO for Transformers**

During inspection of PRIME CRGO, the following points needs to be checked by the Transformer manufacturer. Utility's inspector shall verify all these points during inspection:-

ii) **In case PRIME CRGO cutting is at works of Transformer Manufacturer:**

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/Authorised Agency
Manufacturer's test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below

Certificate of Origin

BIS Certification

Format for Reconciliation/Traceability records

Packing List No./date /Quantity of PRIME CRGO received

Name of Manufacturer

Manufacturer test certificate No./date

Serial No.	Details of Drawing Package/Job reference	Quantity Involved	Commulative Quantity Consumed	Balance Stock
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(iii).1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils

Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).

Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.

ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be

carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations: Transformer manufacturer will maintain records for traceability of laminations to prime CRGO coils and burr/bow on laminations shall be measured. Utility can review these records on surveillance basis.

4. Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/ rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in A.2.2 above.

Above tests shall be witnessed by Utility. In case testing facilities are not available at Manufacturer's work, the sample(s) sealed by Utility to be sent to approved labs for testing.

Inspection Clearance Report would be issued after this inspection

(ii) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/ Authorised Agency

Purchase Order (unpriced) to Core Cutter

Manufacturer test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below

Certificate of origin

BIS Certification

Format for Traceability records as below:-

Packing List No./date /Quantity of PRIME CRGO received

Serial No.	Name of consumer	Details of Package/Job	Drawing reference	Quantity Involved	Commulative Quantity Consumed	Balance Stock	Dispatch
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(iv).1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils
Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).

Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.

ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla, thickness depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations:

Transformer manufacturer representative will inspect laminations and issue their internal Inspection Clearance Report. Inspection will comprise of review of traceability to prime CRGO coils, visual Inspection of PRIME CRGO laminations and record of burr/bow. After clearance given by transformer manufacturer, Utility will issue an Inspection Clearance Report after record review. If so desired by Utility, their representative may also join transformer manufacturer representative during this inspection.

Inspection Clearance Report would be issued after this inspection

vii) Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in B.2.2.

Inspection Clearance Report would be issued after this inspection

NOTE :-

a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.

14.2 Transformer Manufacturer should also involve themselves for ensuring the quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

b) General

If a surveillance sample is drawn and sent to TPL (if testing facility not available with the manufacturer), the Transformer manufacturer can continue manufacturing

temperature on which
above is based)

b) Maximum winding temperature
at an ambient temperature of

8. No-load losses at rated voltage (watt)

9. Full load losses at 75 °C (watt)

10. Total losses at 100% load (watt)

11. Total losses at 50% load (watt)

12. Efficiency at normal voltage :

(i) Unity Power Factor

(a) At 50% load

(b) At 75% load

(c) At full load

(ii) 0.8 Power Factor

(a) At 50% load

(b) At 75% load

(c) At full load

13. Regulation as
percentage of
normal voltage :

(a) At unity power factor

(b) At 0.8 power factor lagging

14. Percentage impedance voltage at normal ratio between HV and LV windings

15. Type of transformers, CRGO/ amorphous type

16. Type of Insulation used in
HV
Windings LV
Windings

17. Type of insulation used in
Core bolts

Core bolt

washers Endplates

Core lamination

18. Impulse withstand test voltage level (kV)
HV Windings LV Windings

19. Characteristics of transformer oil

20. Total content of oil in litres

21. Whether transformer will be transported with oil?

22. Type of transformer tank

23. Approximate overall dimensions

- a) Height mm
- b) Length mm
- c) Width mm

Tank dimensions

- a) Diameter mm
- b) Height mm

24. Mass of insulated conductor

HV
(minimum) kg LV
(minimum) kg

25. Mass of core (minimum) kg (CRGO or amorphous metal)

26. Mass of complete transformer arranged for transport (kg)

ADDITIONAL DETAILS

Sl. No.	Description	
1.	Core grade	
2.	Core dimensions	mm
3.	Gross core area	cm ²
4.	NetCore area	cm ²
5.	Flux density	Tesla
6.	Mass of Core	kg
7.	Loss per kg of core at the specified flux density	watt
8.	Core window height	mm
9.	Center to center distance of the core	mm
10.	No. of LV Turns	
11.	No. of HV turns	
12.	Size of LV Conductor bare/ covered (dia)	mm
13.	Size of HV conductor bare/covered (dia)	mm
14.	No. of parallels	
15.	Current density of LV winding	A/sq mm
16.	Current density of HV winding	A/sq mm
17.	Mass of the LV winding for Transformer	kg
18.	Mass of the HV winding for Transformer	kg
19.	No. of of LV Coils/phase	
20.	No. of HV coils . phase	
21.	Height of LV Windings	mm
22.	Height of HV winding	mm
23.	ID/OD of LV winding HV	mm
24.	ID/OD of LV winding	mm
25.	Size of the duct in LV winding	mm
26.	Size of the duct in HV winding	mm
27.	Size of the duct between HV and LV	mm
28.	HV winding to LV clearance	mm
29.	HV winding to tank clearance	mm
30.	Calculated impedance	%
31.	HV to earth creepage distance	mm
32.	LV to earth creepage distance	mm

SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION

Sl. No.	Item	Source of Material	Place of Manufacture	Place of testing and inspection
1.	Laminations			
2.	Aluminium/Copper			
3.	Insulated winding wires			
4.	Oil			
5.	Press boards			
6.	Kraft paper			
7.	MS plates/Angles/Channels			
8.	Gaskets			
9.	Bushing HV/LV			
10.	Paints			

3. 3-Phase Distribution Transformers 11 or 33 kV/433-250V (Outdoor Type)

1. SCOPE:

- i) This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3-phase 11 kV/433 - 250 V and 33 kV/433-250 V distribution transformers for outdoor use.
- ii) The equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.
- iii) The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.
- iv) All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

2 STANDARDS:

- 2.1 The major materials used in the transformer shall conform in all respects to the relevant/specified Indian Standards and international Standards with latest amendments thereof as on bid opening date, unless otherwise specified herein. Some of the applicable Indian Standards are listed as hereunder:

3.2

Indian Standards	Title	International Standards
IS -2026	Specification for Power Transformers	IEC 76
IS 1180 (Part-I): 2014	Outdoor Type Oil Immersed Distribution Transformers upto and including 2500kVA, 33kV-Specification	
IS 12444	Specification for Copper wire rod	ASTM B-49
IS-335	Specification for Transformer/Mineral Oil	IEC Pub

		296
IS-5	Specification for colors for ready mixed paints	
IS -104	Ready mixed paint, brushing zinc chromate, priming	
IS-2099	Specification for high voltage porcelain bushing	
IS-649	Testing for steel sheets and strips and magnetic circuits	
IS- 3024	Cold rolled grain oriented electrical sheets and strips	
IS - 4257	Dimensions for clamping arrangements for bushings	
IS - 7421	Specification for Low Voltage bushings	
IS - 3347	Specification for Outdoor Bushings	DIN 42531 to 33
IS - 5484	Specification for Al Wire rods	ASTM B - 233
IS - 9335	Specification for Insulating Kraft Paper	IEC 554
IS - 1576	Specification for Insulating Press Board	IEC 641
IS - 6600	Guide for loading of oil Immersed Transformers	IEC 76
IS - 2362	Determination of water content in oil for porcelain bushing of transformer	
IS - 6162	Paper covered Aluminium conductor	
IS - 6160	Rectangular Electrical conductor for electrical machines	
IS - 5561	Electrical power connector	
IS - 6103	Testing of specific resistance of electrical insulating liquids	
IS - 6262	Method of test for power factor and dielectric constant of electrical insulating liquids	
IS - 6792	Determination of electrical strength of insulating oil	
IS - 10028	Installation and maintenance of transformers.	

3 STANDARD RATINGS:

The standard ratings shall be 16, 25, 63, 100,160, 200, 250, 315, 400, 500, 630, 1000, 1250, 1600, 2000 and 2500 kVA for 11 kV distribution transformers and 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600,2000, 2500 kVA for 33 kV distribution transformers.

4 SERVICE CONDITIONS:

4.1 The Distribution Transformers to be supplied against this Specification shall be suitable for satisfactory continuous operation under the following climatic conditions as per IS 2026 (Part - I).

i) Location : At various locations in the country

ii) Maximum ambient air temperature (°C) : 50

iii) Minimum ambient air temperature (°C) : -5

iv) Maximum average daily ambient air temperature (°C):40

v) Maximum yearly weighted average ambient temperature(°C) : 32

vi) Maximum altitude above Altitude of 5000 meters mean sea level (meters) : for HP, J&K, Uttrakhand, Sikkim , Assam, Meghalaya, Manipur, Nagaland, Tripura, Arunachal Pradesh and Mizoram

(iii) Note:

1. The climatic conditions specified above are indicative and can be changed by the user as per requirements.
2. The equipment shall generally be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth unless otherwise specified.

5 PRINCIPAL PARAMETERS:

5.1 The transformers shall be suitable for outdoor installation with three phase, 50 Hz, 11 kV or 33 kV system in which the neutral is effectively earthed and they should be suitable for service with fluctuations in supply voltage upto plus 12.5% to minus 12.5%.

(i) The transformers shall conform to the following specific parameters :

Sl. No.	Item	11 kV Distribution Transformers	33 kV Distribution Transformers
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1	System voltage (Max.)	12 kV	36 kV
2	Rated Voltage (HV)	11 kV	33 kV
3	Rated Voltage (LV)	433 - 250 V*	433 - 250 V*
4	Frequency	50 Hz +/- 5%*	50 Hz +/- 5%
5	No. of Phases	Three	Three
6	Connection HV	Delta	Delta
7	Connection LV	Star (Neutral brought out)	Star (Neutral brought out)
8	Vector group	Dyn-11	Dyn-11
9	Type of cooling	ONAN	ONAN

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed distribution transformers shall be as below (NEMA Standards):

kVA rating	Audible sound levels (decibels)
0-50	48
51-100	51
101-300	55
301-500	56
750	57
1000	58
1500	60
2000	61
2500	62

(iv) TECHNICAL REQUIREMENTS:

6.1.1 CORE MATERIAL

6.1.2.1 The core shall be stack / wound type of high grade Cold Rolled Grain Oriented or Amorphous Core annealed steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer.

6.1.2.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage. CRGO steel for core shall be purchased only from the approved vendors, list of which is available at <http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf>

6.1.2.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall furnish necessary design data in support of this situation.

6.1.2.4 No-load current up to 200kVA shall not exceed 3% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 6% of full load current.

or

No-load current above 200kVA and upto 2500kVA shall not exceed 2% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 5% of full load current.

6.1.2.5 Please refer to “**Check-list for Inspection of Prime quality CRGO for Transformers**” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

7 WINDINGS:

(i) Material:

7.1.1 HV and LV windings shall be wound from Super Enamel covered /Double Paper covered Aluminum

/Electrolytic Copper conductor.

7.1.2 LV winding shall be such that neutral formation will be at top.

7.1.3 The winding construction of single HV coil wound over LV coil is preferable.

7.1.4 Inter layer insulation shall be Nomex /Epoxy dotted Kraft Paper.

7.1.5 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted.

7.1.6 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed Technical Particulars (GTP

Schedule I).

7.1.7 The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

7.1.8 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

8 TAPPING RANGES AND METHODS:

8.1.1 No tapping shall be provided for distribution transformers up to 630 kVA rating.

8.1.2 The tapping shall be as per provisions of IS: 1180 Part-I (2014).

8.1.3 Tap changing shall be carried out by means of an externally operated self-position switch and when the transformer is in de-energised condition. Switch position No.1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Arrangement for pad locking shall be provided. Suitable aluminum anodized plate shall be fixed for tap changing switch to know the position number of tap.

9 OIL:

9.1 The insulating oil shall comply with the requirements of IS 335. Use of recycled oil is not acceptable. The specific resistance of the oil shall be as per IS 335.

9.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.

9.3 The oil shall be filled under vacuum.

9.4 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

10 INSULATION LEVELS:

Sl. No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage(kV)
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1	0.433	-	3
2	11	75	28
3	33	170	70

11 LOSSES:

- 11.1 The transformer of HV voltage up to 11kV, the total losses (no-load + load losses at 75⁰C) at 50% of rated load and total losses at 100% of rated load shall not exceed the maximum total loss values given in Table-3 upto 200kVA & Table-6 for ratings above 200kVA of IS 1180(Part-1):2014.
- 11.2 The maximum allowable losses at rated voltage and rated frequency permitted at 75⁰C for 11/0.433 KVA transformers can be chosen by the utility as per table 3 upto 200 KVA and table 6 for rating above 200 KVA as per Energy Efficiency Level-1 Specified in IS 1180 (Part-1):2014 (amendment-4) for all KVA rating of distribution transformers.
- 11.3 The above losses are maximum allowable and there would not be any positive tolerance. Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above stated values. The utility can evaluate offers with losses lower than the maximum allowable losses on total owning cost basis in accordance with methodology given in Annex-I.

12 TOLERANCES:

- 12.1 No positive tolerance shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

13 PERCENTAGE IMPEDANCE:

The percentage impedance of transformers at 75⁰C for different ratings upto 200 kVA shall be as per Table 3 and for ratings beyond 200 kVA shall be as per Table 6 of IS 1180(Part-1):2014.

14 **Temperature rise:** The temperature rise over ambient shall not exceed the limits given below:

- 14.1 The permissible temperature rise shall be as per IS: 1180 (Part-I):2014.
- 14.2 The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

15 PENALTY FOR NON PERFORMANCE:

- 15.1 During testing at supplier's works if it is found that the actual measured losses are more than the values quoted by the bidder, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.
- 15.2 Purchaser shall reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.
- 15.3 Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance.

16 INSULATION MATERIAL:

- 16.1 Electrical grade insulation epoxy dotted Kraft Paper/Nomex and pressboard of standard make or any other superior material subject to approval of the purchaser shall be used.
- 16.2 All spacers, axial wedges / runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC 641-3-2. In case of cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations.

17.1 TANK:

- Transformer tank construction shall conform in all respect to clause 15 of IS 1180(Part-1):2014.
- The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.
- All joints of tank and fittings shall be oil tight and no bulging should occur during service.
- Inside of tank shall be painted with varnish/hot oil resistant paint.
- The top cover of the tank shall be slightly sloping to drain rain water.

- The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle/Hook Type.
- Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the customer.

i) PLAIN TANK:

17.2.1 The transformer tank shall be of robust construction rectangular/octagonal/round/elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 3.15 mm for the bottom and top and not less than 2.5 mm for the sides for distribution transformers upto and including 25 kVA, 5.0 mm and 3.15 mm respectively for transformers of more than 25 kVA and up to and including 100 kVA and 6 mm and 4 mm respectively above 100 kVA. Tolerances as per IS1852 shall be applicable.

17.2.2 In case of rectangular tanks above 100 kVA the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of 0.8 kg/cm² for 30 minutes. In case of transformers of 100 kVA and below, there shall be no joints at corners and there shall not be more than 2 joints in total.

17.2.3 Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/ sq. cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS 1747 for DT up to 63 KVA. For DT of 63 KVA and above rating, conservator shall be provided.

(i) The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.

(ii) Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than the values as given below:

(All figures are in mm)

Horizontal length of flat plate	Permanent deflection
Up to and including 750	5.0
751 to 1250	6.5

1251 to 1750	8.0
1751 to 2000	9.0

17.2.4 The tank shall further be capable of withstanding a pressure of 0.8kg/sq.cm and a vacuum of 0.7 kg/sq.cm (g) without any deformation.

17.2.5 The radiators can be tube type or fin type or pressed steel type to achieve the desired cooling to limit the specified temperature rise.

17.3 CORRUGATED TANK:

17.3.1 The bidder may offer corrugated tanks for transformers of all ratings.

17.3.2 The transformer tank shall be of robust construction corrugated in shape and shall be built up of tested sheets.

17.3.3 Corrugation panel shall be used for cooling. The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

17.3.4 Tanks with corrugations shall be tested for leakage test at a pressure of 0.25kg/ sq cm measured at the top of the tank.

17.3.5 The transformers with corrugation should be provided with a pallet for transportation, the dimensions of which should be more than the length and width of the transformer tank with corrugations.

18 CONSERVATOR:

(i) Transformers of rating 63 kVA and above with plain tank construction, the provision of conservator is mandatory. For corrugated tank and sealed type transformers with or without inert gas cushion, conservator is not required.

(ii) When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼")] normal size thread with cover. In addition, the cover of the main tank shall be provided with an air release plug.

(iii) The dehydrating agent shall be silica gel. The moisture absorption shall be indicated

by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 500g of silica gel conforming to IS 3401 for transformers upto 200 kVA and 1 kg for transformers above 200 kVA .

- (iv) The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- (v) The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- (vi) The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to -5°C) should be above the sump level.

19 SURFACE PREPARATION AND PAINTING:

(i) GENERAL

- 19.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 19.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is not possible, conventional spray be used with prior approval of purchaser.

19.2 CLEANING AND SURFACE PREPARATION:

- a) After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.
- b) Steel surfaces shall be prepared by shot blast cleaning (IS9954) to grade Sq. 2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).

- c) Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical. Manufacturer to clearly explain such areas in his technical offer.

19.3 PROTECTIVE COATING:

- 19.3.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

19.4 PAINT MATERIAL:

- i) Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site: Heat resistant paint (Hot oil proof) for inside surface
- ii) For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel/polyurethane base paint. These paints can be either air drying or stoving.
- iii) For highly polluted areas, chemical atmosphere or for places very near to the sea coast, paint as above with one coat of high build Micaceous iron oxide (MIO) as an intermediate coat may be used.

19.5 PAINTING PROCEDURE:

- i) All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.
- ii) Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%.

19.6 DAMAGED PAINTWORK:

- (i) Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.
- (ii) Any damaged paint work shall be made good as follows:

- 19.6.2.1 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.

19.6.2.2 A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage.

19.6.2.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

19.6.2.4 The paint shade shall be as per Annexure-Paint which is attached herewith.

19.7 DRY FILM THICKNESS:

19.7.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour.

19.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer’s recommendation.

19.7.3 Particular attention must be paid to full film thickness at the edges.

19.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl. No.	Paint type	Area to be painted	No. of coats	Total dry film thickness (min.) (microns)
1.	Thermo setting powder paint	inside outside	01 01	30 60

2.	Liquid paint			
	a) Epoxy (primer)	outside outside	01	30
	b) P.U. Paint (Finish coat)	inside	02	25 each
	c) Hot oil paint/ Varnish			

			01	35/10
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19.8 TESTS FOR PAINTED SURFACE:

(v)

19.8.1 The painted surface shall be tested for paint thickness.

19.8.2 The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests and Salt spray test and Hardness test as type test as per the relevant ASTM standards.

Note: Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

20 BUSHINGS:

20.1 The bushings arrangement shall be decided by utility during detailed engineering.

20.2 For 33 kV-36 kV class bushings shall be used for transformers of ratings 500 kVA and above. And for transformers below 500 KVA, 33 kV class bushings, for 11 kV - 12 kV class bushings and for 0.433 kV- 1 kV class bushings shall be used.

20.3 Bushing can be of porcelain/epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.

20.4 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257

20.5 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

Voltage	Clearance	
	Phase to phase	Phase to earth
33 kV	350mm	320mm
11 kV	255mm	140mm
LV	75mm	40mm

For DTs of 200 KVA and above, the clearances of cable box shall be as below:

Voltage	Clearance	
	Phase to phase	Phase to earth
33 kV	350mm	220mm
11 kV	130mm	80mm
LV	25mm	20mm

- 20.6 Arcing horns shall be provided on HV bushings.
- 20.7 Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section – IX.
- 20.8 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.
- 20.9 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

21 TERMINAL CONNECTORS:

- 21.1 The LV and HV bushing stems shall be provided with suitable terminal connectors as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561.

22 LIGHTNING ARRESTORS:

- 22.1 9 kV, 5 kA metal oxide lightning arrestors of reputed make conforming to IS 3070 Part-III, one number per phase shall be provided.(To be mounted on pole or to be fitted under the HV bushing with GI earth strip 25x4 mm connected to the body of the transformer with necessary clamping arrangement as per requirement of purchaser.) Lightning arrestors with polymer insulators in conformance with relevant IEC can also be used. 1 clamp for LA shall also be provided for each HT bushing. Supply of LA is not included in DT supplier’s scope.

23 CABLE BOXES:

No cable box shall be provided in transformer below 200 kVA. Above 200kVA, Cable Boxes shall be provided on both HV & LV side.

- 23.1 In case HV/LV terminations are to be made through cables the transformer shall be fitted with suitable cable box on 11 kV side to terminate one 11kV/ 3 core aluminium

conductor cable up to 240 sq. mm. (Size as per requirement).

The bidder shall ensure the arrangement of HT Cable box so as to prevent the ingress of moisture into the box due to rain water directly falling on the box. The cable box on HT side shall be of the split type with faces plain and machined and fitted with Neo-k-TeX or similar quality gasket and complete with brass wiping gland to be mounted on separate split type gland plate with nut-bolt arrangement and MS earthing clamp. The bushings of the cable box shall be fitted with nuts and stem to take the cable cores without bending them. The stem shall be of copper with copper nuts. The cross section of the connecting rods shall be stated and shall be adequate for carrying the rated currents. On the HV side the terminal rod shall have a diameter of not less than 12 mm. The material of connecting rod shall be copper. HT Cable support clamp should be provided to avoid tension due to cable weight.

- 23.2 The transformer shall be fitted with suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression brass glands on LV side to terminate 1.1 kV/single core XLPE armoured cable (Size as per requirement).

24 **TERMINAL MARKINGS:**

High voltage phase windings shall be marked both in the terminal boards inside the tank and on the outside with capital letter 1U, 1V, 1W and low voltage winding for the same phase marked by corresponding small letter 2U, 2V, 2W. The neutral point terminal shall be indicated by the letter 2N. Neutral terminal is to be brought out and connected to local grounding terminal by an earthing strip.

- 26.1 The following standard fittings shall be provided :

- i. Rating and terminal marking plates, non-detachable.
- ii. Earthing terminals with lugs - 2 Nos.
- iii. Lifting lugs for main tank and top cover
- iv. Terminal connectors on the HV/LV bushings (For bare terminations only).
- v. Thermometer pocket with cap - 1 No.
- vi. Air release device (for non-sealed transformer)
- vii. HV bushings - 3 Nos.
- viii. LV bushings - 4 Nos.
- ix. Pulling lugs
- x. Stiffener

- xi. Radiators - No. and length may be mentioned (as per heat dissipation calculations)/ corrugations.
- xii. Arcing horns on HT side - 3 No . Only clamps for lightning arrester shall be provided.
- xiii. Prismatic oil level gauge.
- xiv. Drain cum sampling valve.
- xv. One filter valve on upper side of the transformer (For transformers above 200 kVA)
- xvi. Oil filling hole having p. 1- ¼ ‘’ thread with plug and drain plug on the conservator.
- xvii. Silica gel breather (for non-sealed type transformer)
- xviii. Base channel 75x40 mm for up to 100 kVA and 100 mmx50 mm above 100 kVA, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- xix. 4 No. rollers for transformers of 200 kVA and above.
- xx. Pressure relief device or explosion vent (above 200 kVA)
- xxi. Oil level gauge
 - A. -5 °C and 90°C marking for non-sealed type Transformers
 - B.- 30°C marking for sealed type transformers
- xxii. Nitrogen / air filling device/ pipe with welded cover
Capable of reuse (for sealed type transformers)
- xxiii. Inspection hole for transformers above 200 kVA
- xxiii. Pressure gauge for sealed type transformers above 200 kVA.
- xxiv. Buchholz relay for transformers above 1000 KVA.

27 FASTENERS:

- 27.1 All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.
- 27.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.
- 27.3 All nuts and pins shall be adequately locked.

- 27.4 Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.
- 27.5 All bolts/nuts/washers exposed to atmosphere should be as follows.
- a) Size 12 mm or below – Stainless steel
 - b) Above 12 mm- steel with suitable finish like electro galvanized with passivation or hot dip galvanized.
- 27.6 Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.
- 27.7 The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.
- 27.8 Taper washers shall be provided where necessary.
- 27.9 Protective washers of suitable material shall be provided front and back of the securing screws.
- 28 OVERLOAD CAPACITY:**
- 28.1 The transformers shall be suitable for loading as per IS 6600.
- 29 TESTS:**
- 29.1** All the equipment offered shall be fully type tested by the bidder or his collaborator as per the relevant standards including the additional type tests. The type test must have been conducted on a transformer of same design **during the last five years** at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer. **In case, the offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type tests at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.**
- 29.2 Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards.
- 29.3 The requirements of site tests are also given in this clause.

- 29.4 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted with the bid.
- 29.5 The procedure for testing shall be in accordance with IS1180 (Part-1) :2014 /2026 as the case may be except for temperature rise test.
- 29.6 Before dispatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.
- 30 ROUTINE TESTS:**
- 30.1 Ratio, polarity, phase sequence and vector group.
- 30.2 No Load current and losses at service voltage and normal frequency.
- 30.3 Load losses at rated current and normal frequency.
- 30.4 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted after the receipt of order.
- 30.5 Impedance voltage test.
- 30.6 Resistance of windings at each tap, cold (at or near the test bed temperature).
- 30.7 Insulation resistance.
- 30.8 Induced over voltage withstand test.
- 30.9 Separate source voltage withstand test.
- 30.10 Neutral current measurement-The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.
- 30.11 Oil samples (one sample per lot) to comply with IS 1866.
- 30.12 Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.
- 30.13 Pressure and vacuum test for checking the deflection on one transformer of each type in every inspection.

31 TYPE TESTS TO BE CONDUCTED ON ONE UNIT:

In addition to the tests mentioned in clause 30 and 31 following tests shall be conducted:

- 31.1 Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.
- 31.2 Impulse voltage test: with chopped wave of IS 2026 part-III. BIL for 11 kV shall be 75 kV peak.
- 31.3 Short circuit withstand test: Thermal and dynamic ability.
- 31.4 Air Pressure Test: As per IS – 1180 (Part-1):2014.
- 31.5 Magnetic Balance Test.
- 31.6 Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.
- 31.7 Noise-level measurement.
- 31.8 Measurement of zero-phase sequence impedance.
- 31.9 Measurement of Harmonics of no-load current.
- 31.10 “Vacuum Type Test on Transformer Tank” shall be carried out as per IS 1180 (Part-1): 2014 i.e. The transformer tank shall be subjected to air pressure 80 kPa for 30 minutes and vacuum of 250 mm of mercury for 30 minutes. * The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

*Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18/D.No. 3091 dated 25.08.2017

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.0

- 31.11 Transformer tank together with its radiator and other fittings shall be subjected to pressure corresponding to twice the normal pressure or 0.35 kg / sq.cm whichever is lower,

measured at the base of the tank and maintained for an hour. The permanent deflection of the flat plates after the excess pressure has been released, shall not exceed the figures for vacuum test.

31.12 Pressure relief device test: The pressure relief device shall be subject to increasing fluid pressure. It shall operate before reaching the test pressure as specified in the above class. The operating pressure shall be recorded. The device shall seal-off after the excess pressure has been released.

31.13 **Short Circuit Test and Impulse Voltage Withstand Tests:** The purchaser intends to procure transformers designed and successfully tested for short circuit and impulse test. In case the transformers proposed for supply against the order are not exactly as per the tested design, the supplier shall be required to carry out the short circuit test and impulse voltage withstand test at their own cost in the presence of the representative of the purchaser.

31.13.1 The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.

31.13.2 Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.

31.13.3 It may also be noted that the purchaser reserves the right to conduct short circuit test and impulse voltage withstand test in accordance with the IS, afresh on each ordered rating at purchaser cost, even if the transformers of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the purchaser either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the supplier.

32 ACCEPTANCE TESTS:

32.1 **At least 10% transformers of the offered lot (minimum of one)** shall be subjected to the following routine/ acceptance test in presence of purchaser's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS:1180 (Part-1): 2014 and IS:2026.

32.2 Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil

quality, material, finish and workmanship as per GTP and contract drawings on one transformer of each type in every inspection.

32.3 Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report.

32.4 Temperature rise test on one unit of the total ordered quantity.

33 TESTS AT SITE:

(vi)

The purchaser will conduct the following test on receipt of transformers in their store. The utility shall arrange all equipment, tools & tackle and manpower for the testing. The bidder will depute his representative to witness the same. All such test shall be conducted by utility not later than 10 days from receipt of transformers.

i) Megger Test

ii) Ratio test

34 INSPECTION:

34.1 In respect of raw material such as core stampings, winding conductors, insulating paper and oil, supplier shall use materials manufactured/supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the purchaser. The bidder shall furnish following documents along with their offer in respect of the raw materials:

i. Invoice of supplier.

ii. Mill's certificate.

iii. Packing list.

iv. Bill of landing.

v. Bill of entry certificate by custom.

Please refer to “**Check-list for Inspection of Prime quality CRGO for Transformers**” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

35 INSPECTION AND TESTING OF TRANSFORMER OIL:

- 35.1 To ascertain the quality of the transformer oil, the original manufacturer's tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil as per IS: 335 , after taking out the sample from the manufactured transformers and tested in the presence of purchaser's representative.
- 35.2 To ensure about the quality of transformers, the inspection shall be carried out by the purchaser's representative at following two stages:-
- 35.2.1 Anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.
- 35.2.2 At finished stage i.e. transformers are fully assembled and are ready for dispatch.
- 35.3** The stage inspection shall be carried out in accordance with **Annexure-II**.
- 35.4 After the main raw-material i.e. core and coil material and tanks are arranged and transformers are taken for production on shop floor and a few assembly have been completed, the firm shall intimate the purchaser in this regard, so that an officer for carrying out such inspection could be deputed, as far as possible within seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled to ensure that the laminations used are of good quality. Further, as and when the transformers are ready for despatch, an offer intimating about the readiness of transformers, for final inspection for carrying out tests as per relevant IS shall be sent by the firm along with Routine Test Certificates. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection. The proforma for pre delivery inspection of Distribution transformers is placed at **Annex- III**.
- 35.5 In case of any defect/defective workmanship observed at any stage by the purchaser's Inspecting Officer, the same shall be pointed out to the firm in writing for taking remedial measures. Further processing should only be done after clearance from the Inspecting Officer/ purchaser.
- 35.6 All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall offer the Inspector representing the Purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include Stage Inspection during manufacturing stage as well as Active Part Inspection during Acceptance Tests.
- 35.7 The manufacturer shall provide all services to establish and maintain quality of workman ship in his works and that of his sub-contractors to ensure the mechanical /electrical performance of components, compliance with drawings, identification

and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.

35.8 Purchaser shall have every right to appoint a third party inspection to carry out the inspection process.

35.9 The purchaser has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality supplied. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation purchaser have every right to reject the entire lot or penalize the manufacturer, which may lead to blacklisting, among other things.

36 QUALITY ASSURANCE PLAN:

36.1 The bidder shall invariably furnish following information along with his bid, failing which his bid shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

36.2 Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in the presence of bidder's representative, copies of test certificates.

36.3 Information and copies of test certificates as above in respect of bought out accessories.

36.4 List of manufacturing facilities available.

36.5 Level of automation achieved and list of areas where manual processing exists.

36.6 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.

36.7 List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports. These shall be furnished with the bid. Manufacturer shall possess 0.1 accuracy class instruments for measurement of losses.

36.8 Quality Assurance Plan (QAP) withhold points for purchaser's inspection.

36.9 The successful bidder shall within 30 days of placement of order, submit following information to the purchaser :

36.9.1 List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.

36.9.2 Type test certificates of the raw materials and bought out accessories.

36.9.3 The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing.

36.9.4 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformers- 2015, issued by Department of Heavy Industries, Government of India, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1: (2014).

37 DOCUMENTATION:

37.1 The bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.

37.2 Dimensional tolerances.

37.3 Weight of individual components and total weight.

37.4 An outline drawing front (both primary and secondary sides) and end-elevation and plan of the tank and terminal gear, wherein the principal dimensions shall be given.

37.5 Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.

37.6 Typical general arrangement drawing showing both primary and secondary sides and end- elevation and plan of the transformer.

38 PACKING AND FORWARDING:

38.1 The packing shall be done as per the manufacturer's standard practice. However, it should be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea.

38.2 The marking on each package shall be as per the relevant IS.

39 GUARANTEE

39.1 The material will be guaranteed for a period of at least 60 calendar months from the date of installation at the site or 66 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the “maintenance period.” If the material is damaged within the guaranteed period, it shall be replaced/repared by the supplier free of cost within one month of receipt of intimation. If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 24 months. The total guarantee period will now be 84/90 months as applicable.”

Both stage and final inspection of at least 10-20 percent of the quantity of repaired transformer will be carried out at the manufacturer’s works/local repairing center. The manufacturer has to inform the address of the local repairer in advance. In case, the repair work/replacement of transformer is not effected within three months of the above notice/intimation the consignees will ensure deduction of the amount equal to the price of new transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

The outage period i.e., from the date of failure till unit is repaired/replaces shall not be counted for arriving at the guarantee period. In the event of the supplier’s inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period. Further, installation of 10 percent Distribution Transformers (both new and repaired) shall be carried out in the supervision of manufacturer’s representative.

40 SCHEDULES:

42.1 The bidder shall fill in the following schedule which will be part of the offer. If the schedule are not submitted duly filled in with the offer, the offer shall be liable for rejection.

Schedule-A : Guaranteed Technical Particulars

Schedule-B : Schedule of Deviations

41 DEVIATIONS :

43.1 The bidders are not allowed to deviate from the principal requirements of the Specifications. However, the bidder is required to submit with his bid in the relevant schedule a detailed list of all deviations without any ambiguity. In the absence of a deviation list in the deviation schedules, it is understood that such bid conforms to the bid specifications and no post-bid negotiations shall take place in this regard.

43.2 The discrepancies, if any, between the specification and the catalogues and / or literatures submitted as part of the offer by the bidders, shall not be considered and

representations in this regard shall not be entertained.

43.3 If it is observed that there are deviations in the offer in guaranteed technical particulars other than those specified in the deviation schedules then such deviations shall be treated as deviations.

43.4 All the schedules shall be prepared by vendor and are to be enclosed with the bid.

(vii) Annex-I

METHODOLOGY FOR COMPUTING TOTAL OWNING COST*

TOC = IC + (A xWi) + (B xWc) ; Losses in KW	
Where,	
TOC	= Total Owing Cost
IC	= Initial cost including taxes of transformer as quoted by the manufacturer
A factor	= Cost of no load losses in Rs/KW (A = 288239)
B factor	= Cost of load losses in Rs/KW (B = 93678)
Wi	= No load losses quoted by the manufacturer in KW
Wc	= Load losses quoted by the manufacturer in KW

Note: No (+)ve tolerance shall be allowed at any point of time on the quoted losses after the award. In case, the losses during type testing, routine testing etc are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

* Amendment issued vide letter No. REC/DDUGJY/SBD/DTR-TS/969 Dated 29.09.2016

Annexure-Paint

Painting-Transformer Main tank, pipes, Conservator Tank, Radiator etc.-

	Surface Preparation	primer coat	intermediate under coat	finish coat	total DFT	Colour shade
Main tank, pipes, conservator tank, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer 30-40 micron	Epoxy base Zinc primer 30-40 micron	Aliphatic Polyurethane (PU Paint) (min 50 micron)	Min 110 micron	541 shade of IS:5
Main tank, pipes (above 80 NB), conservator tank, etc (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint	--	--	Min 30 micron	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer 30-40 micron	Epoxy base Zinc primer Min 30-40 micron	Aliphatic Polyurethane (PU Paint) (min)50 micron	Min 110 micron	541 shade of IS:5
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning if required	Hot oil proof low viscosity varnish or hot oil resistant non corrosive paint	--	--	--	Glossy white for paint

PROFORMA FOR STAGE INSPECTION OF DISTRIBUTION TRANSFORMERS**(A) GENERAL INFORMATION:**

1. Name of firm : M/s.
2. Order No. and Date :
3. Rating-wise quantity offered :
4. Details of offer
 - a) Rating
 - b) Quantity
 - c) Serial Numbers
5. Details of last stage inspected lot:
 - a) Total quantity inspected
 - b) Serial Numbers
 - c) Date of stage inspection
 - d) Quantity offered for final inspection of
(a) above with date

(B) Availability of material for offered quantity :

Details to be filled in

(C) Position of manufacturing stage of the offered quantity :

- a) Complete tanked assembly
- b) Core and coil assembly ready
- c) Core assembled
- d) Coils ready for assembly
 - (i) HV Coils
 - (ii) LV Coils

Note: (i) A quantity of less than 100 Nos. shall not be entertained for stage inspection. If the awarded quantity is less than 100 Nos., then whole lot shall be offered in single lot.

- (ii) The stage inspection shall be carried out in case :-
 - (a) At least 25% quantity offered has been tanked and

- (b) core coil assembly of further at least 30% of the quantity offered has been completed.
- (iii) Quantity offered for stage inspection should be offered for final Inspection within 15 days from the date of issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

Sl · No	Particulars	As offered	As observed	Deviation and Remarks
(D)	<u>Inspection of Core:</u>			
	(1) Core Material (1) Manufacturer's Characteristic Certificate in respect of grade of lamination used. (Please furnish test certificate)			
	(2) Remarks regarding Rust ting and smoothness of core.			
	(3) Whether laminations used for top and bottom yoke are in one piece.			
	(II) Core Construction :			
	(1) No. of Steps			
	(2) Dimension of Steps			
	Step No. 1 2 3 4 5 6 7 8 9 10 11 12			
	As offered:			
	W mm			
	T mm			
	As found:			
	W mm			

T mm									
	(3) Core Dia (mm)								
	(4) Total cross Section area of core								
	(5) Effective cross Sectional area of core								
	(6) Clamping arrangement								
	(i) Channel Size								
	(ii) Bolt size and No.								
	(iii) Tie Rods size and No.								
	(iv) Painting								
	(a) Channels								
	(b) Tie Rods								
	(c) Bolts								
	(7) Whether top yoke is cut for LV connection.								
	(8) If yes, at 7 above, whether Reinforcement is done.								
	<p>(9) Size of Support Channels provided for Core base and bottom yoke (Single piece of channels are only acceptable) This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be provided.</p> <p>This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be provided.</p>								
	(10) Thickness of insulation provided between core base and support channel.								

	(11) core length (leg center to leg center)			
	(12) Window height			
	(13) Core height			
	(14) Core weight only (without channels etc.)			
(E)	INSPECTION OF WINDING			
	(I) Winding material			
	(1) Material used for			
	(a) HV winding			
	(b) LV winding			
	(2) Grade of material for			
	(a) HV winding			
	(b) LV winding			
	3) Test certificate of manufacturer (enclose copy) for winding material of:			
	(a) HV			
	(b) LV			
	(II) CONSTRUCTIONAL DETAILS			
	(1) Size of Cross Sectional area of conductor for :			
	(a) HV winding			

	(b) LV winding			
	(2) Type of insulation for conductor of :			
	a) HV winding			
	(b) LV winding			
	(3) Diameter of wire used for delta formation (mm)			

	(4) Diameter of coils in:			
	a) LV winding			
	i) Internal dia (mm)			
	ii) Outer dia (mm)			
	b) HV winding			
	i) Internal dia (mm)			
	ii) Outer dia (mm)			
	(5) Current Density of winding material used for :			
	(a) HV			
	(b) LV			
	(6) Whether neutral formation on top.			
	(7) HV Coils/ Phase			
	a) Number			
	b) Turns / coil			
	c) Total turns			
	(8) LV Coils/ Phase			
	a) Number			
	b) Turns / coil			
	c) Total turns			
	(9) Method of HV Coil Joints			
	(10) Total weight of coils of			
	a) LV winding (kg)			
	b) HV winding (kg)			
(F)	INSULATION MATERIALS :			
	(I) MATERIAL :			
	1) Craft paper			
	a) Make			
	b) Thickness (mm)			
	c) Test Certificate of manufacturer (enclose copy).			

	2) Press Board			
	a) Make			
	b) Thickness (mm)			
	c) Test Certificate of manufacturer (enclose copy).			
	3) Material used for top and bottom yoke and insulation			
	(II) Type and thickness of material used : (mm)			
	a) Between core and LV			
	b) Spacers			
	c) Inter layer			
	d) Between HV and LV winding			
	e) Between phases			
	f) End insulation			
(G)	CLEARANCES : (mm)			
	(I) Related to core and windings			
	1) LV to Core (Radial) 2) Between HV and LV (Radial)			
	3) (i) Phase to phase between HV Conductor			
	(ii) Whether two Nos. Press Board each of minimum 1 mm thick provided to cover the tie rods.			
	4) Thickness of locking spacers between LV coils (mm)			
	5) Axial wedges between HV			

	and LV coils / phase (Nos.)			
	6) No. of radial spacers per phase between HV coils			
	7) Size of duct between LV and HV winding (mm)			
	(II) Between core - coil assembly and tank : (mm)			
	1) Between winding and body:			
	a) Tank lengthwise			
	b) Tank Breadth wise			
	2) Clearance between top cover and top yoke upto 100 kVA and between top cover and top most live part of tap changing switch for 200 kVA and above.			
(H)	TANK : (I) Constructional details : 1) Rectangular shape 2) Thickness of side wall (mm) 3) Thickness of top and bottom plate (mm) 4) Provision of slopping top cover towards HV bushing.			

GUARANTEED TECHNICAL PARTICULARS

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
1	Name of manufacturer		
2	Place of Manufacturing		
3	Transformer capacity	KVA	
4	Voltage	11/0.433-0.250 KV	
5	No. of Phases	3 No./1 No.	
6	Vector Group	DY-11	
7	Type of Cooling	ONAN	
8	Type of Transformer	Sealed/Unsealed	
9	For 200 KVA/500 KVA transformers		
	a) No. of tap positions in HV winding		
	b) Voltage variation		
10	Energy Efficiency Level	Level-1	
11	Losses		
i	Core loss	Watts	
	a) at Normal Voltage	Watts	
	b) at Maximum Voltage	Watts	
ii	Full Load losses at 75 deg.C.	Watts	
iii	Total losses at 50 % loading at 75 deg.C.	Watts	
iv	Total losses at 100 % loading at 75 deg.C.	Watts	
12	Percentage Impedance at 75 deg.C.	%	
13	Maximum temperature rise of		
	a) Windings by resistance method	40 deg C (35 deg C for 5KVA)	
	b) Oil by Thermometer	35 deg C (30 deg C for 5KVA)	
14	Clearances		
	a) Core & LV	mm	
	b) LV & HV	mm	
	c) HV Phase to Phase	mm	
	d) End insulation clearance to Earth	mm	
	e) Any point of winding to tank	mm	
	f) HV to earth creepage distance	mm	

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	g) LV to earth creepage distance	mm	
15	Efficiency at 75 deg.C.		
	a) Unity P.F.		
	1) 125% load	%	
	2) 100% load	%	
	3) 75% load	%	
	4) 50% load	%	
	5) 25% load	%	
	b) 0.8 P.F.		
	1) 125% load	%	
	2) 100% load	%	
	3) 75% load	%	
	4) 50% load	%	
	5) 25% load	%	
16	Regulation at		
	a) Unity P.F.		
	b) 0.8 P.F. at 75 deg.C.		
17	CORE	CRGO/ Amorphous	
i	Core Grade		
ii	Core diameter	mm	
iii	Gross Core area	Mtr ²	
iv	Net Core area	Mtr ²	
v	Flux density	Wb/Mtr ²	
vii	Wt. of Core	Kg	
viii	Loss per kg. of Core at the specified Flux density	Watts	
ix	Core window height	mm	
x	Centre to centre distance of the core	mm	
xi	The nominal flux density at		
	a) 100% rated voltage	≤1.69 Wb/Mtr ²	
	b) 110% of rated voltage	≤1.9 Wb/Mtr ²	
xii	% No load current of full load current at rated voltage and frequency on the secondary and Increase of voltage by 112.5%		
	(i) CRGO Core: at 100% and 112.5% of rated		

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	Voltage		
	a)Up to 200 KVA Transformer	≤ 3% and ≤ 6 %	
	b) Above 200 KVA Transformer	≤ 2% and ≤ 5 %	
	(ii) Amorphous Core: at 100% and 112.5% of rated Voltage		
	a) All Ratings	≤ 2% and ≤ 5 %	
18	WINDINGS	Aluminium Copper	
i	No. of L.V. Turns	No.	
ii	No. of H V turns	No.	
iii	Size of LV Conductor bare/ covered	mm	
iv	Size of HV conductor bare/covered	mm	
v	No. of parallels	No.	
vii	Resistance of HV winding at 20 deg.C	Ohm	
viii	Resistance of LV winding at 20 deg.C	Ohm	
ix	Current density of LV winding	Amps/sq.mm.	
x	Current density of HV winding	Amps/sq.mm.	
xi	Wt. of the LV winding for Transformer	kg.	
xii	Wt. of the HV winding for Transformer	kg.	
xiii	No. of LV Coils/phase	No.	
xiv	No. of HV coils / phase	No.	
xv	Height of LV Windings	mm	
xvi	Height of HV winding	mm	
xvii	ID/OD of LV winding	mm	
xviii	ID/OD of HV winding	mm	
xix	Size of the duct in LV winding	mm	
xx	Size of the duct in HV winding	mm	
xxi	Size of the duct between HV & LV	mm	
xxii	Inter layer insulation provided in design for		
	1) Top & bottom layer		
	2) In between all layer		
	3) Details of end insulation		
	4) Whether wedges are provided at 50% turns of the HV coil		
xxiii	Insulation materials provided		
	a) For Conductors		

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	(1) HV		
	(2) LV		
	B) For Core		
xxiv	Material and Size of the wire used		
	1) HV a) SWG	No.	
	b) Dia	mm	
	2) LV a) Strips size	mm X mm	
	b) No. of Conductors in parallel	No	
	c) Total area of cross section	sq.mm.	
19	Weight content of		
	a) Core lamination (min)	KG	
	b) Windings (min) Aluminium/Copper	KG	
	c) Tank & Fittings	KG	
	d) Oil	KG	
	e) Oil qty (min)	Litre	
	f) Total Weight	KG	
20	Oil Data		
	1. Qty for first filling (min)	Litre	
	2. Grade of oil used		
	3. Maker's name		
	4. BDV at the time of filling	KV	
21	Transformer		
	1) Overall length x breadth x height	mm X mm X mm	
	2) Shape of Tank		
	2) Tank length x breadth x height	mm X mm X mm	
	3) Thickness of plates for		
	a) Side plate (min)	mm	
	b) Top & Bottom plate (min)	mm	
	4) Conservator Dimensions	mm X mm	
	5) Tank base channel dimensions	mm X mm X mm	
22	HV Bushings & Terminals		
	1) Make of HV bushing		
	2) Rating in KV	KV	
	3) Turret Height	mm	
	4) Material of HV terminal	Brass/Copper	

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	5) Current Density of HV terminal	Amps/ <u>sq.mm.</u>	
23	LV Bushings & Terminals		
	1) Make of LV bushing		
	2) Rating in KV	KV	
	3) Turret Height	mm	
	4) Material of LV terminal	Brass/Copper	
	5) Current Density of LV terminal	Amps/ <u>sq.mm.</u>	
24	Details of MCCB		
	(for transformers having rating upto 25		
	Make		
	Rated thermal current	Amp.	
	Current setting	Amp.	
	Minimum short circuit breaking current	KA	
25	Radiation		
	1) Heat dissipation by tank walls exclusive top & bottom		
	2)Heat dissipation by cooling tube		
	3)Dia & thickness of cooling tube		
	4) Whether calculation sheet for selecting cooling area to ensure that the transformer is capable of giving continuous rated output without exceeding temperature rise is enclosed.	Yes/No	
26	Whether the name plate gives all particulars as required in Tender	Yes/No	
27	Whether the transformer offered is already type tested for the design and test reports enclosed	Yes/No	

Name Plate Details

Digit/letter No.	Details	TIN	Remark
1	Name of Company	M	First letter of DISCOM name
2	KVA rating	5	for 5/10/16/25/63/100/200/500 KVA ratings digits will be respectively 1/2/3/4/5/6/7/8
3	Type of Core Material	1	CRGO-1, Amorphous-2
4	Core construction	1	Stack-1, Wound-2
5	Supplier Name Code	1	each supplier will be given 2 digit code no. e.g. M/s XYZ given code no.15
6		5	
7	Month of manufacturing	0	2 digits for Month of manufacturing
8		2	
9	Year of manufacturing	1	2 digits for Year of manufacturing
10		7	
11	CPP Tender No.	9	4 digits for CPP tender no.
12		0	
13		3	
14		2	
15	Sr. No. of transformer given by Supplier	0	5 digits for transformer sr. no. given by supplier (e.g. M/s XYZ will give transformer sr. no. from 00001 to 00260 for P.O. of 260 no. transformers issued to them vide CPP tender no.9032)
16		0	
17		0	
18		0	
19		1	

4. ACSR Conductor

1. SCOPE

This section covers design, manufacture, testing before dispatch, packing, supply and delivery for destination of Kms of ACSR Squirrel, Weasel, Rabbit", Raccoon, Dog and Panther Conductor.

2. STANDARDS

The Conductor shall also comply in all respects with the IS: 398(Part- II)-1996 with latest amendments unless otherwise stipulated in this specification or any other International Standards which ensure equal or higher quality material.

The ACSR Conductor shall also conform to the following standards.

Sl . N o.	Indian Standards	Title	International
1	IS:209-1979	Specification for Zinc	BS-3436-1961
2	IS:398-1996	Specification for aluminum conductors for overhead transmission purposes.	
	Part-II	Aluminum conductors	IEC-209-1966
		Galvanized steel reinforced	BS-215(Part-II)
3	IS:1521-1972	Method of Tensile Testing of Steel wire	ISO/R89-1959
4	IS:1778-1980	Reels and Drums for Bare conductors	BS-1559-1949
5	IS:1841-1978	E.C. Grade Aluminum rod produced by rolling	
6	IS:2629-1966	Recommended practice for Hot Dip Galvanizing of iron and steel	
7	IS:2633-1986	Method of testing uniformity of coating of zinc coated articles.	
8	IS:4826-1968	Galvanized coatings on round steel wires.	ASTM A472-729
9	IS:5484-	E.C. Grade Aluminium rod produced by	

	1978	continuous casting and rolling.	
10	IS:6745-1972	Methods of determination of weight of zinc-coating of zinc coated iron and steel articles	BS-443-1969

Offers conforming to standards other than IS-398 shall be accompanied by the English version of relevant standards in support of the guaranteed technical particulars to be furnished as per format enclosed.

3. GENERAL TECHNICAL REQUIREMENTS

The General Technical Requirements are given in Section-II. The Conductor shall conform to these technical requirements.

The Bidder shall furnish guaranteed technical particulars in Section-III.

3.1. MATERIALS/WORKMANSHIP

3.1.1. The material offered shall be of best quality and workmanship. The steel cored aluminum conductor strands shall consist of hard drawn aluminium wire manufactured from not less than 99.5% pure electrolytic aluminium rods of E.C. grade and copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889- 1987. The steel wire shall be made from material produced either by the acid or basic open hearth process or by electric furnace process or basic oxygenprocess. Steel wire drawn from Bessemer process shall not be used.

3.1.2. The steel wires shall be evenly and uniformly coated with electrolytic high grade, 99.95% purity zinc complying with the latest issue of IS-209 for zinc. The uniformity of zinc coating and the weight of coating shall be in accordance with Section-II and shall be tested and determined according to the latest IS-2633 or any other authoritative standard.

3.1.3. The steel strands shall be hot dip galvanized as per IS: 4826. The coating shall be smooth, continuous, and of uniform thickness, free from imperfections and shall withstand minimum three dips after stranding in standard preece test. The steel strands shall be preformed and postformed in order to prevent spreading of strands in the event of cutting of composite core wire. The properties and characteristics of finished strands and individual wires shall be as prescribed in IEC: 888- 1987. If tested after

stranding, reference shall also be made to cl. 4.1.1 and cl. 4.2.3 of IS : 4826.

4. CONDUCTOR PARAMETERS

The Parameters of individual strands and composite steel cored aluminum conductor, shall be in accordance with the values given in Section-II. Creep in a conductor is attributed partly due to settlement of strands and partly due to non-elastic elongation of metal when subjected to load. The manufacturer of conductor shall furnish the amount of creep which will take place in 10, 20, 30, 40 and 50 years along with the supporting calculations. The calculations should be based on everyday temperature of 32 °C and everyday tension of 25% of UTS of conductor of 11/33 KV Lines.

5. TOLERANCES

The tolerances on standard diameter of Aluminum and Steel wires shall be as detailed in specific technical requirements.

The cross-section of any wire shall not depart from circularity by more than an amount corresponding to the tolerance on the standard diameter. The details of diameters, lay ratios of Aluminum and steel wires shall be in accordance with the Section-II "Technical Requirements".

6. SURFACE CONDITIONS

All aluminum and steel strands shall be smooth, and free from all imperfections, spills/and splits. The finished conductor shall be smooth, compact, uniform and free from all imperfections including spills and splits, die marks, scratches, abrasions, scuff marks, kinks (protrusion of wires), dents, pressmarks, cut marks, wire cross-over, over-riding looseness, pressure and/or unusual bangle noise on tapping, material inclusions, white rust, powder formation or black spots (on account of reaction with trapped rain water etc.), dirt, grit, etc. The surface of conductor shall be free from points, sharp edges, abrasions or other departures from smoothness or uniformity of surface contour that would increase radio interference and corona losses. When subjected to tension upto 50% of the ultimate strength of the conductor, the surface shall not depart from the cylindrical form nor any part of the component parts or strands move relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

7. JOINTS IN WIRES

7.1. Aluminum wires

During stranding, no aluminum wire welds shall be made for the purpose of achieving the required conductor length.

No joint shall be permitted in the individual aluminum wires in the outer most layer of the finished Conductor. However, joints in the 12 wire & 18 wire inner layer of the conductor are permitted but these joints shall be made by the cold pressure butt welding and shall be such that no two such joints shall be within 15 meters of each other in the complete stranded conductor.

7.2. Steel wires

There shall be no joints in finished steel wires forming the core of the steel reinforced aluminum conductor.

8. STRANDING

The wires used in construction of the stranded conductor, shall, before stranding, satisfy all requirements of IS-398 (Part-II) 1996.

In all constructions, the successive layers shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the underlying wire or wires. The outer most layer of wires shall have a right hand lay. The lay ratio of the different layers shall be within the limits given under Section-II.

9. PACKING

9.1. The conductor shall be supplied in non-returnable strong wooden drums provided with lagging of adequate strength constructed to protect the conductor against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS-1778-1980 and latest version except as otherwise specified hereinafter. The conductor drums shall be adequate to wind one or more standard length of 2500 meters of SQUIRREL/WEASEL/RABIT/RACOON/DOG/ PANTHER ACSR conductor.

9.2. The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5KN. The conductor drums shall be provided with necessary clamping arrangements so as to be suitable for tension stringing of power conductor.

- 9.3. The bidders should submit their drawings of the conductor drums along with the bid. After placement of letter of intent the Manufacturer shall submit four copies of fully dimensioned drawing of the drum for Employer's approval. After getting approval from the Employer, Manufacturer shall submit 30 more copies of the approved drawings for further distribution and field use.
- 9.4. All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti fungus shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.
- 9.5. All flanges shall be 2-ply construction with 64 mm thickness. Each ply shall be nailed and clenched together at approximately 90 degrees. Nails shall be driven from the inside face of the flange, punched and then clenched on the outer face. Flange boards shall not be less than the nominal thickness by more than 2 mm. There shall not be less than 2 nails per board in each circle.
- 9.6. The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.
- 9.7. Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.
- 9.8. Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be countersunk. The ends of the barrel shall generally be flushed with the top of the nuts.
- 9.9. The inner cheek of the flanges and drum barrel surface shall be painted with bitumen based paint.
- 9.10. Before reeling, card board or double corrugated or thick bituminized waterproof bamboo paper or HDPE sheet shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. The paper should be dried before use. After reeling the conductor the exposed surface of the outer layer of conductor shall be

wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.

- 9.11. A minimum space of 75 mm shall be provided between the inner surface of the external protective lagging and outer layer of the conductor. Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/galvanised steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 9.12. Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nail shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.
- 9.13. The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges.
- 9.14. Only standard lengths of conductor shall be wound on each drum. The method of lagging to be employed shall be clearly stated in the tender.
- 9.15. As an alternative to wooden drum Bidder may also supply the conductors in non-returnable painted steel drums. The painting shall conform to IS:9954-1981, reaffirmed in 1992. Wooden/ steel drum will be treated at par for evaluation purpose and accordingly the Bidder should quote the package.

10. LABELLING AND MARKING

The drum number shall be branded or gauged or stencilled into the flange. An arrow shall be marked on the sides of the drum, together with the words "Roll this way". Each drum shall have the following information provided on the outside of the flange stencilled with indelible ink.

- i) Manufacturer's name and address.
- ii) Contract/Specification number.
- iii) Size and type of conductor.
- iv) Net weight of the conductor.
- v) Gross weight of the conductor and drum.
- vi) Length of the conductor.
- vii) Position of the conductor end.
- viii) Drum and lot number.
- ix) Name and address of the consignee.

- x) Month and year of manufacture.
- xi) The drum may also be marked with standard specification as per which the conductor is manufactured.

11. STANDARD LENGTHS

- 11.1. The standard length of the conductor shall be 2500 metres. A tolerance of plus or minus 5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.
- 11.2. Random lengths will be accepted provided no length is less than 70% of the standard length and total quantity of such random length shall not be more than 10% of the total quantity order. When one number random length has been manufactured at any time, five (5) more individual lengths, each equivalent to the above random length with a tolerance of +/-5% shall also be manufactured and all above six random lengths shall be dispatched in the same shipment. At any point, the cumulative quantity supplied including such random lengths shall not be more than 12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard length as specified.
- 11.3. Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The Employer reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

12. QUALITY ASSURANCE PLAN

A Quality Assurance Plan including customer hold points covering the manufacturing activities of the material shall be required to be submitted by the tenderer to the Employer along with the tender. The Quality Assurance Plan after the same is found acceptable, will be approved by the Employer.

The contractor shall follow the approved Quality Assurance Plan in true spirit. If desired by the Employer, he shall give access to all the documents and materials to satisfy the Employer that the Quality Assurance Plan is being properly followed.

13. TESTING

13.1. SELECTION OF TEST SAMPLES FOR TYPE TESTS

- 13.1.1. The samples shall be taken from a continuous length of conductor and subjected to all the tests specified in clause 14.

13.2. SELECTION OF TEST SAMPLES FOR ACCEPTANCE TESTS

- 13.2.1. Before dispatch from the works individual wire and finished steel coredaluminum conductor shall be subjected to the tests as specified in IS:398 or any other authoritative standard.
- 13.2.2. Sample for individual wires for test shall be taken before stranding from outer ends of not less than ten per cent of the spools in the case of aluminum wire and ten per cent of the wire coils in the case of steel wires. If samples are taken after stranding, they shall be obtained by cutting 1.2 meters from the outer ends of the finished conductor from not more than 10 per cent of the finished reels.
- 13.2.3. The routine tests shall be same as acceptance test. The manufacturer will draw samples for routine tests as per Cl. 13.1.1 or 13.1.2 of IS: 398 (Part 2) and will maintain the record of routine tests for buyer's review. For acceptance tests, the sample shall be taken as per Cl. shall be as per Cl.13.1.2 of IS: 398 (Part 2).

14. TESTS

The following tests shall be carried out on sample/samples of conductor.

14.1 Type Tests

- (i) Visual examination
- (ii) Measurement of diameters of individual aluminum and steel wires.
- (iii) Measurement of lay ratio of each layer
- (iv) Breaking load test
- (v) Ductility test
- (vi) Wrapping test
- (vii) Resistance test on aluminum wires.
- (viii) DC resistance Test on aluminum wires.
- (ix) Galvanizing test
- (x) Surface condition test
- (xi) Stress Strain test
- (xii) Procedure qualification test on welded joint of Aluminum Strands.

NOTE:-The type test reports shall not be older than FIVE years and shall be valid up to expiry of validity of offer.

The above additional lists if not conducted earlier, shall be done under the subject project package at no extra cost.

14.2 Acceptance tests and Routine tests

- (ii) Visual and dimensional check on drum.
- (iii) Visual examination
- (iv) Measurement of diameters of individual aluminum and steel wires.
- (v) Measurement of lay ratio of each layer
- (vi) Breaking load test
- (vii) Ductility test
- (viii) Wrapping test
- (ix) Resistance test on aluminum wires.
- (x) DC resistance Test on Composite Conductor.
- (xi) Galvanizing test

14.3 Tests During Manufacture

The following tests during manufacture shall be carried out.

- (i) Chemical analysis of zinc used for galvanising,
- (ii) Chemical analysis of aluminum used for making aluminum strands,
- (iii) Chemical analysis of steel used for making steel strands,

14.4 Visual examination

The conductor shall be examined visually for good workmanship and general surface finish of the conductor. The conductor drums shall be rewound in the presence of Inspecting Officer. The Inspector will initially check for Scratches, Joints etc., and that the conductor shall generally conform to the requirements of the specifications/IS 398(Part-II)-1996.

14.5 Measurement of diameters of individual Aluminum and Steel Wires.

The diameters of individual Aluminum and Steel Wires shall be checked to ensure that they conform to the requirements of this specification.

14.6 Measurement of lay-ratios

The lay-ratios of each layer of the conductor shall be measured and checked to ensure that they conform to the requirements of this specification and IS:398 (Part-II)-1996.

14.7 Breaking load test

a) **Breaking load test on complete conductor.**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to 100% of UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

b) **Breaking load test on individual aluminum and galvanized steel wires.**

This test shall be conducted on both Aluminum and Galvanized steel wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm/min. and not greater than 100 mm. / min. The ultimate breaking load of the specimens shall be not less than the values specified in the Section-II.

14.8 Ductility Test

For the purpose of this test both torsion and elongation tests shall be carried out on galvanized steel wires only.

14.9 Torsion Test

One specimen cut from each of the samples taken shall be gripped in two vices exactly 15 cms. apart. One of the vices shall be made to revolve at a speed not exceeding one revolution per second and the other shall be capable of moving longitudinally to allow for contraction or expansion during testing. A small tensile load not exceeding 2 (two) percent of the breaking load of the wire shall be applied to the samples during testing. The test shall be continued until fracture

occurs and the fracture shall show a smooth surface at right angles to the axis of the wire. After fracture, the specimen shall be free from helical splits. The sample shall withstand a number of twists equivalent to not less than 18 on length equal to 100 times the diameter. When twisted after stranding the number of complete twists before fracture occurs shall be not less than 16 on a length equal to 100 times the diameter of the wire. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to the next higher whole number. The fracture shall show a smooth surface at right angles to the axis of the wire.

14.10 Elongation Test

The elongation of one specimen cut from each of the samples taken shall be determined. The specimen shall be straightened by hand and an original gauge length of 200 mm. shall be marked on the wire. A tensile load shall be applied as described in 1.1.4.6.2.1 and the elongation shall be measured after the fractured ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm. of either mark and the required elongation is not obtained, the test shall be disregarded and another test conducted. When tested before stranding, the elongation shall be not less than 4 percent and when tested after stranding, the elongation shall be not less than 3.5 percent.

14.11 Wrapping Test

This test shall be conducted on both Aluminum and Galvanized steel wires.

14.11.1 Aluminum wires

One specimen cut from each of the samples of aluminum wires shall be wrapped round a wire of its own diameter to form a close helix of 8 turns. Six turns shall then be unwrapped and closely wrapped in the same direction as before. The wire shall not break or show any crack.

14.11.2 Galvanized steel wires

One specimen cut from each of the samples of galvanized steel wire taken shall be wrapped round a mandrel of diameter equal to 4 times the wire diameter to form a close helix of 8 turns. Six turns shall then

be unwrapped and again closely wrapped in the same direction as before. The wire shall not break.

14.12 Resistance Test

This test shall be conducted on aluminum wires only, conforming to procedure as per IEC:889. The electrical resistance of one specimen of aluminum wire cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value corresponding to 20 degrees C. by means of following formula.

$$R_{20} = R_T \frac{1 + \alpha (T - 20)}{1 + \alpha (20 - T)}$$

Where

R_{20} = Resistance corrected at 20 degrees C.

R_T = Resistance measured at T degrees C.

α = Constant mass temperature coefficient of resistance 0.004. T = Ambient temperature during measurement

This resistance calculated to 20 degrees C. shall be not more than the maximum value specified in section-II.

14.13 Galvanizing Test

This test shall be conducted on galvanized steel wires only. The uniformity of Zinc coating and the weight of coating shall be in accordance with IS 4826-1979.

14.14 Surface Condition Test

A sample of the finished conductor for use in 11/33 KV system having a minimum length of 5 meters with compression type dead end clamps compressed on both ends in such manner as to permit the conductor to take its normal straight line shape, shall be subjected to a tension of 50 percent of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place or disturb the

longitudinal smoothness of conductor. The measured diameter at any place shall be not less than the sum of the minimum specified diameters of the individual aluminum and steel strands as indicated in Section-II.

14.15 Stress-Strain Test

The test is contemplated only to collect the creep data of the conductor from the manufacturer. A sample of conductor of minimum 10 meters length shall be suitably compressed with dead end clamps. (applicable only for conductors of nominal aluminium area 100 sq. mm and above)

15. TEST SET-UP

- 15.1. The test sample shall be supported in a trough over its full length and the trough adjusted so that the conductor will not be lifted by more than 10mm under tension. This shall be ascertained by actual measurement.
- 15.2. The distance between the clamp and the sleeve mouth shall be monitored with callipers during the test to ensure that, after the test, it does not change by more than $1\text{mm} + 0.1\text{mm}$ from the value before the test.
- 15.3. The conductor strain shall be evaluated from the measured displacements at the two ends of the gauge length of the sample. The gauge reference targets shall be attached to the clamps which lock the steel and aluminum wires together. Target plates may be used with dial gauges or displacement transducers and care shall be taken to position the plates perpendicular to the conductor. Twisting the conductor, lifting it and moving it from side- to-side by the maximum amounts expected during the test should introduce no more than 0.3mm error in the reading.

16. TEST LOADS FOR COMPLETE CONDUCTOR

The loading conditions for repeated stress-strain tests for complete conductor shall be as follows:

- 16.1. 1KN load shall be applied initially to straighten the conductor. The load shall be removed after straightening and then the strain gauges are to be set At zero tension.
- 16.2. For non-continuous stress-strain data, the strain readings at 1KN intervals at lower tensions and 5 KN intervals above 30% of UTS shall be recorded.

- 16.3. The sample shall be reloaded to 30% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released then after the hold period.
- 16.4. The sample shall be reloaded to 50% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released then after the hold period.
- 16.5. Reloading upto 70% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes. The load shall be released.
- 16.6. Reloading upto 85% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10,15, 30, 45 and 60 minutes and the load shall be released then.
- 16.7. Tension shall be applied again and shall be increased uniformly until the actual breaking strength is reached. Simultaneous readings of tension and elongation shall be recorded upto 90% of UTS at the intervals described under Clause 16.6.
- 17. TEST LOADS FOR STEEL CORE ONLY** (applicable only for conductors of nominal aluminum area 100 sq. mm and above)

The loading conditions for repeated stress-strain tests for the steel core of ACSR shall be as follows:

- 17.1. The test shall consist of successive applications of load applied in a manner similar to that for the complete conductor at 30%, 50%, 70% and 85% of UTS.
- 17.2. The steel core shall be loaded until the elongation at the beginning of each hold period corresponds to that obtained on the complete conductor at 30%, 50%, 70% and 85% of UTS respectively.

18. STRESS-STRAIN CURVES

The design stress-strain curve shall be obtained by drawing a smooth curve through the 0.5 and 1 hour points at 30%, 50% and 70% of UTS loadings. The presence of any aluminum slack that can be related to any observed

extrusion entering the span from the compression dead ends shall be removed from the lower ends of the design curves. Both the laboratory and standard stress-strain curves shall be submitted to the Employer along with test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20 deg.C.

19. DC RESISTANCE TEST ON COMPOSITE CONDUCTOR

On a conductor sample of minimum 5m length, two contact clamps shall be fixed with a pre-determined bolt torque. The resistance of the sample shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 deg C as per clause no. 12.8 of IS:398 (Part-II)-1982/1996. The corrected resistance value at 20 deg.C shall conform to the requirements of this specification.

20. PROCEDURE QUALIFICATION TEST ON WELDED ALUMINUM STRANDS.

Two Aluminum wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the guaranteed breaking strength of individual strands.

21. CHEMICAL ANALYSIS OF ALUMINUM AND STEEL

Samples taken from the Aluminum and Steel ingots / coils/ strands shall be chemically/ spectrographically analyzed. The same shall be in conformity with the requirements stated in this specification.

22. CHEMICAL ANALYSIS OF ZINC

Samples taken from the zinc ingots shall be chemically / spectrographically analysed. The same shall be in conformity with the requirements stated in this specification.

23. VISUAL AND DIMENSIONAL CHECK ON DRUMS

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification.

24. REJECTION AND RETEST

- 24.1. In case of failure in any type test, the Manufacturer is either required to manufacture fresh sample lot and repeat all the tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.
- 24.2. If samples are taken for test after stranding and if any selected reel fails in the retest, the manufacturer may test each and every reel and submit them for further inspection. All rejected material shall be suitably marked and segregated.

25. CHECKING AND VERIFICATION OF LENGTH OF CONDUCTOR

The contractor should arrange for inspection by the representative of the Employer specially authorised for this purpose. At least 50% of the total number of drums of conductor subject to minimum of two taken at random should be checked to ascertain the length of conductor. Arrangements should be made available in the works of the manufacturer for transferring the conductor from one reel to another at the same time measuring the length of the conductor so transferred by means of a meter.

26. ADDITIONAL TESTS

The Employer reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Bidder's premises, at site, or in any other standard Laboratory in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the specifications.

27. TESTING EXPENSES

- 27.1. The breakup of the testing charges for the type tests specified shall be indicated separately.
- 27.2. Bidder shall indicate the laboratories in which they propose to conduct the type test. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.
- 27.3. The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the

quoted unit price of the conductor, except for the expenses of the inspector/Employer's representative.

- 27.4. In case of failure in any type test, if repeat type tests are required to be conducted then all the expenses for deputation of Inspector/Employer's representative shall be deducted from the contract price. Also if on receipt of the Manufacturer's notice of testing, the Employer's representative does not find 'plant' to be ready for testing, the expenses incurred by the Employer for re - deputation shall be deducted from contract price.

28. TEST REPORTS

- 28.1. Copies of type test reports shall be furnished in at least six copies alongwith one original. One copy will be returned duly certified by the Employer only after which the commercial production of the material shall start.
- 28.2. Record of Routine test reports shall be maintained by the Manufacturer at his works for periodic inspection by the Employer's representative.
- 28.3. Test certificates of Tests during manufacture shall be maintained by the Manufacturer. These shall be produced for verification as and when desired by the Employer.

29. TEST FACILITIES

The following additional test facilities shall be available at the Manufacturer's works:

- (i) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer, etc.
- (ii) Standard resistance for calibration of resistance bridges.
- (iii) Finished Conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and be free of vibrations, jerks etc. with traverse laying facilities.

30. INSPECTION

- 30.1. The Employer's representative shall, at all times, be entitled to have

- access to the works and all places of manufacture where conductor shall be manufactured and the representative shall have full facilities for unrestricted inspection of the Bidder's works, raw materials and process of manufacture and conducting necessary tests as detailed herein.
- 30.2. The Bidder shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.
- 30.3. The contractor will intimate the Employer about carrying out of the tests at least 45 days in advance of the scheduled date of tests during which the Employer will arrange to depute his representative/s to be present at the time of carrying out of the tests. Six (6) copies of the test reports shall be submitted.
- 30.4. No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, Unless the inspection is waived off by the employer in writing. In the later case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein has been completed and approved by the employer.
- 30.5. The acceptance of any quantity of material shall in no way relieve the Bidder of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.
- 30.6. At least 50% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by the following method:
- "At the works of the manufacturer of the conductor, the conductor shall be transferred from one drum to another at the same time measuring its length with the help of a graduated pulley and Cyclometer. The difference in the average length thus obtained and as declared by the Bidder in the packing list shall be applied to all the drums if the conductor is found short during checking".

31. SCHEDULE OF DEVIATIONS/VARIATIONS

If the tenderer has any exceptions to any of the clause/s laid down in this specification, these should be clearly stated in the schedule of deviations / variations.

SECTION - II SPECIFIC TECHNICAL REQUIREMENTS SCOPE

This section of the specification covers climatic and isoceraunic conditions, specific technical particulars, schedule of requirements & desired deliveries, for conductor for 11/33 kV lines.

1. CLIMATIC & ISOCERAUNIC CONDITIONS TO BE SPECIFIED BY EMPLOYER

1.1 1Maximum Temperature

a) Conductor °C.

1.2 2Minimum Temperature °C.

1.3 i)Max. ambient temperature °C

ii) Mean annual / every day temperature °C

2.4 Basic wind speed m/s

2.5 Relative humidity

i) Maximum %

ii) Minimum %

2.6 Average Rainfall (Max.) mm per annum

2.7 a)Rainy months Mayto Sept.

15 Rainy days in a year (days)

2.8 Average number of thunder storm

2.9 Altitude varying from sea level

2.10 Basic horizontal Seismic Co-efficient(horizontal) Basic vertical Seismic Co-efficient

2.11 System Particulars

a) Line Voltage (kV)

- b) Highest System Voltage (kV)
- c) Number of Circuits
- d) Frequency HZ
- e) Neutral
- f) Short circuit level (KA)

2. SPECIFIC TECHNICAL REQUIREMENTS

CONDUCTOR:					
1. Conductor:	Rabbit/Raccoon/Dog/Weasel/Panther ACSR				
2. IS applicable:	IS-398 (part-II) 1996 latest revision				
3. Wire Diameter	Rabbit	Raccoon	Dog	Weasel	Panther
Aluminium (mm)	6/3.35	6/4.06	6/4.72	6/2.59	30/3.00
Steel(mm)	1/3.35	1/4.09	7/1.57	1/2.59	7/3.00
4. Number of strands:					
Steel centre		1	1	1	1
1st steel layer	-		6		6
1st Aluminium layer	6	6	6	6	12
2nd Aluminium layer					18
5. Sectional Area of Aluminium (sq. mm.)	52.88	78.83	105	31.61	212.1
6. Total Sectional Area(sq.mm.)	61.7	91.97	118.5	36.88	261.5
7. Overall diameter(mm)	10.05	12.27	14.15	7.77	21
8. Approximate weight(Kg./Km.)	10.05	12.27	14.15	7.77	21
9. Calculated D.C resistance at 20 degrees C., maximum. (Ohms/Km)	0.552	4.371	2.2792	0.9289	0.139
10. Ultimate tensile	18.25	26.91	32.41	11.12	89.67

strength (KN)					
11. Final modulus of elasticity (GN/sq.m)	79	79	75	79	80
12. Coefficient of linear expansion x 10 ⁻⁶ per°C	19.1	19.1	19.8	19.1	17.8
13. Lay ratio	Max Min	Max Min	Max Min	Max Min	Max Min
Steel core 6 wire layer			28 13		28 13
Aluminium 1st layer	14 10	14 10	14 10	14 10	14 10
2nd layer					16 10

14. Technical Particulars

a. Diameter-mm	Rabbit		Raccon		Dog		Weasel		Panther		
	Al	Steel	Al	Steel	Al	Steel	Al	Steel	Al	Steel	
Standard(mm)	3.35	3.35	4.09	4.09	1.57	4.72	2.5	2.59	3.00	3.00	
Maximum (mm)	3.42	3.38	4.17	4.13	1.60	4.77	2.6	2.62	3.06	3.03	
Minimum (mm)	3.28	3.32	4.01	4.05	1.54	4.67	2.5	2.56	2.94	2.97	
b. Cross-sectional area of nominal diameter wire (mm ²)	8.814		8.814	13.14	13.14	1.936		17.50	5.269	5.269	7.069
c. Weight (Kg./Km)	68.	23.	102.	35.	15.	47.	41.	14.	55.	19	
.	75	82	48	51	10	30	09	24	13	.1	
d. Min. breaking load (KN)											
Before stranding	11.	1.4	17.2	2.0	2.7	2.7	6.9	0.8	9.2	1.	
.	58	3	7	8	0	8	2	9	9	17	
After Stranding	11.	1.3	16.4	1.9	2.5	2.6	6.5	0.8	8.8	1.	
.	00	6		8	7	4	7	5	3	11	
e. D.C resistance at 20°C min. (Ohm/Km)											

-3.265 -2.194 1.65 -5.49 -4.079

15. Zinc coating of steel core:
- (i) The steel strands shall be hot dip galvanized as per IS: 4826.
 - (ii) Process of Galvanizing: Hot dip.
 - (iii) Quality of Zinc : IS-209/1979 or latest edition.

16. Joints in strands

16.1 Steel : Not permitted

16.2 **Aluminium:** No joint shall be permitted in the Aluminum wires in the outer most layer of the ACSR conductor. But permitted in the inner layers such that no two such joints are within 15 meters of each other in the complete stranded conductor.

15. Chemical composition of high carbon steel wire:

Element	% Composition
i) Carbon	0.5 to 0.85
ii) Manganese	0.5 to 1.10
iii) Phosphorus	Not more than 0.035
iv) Sulphur	Not more than 0.045
v) Silicon	0.10 to 0.35

Guaranteed Technical Particulars of Conductor (To be filled in by the Tenderer)

1. Code Word
2. Maker's name and address
 - a. Aluminium Rods
 - b. Steel Rods
 - c. Complete Conductor
3. Stranding and Wire diameter
 - a. Aluminium
 - i) Nominal
 - ii) Minimum
 - iii) Maximum
 - b. Steel

- | | i) Nominal | ii) Minimum | iii) Maximum |
|-----|--|---|---|
| 4 | Nominal Aluminium Area in <u>sq. mm</u> | | |
| 5 | Sectional Area of Aluminium in Sq. mm. | | |
| 6 | Total Sectional Area in Sq.mm. | | |
| 7 | Cross Sectional area of Nominal Diameter wire in <u>sq.mm</u> . | | |
| | a) Aluminium | b) Steel | c) Overall diameter of conductor in mm. |
| 8 | Breaking load of conductor in KN. | | |
| 9 | Minimum breaking load for | | |
| | a. Aluminium Wire | --- i) Before stranding | ii) After stranding |
| | b. Steel Wire | --- i) Before stranding | ii) After stranding |
| 10 | Zinc Coating of steel wire | | |
| | a. Uniformity of coating, number & duration of dips process test, withstood | | |
| | | i) Before stranding ii) After stranding | 1 Min x nos.
1/2 Min x nos |
| | b. Minimum Weight of coating gm/sq.m | | |
| | | i) Before stranding ii) After stranding | |
| 11. | Mass in kg. per Km. | | |
| | a. Aluminium | | |
| | b. Steel | | |
| | c. Conductor | | |
| 12 | Resistance in ohm per Km at 20 ⁰ C | i) Aluminium | ii) Conductor |
| 13 | Continuous maximum current rating of conductor (Amps. in still air at 45 ⁰ C ambient temperatures). | | |
| 14 | Modulus of elasticity of conductor | | |
| 15. | Co-efficient of linear expansion per degree centigrade of : | | |
| | a. Aluminium wire | | |
| | b. Steel Wire | | |
| | c. Conductor | | |
| 16 | Standard length of each piece in Km. | | |
| 17. | Approximate dimensions of the drum in mm. | | |
| 18 | Weight of the conductor in one drum in Kg. | | |
| 19. | Weight of the drum in Kg. | | |
| 20 | Gross weight of the drum including weight of the conductor. | | |
| 21. | Standard according to which the conductor will be manufactured and tested. | | |
| 22 | Other particulars if any. | | |

5. AAA Conductor

1.1 TECHNICAL DESCRIPTION OF AAAC CONDUCTOR

DETAILS OF CONDUCTORS

- 1.1.1 The AAAC Conductors shall generally conform to IS: 398 (Part-IV), IEC: 104-1987 except where otherwise specified herein.
- 1.1.2 The details of the AAAC Conductors of various sizes are given in the enclosed Table-I

1.2 WORKMANSHIP

- 1.2.1 All the Al-alloy strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.
- 1.2.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), scuff marks, dents, pressmarks, cut marks, wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

1.3 JOINTS IN WIRES

- 1.3.1 No joint shall be permitted in any layer of finished conductor.

1.4 STRANDING

In all constructions, the successive layers shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the underlying wire or wires. The outer most layer of wires shall have a right hand lay. The lay ratio shall be as follow.

Number of wires in Conductor	3/6 Wire layer		12 Wire layer		18 Wire layer	
	Min	Max	Min	Max	Min	Max
3	10	14	-	-	-	-
7	10	14	-	-	-	-
19	10	16	10	14	-	-
37	10	17	10	16	10	14

1.5 TOLERANCES

The manufacturing tolerances in diameter of individual aluminium alloy strand shall be as per **Table-I**.

1.6 MATERIALS

1.6.1 ALUMINUM ALLOY

The wire shall be of heat treated aluminum, magnesium silicon alloy having a composition appropriate to the mechanical & electrical properties as specified in IS 398(Part-4).

The Aluminum Alloy strands drawn from heat treated aluminium alloy redraw rods conforming to Type B as per IEC:104-latest amendment. The chemical composition of redrawn rods shall conform to IS 1997-91, as given below:

<i>Elements</i>	<i>Percent</i>
Si	0.50-0.90
Mg	0.60-0.90
Fe	0.50 max
Cu	0.10 max
Mn	0.03 max
Cr	0.03 max
Zn	0.10 max
B	0.06 max
Other Element (Each)	0.03 max
Other Element (Total)	0.10 max
Al	Remainder

1.7 STANDARD LENGTH

1.7.1 The standard length of the conductor shall be 2000 meters. A tolerance of +/-5% on the standard length offered by the Bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. The conductor drums shall be adequate to wind one or more standard length of 2000 meters of SQUIRREL/WEASEL/RABIT/RACoon/DOG/ PANTHER AAA conductor.

1.7.2 Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of such random lengths shall not be more than 10% of the total quantity ordered.

1.7.3 Bidder shall also indicate the maximum single length, above the

standard length, he can manufacture in the guaranteed technical particulars of offer. The Owner reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the execution of the Contract.

1.8 TESTS AND STANDARDS

The following tests to be conducted for AAAC conductors shall conform to IS 398(Part -IV) 1979 and IEC 888 & 889.

1.8.1 TYPE/PERIODIC

The following tests shall be conducted on samples of each type of conductor :

- a) UTS test on stranded conductor
- b) DC resistance test on stranded conductor

1.8.2 ACCEPTANCE TESTS

- (a) Visual check for joints scratches etc. and length measurement of conductor by rewinding
- (b) Dimensional check on Al-alloy strands
- (c) Check for lay-ratio
- (d) Elongation test
- (e) Breaking load/tensile test on Aluminum alloy strands
- (f) DC resistance test on Aluminum alloy strands
- (g) Wrap test on Aluminum alloy strands (IEC 104, IEC 1089)
- (h) Visual and dimensional (IS:1778-1980) check on drum

1.8.3 ROUTINE TEST

- (a) Check to ensure that there are no joints.
- (b) Check that there are no cuts, fins etc. on the strands.
- (c) Check that drums are as per Specification.
- (d) All acceptance test as mentioned above to be carried out on each coil.

1.8.4 TESTS DURING MANUFACTURE

- (a) Chemical analysis of

Aluminum alloy used for
making strands

1.8.5 TESTING EXPENSES

- i) The type test charges for the conductor should be quoted in the relevant schedule of Bid Proposal Sheets.
- ii) Contractor shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.
- iii) In case of failure in any type test, the Contractor is either required to manufacture fresh sample lot and repeat all the tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing, then the lot already manufactured shall be rejected.

- iv) The entire cost of testing for the acceptance and routine tests and Tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/Owner's representative.
- v) In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/Owner's representative shall be deducted from the contract price. Also if on receipt of the Contractor's notice of testing, the Owner's representative does not find 'The material or testing facilities' to be ready for testing the expenses incurred by the Owner for re-deputation shall be deducted from contract price.

1.8.6 ADDITIONAL TESTS

- i) The Owner reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises, at site or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the Specifications.
- ii) The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test centre. In case of evidence of non-compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items all without any extra cost to the Owner.

1.8.7 SAMPLE BATCH FOR TYPE TESTING

- i) The Contractor shall offer material for selection of samples for type testing only after getting Quality Assurance Plan approved from Owner's Quality Assurance Deptt. The sample shall be manufactured

strictly in accordance with the Quality Assurance Plan approved by Owner.

- ii) The Contractor shall offer at least three drums for selection of sample required for conducting all the type tests.
- iii) The Contractor is required to carry out all the acceptance tests successfully in presence of Owner's representative before sample selection.

1.8.8 TEST REPORTS

- i) Copies of type test reports shall be furnished in at least six copies along with one original. One copy will be returned duly certified by the Owner only after which the commercial production of the material shall start.

- ii) Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Owner's representative.
- iii) Test Certificates of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Owner.

1.9 INSPECTION

1.9.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the Contractor's works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

1.9.2 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

1.9.3 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the Owner in writing. In the latter case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

1.9.4 The acceptance of any quantity of material shall in no way relieve the Contractor of any of his responsibilities for meeting all requirements of the Specification, and shall not prevent subsequent rejection if such material is later found to be defective.

1.9.5 TEST FACILITIES

The following additional test facilities shall be available at the Contractor's works:

- i) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.
- ii) Standard resistance for calibration of resistance bridges.
- iii) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

1.10 PACKING

1.10.1 The conductor shall be supplied in non - returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Contractor shall be responsible for any loss or damage

during transportation handling and storage due to improper packing. The drums shall generally conform to IS:1778-1980, except as otherwise specified hereinafter.

- 1.10.2 The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.
- 1.10.3 The Contractor should submit their proposed drum drawings along with the bid.
- 1.10.4 The Contractor may offer more than one length of the conductor in a single drum.
- 1.10.5 All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality, which is not harmful to the conductor.
- 1.10.6 The flanges shall be of two ply construction with a total thickness of 64 mm with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. Flange boards shall not be less than the nominal thickness by more than 2mm. There shall not be less than 2 nails per board in each circle. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.
- 1.10.7 The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

- 1.10.8 Barrel studs shall be used for the construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.
- 1.10.9 Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 1.10.10 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen based paint.
- 1.10.11 Before reeling, card board or double corrugated or thick bituminous water-proof bamboo paper or HDPE sheet shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. The paper should be dried before use. After reeling the conductor the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.
- 1.10.12 A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective lagging and outer layer of the conductor. Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/ galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 1.10.13 Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

- 1.10.14 The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.
- 1.10.15 A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steel drum and secured to the central steel plate by welding.
- 1.10.16 Outside the protective lagging, there shall be minimum of two binder consisting of hoop iron/ galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 1.10.17 The conductor ends shall be properly sealed and secured with the help of U-nail on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.
- 1.10.18 As an alternative to wooden drum Contractor may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS: 9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose and accordingly the Contractor should quote in the package.

1.11 MARKING

Each drum shall have the following information stenciled on it in indelible ink along with other essential data :

- a. Contract/Award letter number.
- b. Name and address of consignee.
- c. Manufacturer's name and address.
- d. Drum and lot number
- e. Size and type of conductor
- f. Length of conductor in meters
- g. Arrow marking for unwinding
- h. Position of the conductor ends
- i. Number of turns in the outer most layer.
- j. Gross weight of drum after putting lagging.
- k. Average weight of the drum without lagging.
- l. Net weight of the conductor in the drum.

m. Month and year of manufacture of conductor

The above should be indicated in the packing list also.

1.12 VERIFICATION OF CONDUCTOR LENGTH

The Owner reserves the right to verify the length of conductor after unreeling at least Two (2) percent of the drums in a lot offered for inspection.

For the balance drums, length verification shall be done by the owner based on report/certification from Manufacturer/Contractor.

1.13 STANDARDS

1.13.1 The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

1.13.2 In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Contractor and those specified in this document will be provided by the Contractor to establish their equivalence.

SL .NO.	Indian Standard	Title	International Standard
1	IS:398 (Part-IV)	Aluminum Alloy stranded conductor	IEC : 208-1966 BS-3242-1970
2	IS : 9997-1988	Aluminum Alloy Redraw Rods	IEC 104-1987
3	IS : 1778-1980 Reels	Reels and Drums for bare conductors	BS:1559-1949

ANNEXURE-A**1.0 TESTS ON AAAC CONDUCTORS****1.1 UTS Test on Stranded Conductor**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per IS:398-(Part-V)-1982. The resistance corrected at 20°C shall conform to the requirements of this Specification.

1.3 CHEMICAL ANALYSIS OF ALUMINIUM ALLOY

Samples taken from the Aluminium alloy ingots/coils/strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this Specification.

1.4 VISUAL AND DIMENSIONAL CHECK ON DRUMS

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

1.5 VISUAL CHECK FOR JOINTS, SCRATCHES ETC.

Conductor drums shall be rewound in the presence of the Owner. The Owner shall visually check for scratches, joints etc. and that the conductor generally conforms to the requirements of this

Specification. **Two percent (2%)** drums from each lot shall be rewound in the presence of the Owner's representative.

1.6 DIMENSIONAL CHECK ON ALUMINUM ALLOY STRANDS

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.7 CHECK FOR LAY-RATIOS OF VARIOUS LAYERS

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

1.8 TORSION AND ELONGATION TESTS ON ALUMINUM ALLOY STRANDS

The test procedures shall be as per clause No. 10.3 of IEC : 888. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

1.9 CHECK ON BARREL BATTEN STRENGTH OF DRUMS

The details regarding barrel batten strength test will be discussed and mutually agreed to by the Contractor & Owner in the Quality Assurance Programme.

1.10

Breaking Load Test on Individual Aluminium Alloy Wires

The test shall be conducted on Aluminum alloy wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually Si the jaws of the testing machine shall be not less than 25 mm/min. and not greater than 100 mm./min. The ultimate breaking load of the specimens shall be not less than the values specified in the Specification.

1.11 RESISTANCE TEST ON ALUMINUM ALLOY WIRE

The test shall be conducted on aluminium alloy wires only, conforming to procedure as per IEC: 889. The electrical resistance of one specimen of aluminium wire cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value corresponding to 20 degree C. by means of following formula.

$$R_{20} = \frac{R_T}{1 + \alpha \times (T - 20)}$$

- Where
 - R₂₀ = Resistance corrected at 20 degrees C.
 - R_T = Resistance measured at T degrees C.
 - alpha = Constant mass temperature coefficient of resistance 0.004.
 - T = Ambient temperature during measurement
- This resistance calculated to 20 degrees C. shall be not more than the maximum value specified in the specification.

Table-1

Details of parameters of AAA conductor

S · N ·	Parameter	Squirr el	Wease l	Rabbit	Raccon	DOG	wolf	Panther
1	Total section al area of conductor (sqmm)	22	34	55	80	100	173	232
2	(No of Al strand/dia in mm)	7/2.00	7/2.50	7/3.15	7/3.81	7/4.26	19/3.40	19/3.94
3	Overall diameter (mm)	6	7.5	9.45	11.43	12.78	17	19.7
4	approx mass (kg/km)	60.16	94	149.2	218.26	272.86	474.02	636.67
5	Resistan ce at 20 deg cel (ohms/k m)	1.541	0.99	0.621	0.425	0.339	0.1969	0.1471
6	approx calculat ed breakin g load	6.45	10.11	16.03	23.41	29.26	50.54	68.05

	(kN)							
7	Final modulus of Elasticity, GN/sqm (kg/sq cm)	0.6324 x 10 (pwr 6)	0.6324 x 10	0.6324 x 10	0.6324 x 10	0.6324 x 10	0.612x10	0.612x10
8	Coefficient of linear Expansion/ C	23.0 X10 (pwr - 6)	23.0 X10	23.0 X10	23.0 X10	23.0 X10	23.0 X10	23.0 X10
9	Details of Aluminium							

S.N	Parameter	Squirrel	Weasel	Rabbit	Raccoon	DOG	wolf	Panther
	Strands							
a	Minimum breaking load of the strand before	0.97	1.52	2.41	3.52	4.4	2.8	3.77
b	Minimum breaking load of the strand after stranding	0.92	1.44	2.29	3.34	4.18	2.66	3.58
c	Maximum DC resistance of strands at 20 deg C	10.653	6.845	4.29	2.938	2.345	3.677	2.746
d	Mass (kg/km)	8.482	13.25	21.04	30.78	38.48	24.51	32.92
e	Diameter							
i	Nominal	2.0	2.50	3.15	3.81	4.26	3.40	3.94
ii	Maximum	2.02	2.53	3.18	3.85	4.30	3.43	3.98
iii	Minimum	1.98	2.47	3.12	3.77	4.22	3.37	3.90

GUARANTEED TECHNICAL PARTICULARS (GTP)

Size of Conductor: 34 mm ² AAAC Weasel	Size of Conductor: 55 mm ² AAAC Rabbit	Size of Conductor: 100mm ² AAACDog
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Bidder has to confirm following important requirements.

Sl.No.	PARTICULARS				CONFIRMATION
A1	Conductor shall be manufactured as per IS-398 Part-IV/1994 or latest amendment of it.				
A2	Wooden drums shall be as per IS-1778/1980 with latest amendment, if any and shall be painted as per specification				
A3	Spacing between outer layer of conductor and inner surface of lagging shall be 75mm min.				
A4	Standard length shall be (a) 2000 meters for 34 mm ² & 55 mm ² and (b) 1100 meters for 100 mm ² sizes with 5% (five percent) tolerance.				
A5	Short length shall not be less than 50% of the standard length. Also such random / short length shall not exceed 5% (five percent) of the ordered quantity.				
A6	Maximum three numbers of random length shall be wound on any one drum.				
A7	Conductor shall have 7 Nos. of wires. And outer lay shall be right handed.				
A8	Drum Size shall be as per IS-1778/80 with Amendment No. I of 1989				
9	Properties of individual wires shall be as under:				
	Dia of wire Weasel Rabbit Dog				
	Nominal	2.5	3.15	4.26	
	Minimum	2.47	3.12	4.22	
	Maximum	2.53	3.18	4.30	
	Mass in kg/km	13.25	21.04	38.48	
	Min.BL after stranding	1.44	2.29	4.18	
	Res.at 20°C (max)	6.845	4.290	2.345	
	App. overall diam. of complete stranded conductor in mm	7.50	9.45	12.78	
	App. mass in kg /km	94.00	149.20	272.86	
	Approx. calculated breaking load in KN	10.11	16.03	29.26	
	Calculated max. res. at 20°C in ohms/km	0.990	0.621	0.339	
	Minimum lay ratio	10	10	10	
Maximum lay ratio	14	14	14		

Sl.No.	PARTICULARS	CONFIRMATION
B1	BIS License number(Copy Enclosed)	
B2	Validity Up to	
B3	List of Plant & Machinery.	
B4	List of NABL approved test house calibrated Testing equipment.	

6. PCC Poles

8.5 M. LONG 180 KG. WORKING LOAD PCC POLES.

SCOPE:

This specification covers pre-stressed concrete poles suitable for use in 11KV/L.T. Overhead Power lines and conforming to IS: 1678:1998 (and its amendments thereof).

2.0 GENERAL:

2.1 Solid sections pre-stressed cement concrete poles shall be suitable for use in overhead 11KV/L.T. Distribution lines and suitable for a working load of 180 KG. applied in transverse direction at a distance of 300 mm. below top. The Overall length of the pole shall be 8.5 M. having depth of plantation as 1.52 mtr. suitable for plantation direction into ground, when used in straight-line position. The structural strength of pole in longitudinal direction shall be at least one fourth of the strength in transverse direction. The average permanent load is 40% of working load.

Poles of working load 200 Kg. applied in transverse direction at a distance of 600 mm below top shall also be acceptable. However no extra cost shall be payable for this design.

For earthing G.I wire No. 8 SWG shall be embedded with projecting length of 150 mm. at 300 mm. from top and 150 mm. at 1350 mm. from bottom as per enclosed drawing. The pole shall conform to IS: 1678-1998, IS: 1343-1980 and IS: 456-2000. (Or their latest editions/revisions thereof)

Two numbers through holes of 18-mm. dia. on the broader longitudinal side of the poles in the direction of conductor to be laid normal to and shall be provided such that the centers of these holes are at a distance of 100 mm. and 200 mm. from the top of poles.

Apart from above, necessary lifting hooks may also be provided.

2.1 The bidders shall quote only for following cross sections of 8.5 M long PCC Poles.

Category-I:	90 mm × 145 to 300 mm.	Tolerance
Category-II:	100 mm × 125 to 280 mm.	± 5 mm

3.0 MATERIAL:

3.1 CEMENT:

The cement used in the manufacture of prestressed concrete poles shall be any of the following: -

- a) Portland slag cement conforming to IS: 455 but with not more than 50 percent slag content.
- b) Rapid hardening Portland cement conforming to IS: 8041.
- c) 43 Grade ordinary Portland conforming to IS: 8112 and
- d) 53 Grade ordinary Portland cement conforming to IS: 12269.

3.2 AGGREGATES:

Aggregates used for manufacture of prestressed concrete pole shall conform to IS: 383:1970(latest amendments thereof). If required a sample of the aggregates shall be submitted by the manufacturer to the purchaser for approval. The maximum size of the aggregate shall in no case exceed 20 mm.

3.3 WATER:

The water used for concrete mixing and curing shall be clean and free from organic and inorganic matter harmful to concrete.

3.4 ADMIXTURE:

The use of admixture is not generally recommended. These may be used only with the approval of the purchaser based on evidence that with the passage of time neither the compressive strength of concrete is reduced by more than 10% nor are other requisite qualities of concrete and/or steel impaired by the use of such admixtures .The admixture shall conform to IS: 9103.

3.5 PRESTRESSING STEEL (High Tensile Steel):

High tensile steel used for manufacture of prestressed concrete poles shall conform to IS: 1785 or IS: 2090 or IS 6003-1983 (latest amendments thereof). The Pre-stressing steel shall be free from splits, harmful scratches surface flaws, rough rust, scale and other similar deleterious matter liable to affect adversely proper tensioning or its bond with concrete. The diameter of smooth wire used for prestressing of poles shall be 4 mm. or 5-mm. dia. or a combination of two sizes and its ultimate tensile strength shall not be less than 175 Kg/mm² for 4 mm wire & 160 Kg/mm² for 5 mm dia wire.

3.6 OTHER REINFORCEMENT:

Apart from the high tensile steel provided for prestressing the poles, 6mm. dia plain round M.S Bar or 4mm.dia.H.T. Wire stirrups (as per IS: 432 or IS: 1786) shall be provided 4 Nos. at each end and 4 Nos. in the mid portion uniformly distributed.

The surface of reinforcement shall be free from loose scale, oil, grease, clay or other material that may have degenerating affect on the bond between the reinforcement and concrete.

4.0 CONCRETE:

Design Mix. Concrete as defined in para 9.0 of IS: 456: 2000 and para 8 of IS: 1343: 1980 will be used in the manufacture of the poles. The design of concrete mix shall conform to the requirements laid down for controlled concrete under Para 9.2 of IS: 456:2000 subject to following further conditions.

- a) Minimum cube strength at 28 days shall not be less than 450 Kg/cm² in accordance with acceptability criteria given in clause 16 of IS: 456:2000.
- b) The mix shall contain as low as possible water cement ratio as is consistent with adequate workability.
- c) The concrete shall be compacted thoroughly by vibration, pressure, shock, or other means and shall have a density of not less than 2.4 MT/cm³.
- d) The cube strength of concrete at transfer of prestress shall not be less than 245 Kg/cm².
- e) The supplier shall be required to maintain a register showing the test results of cubes at the age of 3 and 28 days and at the transfer of prestress. For strength test the cubes shall be taken for each days casting. The register will show the serial number and the pole cast that day for which the test will apply. The acceptability criteria will be as per Para 16.3 to 17.5 of IS: 456. The register shall be opened for inspection with the authorized representative of the Corporation.
- f) The tenderer shall give a proper mix design of the grade M 45 of design mix concrete proposed to be used for casting of pole and such mix design may be supported by the test certificate of some Govt. Lab, or other Recognized Lab. Mix design done earlier not prior to one year may be considered adequate for later work, provided there is no change in source and quality of material.

5.0 DESIGN:

- 5.1 The poles shall be so designed that they do not fail owing to failure initiated by compression in concrete. Maximum wind pressure to be assumed may be determined as specified in IS: 875. (Part-3).
- 5.2 The pole shall be 8.5 M. long and should be designed for an ultimate load of 450 Kg. /500 Kg. acting at 300 mm/600 mm. below top. The dimensions, reinforcement etc. required to be provided may be shown in the drawing supplied by the tenderer.
- 5.3 The ultimate moment capacity in longitudinal direction should be atleast one fourth of that in transverse direction. The PCC Pole be designed so that it should be safe against bending, shear, torsion and axial load at various stages of loading under most unfavorable condition of loading.
- 5.4 The G.I Wire, no.8 SWG, which be in one continuous length, shall be embedded in the pole for earthing purpose. No joint of any kind in this wire shall be permitted. The position and details of connection to be provided at the end of earth wire have been shown in the enclosed drawing. Two nos. Galvanized bolts with two nuts and 3 washers with each bolt are to be supplied by the manufacturer.
- 5.5 The position and diameter of the holes to be provided in the poles are also shown in the enclosed drawing and shall be centrally located and will be perpendicular to the face of the pole.

5.6 Factor of safety against ultimate failure is 2.5. While it is 1.0 for first crack moment. Designer should mention basis for adopting various design constants e.g. permissible tensile, compressive stress, modulus of rupture etc.

5.7 The poles shall be designed to be suitable for fitting stays and clamps.

5.8 Eye hooks shall be provided for lifting of poles. The poles should be strong enough for lifting and erection in any direction during handling and transport. During erection poles are laid on the ground and lifted at some point near the end, similarly while loading and unloading the poles from carriers they are lifted at one end resting on the ground and pushed on to the trucks. The poles should be able to withstand all such manual handling.

5.9 TRANSVERSE STRENGTH AT FAILURE:

The poles shall be designed that its strength in transverse direction shall be sufficient to take the load due to wind on wires and poles, multiplied by load factor.

6.0 MANUFACTURE:

The tensioning of prestressing tendons shall be carried out in a manner that will induce a smooth and even rate of increase of stress in the tendons.

6.1 The force induced in the prestressing tendon shall be determined by suitable means attached to the tensioning apparatus. It is essential that the method used to determine the initial prestress in the wire give accurate result. Each wire shall be anchored positively during casting. Prestress in each wire shall be uniform. Care must be taken to ensure that anchorage do not yield before concrete attains the desired strength.

6.2 The cover of concrete measured from the outside of the prestressing tendon shall be at least 30 mm. or the size of the cable or bar whichever is bigger.

6.3 When measuring the prestressing force, any slip which may occur in the gripping device shall be taken into consideration.

6.4 The transfer of pre-stressed shall be carried out gradually by a proper device, so that the entire set of wires are released simultaneously.

6.5 In long line method, where the transfer is made on several moulds at a time, care shall be taken to ensure that prestressing force is evenly applied on all moulds and that the transfer of prestress to concrete is uniform along with entire length of tension line by ensuring correct alignment of moulds on guide plates.

6.6 The high tensile wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case.

6.7 COMPACTING:

Concrete shall be compacted by vibrating, Shocking or other suitable mechanical means. Hand compaction shall not be permitted

6.8 CURING:

To be done as specified in IS: 1678 (1998). Curing of PCC Pole preferably be done in tanks filled with water. The firms who confirm in writing compulsorily, at the time of bidding, of having curing tank facility or give consent for construction of curing tank within a period of two months, shall be given positive preference in final quantity allotment.

7.0 INSPECTION / TESTING:

7.1 The minimum offered number of poles for inspection/ testing should not be less than 500.

7.2 The PVVNL authorized representative shall be entitled for periodical checking and inspecting of the raw material to be used in entire production scheme and finished poles. The supplier's shall be bound to follow all written instructions found necessary to ensure quality control and conformity the product to the relevant standards.

7.3 The transverse strength test on the poles shall be performed in accordance with IS: 2905-1989 (or latest amendments thereof).

7.4 A pole shall be deemed not to have passed the test if hair cracks appear at a stage prior to application of 50% of the ultimate Transverse load or the hair cracks if any, produced on application of 60% of the minimum ultimate Transverse load of 450 Kg. at 300 mm. from top do not close upon the removal or reduction of test load.

7.5 For the purpose of test, a lot shall consist of maximum of 200 Nos. of poles. 15 Nos. Of poles out of a lot shall be

tested for over all length, cross section and uprightness, and 1% of the poles of the lot shall be tested till breakage amongst those 15 Nos. for transverse strength. Lot with lesser number of poles will also be tested as per above criteria.

7.6 The poles for test shall be selected at random out of a lot.

7.7 A lot shall be considered as conforming to these specifications if it satisfied the following conditions:

- (A) The number of poles which do not satisfy the requirement of overall length, cross section and uprightness shall not exceed one no. out of the 15 Nos. poles tested. If the number of such poles exceeds one then all the poles in a lot shall be tested for these requirements and those not satisfying the requirement shall be rejected.
- (B) All the poles tested for transverse strength test shall satisfy the requirement of the test. If one or more poles fail, twice the number of poles originally tested shall be taken from those already selected, and subjected to the test. If there is no failure among these poles, the lot shall be considered to have satisfied the requirements of this test.
- (C) A pole should be deemed to have passed the transverse load test if there is no permanent set observed 10 minutes after the release of applied load 180 Kg.

7.8 No payment shall be made for broken pole to the extent of 1% or more during inspection/testing out of the lot offered for the inspection.

8.0 **TOLERANCE:**

- (i) The tolerance on overall length of the pole shall be ± 15 mm.
- (ii) The tolerance on cross sectional dimensions shall be ± 5 mm.
- (iii) The tolerance on the uprightness or straightness of the pole shall be 0.5% (Measurement of uprightness or straightness of pole shall be done as per clause No. 4.2.1.1 of IS: 1678:1998).
- (iv) A tolerance of ± 15 mm is also allowed in the position of G.I Wire.

9.0 **MARKING:**

The pole shall be clearly and indelibly engraved with the following particulars during manufacture so as to easily read after erection in position.

9.1(a) Name of firm, Serial No. of pole & PO No. at (i) 400 mm, below top (ii) 3.0 meters from the bottom.

9.1(b) P.V.V.N.L., Date, month, and year of casting at a place in between name of firm as given in (a).

9.2 Colored indelible depth indelible depth marker at 1.52 mtr. from bottom to verify planting depth is also to be ensured.

10.0 **SPECIAL AND IMPORTANT CONDITIONS OF THE TENDER:**

1. The Price of 8.5 M Long PCC Pole are **FIRM** in all respect and the tenderer must quote accordingly.
2. TENDERER MUST QUOTE FOR A MINIMUM OF 15% QUANTITY 8.5 M LONG PCC POLES, OTHERWISE THEIR TENDER SHALL NOT BE CONSIDERED.
3. FOR LOADING/UNLOADING/TRANSPORT AND INSURANCE AGAINST ALL RISKS INCLUDING INSURANCE CHARGES FOR 30 DAYS STORAGE AFTER RECEIPT OF POLES AT DESTINATION STORES /SUBSTATION HAS TO BE QUOTED IN THE FOLLOWING SLABS (I) 0-25 KM. (II) 26-50 KM. (III) 51-75 KM. (IV) 76-100 KM. (V) 101-150 KM (VI) 151-200 KM (VII) 201-250 KM (VIII) 251-300 KM (IX) 301-350 KM HAS TO BE QUOTED.

NOTES: Firm situated outside PVVNL Area shall transport the PCC Poles from their works to the nearest PVVNL Area border free of cost. This can be further understood as if the nearest PVVNL Area border from the firms works is 'X' Km. & the poles have been transported for total 'Y' Km. Distance then the firm shall be given transportation charges/ Corresponding to (Y-X) Km. Only.

Incase of any ambiguity in quoting the above rates, the tender is liable to be rejected.

4. 'Proven design' as mentioned in clause No.1.2.6 of Instruction to Tenderers implies that the drawing & design calculation of 8.5 M Long PCC Pole should be got approved by a approved Institution.
5. Data of R/R shall be deemed to be date of delivery for dispatch by rail, the data of receipt of material in purchaser's store shall be deemed to be the date of delivery for dispatch by Road.
6. No payment shall be made for broken pole during inspection/testing out of the lot offered for inspection.

7. THE BIDDER SHOULD SIGN AND STAMP EACH PAGE OF THE BIDS ITS ANNEXURE/DOCUMENTS NECESSARILY.
8. Incase of any Inconsistency the provisions contained above shall prevail.
9. The tender part II (price part) of bidders who quote poles of cross-sections different form that mentioned in the tender specification shall not be opened.

TECHNICAL SPECIFICATION FOR 11 M. LONG 400 KG. WORKING LOAD PCC POLES (F.O.S. = 2.5).

1.0 SCOPE:

This specification covers pre-stressed concrete poles suitable for use in 33 KV & 11KV etc. Overhead Power lines and conforming to IS: 1678:1998 (and its amendments thereof).

2.0 APPLICABLE STANDARDS:

Except when they conflict with specific requirements in this Specification, the PCC poles shall comply with the relevant provisions made in the following Indian Standards or the latest versions thereof.

- a) IS: 1678, Specification for pre-stressed concrete poles for overhead power, traction and telecommunication lines.
- b) IS: 2905, Method of test for concrete poles for overhead power and telecommunication lines.
- c) IS: 7321, Code of practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines.
- d) IS: 1343, Code of practice for pre-stressed concrete.
- e) IS: 456, Code of practice for Plain and reinforced concrete.
- f) IS 6003, Code of practice for HT Wire for pre-stressed concrete.
- g) IS: 383, Code of practice for aggregates used for manufacture of PCC Poles.

3.0 TERMINOLOGY:

For the purpose of this specification, following definitions shall apply: -

3.1 AVERAGE PERMANENT LOAD

That fraction of the working load which may be considered of long duration over a period of one year.

3.2 LOAD FACTOR

The ratio of ultimate transverse load to the transverse load at first crack.

3.3 TRANSVERSE

The direction of the line bisecting the angle contained by the conductor at the pole. In the case of a straight run, this will be normal to the run of the line.

3.4 TRANSVERSE LOAD AT FIRST CRACK

For design, the transverse load at first crack shall be taken as not less than the value of the working load.

3.5 WORKING LOAD

The maximum load in the transverse direction, that is ever likely to occur, including the wind pressure on the pole. This load is assumed to act at a point 600 mm below the top with the butt end of the pole planted to the required depth as intended in the design.

3.6 ULTIMATE FAILURE

The condition existing when the pole ceases to sustain a load increment owing to either crushing of concrete, or snapping of the pre-stressing tendon or permanent stretching of the steel in any part of the pole.

3.7 **ULTIMATE TRANSVERSE LOAD**

The load at which failure occurs, when it is applied at a point 600 mm below the top and perpendicular to the axis of the pole along the transverse direction with the butt end of the pole planted to the required depth as intended in the design.

4.0 **GENERAL:**

4.1 Solid sections pre-stressed cement concrete poles shall be suitable for use in overhead 33KV & 11KV lines and suitable for a working load of 400 KG. applied in transverse direction at a distance of 600 mm. below top. The Overall length of the pole shall be 11 M. having depth of plantation as 1.80 Mtr. suitable for plantation direction into ground, when used in straight-line position. The structural strength of pole in longitudinal direction shall be at least one fourth of the strength in transverse direction. The average permanent load is 40% of working load.

For earthing G.I wire 8 SWG shall be embedded with projecting length of 175 mm. at 300 mm. from top and 175 mm. at 1650 mm. from bottom/butt end of PCC Poles. Earth wire shall not be allowed to come in contact with HT wire. The pole shall conform to IS: 1678-1998, IS: 1343-1980 and IS: 456-2000. (Or their latest editions/revisions thereof)

Two numbers through holes of 18-mm. dia. on the broader longitudinal side of the poles in the direction of conductor to be laid normal to and shall be provided such that the centers of these holes are at a distance of 100 mm. and 200 mm. from the top of poles.

Apart from above, necessary **lifting hooks** made of triple wire 4 mm dia at four locations, 1.80 mtr. and 3.60 mtr. from butt end & 2.25 mtr. and 4.5 mtr. from top end. (To be mentioned in the drawing) may also be provided.

5.0 **MATERIAL:**

5.1 **CEMENT:**

The cement used in the manufacture of prestressed concrete poles shall be any of the following: -

- a) Portland slag cement conforming to IS: 455 but with not more than 50 percent slag content.
- b) Rapid hardening Portland cement conforming to IS: 8041.
- c) 43 Grade ordinary Portland conforming to IS: 8112 and
- d) 53 Grade ordinary Portland cement conforming to IS: 12269.

5.2 **AGGREGATES:**

Aggregates used for manufacture of prestressed concrete pole shall conform to IS: 383:1970(latest amendments thereof). If required a sample of the aggregates shall be submitted by the manufacturer to the purchaser for approval. The maximum size of the aggregate shall in no case exceed 20 mm.

5.3 **WATER:**

The water used for concrete mixing and curing shall be clean and free from organic and inorganic matter harmful to concrete. Potable water shall be generally suitable.

5.4 **ADMIXTURE:**

The use of admixture is not generally recommended. These may be used only with the approval of the purchaser based on evidence that with the passage of time neither the compressive strength of concrete is reduced by more than 10% nor are other requisite qualities of concrete and/or steel impaired by the use of such admixtures. The admixture shall conform to IS: 9103. Admixture should not contain calcium chloride or other chlorides or other salts which are likely to cause corrosion of pre-stressing steel.

5.5 **PRESTRESSING STEEL (High Tensile Steel):**

High tensile steel used for manufacture of prestressed concrete poles shall conform to IS: 1785 or IS: 2090 or IS 6003-1983 (latest amendments thereof). The Pre-stressing steel shall be free from splits, harmful

scratches surface flaws, rough rust, scale and other similar deleterious matter liable to affect adversely proper tensioning or its bond with concrete. The diameter of smooth wire used for prestressing of poles shall be 4 mm. or 5-mm. dia. or a combination of two sizes and its ultimate tensile strength shall not be less than 175 Kg/mm^2 for 4 mm wire & 160 Kg/mm^2 for 5 mm dia wire.

5.6 OTHER REINFORCEMENT:

Apart from the high tensile steel provided for prestressing the poles, 6mm. dia plain round M.S Bar or 4mm.dia. H.T. Wire stirrups (as per IS: 432 or IS: 1786) shall be provided 4 Nos. at each end and 4 Nos. in the mid portion uniformly distributed (to be shown in the drawing). Un-tensioned reinforcement, if any, as required in design shall also be shown in drawing.

The surface of reinforcement shall be free from loose scale, oil, grease, clay or other material that may have degenerating affect on the bond between the reinforcement and concrete.

6.0 CONCRETE:

Design Mix. Concrete as defined in para 9.0 of IS: 456: 2000 and para 8 of IS: 1343: 1980 will be used in the manufacture of the poles. The design of concrete mix shall conform to the requirements laid down for controlled concrete under Para 9.2 of IS: 456:2000 subject to following further conditions.

- a) Minimum cube strength at 28 days shall not be less than 450 Kg/cm^2 in accordance with acceptability criteria given in clause 16 of IS: 456:2000.
- b) The mix shall contain as low as possible water cement ratio as is consistent with adequate workability.
- c) The concrete shall be compacted thoroughly by vibration, pressure, shock, or other means and shall have a density of not less than 2.4 MT/M^3 .
- d) The cube strength of concrete at transfer of prestress shall not be less than 245 Kg/cm^2 .
- g) The supplier shall be required to maintain a register showing the test results of cubes at the age of 3 and 28 days and at the transfer of prestress. For strength test the cubes shall be taken for each days casting. The register will show the serial number and the pole cast that day for which the test will apply. The acceptability criteria will be as per Para 16.3 to 17.5 of IS: 456. The register shall be opened for inspection with the authorized representative of the Corporation.
- h) The tenderer shall give a proper mix design of the grade M 45 of design mix concrete proposed to be used for casting of pole and such mix design may be supported by the test certificate of some Govt. Lab, or other Recognized Lab. Mix design done earlier not prior to one year may be considered adequate for later work, provided there is no change in source and quality of material.

7.0 DESIGN:

- 7.1 The poles shall be so designed that they do not fail owing to failure initiated by compression in concrete. Maximum wind pressure to be assumed may be determined as specified in IS: 875. (Part-3).
- 7.2 The pole shall be 11 M. long and should be designed for an ultimate load of 1 MT acting at 600 mm. below top. The dimensions, reinforcement etc. required to be provided may be shown in the drawing supplied by the tenderer supported by design calculation memo.
- 7.3 The ultimate moment capacity in longitudinal direction should be atleast one fourth of that in transverse direction. The PCC Pole be designed so that it should be safe against bending, shear, torsion and axial load at various stages of loading under most unfavorable condition of loading.
- 7.4 The G.I Wire, 8 SWG, which be in one continuous length, shall be embedded in the pole for earthing purpose. No joint of any kind in this wire shall be permitted. The position and details of connection to be provided at the end of earth wire have to be shown in the drawing.
- 7.5 The position of 18 mm diameter of the holes at 100 mm and 200 mm from top shall be provided in the poles are also to be shown in the drawing and shall be centrally located and will be perpendicular to the face of the pole.
- 7.6 Factor of safety against ultimate failure is 2.5. While it is 1.0 for first crack moment. Designer should mention basis for adopting various design constants e.g. per missible tensile, compressive stress, modulus of rupture etc.
- 7.7 The poles shall be designed to be suitable for fitting stays and clamps.
- 7.8 Separate Eye hooks shall be provided for handling and transport of poles, one at each of the pole and should be on the

shorter dimension of the cross section. The poles should be strong enough for lifting and erection in any direction during handling and transport. During erection, poles are laid on the ground and lifted at some point near the end, similarly while loading and unloading the poles from carriers they are lifted at one end resting on the ground and pushed on to the trucks. The poles should be able to withstand all such manual handling.

7.9 TRANSVERSE STRENGTH AT FAILURE:

The poles shall be designed that its strength in transverse direction shall be sufficient to take the load due to wind on wires and poles, multiplied by load factor.

8.0 MANUFACTURE:

The tensioning of prestressing tendons shall be carried out in a manner that will induce a smooth and even rate of increase of stress in the tendons.

8.1 The force induced in the prestressing tendon shall be determined by suitable means attached to the tensioning apparatus. It is essential that the method used to determine the initial prestress in the wire give accurate result. Each wire shall be anchored positively during casting. Prestress in each wire shall be uniform. Care must be taken to ensure that anchorage do not yield before concrete attains the desired strength.

8.2 The cover of concrete measured from the outside of the prestressing tendon shall be atleast 30 mm. or the size of the cable or bar whichever is bigger.

8.3 When measuring the prestressing force, any slip which may occur in the gripping device shall be taken into consideration.

8.4 The transfer of pre-stressed shall be carried out gradually by a proper device, so that the entire set of wires are released simultaneously.

8.5 In long line method, where the transfer is made on several moulds at a time, care shall be taken to ensure that prestressing force is evenly applied on all moulds and that the transfer of prestress to concrete is uniform along with entire length of tension line by ensuring correct alignment of moulds on guide plates.

8.6 The high tensile wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case.

8.7 The pre-stressing wires shall be de-tensioned only after the concrete has attained the specified strength at transfer (i.e. 245 kg / cm²). The cubes cast for the purpose of determining the strength at transfer should be cured, as far as possible, under conditions similar to those under which the poles are cured, the transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS: 1343 (Code of practice for pre-stressed concrete The manufacturer shall supply, when required by the owner or his representative, result of compressive test conducted in accordance with IS: 456 (Code of practice for plain and reinforced concrete on concrete cubes made from the concrete used for the poles. If the owner so desired, the manufacturer shall supply cubes for test purposes and such cubes shall supply cubes for test purposes and such cubes shall be tested in accordance with IS: 456 (Code of practice for plain and reinforced concrete).

8.8 The pre-tensioning shall be done by slowly releasing the wires, without imparting shock or sudden load to the poles. The rate of pre-tensioning may be controlled by any suitable means either mechanical (screw type) or hydraulic. The poles shall not be pre-tensioning or released by cutting the pre-stressing wires using flames or bar croppers while the wires are still under tension.

8.9 COMPACTING:

Concrete shall be compacted by vibrating, Shocking or other suitable mechanical means. Hand compaction shall not be permitted

8.10 CURING:

Curing to be done as specified in IS: 1678 (1998). Curing of PCC Pole be preferably done in tanks filled with water. The concrete shall be covered with a layer of sacking, canvass hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of pre-stress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface

cracking of the unit, the interval should depend on the atmospheric humidity and temperature.

9.0 INSPECTION / TESTING:

- 9.1 The minimum offered number of poles for inspection/ testing should not be less than 200.
- 9.2 The PVVNL authorized representative shall be entitled for periodical checking and inspecting of the raw material to be used in entire production scheme and finished poles. The supplier's shall be bound to follow all written instructions found necessary to ensure quality control and conformity the product to the relevant standards.
- 9.3 The transverse strength test on the poles shall be performed in accordance with IS: 2905-1989 (or latest amendments thereof). The pole may be tested in either horizontal or vertical position. If tested in horizontal position, provisions shall be made to compensate for the overhanging weight of the pole. For this purpose, the overhanging position of the pole may be supported on a moveable trolley or similar device the frictional resistance of supporting devices should be separately determined and deducted from the ultimate load applied on the pole. The pole shall be rigidly fixed longitudinally at the butt end for a distance equal to agreed planting depth i.e. 1.80 Mtr. and it shall be secured firmly in place with wooden shackles with concave surface and other packing shall be placed under pole to prevent injury to butt section. The transverse load shall be applied at a point 600 mm from the top of the pole and shall be steadily and gradually increased to the design value of the transverse load at the first crack. The deflection of pole at this load shall be measured. The pulling line shall be secured around the pole at load point. Load measuring device (Dynamometer) shall be placed in a way so as to accurately measure the tension in the pulling line, the other end of which is attached to the loading equipment.
- 9.4 A pole shall be deemed not to have passed the test if hair cracks appear at a stage prior to application of 50% of the ultimate Transverse load or the hair cracks if any, produced on application of 60% of the minimum ultimate Transverse load of 1000 Kg. at 600 mm. from top do not close upon the removal or reduction of test load. The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load and held for 2 minutes. This procedure shall be repeated until the load reaches the value of 80% of the minimum ultimate transverse load and thereafter increased by 5% of the minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes. The load applied to PCC Poles at the point of failure shall be measured to nearest 5 Kgs. PCC Poles shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse load.
- 9.5 For the purpose of test, a lot shall consist of maximum of 200 Nos. of poles. 15 Nos. of poles out of a lot shall be tested for over all length, cross section and uprightness, and 1% of the poles of the lot shall be tested till breakage for transverse strength test amongst those taken 15 Nos. for dimensional checks. Lot with lesser number of poles will also be tested as per above criteria.
- 9.6 The poles for test shall be selected at random out of a lot.
- 9.7 A lot shall be considered as conforming to these specifications if it satisfied the following conditions:
- (D) The number of poles which do not satisfy the requirement of overall length, cross section and uprightness shall not exceed one no. out of the 15 Nos. poles tested. If the number of such poles exceeds one then all the poles in a lot shall be tested for these requirements and those not satisfying the requirement shall be rejected.
 - (E) All the poles tested for transverse strength test shall satisfy the requirement of the test. If one or more poles fail, twice the number of poles originally tested shall be taken from those already selected, and subjected to the test. If there is no failure among these poles, the lot shall be considered to have satisfied the requirements of this test.
 - (F) A pole should be deemed to have passed the transverse load test if there is no permanent set observed 10 minutes after the release of applied load of 400 Kg.
 - (G) Measurement of cover- After completion of the transverse load test, the sample poles shall be taken and checked for cover of concrete. The cover of the pole shall be measured at 3 points, 1 within 1 meter from the butt end of the pole, the second within 0.6 meter from the top and third at an intermediate point and the mean value shall be compared with specified value.
- 9.8 No payment shall be made for broken pole to the extent of 1% or more during inspection/testing out of the lot offered for the inspection.

10.0 TOLERANCE:

- (i) The tolerance on overall length of the pole shall be ± 15 mm.

- (ii) The tolerance on cross sectional dimensions shall be ± 5 mm.
- (iii) The tolerance on the uprightness or straightness of the pole shall be 0.5% (Measurement of uprightness or straightness of pole shall be done as per clause No. 4.2.1.1 of IS: 1678:1998).
- (iv) A tolerance of ± 15 mm is also allowed in the position of G.I Wire.
- (v) The tolerance of ± 3 mm on individual value and ± 1 mm on average value of clear concrete cover taken at 3 points is allowed.

11.0 **MARKING:**

The pole shall be clearly and indelibly engraved with the following particulars during manufacturing of PCC pole so as to easily read after erection in position.

- (a) Name of firm & Serial No. of pole at two positions (i) 400 mm below top (ii) 3.0 meters from the bottom.
- (c) P.V.V.N.L., Date, month, and year of casting at a place in between name of firm as given in (a).

12.0 **SPECIAL AND IMPORTANT CONDITIONS OF THE TENDER:**

1. The Price of 11 M Long PCC Pole are **FIRM** in all respect and the tenderer must quote accordingly.
- 2- TENDERER MUST QUOTE FOR A MINIMUM OF 20% QUANTITY 11 M LONG PCC POLES, OTHERWISE THEIR TENDER SHALL NOT BE CONSIDERED.
3. FOR LOADING/UNLOADING /TRANSPORT AND INSURANCE AGAINST ALL RISKS INCLUDING INSURANCE CHARGES FOR 30 DAYS STORAGE AFTER RECEIPT OF POLES AT DESTINATION STORES /SUBSTATION HAS TO BE QUOTED IN THE FOLLOWING SLABS (I) 0-50 KM. (II) 51-100 KM. (III) 101-150 KM. (IV) 151-200 KM. (V) Above 200 KM HAS TO BE QUOTED.

NOTES: Firm situated outside PVVNL Area shall transport the PCC Poles from their works to the nearest PVVNL Area border free of cost. This can be further understood as if the nearest PVVNL Area border from the firms works is 'X' Km. & the poles have been transported for total 'Y' Km. Distance then the firm shall be given transportation charges/ Corresponding to (Y-X) Km. Only.

Incase of any ambiguity in quoting the above rates, the tender is liable to be rejected.

4. 'Proven design' as mentioned in clause No.1.2.6 of Instruction to Tenderers implies that the drawing & design calculation of 11 M Long PCC Pole should be got approved by a approved Institution.
5. Data of R/R shall be deemed to be date of delivery for dispatch by rail, the data of receipt of material in purchaser's store shall be deemed to be the date of delivery for dispatch by Road.
6. No payment shall be made for broken pole during inspection/testing out of the lot offered for inspection.
10. THE BIDDER SHOULD SIGN AND STAMP EACH PAGE OF THE BIDS ITS ANNEXURE/DOCUMENTS NECESSARILY.
11. Incase of any Inconsistency the provisions contained above shall prevail.
12. The tender part II (price part) of bidders who quote poles of cross-sections different from that mentioned in the tender specification shall not be opened.

7. Tubular Steel Poles for Overhead Lines

1 SCOPE:

This specification covers the general requirements towards design, manufacture, testing at manufacturers works, supply and delivery for tubular steel poles of circular cross section (swaged type) for overhead lines.

2 STANDARD:

The tubular steel poles shall conform to the latest edition of Indian Standard specification IS: 2713 (Part – I, III): 1980 or any other authoritative standards (as amended up-to-date) except where specified otherwise in this specification.

3 Topography and Climatic Condition:

The materials offered, shall be suitable for operation in tropical climate and will be subjected to the sun and inclement weather and shall be able to withstand wide range of temperature variation. For the purpose of design, average atmospheric temperature may be considered to be 50°C with humidity nearing saturation.

4 Materials:

4.1 The materials used in construction of tubular steel poles shall be of the tested quality of steels of minimum tensile strength 540 MPa (: 55 Kgf/mm²).

4.2 The materials, when analysed in accordance with IS: 228 (Part-III: 1972) and IS : 228 (Part-IX) shall not show sulphur and phosphorous contents of more than 0.060 percent each.

5 Types, Size and construction:

5.1 Tubular Steel Poles shall be swaged type.

5.2 Swaged poles shall be made of seamless or welded tubes of suitable lengths swaged and jointed together. No circumferential joints shall be permitted in the individual tube lengths of the poles. If welded tubes are used they shall have one longitudinal weld seam only: and the longitudinal welds shall be staggered at each swaged joint.

- 5.3** Swaging may be done by any mechanical process. The upper edge of each joint shall be chamfered if at an angle of about 45°. The upper edge need not be chamfered if a circumferential weld is to be deposited in accordance with clause No. 5.3 2 of IS: 2713 (Part-I):1980.
- 5.4** The length of joints on swaged poles shall be in accordance with clause No. 5.4 of IS: 2713 (Par-I): 1980.
- 5.5.** Poles shall be well-finished, clean and free from harmful surface defects. Ends of the poles shall be cut square. Poles shall be straight, smooth and culindrical. The weld joints, if any, shall be of good quality, free from scale, surface defects, cracks, etc.
- 5.6.** Tolerances for outside diameter, thickness, length, weight and straightness shall be in accordance with IS: 2713 (Part-I) : 1980.
- 5.7.** The poles shall be coated with black bituminous paint conforming to IS: 158-1968 throughout, internally and externally, upto the level which goes inside the earth. The remaining portion of the exterior shall be painted with one coat of red oxide primer as specified in IS: 2074-1979.

6 Earthing Arrangements:

For earthing arrangement a through hole of 14mm diameter shall be provided in each pole at a height of 300mm above the planting depth.

7 Tests and Test Certificates:

- 7.1** The following tests shall be conducted on finished poles :
- A. Tensile test and chemical analysis for sulphur and phosphorous,
 - B. Deflocation test,
 - C. Permanent set test, and
 - D. Drop test.
- 7.2** In addition to above verification of dimensions as per IS: 2713 (Part-III) : 1980 shall be carried out during acceptance lots.
- 7.3** Number of poles selected for conducting different tests shall be in accordance to clause No. 10.1.1 and No. 10.1.12: of IS: 2713 (Part-I) 1980.

7.4 Tests shall be carried out before supply of each consignment at the manufacturers works and test certificates should be submitted to the purchaser for approval prior to delivery.

7.5 Re-tests, if any, shall be made in accordance with IS: 2713 (Part-I) 1980.

7.6 Purchaser reserves the right to inspect during manufacturing and depute his representative to inspect/test at the works.

7.7 If any extra cost is required for carrying out the above specified tests, the same shall be borne by the manufacturer.

8 Marking:

8.1 The poles shall be marked with designation, manufacturer's identification, year of manufacture and name of the purchaser: Employer Name; RDSS

8.2 The poles may also be marked with the ISI certification mark.

9 Guaranteed technical particulars:

9.1 The manufacturer shall furnish all necessary guaranteed technical particulars in the prescribed Performa enclosed hereinafter.

10 Performance:-

10.1 The manufacturer shall furnish a list of the major supplies effected during the last 3 (three) years indicating the volume of supply and actual delivery dates.

10.2 Manufacturer may not be considered if the past manufacturing experience is found to be less than 3 (three) years.

11 Deviation:-

Any deviation in technical specification shall be clearly indicated with sufficient reasons thereof. Purchaser shall however reserve the right to accept and/or reject the same without assigning any reasons what-so-ever.

ANNEXURE –‘A’

SPECIFIC TECHNICAL REQUIREMENTS FOR
TUBULAR STEEL POLES : SWAGED TYPE

	9 meters long	11 meters long	13 meters long
1) Standard			
2) Type of Pole			
3) Designation	410 SP 33	410 SP 55	410 SP 72
4) Overall Length	9 meters	11 meters	13 meters
5) Planting depth	1.5 meters	1.8 meters	2.0 meters
6) Height above ground	7.5 meters	9.2 meters	11.0 meters
7) Effective length of Each section.			
a) Bottom	5.0 meters	5.6 meters	5.80 meters
b) Middle	2.0 meters	2.7 meters	3.60 meters
c) Top	2.0 meters	2.7 meters	3.60 meters
8) Outside diameter and Thickness of each Section.			
a) Bottom	165.1x5.40 mm	193.7x4.85 Mm	219.1x5.90 mm
b) Middle	139.7x4.50 mm	165.1x4.50 Mm	193.7x4.85 mm
c) Top	114.3x3.65 mm	139.7x4.50 Mm	165.1x4.50 mm
9) Joint Length (in cm.):			
a) Bottom (J2)	35 cm.	40 cm.	45 cm.
b) Top (J1)	30 cm.	35 cm.	40 cm.
10) Approximate weight of Pole	164 Kg.	227 Kg.	343 Kg.
11) Point of application of load below/top (mtr.)	0.3 mtr.	0.6 mtr.	0.6 mtr
12) Breaking load (inKgf)	612	650	828
13) Working load with factor of Safety : 2.5 (in Kgf)	245	260	331

14) Crippling load (inKgf)	435	462	588	
15) Load for permanent set Not exceeding 13mm (in Kgf)	297	316	402	
16) Load for Temporary Deflection of 157.5 mm (in Kgf)	157	130	121	
17) Tolerance	IS : 2713 (Part-I & Part-III): 1980			
18) Finish				
19) Manufacturing clause				

8. Hot rolled parallel flange steel sections for pole support, beams and columns

Parallel flange sections (WPS160 x 160 x 30.44 kg/m) and (WPS 160 x 23.83 kg/m) are hot rolled steel sections, with parallel or nearly parallel flange with square toes and curves at the root of flange and web as per IS12778: 2004.

This standard covers the nominal dimensions; mass and sectional properties of hot rolled parallel flange beams.

REFERENCES All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the following standards:

- a) IS 2062:1999 Steel for general structural purposes — Specification (fifth revision)
- b) IS 8500:1991 Structural steel — Micro alloyed (medium and high strength qualities) — Specification (first revision)
- c) IS 12779:1989 Rolling and cutting tolerances for hot rolled parallel flange beam and cutting sections

Wide Parallel Flange Beams, WPB These are doubly symmetric shapes, generally used as beams or columns whose inside flange surfaces are substantially parallel. Beams or columns under the standard have nominal flange width same as depth up to nominal beam depth 300 mm. Beam depth larger than 300 mm have nominal flange width 300 to 400 mm. Columns may have flange widths more than the depths. Beams and column section are manufactured with heavy, medium and light flange and web thickness. Beams and columns are designated by nominal depth and nominal flange width and mass in kg/m. For example, WPB 600 x 300 x 128.79 would mean wide parallel flange beam having nominal depth 600 mm nominal flange width of 300 mm and

beam mass of 128.79 kg/m; WPB 360 x 370 x 136.20 would mean wide parallel flange columns having nominal depth of 360 mm and nominal flange width of 370 mm and a mass of 136.20 kg/m.

Nominal dimensions and mass of wide parallel flange beams shall conform to the values given in Tables 1 to 3, respectively of the standard IS12778: 2004.

Sectional properties of the beam are given in Tables 1 to 3 of IS12778: 2004. Steel grades - Material strength of steel sections shall be conforming to IS 2062 for mild steel and IS 8500 for medium and high strength steel. Dimensional and mass tolerances of the various sections shall conform to the appropriate values stipulated in IS 12779.

Product shall be tested in NABL accredited laboratory of M/S RITES for relevant properties or the test certificate be issued by manufacturer for Parallel Flanged Section WPB 160 as per IS 2062 after testing license from BIS.

9. Hot Rolled Steel Beams (Joists)

1. SCOPE :-

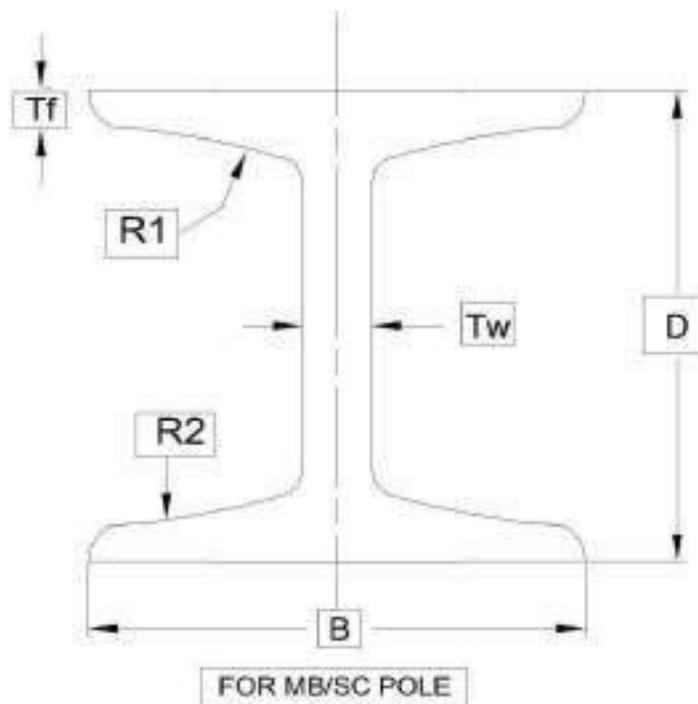
Specification covers the manufacture, testing at works and supply of various sizes of Hot rolled steel beams.

2. APPLICABLE STANDARDS:

The Mild shall be conforming to IS:2062 – 1992 GRADE ‘ A ‘ modified upto date or its equivalent international standard for steel materials, document for which shall be made available at the time of inspection to the Employer’s representative. The dimensions of Hot Rolled Steel Beams shall be conforming to IS: 808 / 1989 amended upto date and tolerance as per IS : 1852 modified upto date.

3. GENERAL REQUIREMENTS :

Material shall be supplied as per the sizes and technical details as per following requirements and drawing.



Note: 1) All Dimensions are as per annexure-I
2) Drawing is not to the scale

GUARANTEED TECHNICAL PARTICULARS
RSJ POLE/HDG RSJ POLE

Sr. No.	Particulars	Employer's Requirement/ To be offered by the Bidder				
		116x100	MB 125x70	MB 175x85	SC 152x152	UC 152x152
1.	Designation (DxB) (mm x mm)	116x100	MB 125x70	MB 175x85	SC 152x152	UC 152x152
2.	Length of joist-Meter with ± 100 mm tolerance	9m/10m/ 11m/13m	8m/9m	9m	11m/13m	11m/13m
3.	Weight (kg/M)	23.0	13.3	19.6	37.1	37.0
4.	Sectional area (A) (Sq.cm.)	29.3	17.0	25.0	47.4	47.11
5.	Depth of section (D) (mm)	116	125	175	152	161.8
6.	Width of flange (B) (mm)	100	70	85	152	154.4
7.	Thickness of flange (Tf) (mm)	10	8	9	11.9	11.5
8.	Thickness of Web (Tw) (mm)	8.5	5	5.8	7.9	8.0
9.	Radius of fillet or root (R1)(mm)	15	9	10	11.7	7.6
10.	Radius of tow (R2) (mm)	3	4.5	5	3	--
11.	Moment of Inertia (i) Ixx (cm ⁴) (i) Iyy (cm ⁴)	643.8 143.5	445 38.5	1260 76.7	1970 700	2210 706.2
12.	Radius of Gyration GR xx (cm)	4.69	5.16	7.13	6.45	6.85
13.	Modulus of Section (i)Z xx (cm ³) (ii)Z yy (cm ³)	111 28.7	71.2 11	144 18	259 91.9	273.2 91.48
14.	Tolerance in dimensions and weight	----- As per IS: 1852 Updated -----				

10. Mild Steel Channel, Angle And Flat

1) APPLICABLE STANDARDS:

The mild steel shall conform to IS: 2062 grade 'a' modified upto date or equivalent international standard for steel materials, documents for which shall be made available at the time of inspection to the owner's representative.

2) GENERAL REQUIREMENTS:

Material shall be supplied as per the following sizes:

100x50 ISMC channel conforming to IS: 2062 grade 'a' modified upto date or its equivalent International Standard having length ranging from 5.5 to 13.5 meters. 75x40 ISMC channel conforming to IS: 2062 grade 'a' modified upto date or its equivalent International Standard having length ranging from 5.5 to 13.5 meters.

50x50x8 mm or 6 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.

45X45X5 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.

60x65x6 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.

25X3mm, 50X6mm, 50x8mm, 75X8mm and 80X8 flats conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 9.5 meters.

3) GALVANISATION:

All above steel members shall be fabricated as per approved drawing having smooth edge, drilled circular/elliptical holes of suitable measurements.

All structural steel members and bolts shall be galvanized as per IS:4759 and zinc coating shall not be less than 610gm/sq. meter for all structural steel members. All weld shall be 6mm filled weld unless specified otherwise. All nuts and bolt shall be of property class 5.6 of IS 1367. Plain washers shall be as per IS 2016 and spring washers shall be IS:3063

4) INSPECTION:

All inspection/test will be carried out by representative of owner.

All tests and inspection shall be made at the place of manufacturer unless otherwise specially agreed upon by the manufacturer and the owner. The manufacturer shall provide all reasonable facilities, without charge to satisfy him that the material is being supplied in accordance with the specification.

11. 11 & 33 KV Outdoor Type Current Transformer

4.1 INTRODUCTION

This section covers the specification of 33 kV and 11kV Current Transformer suitable for outdoor service. Any other parts not specifically mentioned in this specification but otherwise required for proper functioning of the equipment should be included by the tender in the offer. The CTs should normally be installed above VCB. The VCB & CT should be installed on common mounting structure. In places, where VCB are not provided in the Substation separate CT mounting structure shall be provided with CTs.

4.2 APPLICABLE STANDARDS

Unless otherwise modified in this specification, the Current Transformer shall comply with the latest version of relevant standards (IS 2165, IS 2705(I-IV), IS 2099, IS 5621, IS 2071, IS 335, IS 13947(part I), IEC 185, IEC 270, IEC 44(4), IEC 171, IEC 60, IEC 8263, IEC 815, Indian electricity Rules 2003) or better international standards. This list of standards is for guidance only. The contractor shall be solely responsible to design & manufacture the CT suitable for 33kV & /11 kV systems.

4.3 AMBIENT CONDITIONS

The CT supplied against these specifications shall be suitable for satisfactory continuous operation under the tropical conditions. The detail condition is mentioned in General Technical requirement.

4.4 SYSTEM PARTICULARS

a)	Nominal System Voltage	33kV & 11kV
b)	Highest system Voltage	36kV & 12kV
c)	Rated Frequency	50Hz & 50Hz
d)	No of phases	Three & Three
e)	System neutral earthing	-Solidly Earthed-
f)	One minute Power Freq. withstand voltage (rms)	70kV & 28kV
g)	Lighting Impulse withstand Voltage	170kVp & 75kVp

- i) System fault level -25kA for 3sec-

4.5 TECHNICAL PARAMETERS OF CT

- a) Type Single phase, dead tank, outdoor,oil filled & hermetically sealed
- b) Type of mounting Pedestal type
- c) Rated primary current As per BPS
- d) Rated Continuous thermal current 120 % of rated Primary current
- e) Rated short time withstand Requirement for sec. Winding As per IS 2705 Pt. I
- f) Rated short time withstand Current 25kA(RMS)
 - i) Duration (for primary current of 150amps and above) 3Sec
 - ii) Duration (for primary current below 150amps) 1Sec
- g) Rated dynamic withstand Current (KA rms) 62.5
- h) Max temp rise As per IEC-185/ IS 2705
- i) Minimum creepage distance of porcelain housing(mm) 25 mm /KV
- j) One minute power frequency Withstand voltage between Secondary terminal & earth 3 kV
- k) Detail of Secondary Cores Metering Protn. Current ratio (As per BPS)
- Accuracy class 0.5 5P10
- Burden (VA) 30 30

Instrument security Factor	≤ 5	-
Accuracy Limit Factor	-	≥ 10

Note: The ratings indicated for instrument transformer are tentative only and may be changed to meet the requirements.

4.6 PORCELAIN HOUSING

It shall be single piece of homogeneous, vitreous porcelain of high mechanical & dielectric strength. It will be glazed with uniform Brown or Dark brown colour with smooth surface finish. The creepage distance for the porcelain housing shall be at least 25 mm per kV.

4.7 WINDING

1 PRIMARY WINDING

It shall be made of high conductivity rigid copper wire. The primary winding current density shall not exceed the limit of 1.6 Amp per sq. mm for normal rating.

The design current density for short circuit current as well as conductivity of metal used for primary winding shall be as per IS 2705. The calculation for the selection of winding cross section shall be furnished by contractor.

The primary terminal shall be of maximum* size of 30 mm dia x 80 mm length of heavily tinned (min. thickness 15 micron) electrolytic copper of 99.9 % conductivity. Manufacturer shall design the diameter of primary terminal keeping current density 1.6A per sq. mm for the given capacity of CT.*

*Amendment issued vide letter No. REC/DDUGJY/SBD/2017/2148 Dated 21.07.2017.

2 SECONDARY WINDING

shall be made of insulated copper wire of electrolytic grade. Type of insulation used shall be described in the offer. For multi ratio design, the multi ratio will be achieved by reconnection of the primary winding or secondary winding. The excitation current of the CT shall be as low as possible. The contractor shall furnish the magnetization curves for all the cores.

The terminal box shall be dust free & vermin proof. The size of the terminal box shall be big enough to enable easy access and working space with the use of normal tools.

The secondary terminals studs shall be provided with at least 3 nuts and two plain washers, these shall be made of brass duly nickel plated. The min. stud outer dia shall be 6 mm & length 15 mm. The min spacing between the centres of the adjacent studs shall be 1.5 time the outer dia of the stud.

3 POLARITY

The polarity shall be marked on each CT at the primary and secondary terminals.

4.8 TANK & HARDWARES

The CT will be dead tank type. The tank shall be fabricated of MS steel sheet of min. 3.15 mm for sides & 5 mm for top & bottom. The tank will be finished with min. 2 coats of zinc rich epoxy paint externally. The inner surface shall be painted with oil resistance white enamel paint.

All ferrous hardwares, exposed to atmosphere shall be hot dipped galvanized.

4.9 INSULATION OIL

The first filling of oil in CT shall be in contractor's scope. The oil shall be as per IS 335.

To ensure prevention of oil leakage, the manufacturer will give following details supported by drawings:

- i) Location of emergence of Primary & Secondary terminals
- ii) Interface between porcelain & metal tanks
- iii) Cover of the secondary terminal box

Any nut & bolt and screw used for fixation of the interfacing porcelain bushing for taking out the terminals shall be provided on flanges cemented to the bushings & not on the porcelain.

If gasket joints are used, Nitrite Butyl Rubber gasket shall be used. The grooves shall be machined with adequate space for accommodating gasket under pressure.

The CT shall be vacuum filled with oil after processing. It will be properly sealed to eliminate breathing & to prevent air & moisture from entering the tank. The sealing methods/arrangement shall be described by the contractor & be approved by the owner.

4.10 OIL LEVEL INDICATOR

The CT shall be fitted with prismatic type oil sight window at suitable location so that the oil level is clearly visible with naked eye to an observer standing at ground level.

To compensate oil volume variation due to temperature variation, Nitrogen cushion or the stainless steel bellows shall be used. Rubber diaphragms are not permitted for this purpose.

4.11 EARTHING

Two earthing terminals shall be provided on the metallic tank of size 16 mm dia & 30 mm length each with one plain washer & one nut for connection to the station earth mat

4.12 Junction Box

The junction box shall be of MS sheet having thickness of 2mm, synthetic enamel painted as per procedure mentioned in General Technical Requirement (Min. thickness 55 micron). The shade of junction box shall be 697 of IS: 5. Disconnecting type terminal blocks for CT secondary lead shall be provided. The junction boxes shall be weather proof type with gaskets, as per section-I (Introduction and general technical requirements) conforming to IP-55 as per IS-13947 (Part-I).

4.13 LIFTING & MOUNTING ARRANGEMENT

The CT shall be provided with two lifting eyes to lift the CT. This shall be so positioned so as to avoid any damage to the CT during lifting for instillation or transportation purpose. This shall be detailed in General Arrangement drawing.

The CT shall be of pedestal mounting type suitable for outdoor installation on steel/cement concrete structures. All the clamps, bolts, nut and washers etc. required for mounting the CT on the structure shall be supplied along with the CT and shall be galvanized. The contractor shall supply all the terminal connectors etc. required for connection to the CT.

4.14 TESTING

All Type and Routine Tests shall be as per relevant IS and/or IEC.

GUARANTEED TECHNICAL PARTICULARS OF CURRENT TRANSFORMER

Sl.No.	Particular of GTP Parameter	Bidders Confirmation	
		33kV CT	11kV CT
1	Manufacturer's Name & address		
2	Type of equipment		
3	Type of Mounting		

Sl.No.	Particular of GTP Parameter	Bidders Confirmation	
		33kV CT	11kV CT
4	Equipment Conforming to Standards		
5	Rated Voltage / Highest System Voltage in KV		
6	Rated Primary Current (Amp)		
7	Rated Secondary Current (Amp)		
8	Frequency (HZ)		
9	Ratio of Current Transformer		
10	Details of Cores		
i)	Number of Cores		
ii)	Purpose		
iii)	Burden (VA)		
iv)	Class of Accuracy		
11	Rated Short Time Withstand Current for 1 Sec. duration		
12	Rated Dynamic Withstand Current (KA _p)		
13	Method of Earthing system to be connected to		
14	One-minute Dry Power Frequency Withstand Voltage (KV rms) of Primary Winding		
15	One-minute Wet Power Frequency Withstand Voltage (KV rms) of Primary Winding		
16	1.2/50 micro-second Impulse Withstand Voltage (KVP)		
17	The die-electric Withstand values (KV _p)of external & internal insulation		
18	One minute Power Frequency Withstand Voltage (KV rms) of Secondary Winding		
19	Minimum Creepage Distance (mm)		
20	Weight of oil (kg/Ltrs.)		
21	Total Weight (kg)		
22	Mounting details		
23	Overall dimension		
24	Type of Winding		
25	Material of Winding		
26	Size & Cross Section of Primary Winding		
27	Size & Cross Section of Secondary Winding		
28	No. of Primary Turns		
29	No. of Secondary Turns		
30	Current Density of Primary & Secondary Winding (max. – 1.6A/sq.mm)		
31	Primary Terminal		
32	Type of Insulation		
33	Whether Current Transformer confirms to Temperature Rise		

12. 33 & 11 kV Outdoor Type Potential Transformer

1 INTRODUCTION

This chapter covers specification of 33kV and 11kV Potential Transformer suitable for outdoor service. Any other parts not specifically mentioned in this specification but otherwise required for proper functioning of the equipment should be included by the tender in the offer.

2 APPLICABLE STANDARDS

Unless otherwise modified in this specification, the Potential Transformer shall comply with the latest version of relevant standards (IS 3156, IS 2099, IS 5621, IS 335, IS 13947(Part I), IEC 186, Indian electricity Rules 2003, IEC 815) or better international standards. This list of standards is for guidance only. The contractor shall be solely responsible to design & manufacture the PT suitable for 33 kV/11kV systems.

3 AMBIENT CONDITIONS

The PT supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as detailed in general technical requirement.

4 SYSTEM PARTICULARS

a)	Nominal System Voltage	33kV	11kV
b)	Highest system Voltage	36kV	12kV
c)	Rated Frequency	50Hz	50Hz
d)	No of phases	Three	Three
e)	System neutral earthing	---Solidly Earthed--	
f)	One minute Power Freq. Withstand voltage (rms)	70kV	28kV
g)	Lighting Impulse withstand Voltage	170kVp 75kVp	
h)	System fault level	---25 kA for 3sec---	

5 TECHNICAL PARAMETERS OF PT

a)	Rated primary Voltage	36 KV	12 KV
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b) Type	Single phase potential transformer	
c) Voltage/ Ratio(kV)	33/0.11	11/0.11
d) Rated voltage factor	1.2continuous	1.5 – 30seconds-
e) One minute power freq. Withstand voltage for		
	Primary Terminals	70 kV(rms) 28 kV
	Secondary winding	36 kV 12 KV
f) Min. Creepage Distance	25 mm/kV of Highest System Voltage	
g) Detail of secondaries	Core I	Application Metering
	Accuracy	0.5
	Burden (VA)	100

Note: The ratings indicated for instrument transformer are tentative only and may be changed to meet the requirements.

6 PORCELAIN HOUSING

It shall be single piece of homogeneous, vitreous porcelain of high mechanical & dielectric strength. It will be glazed with uniform Brown or Dark brown colour with smooth surface finish. The creepage distance for the porcelain housing shall be at least 25mm per kV.

The contractor shall clearly detail in his bid the details of attaching the metallic flange to porcelain, pressure release valve and also how primary & secondary terminals shall be brought out.

7 WINDING

PRIMARY WINDING

It shall be made of insulated electrolytic copper wire. The neutral end of the winding shall be brought outside for earthing.

The primary terminal shall be of standard size of 30 mm dia x 80 mm length of heavily tinned (min. thickness 15 micron) electrolytic copper of 99.9 % conductivity.

SECONDARY WINDING

It shall be made of insulated copper wire of electrolytic grade. The terminal box shall be dust free & vermin proof. The size of the terminal box shall be big enough to enable easy access and working space with the use of normal tools.

The secondary terminals studs shall be provided with at least 3 nuts and two plain washers. These shall be made of brass duly nickel plated. The min. stud outer dia shall be 6* mm & length 15 mm. The min spacing between the centres of the adjacent studs shall be 1.5 time the outer dia of the stud.

*Amendment issued vide letter No. REC/DDUGJY/SBD/2017/2148 Dated 21.07.2017.

POLARITY

The polarity shall be marked on each PT at the primary and secondary terminals.

8 TANK & HARDWARES

It shall be fabricated of MS steel sheet of min. 3.15 mm for sides & 5 mm for top & bottom. The tank will be finished with min. 2 coats of zinc rich epoxy paint externally. The inner surface shall be painted with oil resistance white enamel paint.

All ferrous hardware, exposed to atmosphere shall be hot dipped galvanized.

9 INSULATION OIL

The first filling of oil in PT shall be in contractor's scope. The oil shall be as per IS 335. To ensure prevention of oil leakage, the manufacturer will give following details supported by drawings:

- i) Location of emergence of Primary & Secondary terminals
- ii) Interface between porcelain & metal tanks
- iii) Cover of the secondary terminal box

Any nut & bolt and screw used for fixation of the interfacing porcelain bushing for taking out the terminals shall be provided on flanges cemented to the bushings & not on the porcelain.

If gasket joints are used, Nitrite Butyl Rubber gasket shall be used. The grooves shall be in machined with adequate space for accommodating gasket under pressure.

The PT shall be vacuum filled with oil after processing. It will be properly sealed to eliminate breathing & to prevent air & moisture from entering the tank. The sealing methods/arrangement shall be described by the contractor & be approved by the owner.

10 OIL LEVEL INDICATOR

The PT shall be fitted with prismatic type oil sight window at suitable location so that the oil level is clearly visible with naked eye to an observer standing at ground level.

To compensate oil volume variation due to temperature variation, Nitrogen cushion or the stainless steel bellows shall be used. Rubber diaphragms are not permitted for this purpose.

11 EARTHING

Two earthing terminals shall be provided on the metallic tank of size 16 mm dia & 30 mm length each with one plain washer & one nut for connection to the station earth mat

12 Junction Box

The junction box shall be of MS sheet having thickness of 2mm, synthetic enamel painted as per procedure mentioned in General technical Requirement (Min. thickness 55 micron). The shade of junction box shall be 697 of IS: 5. Disconnecting type terminal blocks for PT secondary lead shall be provided. The junction boxes shall be weather proof type with gaskets as per section-I (Introduction and general technical requirements) conforming to IP-55 as per IS-13947 (Part-I).

One junction box shall be provided for 3 numbers of single phase CT's and PT's.

13 LIFTING & MOUNTING ARRANGEMENT

The PT shall be provided with two lifting eyes to lift the PT. This shall be so positioned so as to avoid any damage to the PT during lifting for installation or transportation purpose. This shall be detailed in General Arrangement drawing.

The PT shall be of pedestal mounting type suitable for outdoor installation on steel/cement concrete structures. All the clamps, bolts, nut and washers etc. required for mounting the PT on the structure shall be supplied along with the PT and shall be galvanized. The contractor shall supply all the terminal connectors etc. required for connection to the PT.

14 TESTING

All Type and Routine Tests shall be as per relevant IS and /or IEC.
GTP to be submitted by the Bidder

Description	Particulars	
Name of the manufacturer		
Factory address		
Equipment		
Reference Standard		
Type		
Rated voltage		
Highest voltage		
Frequency		
Basic Insulation Level		
Class of insulation		
Creepage distance		
Ratio		
Class of accuracy	Core - I :	, Core - II :
Burden	Core - I :	, Core - II :
Voltage factor		
Core identification	Core - I :	, Core - II :
Place of installation		
Material & size of Primary Stud		
Material & size of Secondary Stud		
Primary terminal connector		
Fixing hole centre distance		
Painting process		
Paint shed		
IP of Secondary Terminal Box		
Weight of oil		
Volume of oil		
Height of PT		
Total weight of PT		
Guarantee		
Type Test Report	Tested at	Date of Test
a. Highvoltage Power frequency wet withstand voltage test		
b. Lightning impulse voltage withstand test		
c. Temperature rise Test		
d.Determination of error.		

13. Control & Relay Panel for 33 kV Feeder with Directional or Non-directional O/C and E/F protection and 33/11 kV Transformer Panel with & without Differential Protection for various 33/11 kV Sub-Stations

1.0 Scope:

This specification covers design, manufacture, assembly, testing before supply, inspection, packing and delivery and other basic technical requirements in respect of control and relay panels for 33 kV feeders, 33/11KV Power Transformers without differential protection and 33/11KV Power Transformers with differential protection to be installed at various 33/11 kV sub-stations. The equipment to be supplied against this specification is required for vital installations where continuity of service is very important. The design, materials and manufacture of the equipment shall, therefore, be of the highest order to ensure continuous and trouble-free service over the years. The Manufacturer has to design the Schematics for protection and Control of all equipment including monitoring indications, visual and audible alarm, interlocking schemes among different equipment. Any other requirement which are not specifically covered here but which are necessary for successful commissioning of the Sub stations are also within the scope of the Contract.

The equipment manufactured should conform to the relevant standards and of highest quality of engineering design and workmanship. The equipment manufactured shall ensure satisfactory and reliable performance throughout the service life. The Schedule of requirement of the Panel is furnished separately in details.

2.0 Service Conditions:

2.1. System particulars:

Nominal system voltage	33 kV & 11 kV
Corresponding highest system voltage	36 kV & 12 kV
Frequency	50 Hz±3%
Number of phases	3
Neutral earthing	33 kV Grounded through Earthing Transformer 11 kV solidly earthed

2.2. Equipment supplied against the specification shall be suitable for satisfactory operation under the following tropical conditions:-

Max. ambient air temperature	60 ° C
Max. relative humidity	100 %
Max. annual rainfall	1450 mm
Max. wind pressure	150 kg/sq.m.
Max. altitude above mean sea level	1500 mtrs.
Isoceraunic level	50
Reference Ambient Temperature for temperature rise	50 deg C
Climatic Condition	Moderately hot and humid tropical climate conducive to rust and fungus growth

2.3. The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

2.4. Auxiliary supplies available at the various sub-stations are as follows:-

3.2.1 Rating:

i.	A. C. Supply	230 volts, with ± 10% variation, Frequency 50Hz with ±3%
ii	D.C. Supply	30 V DC. DC system is 2(two) wire with necessary earth fault annunciation scheme. DC supply shall be normally fed from Battery charger. In case of failure of AC supply to Battery Charger, DC supply voltage will be available from Lead Acid Battery.

2.5. Unless otherwise specified all equipment and material shall conform to the latest IS applicable standards. Equipment complying with other internationally recognized standards will also be considered if it ensures performance equivalent or superior to Indian standards. In the event of supply of equipment conforming to any international \ internationally recognized standards other than the standard listed below.

2.6. The equipment provided shall also comply with the latest revisions of Indian Electricity act and Indian Electricity rules and any other applicable statutory provisions, rules and regulations.

2.7. All equipment provided under the specification shall generally conform to the latest issue of the following :-

a)	IS 12063/1987	Degree of Protection provided for enclosure of electrical equipment.
b)	IS 5/2004	Colour for ready mixed paints & enamels.
c)	IS 3231 / 1986 & 1987	Electrical relays for power system protection
d)	IEC 60255	Numerical biased protection relay
d)	IS 8686/1977	Static Protective Relays
e)	IS 1248/2003	Indicating instruments
f)	IS 14697/1999	HT Static Tri vector TOD Energy meter
g)	IS 6875 amended up to date	Control switches
h)	IS 4794/1968 & 1986	Push buttons
i)	IEC 337 & 337-1	Control Switches (LV Switching devices for control and auxiliary circuit)
j)	IEC:60185	Current Transformers
k)	IEC:60186	Voltage Transformer
l)	IS 375	Marking and arrangement for Switchgear Bus
m)	IS:5578/1984	Marking of insulated conductors.

2.8. CT, PT Ratio and Transformer Details:-

CIRCUIT	33KV CT RATIO/CLASS
33Kv Feeder	400-200/1-1 A 0.5,5P20
33kv side of 33/11kv transformer	400-200/1-1-1A, for 10 & 12 MVA 0.5/5P20/PS and 200-100/1-1A For up to 6.3 MVA Tr. 0.5/5P20
	600-400/1-1-1A, 0.5/5P20/PS at phase side (Indoor

11KV side CT for 6.3MVA & 10MVA Transformer	Panel)
11KV transformer Bushing CT for REF	600/1A, PS for 10 MVA 33/11KV transformer for both Phase & neutral. 400/1A, PS for u p t o 6.3 MVA 33/11KV transformer for only neutral.
33 KV PT RATIO	33KV, single phase
Electro-magnetic Ratio/Class	PT 33KV/ $\sqrt{3}$, 110V/ $\sqrt{3}$ -110V/ $\sqrt{3}$,0.5/3P
TRANSFORMER DETAILS	33/11KV, up to 12 MVA, Dyn11

3.0 CONSTRUCTIONAL DETAILS :

3.1. CONTROL AND RELAY PANEL

The Control and Relay Panel shall be of Simplex type and the access door shall be provided at the back of each Panel where no instruments or relays shall be mounted. The indicating and signaling devices and relays etc. shall be mounted on the front side and the auxiliaries which shall be inside the Panel. The access door shall be at the back side and of double door type of height 1900 mm.

In front of Panel where relays and instruments are to be mounted shall be stretcher leveled steel plate 3 mm. thick and side panel, doors and top covers shall be of 2mm. thick steel plate. Light sections of structural steel shall be used for panel frame.

The individual panel shall be 2250 mm. in height with Channel base, 610 mm. in depth and of suitable width limited to 1000mm to accommodate the equipment at a suitable height, suitable gaps to facilitate easy workability as specified hereafter. Individual piece of Channel base of C&R Panel is to be provided to obtain the flexibility of interchanging the Panel, if any.

The complete panel shall incorporate all necessary instruments, meters, relays, auxiliary relays, control switches, indicating lamps, mimic, annunciator, audible alarms, horizontal and vertical wiring trough, wiring supports, interior lighting system, terminal blocks , fuses and links etc.

3.2. CONSTRUCTIONAL FEATURES

- a. The Control and Relay Panel frame shall be suitable for erection of flush concrete floor and secured to it by means of evenly spaced grout bolt projecting through the base channels from members of the frame.
- b. The manufacturer shall ensure that the equipment specified and such unspecified complementary equipment required for completeness of protection/control scheme be properly accommodated in the panels without congestion and if necessary to provide panels with larger width. No price increase at a later date on this account shall be allowed.
- c. Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof for tropical use. The enclosure shall provide a degree of protection not less than IP-41 in accordance with IS-2147. Type test report in this respect shall be furnished with offer.
- d. Panels shall be free standing, floor mounting type and shall comprise structural frames enclosed completely with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of panels such as base frame, front sheets and door frames and not less than 2mm for sides, door, top & bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.
- e. Design, material selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent front outside, with all exterior surfaces true and smooth.
- f. All holes and extension windows in the Panel shall be blanked and access doors shall be lined with compressible liners at the edges. The EMPLOYER will shut off the bottom crevices with cream cement, the Cable Entry holes with weak concrete and the cable trench with present R.C. Slabs or checker plate. All control and supply cables will be laid in a distribution trench running under the panel . The Cable will branch off into each cubicle through entry holes in the concrete floor opening in the bottom cubicles. Necessary Drawings for concrete floor and trench shall be supplied by the manufacturer to enable the EMPLOYER to construct the foundation floor for these panels. The drawings shall show details of the distributing trench, cable entry holes, glands and positions of grouting bolts. The EMPLOYER will prepare foundation with pocket for grouting bolts. The manufacturer shall supply channel base, suitable grouting bolts, lock nut and washers.

- g. Control Cable entries to the panel shall be from the bottom. Bottom plates of the panels shall be fitted with detachable gland plates to allow cable entries from the bottom. Gland plates shall be suitable for fixing the cable glands at an elevated height of at least 100 mm above the ground level. Terminal Connectors and Test terminal blocks for cables shall be fixed at an elevated height of at least 200 mm above the Bottom plate. Side blocks cut out to be arranged at the top of both sides of panel for inter panel bus wires. Dimensions of the cut out will be 300 mm X 50 mm , 255 mm from the top.

3.2.1 General :

- a. Materials shall be new; the best quality of their respective kinds and such as are usual and suitable for work of like character. All materials shall comply with the latest issues of the specified standard unless otherwise specified or permitted by EMPLOYER.
- b. Workmanship shall be of the highest class throughout to ensure reliable and vibrations free operations. The design, dimensions and materials of all parts shall be such that the stresses to which they may be subjected shall not cause distortion, undue wear, or damage under the most severe conditions encountered in service.
- c. All parts shall conform to the dimensions shown and shall be built in accordance with approved drawings. All joints, datum surfaces and meeting components shall be machined and all castings shall be spot faced for nuts. All machined finishes shall be shown on the drawings. All screw, bolts, studs and nuts and threads for pipe shall conform to the latest standards of the International Organization for Standardization covering these components and shall all conform to the standards for metric sizes.
- d. All materials and works that have cracks, flaws or other defects or inferior workmanship will be rejected by EMPLOYER.

3.2.2 Assembly :-

Necessary items of equipment shall be assembled in the factory prior to shipment and routine tests shall be performed by the manufacturer as per the requirements of the latest issue of IEC/IS as specified under each equipment in these specifications to demonstrate to the satisfaction of EMPLOYER that the switchgear panels comply with the requirements of the relevant IEC/IS standards.

3.2.3 Casting :-

Casting shall be true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage defects, cracks or other injurious defects, shall be satisfactorily cleaned for their intended purpose.

3.2.4 Welding:-

Wherever welding is specified or permitted, a welding process, including stress relieve treatment as required if necessary, conforming to an appropriate and widely recognized professional standard shall be used. All welders and welding operators shall be fully qualified by such a standard.

4.0 Mounting

- 9.1 All equipment on and inside the panels shall be mounted and completely wired to the terminal blocks ready for external connection.
- 9.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking shall be clearly visible and of permanent nature.
- 9.3 The manufacturer shall carry out cutout, mounting and wiring of the bought out items which are to be mounted in the panel in accordance with the corresponding equipment manufacturer's drawings.
- 9.4 The centre line of switches, push buttons and indicating lamps shall be not less than 750 mm from the bottom of the panel. The centre line of relays and meters and recorders shall be not less than 450 mm from the bottom of the panel.
- 9.5 The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top of all meters, relays and recorders etc. shall be in one line.
- 9.6 The control switches for circuit breakers shall be located on the mimic diagram corresponding to their exact position of the controlled equipment in the single line drawing. The location of the switches shall be within working height from the floor level for easy and comfortable operation.

9.7 No equipment shall be mounted on the doors.

9.8 All the equipment connections and cabling shall be designed and arranged to minimise the risk of fire and damage.

The constructional details and mounting arrangement for various front mounted equipments shall be as per the enclosed drawings. The center lines of any relays, if additionally provided, shall not be less than 450 mm from ground level.

5.0 WIRING

5.1 All wiring shall be carried out with 1100 volts grade single core, multistrand flexible tinned copper wires with PVC insulation which has provided its utility in tropical region against hot and moist climate and vermin (Misc. white ant and cockroaches etc.) Rubber insulated wiring will not be accepted. Wire numberings and colour code for wiring shall be as per IS:5578/1984. The wiring should be encased in suitable width PVC casing. The wiring diagram for various schematics shall be made on thick and laminated durable white paper in permanent black ink and same should be pasted on the inside surface of the door.

5.2 The sizes of wiring in different circuit shall not be less than these specified below:

TABLE-I

Circuit	Permissible size of wire
Metering and Relaying Circuits connected Current Transformer	2.5 mm ²
Potential Circuits for metering and Relaying, Control, Visual Audible Alarms and Signalling Circuit	1.5 mm ²

The following colour schemes shall be used for the Wiring:

TABLE – II

Circuit where used	Colour of Wire
Red Phase of Instrument Transformer	Red

Circuits	
Yellow Phase of Instrument Transformer Circuits	Yellow
Blue Phase of Instrument Transformer Circuits	Blue
Neutral connection, earthed or not earthed in the instrument Transformer Circuit	Black
A.C. Control Wiring Circuits using auxiliary supply and	Black
D.C. Control Wiring Circuit using Battery Supply	Grey
Earth Connection	Green

5.35.3

- a) All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & trough shall be used for this purpose.
- b) Longitudinal troughs extending throughout the full length of the panel shall be used for inter panel wiring. Inter connections to adjacent panels shall be brought out to a separate set of terminal blocks wires. All bus wiring for inter panel connection shall preferably be provided near the top of the panels running throughout the entire length of the panels.
- c) Wiring connected to the space heaters in the cubicles shall have porcelain beaded insulation over a safe length from the heater terminals.
- d) Wire termination shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided to all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected for any purpose. Termination shall be such that no strand of a conductor shall left loose or overhanging. Conductor termination shall be secured to the holding nuts/screws, terminal blocks etc. with washers interposed between the terminals/holding nuts/screw heads. The terminals shall be so connected that no conductor ferrule code gets masked due to overlay of conductors.

- e) All spare contacts of relays shall be wired up to terminal blocks.
- f) Each wire shall be continuous from end to end and shall not have any joint within itself individually.
- g) Wires shall be connected only at the connection terminals or studs of the terminal blocks, meters, relays, instruments and other panel devices.

Terminal Ends of all wires shall be provided with numbered Ferrules. At point of inter-connection where a change of number is necessary, duplicate Ferrules shall be provided with the appropriate numbers on the changing end.

- h) At the terminal connection, washers shall be interposed between terminals, wire terminals and the holding nuts. All holding nuts shall be secured by locking nuts. The connection stud shall project at least 6 mm from the lock nut surface. Wire ends shall be so connected at the terminal studs that no wire terminal numbered ferrule gets masked due to succeeding connections. All wires shall be suitable for bending to meet the terminal stud at right angles with the stud axis, and they shall not be skewed.
- i) All studs, nuts, bolt_s screws etc. shall be threaded according to the British Standard practice unless EMPLOYER_s prior approval to any other practice of threading is obtained.

6.0 TERMINAL BLOCK CONNECTION

Terminal blocks shall be of clip-on design made out of non-trackable insulating material of 1100 V grade. All terminals shall be stud type, with all current carrying and live parts made of tinned plated brass. The studs shall be of min 4 mm dia brass. The washers, nuts, etc. used for terminal connectors shall also be of tinned plated brass. All blocks shall be shrouded by easily removable shrouds made of transparent dielectric materials.

The terminal connector/blocks shall be disconnecting type terminal connectors for PT and same with automatic shorting of C.T. secondary terminals shall be provided in CT secondary circuit. All other terminal connectors shall be Non-disconnecting type. Terminal should be shock protected in single moulded piece. Terminal block should have screw locking design to prevent loosening of conductor. Provision shall be made on each pillar, for holding 10% extra connection (5% incoming + 5% outgoing).

At least 20% spare terminals for each type shall be provided. All terminals shall be provided with ferrules indelibly marked or numbered and identification shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10 Amps for control circuit. For power circuit it shall not be less than 15 Amps.

7.0 SPACE FOR CONTROL CABLES AND CABLE GLANDS

Sufficient space for receiving the Control Cables inside the Panel at the bottom of the cubicles and mounting arrangement for the terminal cable glands shall be provided. Removable type separate cable entry plate (may be two) shall be fixed with bottom plate. The specification does not cover supply of control cables and cable glands for which the EMPLOYER will make separate arrangement.

8.0 SPACE HEATERS

240 V, 50 HZ Tubular Space Heaters suitable for connection to the Single Phase A.C. Supply complete with On-Off Switches located at convenient position shall be provided at the bottom of the Panel to prevent condensation of moisture. The Watt loss per Unit surface of heater shall be low enough to keep surface temperature well below sensible heat. A thermostat control unit with variable temperature shall be installed to control the heater. The 240 V AC supply for the heater shall be controlled by a suitably rated single pole miniature circuit breaker compartment to be mounted on an insulator. One AC Ammeter with 0-1.0 Amp range shall be provided in series with the heater to monitor the current drawal of the Heater.

9.0 DISTRIBUTION AND CONTROL OF AUX. POWER CIRCUIT

9.1. D.C. CIRCUIT

There shall be only one 30V D.C. for the entire Control and Relay Panel fed from a D.C. Distribution Panel. A continuous D.C. Bus shall be provided in the Control and Relay Panel and D.C. supply for control, protection, indication and supervision of circuit breaker and other equipment shall be teed off from D.C. bus through a set of 20 Amp rated H.R.C. Fuse on positive and negative side. D.C. supply to be teed off shall be distributed within the Panel as below:

- (a) Control DC scheme both positive and negative side with 16 Amp fuse

- (b) Close/Trip Ckt 1 and Trip Ckt 2 without fuse; closing circuit with 10A fuse.
- (c) Indication Circuit through a set of 6 Amp. HRC Fuse both at +ve and –ve side
- (d) Protective relay circuits through 6A fuse both at +ve and –ve side
- (e) Annunciation ckt with 6Amp fuse on both at +ve and –ve side
- (f) DC Emergency Lamp with 6Amp fuse both at +ve and –ve side

Three nos. of D.C. operated no-volt auxiliary relay(self reset type) provided with hand reset type flag with inscription — Main D.C. Fail , _Control Dc fail & Protection DC fail with 4NO+4NC in each relay. 2 NC contact for _DC fail‘ alarm and Indication, 1NO wired upto SCADA TB and 1NO wired upto spare TB.

One Push button having N/C Contact used in Series with the above relay for _D.C. Fall Test‘ purpose.

9.2. A.C. CIRCUITS

230 Volts, Single Phase A.C. Aux. Supply to the Control and Relay Panel will be fed from A.C. Distribution Panel through a 16Amp MCB provided there. One 16 Amps rated HRC Fuse shall be provided at the Control & Relay Panel for the Incoming A.C. Supply. Two A.C. operated no volt auxiliary relay (self reset type) rated for 230V shall be provided with hand reset flag with inscription — _A.C. Fail & DC Fail Accept with 4NO+4NC contacts for each relay. One push button having N/C Contact used in Series with above relay for—A.C. Fail Tes‘ purpose.

9.3. P.T. SECONDARY CIRCUIT

There may be two nos. 33KV bus PT, one in each bus section. P.T. supply shall be available from selected 33 KV Bus P.T through suitable PT selection scheme by switch. Two sets of Fuse and link of suitable rating shall be provided for the Incoming P.T supplies and two sets, one for each PT of 3 nos. coloured LED indicating lamps shall be provided for supervision of the Fuse. Lamps shall be connected between respective phases and neutral. The arrangement of distribution of P.T. Secondary Circuit shall be as follows:

- (a) Potential supply to the protective relay circuit for Feeder where necessary shall be fed from selected Bus P.T. supply bus.
- (b) Potential supply to meters, Energy meters and indicating instrument of each

panel shall be fed from selected Bus P.T. supply bus.

- (c) Selected P.T. secondary supply to the protective relays of each panel shall be fed through 4 poles - MCB and link in neutral in each panel where necessary with two change over contacts for annunciation.
- d) Selected P.T. secondary supply for metering and indicating instruments of each panel shall be fed through 4 pole MCB in each phase and link in neutral in each panel of 33KV system voltage.
- e) Two position (PT-1/PT-2), minimum 4(four) way PT selector switch (stay put type), minimum 16A rating shall be provided in each panel for metering ckt. Additional 4 way PT selector switch is required for protection wherever applicable. The no. of way may increase during detailed engineering.

9.4. FUSE AND LINK

Fuses shall be of cartridge type. Carrier and base for the fuse and links for all D.C. and A.C. Circuits shall have imprint of rating, voltage and circuit designation.

9.5. MIMIC DIAGRAMS

a) Provision shall be made for 10 mm. wide painted and overall drawing mimic diagram by the EMPLOYER on the exterior of the front panel to represent the single line arrangement of the station equipment. Provision shall be made in such a way that centre line of the mimic bus shall be at a suitable height from the bottom of the C&R Panel.

b) Colour scheme for mimic diagram as follows:-

KV Class	Colour	Shade Index as per ISS
33 KV	Brilliant green	221
11 KV	Air Craft blue	108
400/230 V	Black	309
Earth	White	-
110 V	Canary yellow	-

c) In 33 KV simplex type C&R panels, Symbol marking for the position indication of isolators, earth switches etc, ON/OFF indication for Circuit breaker, PT supply indication, CB spring charge, auto trip, trip ckt healthy etc. shall be mounted along the mimic diagram at appropriate location. Non-Discrepancy type control switch for the C.B. shall be mounted within the mimic, indicating the C.B. ON/OFF status.

10.0 Labeling

All front mounted as well as internally mounted items including MCBs shall be provided with individual identification labels. Labels shall be mounted directly below the respective equipment and shall clearly indicate the equipment designation. Labelling shall be on aluminium anodised plates of 1 mm thickness, letters are to be properly engraved.

11.0 Earth Bus

Each panel shall be provided with two earth bus of size 25 x 6 mm (min) each. The earth bus shall be of tinned plated copper, and all metallic cases of relays, instruments etc. shall be connected to this earth bus independently for their effective earthing. The wire used for earth connections shall have green insulation.

12.0 Circuit breaker Control Switch:

19.1 PISTOL GRIP TYPE Non- discrepancy T-N-C spring return type switch shall be provided for remote operation of circuit breaker to ensure that manual pumping of closing solenoid not possible. The switch shall be mounted in the mimic diagram itself such that the stay-put ('N') position will render the continuity of the mimic. One green LED for 'breaker open' indication and one red LED for 'breaker closed' indication shall also be provided adjacent to the T-N-C switch.

19.2 Switches should have finger touch proof terminals. For the convenience of maintenance, screw driver guide should be from top/bottom of the switch and not from the side. Terminal wire should be inserted from the side of the switch terminal.

19.3 Terminal screws must be captive to avoid misplace during maintenance.

19.4 Switch shall be with 48 mm x 48 mm escutcheon plate marked with Trip & Close.

19.5 Trip-neutral-close, with pistol grip handle must be pushed in to spring return to either trip or close position from Neutral position for safety and not just turn to

trip.

19.6 One contact to close in each position of Trip and Close. Contact rating shall be 12A at 30 V DC.

19.7 One spare contact is required in off & on position.

13.0 Local/Remote switch:

Local/Remote switch should be 4-pole, 2 way Lockable and stay put type.

14.0 INDICATING LAMPS & CONTACT MULTIPLIER

i) INDICATING LAMPS

L.E.D. Type Indicating Lamps shall be provided on the Control Panel to indicate the following:

S.No.	Functions	Quantity	Colour of Lamp
1	C.B. Spring charged indication	1 No.	Blue
2	C.B. trip Coil/Circuit healthy indication	2 No.	White
3	C.B. Auto tripped indication	1 No.	Amber
4	Panel D.C. Fail indication	1 No.	Amber
5	P.T. Supply indicating Lamp	2 sets	Red/Yellow/Blue
6	C.B. —ON indication	1 No.	Red
7	C.B. —OFF indication	1 No.	Green

All the lamps shall be connected to the auxiliary D.C. supply of the Sub-Station except Sl. No. (4) & Sl. No. (5) which should be connected to the auxiliary A.C. supply and P.T. Secondary supply respectively. The Lamp shall be suitable for Panel purpose and shall be Low Watt consumption. All indicators shall have bright LEDs having long life. Conventional bulbs are not acceptable. The indicating LEDs with resistors shall withstand 120% of rated voltage on a continuous basis. However, the specification of indicating lamps may likely to be changed/ modified as per requirement

of EMPLOYER.

Lamps for circuit breaker “ON”, “OFF”, “TRIP CKT HEALTHY” and “AUTO TRIP” indications. LED indicating lamp complete with static circuits and features should be supplied with Low voltage protection circuit (LVGP) and surge suppressor circuit having LED indication. Lamp assembly should be of fire – retardant glass epoxy PCB , industrial heat resistant, fire resistant, non hygroscopic DMC material, chrome – plated corrosion resistant solid brass bezel, polycarbonate lens in desired colour shades of Red, Green , Amber, Yellow etc. the intensity of light should be minimum 100 mcd at 20 mA . Indication lamp should be suitable to operate on 30 V direct current supply source. Acceptable make are BINAY Opto Electronic Private Ltd. or equipment.

ii) Contact Multiplier

230 Volts, Single Phase, 50 hz A.C.. Supply operated Contact Multiplier to be provided, if required.

15.0 TERMINAL BLOCK / TTB

1. Terminal Blocks for incoming A.C and D.C. Circuit and C.T., P.T. & SCADA Circuit should be located on the left hand side and Transformer supervision, breaker control and spare in right hand side of the wall of the Panel seen from back side respectively.
2. 3-Phase, 4-Wire Link type Test Terminal Block having sealing provision shall be provided in Metering Circuit of each Panel.

16.0 SAFETY EARTHING

1. Earthing of metallic parts or metallic bodies of the equipment on the Panel shall be done with soft drawn single conductor bare Copper Tail connections shall have minimum area of 16 sq, mm. and the main earthing connection 60 sq.mm. These wires shall be connected by suitable terminals and clamps junction. Soldered connections shall not be employed.
2. The neutral point of star connected LV winding of instrument transformers and one corner of the open delta connected LV side of instrument transformers shall be similarly earthed by tail connected with main earth wire of Panel Earthing

System. Multiple earthing of any instrument transformer circuit shall be avoided.

17.0 PANEL LIGHTING

1. The Panel interior shall be illuminated by CFL lamps connected to 230 Volt Single Phase A.C. The illumination of the interior shall be free from shadows and shall be planned to avoid any strain or fatigue to the wireman likely to be caused due to sub-normal or non-uniform illumination. One emergency D.C. light shall be provided for each panel with individual switch with proper identification mark.
2. A toggle switch or door operated switch shall be provided for control of A.C. lighting in each panel.
3. One combined 15 Amps. 3-Pin and 5 Amps. 2-Pin Power Socket outlet together with Plus Pins shall be provided at convenient points in each Panel for A.C. Supply.

18.0 ANNUNCIATOR

A. ELECTRONIC ANNUNCIATOR

1. Suitable Multi-way Microprocessor based electronic Annunciator for the visual and audible alarm on the control panel using bright LEDs shall be provided in each panel to indicate over current and earth fault protection operated. In addition to above, each electronic annunciator of Transformer Control Panel shall have provision to indicate Transformer trouble trip/alarm function operated. Also one window of the Annunciator shall have to be used for Non-Trip A.C. Fail Alarm Indication and one window for Trip Circuit unhealthy indication. Each Electronic Annunciator shall have provision for connection with accept/reset/lamp test/mute Push buttons for proper functions. Electronic annunciator shall have provision for connection with Electronic Buzzer/Electronic Bell for Trip & Non-Trip Audio Alarm of common annunciation scheme. Electronic Annunciation shall have provision for flashing illuminating display with inscription for operation of respective Protection Relay. The Micro-Processor based Electronic Annunciator should have separate coloured windows for Trip & Non-Trip Annunciation for easy detection.
2. Annunciator fascia units shall have translucent plastic windows for each

alarm point.

3. Electronic Annunciator shall have first Fault Indication Facilities & System Watch Dog
 4. Annunciator facia plate shall be engraved in black lettering with respective alarm inscription as specified. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall be about 5 mm. The inscriptions shall be visible only when the respective facia LED will glow.
 5. Annunciator facia units shall be suitable for flush mounting on panels. Replacement of individual facia inscription plate and LED shall be possible from front of the panel.
 6. Unless otherwise specified, one alarm buzzer meant for non-trip alarms and one bell meant for trip alarms shall be provided in each control panel (mounted inside).
 7. Each annunciator shall be provided with 'Accept', 'Reset' and 'Test' push buttons, in addition to external PB.
 8. Special precaution shall be taken by the manufacturer to ensure that spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels.
 9. In case 'RESET' push button is pressed before abnormality is cleared, the LEDs shall continue to glow steadily and shall go out only when normal condition is restored.
 10. Any new annunciation appearing after the operation of 'Accept' for previous annunciation, shall provide a fresh audible alarm with accompanied visual alarm, even if the process of "acknowledging" or "resetting" of previous alarm is going on or is yet to be carried out.
- B. Provision for testing healthiness of visual and audible alarm circuits of annunciator shall be available.

16 Window Annunciation Scheme for 10 MVA & 12 MVA Transformer
(individually controlled) to indicate following functions:-

1	Differential protection(87) operated	1 no.
2	Non-directional protection (O/C+E/F) operated	1 no.
3	Oil Temp./Winding Temp/MOG Alarm for transformer	1 no.
4	Oil Temp./Winding Temp Trip for transformer	1 no.
5	REF 64R(HV side) tripped	1 no.
6	REF 164R(LV side) tripped	1 no.
7	Buchholz Alarm for transformer	1 no.
8	Buchholz Trip for transformer	1 no.
9	OLTC Buchholz/ Main Tank PRV Trip for transformer	1 no.
10	AC fail	1 no.
11	Trip Circuit/Coil 1or Trip Circuit/Coil 2 Unhealthy	1 no.
12	Non-directional O/C & E/F Relay Trouble	1 no.
13	Differential relay trouble	1 no.
14	Spare	1 no.
15	Spare	1 no.
16	Spare	1 no.
	Mounting	Flush
	No. of facia windows	16
	Supply voltage	30 V DC
	No. of LEDs per window	2
	Lettering on facia plate	Properly engraved

12 Window Annunciation Scheme for up to 6.3 MVA Transformer (individually controlled) to indicate following functions:-		
i)	Non-directional protection (O/C+E/F) operated	1 no.
ii)	Oil Temp./Winding Temp/MOG Alarm for transformer	1 no.

	transformer	
iii)	Oil Temp./Winding Temp Trip for transformer	1 no.
iv)	REF 64R (HV side) tripped	1 no.
v)	REF 164R (LV side) tripped	1 no.
vi)	Buchholz Alarm for transformer	1 no.
vii)	Buchholz Trip for transformer	1 no.
viii)	OLTC Buchholz/ Main Tank PRV Trip for transformer	1 no.
ix)	Panel AC fail	1 no.
x)	Trip Circuit/Coil 1 or Trip Circuit/Coil 2 Unhealthy	1 no.
xi)	Panel AC fail	1 no.
xii)	Non-directional O/C & E/F Relay Trouble	1 no.
xiii)	Spare	1 no.
	Mounting	Flush
	No. of facia windows	12
	Supply voltage	30 V DC
	No. of LEDs per window	2
	Lettering on facia plate	Properly engraved

12 Window Annunciation Scheme for Feeders to indicate following functions :-		
i)	Non-directional O/C operated	1 No
ii)	Non-directional E/F operated	1 No
iii)	Panel D.C. Fail	1 No
iv)	Trip Circuit Coil 2 Unhealthy	1 no.
v)	Panel AC fail	1 no.
vi)	Trip Circuit/Coil 1 Unhealthy	1 no.
vii)	Non-directional O/C & E/F Relay Trouble	1 no.
viii)	PT MCB Tripped	1 No
ix)	Spare	1 no
x)	Spare	1 no.

xi)	Spare	1 no.
xii)	Spare	1 no.
Mounting		Flush
No. of facia windows		12
Supply voltage		30 V DC
No. of LEDs per window		2
Lettering on facia plate		Properly engraved

12 Window Annunciation Scheme for Parallel Feeders to indicate following functions:-		
i)	Directional O/C operated	1 no.
ii)	Directional E/F operated	1 no.
iii)	Panel DC Fail	1 no.
iv)	Trip Circuit/Coil 2 Unhealthy	1 no.
v)	Panel AC fail	1 no.
vi)	Trip Circuit/Coil 1 Unhealthy	1 no.
vii)	Directional O/C & E/F Relay Trouble	1 no.
viii)	PT MCB Tripped	1 no.
ix)	Spare	1 no.
x)	Spare	1 no.
xi)	Spare	1 no.
xii)	Spare	1 no.
Mounting		Flush
No. of facia windows		12
Supply voltage		30 V DC
No. of LEDs per window		2
Lettering on facia plate		Properly engraved

C. PANEL D.C. FAIL ALARM SCHEME

Control & Relay Panel shall have a common — Panel D.C. Fail Alarm Scheme operated by 230 V Single phase A.C. Aux. Supply for audible as well as visual alarm in case of failure of D.C. incoming supply to the Panel.

Another Single Element Relay without Flag and 1 no. self-reset type N/O & 1 no. N/C contact having inscription Panel D.C. fail' alarm accept Relay shall be provided. Besides above, 1 no. Indicating Lamp, 1 no. A.C. Operated Electric Hooter and 2 nos. Push Button, one having 1 no. N/C contact, the other having 1 no. N/O contact shall also be provided for successful operation of the scheme. All auxiliary relays required to render Annunciation System operative and shall be considered to be within the scope of the tender.

AC fail, DC fail scheme shall be operated by relay not contactor.

19.0 INDICATING INSTRUMENT AND METERS

- a. All instruments shall be flush mounted, back connected type and provided with dust tight cases for tropical use with dull black enamel finish. All fixing screws, nuts and threaded parts shall be designed to Indian Standards.
- b. All instruments shall be of class 0.5 type. The calibration of the instruments shall function satisfactorily when mounted on steel panels or alternatively magnetically shielded instruments shall be used.
- c. Instruments shall be capable of indicating freely when operated continuously at any temperature from 0 to 50 degree C.
- d. All circuits of instruments shall be capable of withstanding applied load of 20% greater than the rated capacity for a period of eight hours.
- e. The instruments shall be capable of withstanding the effect of shock vibration and a di- electric test of 2000 Volts r.m.s. to ground for one minute as per relevant ISS.

19.1 Ammeters:

All ammeters shall be provided with direct reading scale. Full Scale Value of the Ammeters shall be 100% of the nominal current of maximum C.T. ratio. The ammeters shall be connected to measuring C.T. Core. Ammeters shall be suitable for R.Y.B. Phase measurements. However, the ammeters to be supplied shall be of type —DIGITAL. The auxiliary power of the ammeters should be 230V AC.

19.2 Voltmeters

Volt Meter shall be provided with direct reading scale. The maximum value of the volt-scale be

15% in excess of the normal Circuit Voltage. The rated voltage of the Volt Meter shall be 110V A.C. However, the voltmeters to be supplied shall be of type —DIGITAL. The auxiliary power of the voltmeters should be 230V AC.

a. Voltmeter Selector Switch:

One Voltmeter selector switch having 7 position 6 way stay-put type shall be provided.

b. PT Selector Switch:

One PT selector switch, 2 position, stayput type shall be provided.

19.3 Energy Meters

Tariff Metering Equipments

(a) Three element Tri-vector Meters shall be supplied by the EMPLOYER. But Panel Wiring for the Meters along with Test Terminal Block and space for the Tri-vector Meters are to be provided for the Panels.

20.0 NAME OF IDENTITY PLATES

a) All instruments, relays and such other similar electrical devices mounted on the control and relay panel shall be provided with name plates bearing the manufacturer's name, serial identifying number and the Electrical rating data.

b) 3mm thick and 25mmX150mm brass or plastic plates bearing suitable

identification marks shall be fixed under the terminal wiring at the test blocks, at the fuse blocks and at the cable terminals. Similar plates shall be fixed on the exterior of the panel in appropriate places to indicate function of control switches, push button etc. such as isolator control switch, breaker control switch, DC fail test, accept reset etc. Suitable identification marks shall be provided for individual casing part of the relays and other equipment. Plates should be screwed and riveted to the Panel.

- c) 50mm wide brass or plastic plate bearing suitable circuit description (which will be furnished after order is placed) etched in 30 mm size letters shall be provided for each panel and mounted on the top of both outer of the front panels. These plates shall be removable type.
- d) Schematic Diagram of CT, PT, CB circuitry & AC, DC Ckt, Indication and Annunciation Ckt along with protection circuitry giving the terminal nos. and Bus wire details shall be printed in laminated durable stickers and pasted inside the panel Door page wise of the respective panel.
- e) Each unit of control and relay panel shall be provided with a label located at the bottom on the front and shall contain the following details :
 - i) Manufacturer's name
 - ii) P.O.no. and date
 - iii) Drg. ref. no. pertaining to the panel.

21.0 PAINTING

Panel painting shall be done by the modern process of painting. All unfurnished surface of the steel panel and frame work shall be sand blasted or suitably cured to remove rust, scale, foreign adhering matter or grease. A suitable rust resisting primer shall be applied on the interior and exterior surface of steel, which shall be followed by application of an undercoat suitable to serve as base and binder forth finishing coat.

Details of Painting:-

Surface treatment	by seven tank process
Paint type	Powder coated. Pure polyester base grade A structure finish
Paint shade	RAL 7032 for external & internal surface

Paint thickness	Minimum 80 microns
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22.0 RELAYS:

A. GENERAL REQUIREMENT

The main protective relays SCADA Compatible Numerical Directional/Non Directional O/C & E/F Relays shall be of panel manufacturers own make. However, multinational company manufacturing panel in India may import required/desired relays from their foreign counterpart with same brand name at their own risk, cost and responsibility without hampering the stipulated delivery schedule as stated in the tender notification.

All numerical relays shall be provided with 'Relay Failure Annunciation contact'.

B. SCADA COMPATIBLE NUMERICAL DIRECTIONAL/NON DIRECTIONAL O/C & E/F RELAYS

The primary requirements of the relays are to protect the respective single circuit or double circuit feeders and 33/11KV Power Transformers in the event of fault. The Directional/Non Directional E/F relays shall provide suitable sensitivity for limited earth fault current.

The relay should be suitable for substation automation, primary circuit breaker operation through SCADA from remote control room.

THE DETAILED SPECIFICATION OF Non-Directional O/C and E/F RELAY IS AS PER ANNEXURE-I OF SPECIFICATION

THE DETAILED SPECIFICATION OF Directional O/C and E/F RELAY IS AS PER ANNEXURE-II OF SPECIFICATION

C. OTHER PROTECTIVE RELAYS

- Differential relay shall be of numerical type
- REF relay etc. may be of static type.

D. OTHER PARTICULARS RELATED TO ALL RELAYS

- 1) All shall conform to the requirement of IS: 3231 / IEC 255 and shall be suitable for operation within a temperature range 0°C to 55°C and 95% relative humidity. Relays shall be suitable for flush / semi flush mounting on the panel with connections from the rear, protected with dust tight cases for tropical use and with transparent cover removable from the front.
- 2) All A.C. relays shall be suitable for operation at 50Hz. The current coils shall be rated for a continuous current of 1 amp and the voltage coil for 230V normal. The contacts of the relays shall be properly designed to prevent or minimise damage due to arcs which have to be broken successfully against 30V +/- 10% volt DC. When open, the contacts shall withstand a voltage of 115% of the normal circuit voltage. The relays shall be designed for satisfactory operation between 70% to 110% of rated D.C. voltage of the sub-station. The voltage operated relays shall have adequate thermal capacity for continuous operation.
- 3) Timers shall be of static type. Pneumatic timers are not acceptable.
- 4) The Relays shall preferably be provided with suitable Seal-in-Devices. Relays should be immune to all types of external influences like Electro static, Electromagnetic, Radio interference, shock etc.
- 5) All the numerical relay should have provision for setting all the features available in the relay and viewing those setting as well as different other parameters through both built in display unit as well as through PC. All numerical relays shall have self monitoring feature with watch dog contact. The supply of relay should be inclusive of necessary software and hardware for interfacing with a PC, to be supplied by the manufacturer.

E. PROTECTION SCHEMES

E-1 PROTECTION SCHEMES FOR 33 KV FEEDER

NON-DIRECTIONAL OVER CURRENT AND E/F PROTECTION :

This relay shall be used for 33KV radial feeder. The relay shall

- a) be three O/C & one E/F element type.
- b) have IDMT characteristics with time current characteristics of 3 sec at 10 times current setting.
- c) have variable current setting of 50% to 200% of rated current and adjustable time setting.
- d) have high set unit with current setting 500%-2000% for protection and 33 KV feeder protection, with very low transient overreach.
- e) Definite Time Sensitive Earth Fault Protection may be inbuilt function of Numerical over-current Relay and shall have a variable current setting range minimum 1% to 40% in very small steps of CT secondary current and wide range of definite time setting range minimum. 0.1 to 10 Sec. This relay shall be used in 33 KV feeder for detection of line to ground fault current of both very low and high magnitude where the 33 KV system is grounded through earthing transformer.
- f) LED indication for numerical relays of different type of faults including phase identification.

E-2 PROTECTION SCHEMES FOR 33 KV PARELLEL FEEDERS AT RECEIVING ENDS

DIRECTIONAL PROTECTION

Directional O/C & Directional Instantaneous E/F Relays shall be required for 33 KV parallel feeders as specified in the schedule of requirement. Each Feeder shall be provided with 3 elements IDMT Voltage polarized O/C Relays and single element voltage polarized E/F Relay. The O/C Relays shall be IDMT type with high set element. The E/F Relay shall have directional sensitive E/F setting having wide range of setting (1-40%) & wide range of definite time setting range minimum. 0.1 to 10 Sec. The relay shall also have instantaneous unit. The relay shall have necessary P.T. fuse failure monitoring scheme.

Characteristics:-

O/C IDMT Unit	Element: with High Set	Current Settings & Operating time	IDMT-50-200%, 0-3 sec, Inst.- 500-2000% or 400-1600%
MTA		Selectable MTA for Directional Relay should cover 1 st quadrant in a non-effectively grounded system	
Polarized Voltage	P.T.	110 V A.C.	
E/F Element			
Current Setting		1-40% (minimum.) in very small steps	
Operating Time of Relay		Instantaneous	
Operating Time of Timer		0.1 to 10 Sec in very small steps	
MTA		Selectable MTA for Directional Relay should cover 1 st quadrant in a non-effectively grounded system	
Open Delta Voltage	P.T.	63.5 V A.C.	

The numerical directional relay shall have in-built feature for derivation of zero sequence voltage internally. If separate IVT is required for derivation of zero sequence voltage for directional earth fault element, the particulars shall be as per following Technical Parameters:-

1	Insulation Level	1.1KV
2	Over Voltage Factor	1.2 Cont./1.9 for 8 Hrs.
3	Transformation	110 V/ $\sqrt{3}$ / 110/ $\sqrt{3}$

	Ratio	
4	VA Burden/Phase	7.5
5	Accuracy Class	3P
6	No. of Phase	Single
7	Type	Epoxy Cast Resin Indoor Single Phase Voltage Transformer
8	Formation	3 nos. Single Phase P.T. shall be connected in primary as Star and Secondary as Open Delta with neutral of Primary and one end of Open Delta earthed.

E-3 PROTECTION OF 33 KV INDIVIDUAL TRANSFORMERS

For protection of H.V. Side of the Transformers, following main protective relays are required

- i) Numerical O/C protection.
- ii) 2 sets Restricted E/F Relay shall be provided for HV and LV side of individual control transformer panel.
- iii) 1 set Differential Relay in addition to above, shall be provided for 10 MVA 33/11KV transformer panel.

Differential Relay shall be

- a) Provided at 33KV panel of the transformers to be protected. It shall be numerical adjustable/variable percentage biased type differential relay.

Necessary software, cables, connectors and other accessories as required for download, analyze data etc. shall be within the scope of successful manufacturer.
- b) The relay shall be very fast in operation with an operating time less than 40 millisecond at 5 times setting.
- c) The relays shall be inherently stable for external through fault conditions without affecting the speed of operation for internal faults.
- d) The relay shall have either a built in facility of ratio and phase angle correction or necessary interposing Auxiliary current transformers of universal type, shall be provided in the respective panel.

- e) The relay shall be provided with 2nd harmonic restraint or any other inrush proof feature to prevent operation due to magnetizing inrush current when the transformer is charged either from HV or LV side. But this shall not affect the speed of operation for internal fault.
- f) It shall be provided with 5th harmonic restraint features to prevent operation due to possible over excitation of the transformer. This shall also not affect the speed of operation for internal fault.
- g) The relay shall have adjustable bias setting range 20% to 50% and adjustable operating setting range of 10% to 50% at zero bias.
- h) It shall have three instantaneous high set over current units for clearing heavy internal fault.
- i) The relay shall be with 2-bias winding.
- j) The relay shall be such that there will not be any necessity of changing the setting of the relay whenever the transformer taps are changed from +5% to -10%.
- k) The manufacturer has to furnish the type test report from CPRI/NABL accredited Govt. recognized Test House and performance certificate from Power Utilities in India.
- l) Differential relay shall have facility for setting, parameterization, downloading the storage data, data captured by disturbance recorder etc. locally through PC. The necessary PC, Windows based Licensed software for establishing the facility to be considered in the scope of the supply by the Manufacturer.
- m) The relay shall have disturbance recording (with time stamping) function with suitable no. of analog and digital channels, Memory size and number of disturbances stored in the relay shall be clearly indicated in the offer. No. of site selectable BI, BO and watchdog contact details, communication port details (front, rear) along with necessary hardware and software details shall be furnished.

E-4 RESTRICTED EARTH FAULT PROTECTION

The above protection shall be provided for 33/11 KV transformers at HV and LV side. The Relay shall be:

- a) Single pole type.
- b) Current/voltage operated high impedance type with a suitable setting to cover the maximum portion of transformer winding. Necessary calculation to prove the above winding coverage shall be furnished along with the tender.
- c) Tuned to the system frequency.
- d) Have suitable nonlinear resistor to limit the peak voltage and stabilizing resistance.
- e) Operating time shall be less than 40 ms.
- f) Shall be standalone type.
- g) Have suitable stabilizing resistor to prevent mal operation during external faults if necessary.

E-5 A set of D.C. Voltage Operated Aux. Relays with coil cut-off arrangement and 4NO and 4 NC contacts, hand reset with flag indicator type shall be provided for each Transformer for

- (a) Buchholz Alarm
- (b) Buchholz Trip
- (c) Winding Temp. Trip & winding temp. alarm
- (d) Oil Temp trip & Oil Temp. Alarm
- (e) Low Oil Level Alarm
- (f) Pressure Release Device Trip
- (g) OSR for OLTC trip

Each Transformer Panel shall be provided with a High Speed Tripping Relay with coil cut- off arrangement having 6 NO and 4 NC electrical reset with flag indicator type.

E-6 AUXILIARY RELAYS, TRIP RELAYS and TRIP COIL/ CIRCUIT SUPERVISION RELAYS

Auxiliary Relays- D.C. Voltage operated auxiliary relays provided with mechanically operated hand reset indicator and sufficient no. of hand reset contacts shall be provided for protection and supervision against transformer internal trouble/faults. No of elements and number of relays shall be as per requirement of individual

transformer.

For Trip Circuit Supervision Relays - All Panels should be provided with D.C. Voltage operated Trip Circuit Supervision Relay having provisions for pre & post close supervision of Trip Circuit with set of self-reset contacts provided for Trip Circuit Healthy Indication and Trip Circuit unhealthy indication & Alarm in respect of Trip Coil/circuits of respective Breakers.

Tripping Relays- All Panels should be provided with D.C. Voltage operated High Speed Tripping Relays having self reset contacts capable to make, carry and break trip coil current. Sets of Trip Contacts shall be provided for Inter-tripping function of corresponding 11

KV Incoming Switchgear and closing blocking function of 33 KV & 11 KV Breakers in respect of Transformer Control Panels. Each set of trip relay shall have minimum two nos. NO and 1No. NC contact as SPARES. The operating time of master trip relay shall be less than 40 ms and electrical reset type.

E-7 TRIP CIRCUIT/COIL SUPERVISION SCHEME :

Trip circuit supervision scheme shall be such that testing of trip circuit healthiness is possible irrespective of whether the C. B. is in the closed or open position. The Trip Circuit Healthy LED should glow continuously in CB ‘ON’ Position and on demand in C.B. ‘OFF’ position. The rating of dropping resistance in series with Trip Circuit Healthy LED shall be such that the Trip Coil should not get damaged because of continuous current flowing through it.

E-8 Principal requirements of protective relays, metering equipments, auxiliary relays breaker control switches etc. are as follows:

E-8-1 Ammeter:

Each circuit one ammeter shall be provided with the following :

Mounting	Flush
Size	96 x 96 mm. case
Response Time	1 second
Operating Temperature	Up to 55°C
Dielectric Strength	2 kV RMS for 1 minute
Auxiliary Supply	230 volt A.C, 50 Hz

Operating Current	1 A from CT Secondary.
Type	Panel Mounting with 3 ¹ / ₂ Digital Display.

E-8-2 Volt Meter :-

Mounting	Flush
Size	96 x 96 mm. Case
Response Time	1 second
Operating Temperature	Up to 55°C
Dielectric Strength	2 kV RMS for 1 minute
Auxiliary Supply	230 V A.C., 50 Hz
Frequency	50 Hz
Operating Voltage	110 V from PT Secondary.
Type	Panel Mounting with 3 ¹ / ₂ Digital Display.

E-8-3 Buzzer

One DC buzzer shall be provided in the panel for non-trip alarm. One DC Bell shall be provided for Trip alarm and one AC Bell for Panel DC fail alarm.

E-8-4 High speed tripping relay electrically resettable type confirming to IS – 3231

Aux. voltage	30 V or 110 V D.C to be decided during detailed engineering stage
Coil rating	30V D.C., voltage band for satisfactory operation : 50 to 120% of rated voltage
Operating Time	40 m. seconds nominal at rated voltage
Burden of relay coil watts (Max)	Low burden 40 Watt at rated voltage
Operating temp	-10 deg C to 55 deg C.
Operational indication for each element	Mechanical red colour Flag : Electrical Reset Type
	6 NO + 4 NC combination with additional hand

Contact Configuration	reset coil cut of contact (Seal in contact)
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Contact ratings:

Make and carry	A.C. 1250 VA with max 5 amp & 660 Volts D.C. 1250 W dc with max 5 amp & 660 Volts
Make and carry for 3 sec.	A.C. 7500 VA with max 30 amp & 660 Volts D.C. 7500 W dc with max 30 amp & 660 Volts
Break	A.C. 1250 VA with max 5 amp & 660 Volts D.C. – 100 W resistive 50 watt inductive with max 5 amp & 660 Volts
Insulation	2 KV RMS, 50Hz for 1 min. 2.5 KV/1 sec between all terminals & case as per IS 3231. 1 KV RMS, 50Hz for 1 min. across open contact
Type of mounting	Flush

E-8-5 Numerical based differential protection relay with inbuilt current amplitude & vector group compensation feature & also with differential high set element for two winding power transformer compliant to IEC 60255.

Aux. voltage	30 V or 110 V D.C to be decided during detailed engineering stage
C.T. secondary	Selectable 1 amps / 5 amps for both HV & LV sides
Online display of HV & LV phase currents & differential current	
Adjustable bias setting	10 to 50% In.
Operation based on fundamental frequency	
Programmable HV/LV CT ratio of T/F vector group	
Inbuilt REF protection	
Inbuilt HV & LV side over current & earth fault protection	
Inbuilt transformer trouble auxiliary relay	
Backlit LCD display	
Harmonic restrain feature	
Storing facility of latest 5 fault events with real time clock	

Password protection	
DC burden	Quiescent condition – approx 4 watt Under trip condition – 30 Volt - approx 4 watt, 110 Volt - approx 7 watt.
AC burden	Through current only – approx 0.15 VA for 1 amp & 0.30 VA for 5 amp (per bias circuit) Bias & differential Ckt only: 2.8 VA for 1 amp & 3.2 VA for 5 amp.
Contact arrangements	Two change over self reset tripping contacts & two annunciation contacts
Contact rating	Make & carry 7500VA for 0.2 sec. with max 30 A & 300 V AC or DC carry continuously 5 amp AC or DC break 1250 VA AC or 50 W DC resistive, 25 W L/R – 0.04 s subject to max. 5 amp & 300 Volts
Current Input	Six for differential & one for REF
Self diagnosis feature for healthiness of relay	
Flush mounted / draw out type	

23.0 Guarantee:-

The panels shall be delivered to the various consignees of the EMPLOYER and shall be suitably packed to avoid damages during transit.

The C&R Panel with relays with all integral parts of the Equipment will be guaranteed for the period of five years from the date of last dispatch.

In the event of any defect in the Equipment, relay, any integral part of the Equipment arising out of faulty design, materials, workmanship within the above period, the supplier shall guarantee to replace or repair to the satisfaction of EMPLOYER.

If the supplier fails to do so, within one month of receipt of intimation, EMPLOYER reserves the right to effect repair or replacement by any other agency and recover charges for repair or replacement from the supplier.

24.0 TESTS :-

24.1 Type Test : -

24.1.1 The Manufacturer should submit the Type test report including functional test for all the protective relays and C&R panels carried out within five years from the due date of submission of tender from CPRI/NABL accredited Laboratory/ Govt. Recognized test house or Laboratory on the tendered Items as per relevant Standard & Tender Specification with the purchase order failing which the lot shall be rejected. The Type tests for Numerical Relays is to be submitted as specified in Annexure-I & II of Relays specification.

24.1.2 Test at Factory:

The following Tests shall be carried out 6 copies of Test certificates shall be submitted for approval. The Equipments shall only be dispatched after approval of the test certificates.

1. Checking of wiring of circuits and the continuity.
2. One minute applied voltage test. All Equipment on panel and small wiring shall be tested for withstand voltage of 2000Volts to earth & between different voltage circuits.
3. Insulation resistance of the complete wiring, circuit by circuit with all equipments mounted on the Board before and after H.V. test mentioned under 2 above.
4. Routine tests according to relevant National standard are on the Instruments, relays & other devices.

25.0 INSPECTION:

25.1 Acceptance test at manufacturer's works in presence of purchaser's representatives shall be carried out. The supplier shall give at least 15 days notice of the date when the tests are to be carried out. Purchasers shall give the right to select any quantity of the item wise offered lot for testing, offered for inspection and in the event of failure in test(s), the purchaser shall have the right to reject the offered equipments.

25.2 All relays, meters & annunciators provided in the control & relay panels are to be accepted only after successful hundred percent performance testing at testing department of EMPLOYER.

25.3 The inspection may be carried out by the EMPLOYER at any stage of manufacturing. The successful Manufacturer shall grant free access to the EMPLOYER's

representative/s at a reasonable notice when the work is in progress. Inspection and acceptance of any equipment under this specification by the EMPLOYER, shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

25.4 The manufacturer shall keep the EMPLOYER informed in advance, about the manufacturing programme so that arrangement can be made from stage inspection.

25.5 The EMPLOYER reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. The supplier shall keep the EMPLOYER informed, in advance, about such testing programme.

26.0 SPARES:

The manufacturer shall quote item-wise Unit Prices for all type of relays and other consumable spares recommended by him. Such spare shall include Fuse Holders, Fuses, Indicating Lamps, essential spare parts of Relays, Instrument, extra Control Switches etc. EMPLOYER may procure these items from the successful manufacturer.

27.0 DRAWING & LITERATURE

Triplicate copies of the following drawings and literature shall be submitted along with the order copy:-

(a) Principal dimension details of each unit cubicles, complete assembly of panel and proposed arrangement of the Panel in a Control Room.

(b) Front and rear views of the Panel with instrument and device positions marked.

(c) Pictorial views of the Control Switches Terminal Blocks, Indication Instruments, Test Blocks and exploded views of draw out type instructions and Fuse Blocks.

(d) Schematic Wing Diagram for Test Terminal Block.

(e) Illustrative, descriptive literature, General Technical Data & Specification of Devices.

(f) make, type, particulars, literatures of each and every relay (protective & auxiliary), meters, annunciators, switches, lamps, TBS, TTBS etc. along with bill of material in

line with specification.

28.0 CONTRACT DRAWINGS & LITERATURE

In the event of an order materializing, the Supplier also submit four prints of each drawing for approval of the EMPLOYER along with 2 sets of literature as mentioned in the spec.

The Contract drawings shall cover the followings:-

- (a) Details of construction and dimensions of a cubicle and of the complete Panel.
- (b) Template for foundation and details of Cable Trench and Cable Entry Holes in the Foundation Platform.
- (c) Elementary diagrams of all controls, metering, protection annunciation and other circuits. All devices shall be numbered according to ASA or international usage, which shall be separately coded.
- (d) Cabling and wiring diagram of the cubicles and inter-connections between them. Ferrule numbers, device number and grouping for cable take off shall be distinctly shown.
- (e) Dimensional outline drilling diagram and special mounting arrangement if any, of such type of various devices on the Panel.
- (f) Inter-connection diagram between Control Panel and C.B. power and instrument transformer etc.
- (g) Wiring Schedule for Control & Relay Panel.
- (h) Internal wiring diagram of all devices and elementary wiring diagram of relays where internal wiring is in triplicate. Construction details of switches, terminal blocks and test blocks etc.
- (i) After approval, 10 sets of the final contract drawing for each set of Control & Relay Panels are to be supplied by the Manufacturer. One set reproducible tracing of the above drawings in soft format shall also be supplied.

In the event of contract being awarded, 4 copies of the following literatures shall be

supplied along with the drawings as mentioned:-

- (a) Literature describing construction, operation, adjustment and rating specifications of all the protective and auxiliary relays, recording instruments, metering instruments and control switches.
- (b) Literature giving rating data, details and adjustments for calibration of the indicating instruments.
- (c) Calibration instruments for the metering instruments.
- (d) List of spare parts, identification number of renewable parts of relays, instruments and switches etc. with the help of which the EMPLOYER will be able to procure spare parts from the manufacturer at any subsequent time.
- (e) It is desired that the complete schematic drawing is provided on a permanently laminated/engraved plate of suitable thickness which has to be bolted/riveted at the four corners on the inside face of rear door. In addition, one more plate of similar type and dimension shall be provided on the outside of the rear door providing guidelines and instructions for operation. The guidelines and schematic to be provided on the plates shall be as per approved drawings.

29.0 DOCUMENTS TO BE SUBMITTED ALONGWITH THE OFFER:

The manufacturer shall invariably submit the following documents failing which the offers are liable for rejection:-

- 29.1 Bill of Material (schedule-IA/IB/IC).
- 29.2 Documents supporting the qualifying requirements/past performance reports schedule-III).
- 29.3 Undertakings from relay manufacturer regarding (Schedule-IV) : -
- 29.3.1 Non-phasing out of the relays for at least 10 years from the date of supply
- 29.3.2 For extending technical support and back-up guarantee
- 29.4 Detailed catalogue/technical literature in respect of all components/accessories including bought-out items.

29.5 Names of supplier of bought out item.

29.6 List of testing equipment available with the Manufacturer.

30.0 QUALITY ASSURANCE PLAN

30.1 The Manufacturer shall invariably furnish QAP as specified in Annexure-III along with his offer the QAP adopted by him in the process of manufacturing.

30.2 Precautions taken for ensuring usages of quality raw material and subcomponent shall be stated in QAP.

31.0 GUARANTEED TECHNICAL PARTICULARS:

Manufacturer shall furnish Guaranteed Technical Particulars of equipment offered mentioning thereon Make & Technical particulars of each device as per schedule specified. Performance Guarantee will be based on the Guaranteed Technical Particulars.

Schedule-II -- GTP for C&R Panel

Schedule-V—GTP for Non Directional/ Directional O/C & E/F Relay

Schedule-VI—GTP for Master Trip Relay

Schedule- VII – GTP for Differential Protection Relay

The discrepancies, if any, between the specification and the catalogs and/or literatures submitted as part of the offer by the manufacturers, the same shall not be considered and representations in this regard will not be entertained.

32.0 Bus Configuration and Bill of material

32.1 33/11KV delta star individual control transformer panel having HV side control and protection. Single main bus with bus section isolator scheme.

2 nos.	Circuit label engraved suitably at front and inner side
1 no.	Section of painted and overlaid mimic diagram
1 no.	Circuit breaker control switch.
6 nos.	Indicating lamps for circuit breaker ON/OFF, spring charged, trip circuit 1 & 2 healthy and auto trip indication.
2 nos.	Trip circuit supervision relay to supervise the TC 1 & 2 both under pre close and post close condition.
3 nos.	96 mm x 96 mm ammeter scaled suitably.
1 no.	volt meter of 96 mm x 96 mm
1 no.	Suitable space and wiring for non-tariff TVM for energy management.
1 set	Three phase 4 wire test terminal block for above.
1 no	Auxiliary relay with test push button for panel DC supervision relay.
16	Fascia window type annunciator complete with accept reset and test PB but without audible bell.
1 no	Triple pole, IDMTL, non-directional over current relay with setting range 50% - 200% for IDMTL units and 500% - 2000% for high set unit.
2 nos	Restricted Earth Fault Relay current operated having setting range 10% to 40% both for HV & LV side of the Transformer.
1 no	High speed master tripping relay with contacts as required with lock out and coil supervision scheme complete.
1 set	Two bias Transformer differential relay (for 10 MVA only) with Interposing auxiliary CTs

	(universal type) where ever necessary.
1 no.	PT selector switch, two position PT-1/PT-2 switch, stay put type (16 A)
1 no.	Space heater with On/OFF switch and thermostat.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Buchholz trip and Buchholz alarm function. Each element with 4NO+2NC Contact.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer winding temp. trip and alarm function. Each element with 4NO+2NC Contact.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Low Oil Level(Main Tank and OSR(OLTC) alarm function. Each element with 4NO+2NC Contact.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Oil Temp. Trip and alarm function. Each element with 4NO+2NC Contact.
1 no.	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Main tank PRV trip and OLTC PRV Trip function. Each element with 4NO+2NC Contact.
1 no	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for OLTC Buchholz trip and spare. Each element with 4NO+2NC Contact.
1 no.	DC operated emergency lamp with switch.
1 no.	Cubicle illumination lamp operated from door switch.
1 no.	15A, 3 phase plug & socket with switch.
1 set	Panel accessories as necessary.
1 set	Other equipment, relays etc. as required to fulfill the scheme Requirement.
1 no	Local/Remote switch

32.2 33KV single feeder line C&R Panel with Non directional O/C & E/F protection

and 33KV parallel feeder line C&R Panel with directional O/C & E/F protection.
Single main bus with bus section isolator scheme.

2 no.	Circuit label engraved suitably at front and inner side
1 no.	Section of painted and overlaid mimic diagram
1 no.	Circuit breaker control switch.
6 nos.	Indicating lamps for circuit breaker ON/OFF, spring charged, trip circuit 1 & 2 healthy and auto trip indication.
2 nos.	Trip circuit supervision relay to supervise the TC 1 & 2 both under pre close and post close condition.
3 nos.	ammeter of 96 mm x 96 mm scaled suitably.
1 no	Voltmeter of 96 mm x 96 mm scaled suitably
1 no.	Suitable space and wiring for non-tariff TVM for energy management.
1 no.	Three phase 4 wire test terminal block for above.
1 no.	Auxiliary relay with test push button for panel DC supervision relay.
12 way	Fascia window type annunciator complete with accept reset and test PB but without audible bell.
1 no	Triple pole, IDMTL, non-dir- over current relay as per clause 23
1 no.	Single pole definite time sensitive E/F relay current operated having wide setting range for single circuit line.
1 no	Triple pole, IDMTL, directional over current relay with setting range 50% - 200% for IDMTL units and instantaneous high set unit -500% - 2000% applicable for parallel line feeder as per schedule
1 no	Single pole directional definite time sensitive E/F relay current operated having wide setting range for single circuit line. NECESSARY IPTs ARE WITHIN THE SCOPE OF MANUFACTURER
1 no.	High speed master tripping relay with contacts as required with lock out and coil supervision scheme complete.
1 no.	PT selector switch, two position PT-1/PT-2 switch, stay put type (16 A)
1 no.	Space heater with On/OFF switch and thermostat.
1 no.	DC operated emergency lamp with switch.
1 no.	Cubicle illumination lamp operated from door switch.
1 no.	15A, 3 phase plug & socket with switch.
1 set	Panel accessories as necessary.
1 no	Local/Remote switch
1 set	Other equipment, relays etc. as required to fulfill the scheme Requirement.

32.3 Common items:(where ever mentioned)

1 no.	96 mm x 96 mm voltmeter scaled suitably.
3+3nos	PT supply Indicating lamps, red-yellow-blue for each PT.
1 no	Voltmeter selector switch, 4-position, RY—YB—BR—OFF.
1 set	Audible bell and hooter for trip and non-trip fascia annunciation.
1 no	AC operated single element, auxiliary relay having only self reset contacts and with reverse flag for incoming AC supply supervision with test push button.
1 no	DC operated, two element, auxiliary relay having only self reset contact and with reverse flag for incoming DC and alarm bus DC fail supervision.
2 nos.	Test push button for above.
1 no	Single element AC operated auxiliary relay having self reset contact only for incoming DC and alarm bus DC fail alarm cancellation.
1 no	Push button for incoming DC and alarm bus DC fail alarm accept.
1 no	Indicating lamp for incoming DC and Alarm bus DC fail indication.
1 no	AC operated buzzer for incoming DC and Alarm bus DC fail audible alarm.

Annexure - IV**Standard Make of Relay and Fitments**

1.	Relays	Schneider, ABB, Siemens, Alstom
2.	Breaker Control Switch/ Local- Remote switch	Kaycee/Recom/Switron
3.	Ammeter/Voltmeter Selector switch	Kaycee/ Recom
4.	Static Ammeter/ voltmeter	AE/RISHAV/Secure
5.	Push Buttons	Vaishno/Teknic/Lumen/STS
6.	Indicating Lamps with lenses	Vaishno/Teknic/Lumen/STS
7.	Panel wiring	Finolex/Havvels/ KEI/ R. R. kables
8.	Hooter/Buzzer/Bell	Vaishno/STS/JVS/Bharani
9.	Annunciator	MINILEC/ALAN/ INSTALARM/EAPL

Annexure-V**Legend of Devices associated with 33kV C & R Panel**

Symbol Reference	Description	Particulars
A1-A2-A3, Ah	Ammeter	As specified
V	Voltmeter	As specified
VS	Manual Voltmeter Selector Switch	As specified
EM	Tri-Vector Meter	As specified
CS	Control switch T-A/T-N-A/C-C spring return type	As specified
L/R	Local/Remote switch	As specified
IL-R	CB „ON“ Indication Red lamp	As specified
IL-G	CB „OFF“ Indication Green lamp	As specified
IL-W	„Trip /Close signal received from Remote Indication white Lamp	As specified
IL-B	“Spring charged” Indication Blue lamp	As specified
IL-A	CB “ Auto trip” Indication Amber lamp	As specified
PB	Push Button	As specified
ANN	DC operated electric Buzzer and Microprocessor based Electronic annunciator with built in watch dog and first fault indication facility. The annunciator shall have provision for trip and non trip alarm functions and Accept/Test/Reset/Mute Push buttons	As specified
H,HS,TH	Heater, Heater Switch, Thermostat	As specified
FS	Fuse	As specified
LK	Link	As specified
MCB1	MCB 2 pole 32 A for DC supply	As specified
MCB2	MCB 2 pole 16 A for AC supply	As specified
MCB3	MCB 2 pole for spring charging motor supply	As specified
MVS	Manual PT selector switch	As specified
IR-I	Remote inter tripping contact from 33 kV Transformer Control and	As specified

	relay Panel	
TC	Tripping Coil	As specified
CC	Closing Coil	As specified
86	Tripping Relay for Tripping function	As specified
52	Vacuum Circuit breaker	As specified
52a,52b	NO and NC contacts of Breaker Auxiliary switch respectively	As specified
PT	Potential Transformer	As specified
CT	Current Transformer	As specified
TTB	Test Terminal Block	As specified
51/50 R- Y-B-N	O/C and E/F protection	As specified
67 R-Y- B-N	Directional O/C and E/F protection	As specified
64	Restricted Earth Fault Protection	As specified
87	Differential Protection	As specified

 SCHEDULE-I A

(To be submitted, duly filled in, along with the offer) Bill of materials for 33 KV feeder C&R panels

Sr. No	Description	Quantity	Make, Type & design
1	Circuit label	1 No.	
2	Mimic section(Brilliant green paint to shade No.221 of IS 5 to be used)	1 No.	
3	T-N-C type control switch for circuit breaker.	1 No.	
4	Indicating LEDs for Spring charge indication(Blue) Trip circuit healthy indication(white) one each for Trip ckt 1 and Trip Ckt 2 Breaker 'ON' indication(Red) Breaker 'OFF' indication(Green)	1 No. 2 Nos. 1 No. 1 No.	
5	Push button for Trip circuit test Alarm Accept/Reset/Test/Mute	1 No. 4 Nos.	
6	Numerical non-directional IDMT over current and earth fault relay with high set instantaneous trip feature	1 No.	
7	High speed Master tripping relay (Electrically resettable)	1 No.	
8	12 window annunciation scheme with accept, reset and LED test push button with self resetting audible alarm.	1 Set	
9	Ammeter (96 mm x 96 mm.)	3 Nos.	
10	Voltmeter (96 mm x 96 mm.) & selector switch.	1 Set	

11	Local / Remote switch	1 Set	
Internally mounted			
1	Space heater and control switch	1 Set	
2	Cubical illumination lamp and door switch	1Set	
3	Power Plug, socket and control switch	1 set	
4	Alarm bell for trip	1 No.	
5	Alarm cancellation relay	1 No.	
6	Alarm buzzer for non trip with auto-stop feature (with variable time setting 0-60 seconds)	1 No.	
7	MCBs	As required	
8	Fuse and Links	As required	
9	Control wire	As required	

SCHEDULE-I B

Bill of materials for 33/11KV Transformer C&R panels with differential protection

Sr. No	Description	Quantity	Make ,Type and design
1	Circuit label	1 No.	
2	Mimic section (Brilliant green paint to shade No. 221 of IS 5 to be used)	1 Set	
3	T-N-C type control switch for circuit breaker.	1 No.	
4	Indicating LEDs for		
	Spring charge indication(blue)	1 No.	
	Trip circuit healthy indication(white)) one each for Trip	1 No.	

	ckt 1 and Trip Ckt 2		
	Breaker 'ON' indication(Red)	1 No.	
	Breaker 'OFF' indication(Green)	1 No.	
5	Push button for Trip Circuit Healthy Test, Alarm accept/Reset/Test/Mute	5 NoS.	
6	Trip circuit Healthy test	1 No.	
7	Numerical non-directional IDMT over current and earth fault relay with high set instantaneous trip feature	1 No.	
8	High speed master tripping relay (electrically resettable)	1 No.	
9	Space for HT Static TOD Tri-vector Energy meter and TTB.	1 No.	
10	Ammeter (96 mm x 96 mm.)	3 Nos. and 1 No.	
11	Voltmeter (96 mm x 96 mm.) & selector switch.	1 Sets	
12	Transformer differential numerical relay	1 No.	
13	16 window annunciation scheme with accept, reset and LED test push button with self resetting audible alarm.	1 No.	
14	Auxiliary relay for main tank Buchholz Alarm/trip (2- element)	1 Set	
15	Aux. relay for winding temp Alarm/trip (2-element)	1 Set	
16	Aux. relay for OLTC Buchholz Alarm/trip (2-element)	1 Set	
17	Aux. relay for low oil level alarm(Main Tank) & OSR(OLTC) Trip (2-element)	1 Set	
18	Aux. relay for oil temp alarm/trip (2-element)	1 Set	
19	Aux. relay for Main tank PRV & OLTC PRV Trip (2- element)	1 Set	
Internally mounted			
1	Space heater and control switch	1 No.	
2	Cubicle illumination lamp with door switch.	1 No.	
3	Power plug with control switch	1 No.	
4	MCB.	As required	

5	Fuse and Links	As required	
6	Control wire	As required	

SCHEDULE-IC

(To be submitted duly filled in alongwith the offer)

Bill of materials for 33/11KV Transformer C&R panels without differential protection.

Sr.	Description	Quantity	Make and Type desig
1	Circuit label	1 No.	
2	Mimic section (Brilliant green paint to shade No.221 of IS 5 to be used)	1 Set	
3	T-N-C type control switch for circuit breaker	1 No.	
4	Indicating LEDs for		
	Spring charge indication(blue)	1 No.	
	Trip circuit healthy indication (white) one each for Trip Ckt 1 and Trip Ckt 2	2 Nos.	
	Breaker 'ON' indication (Red)	1 No.	
	Breaker 'OFF' indication (Green)	1 No.	
5	Push button for Annunciation AC/RE/TEST/MUTS & Trip Circuit Healthy	5 Nos	
6	Numerical non-directional IDMT over current and earth fault relay with high set instantaneous trip feature.	1 No.	
7	High speed tripping relay (electrically resettable)	1 No.	
8	Space for HT TOD Tri-vector Energy meter and TTB.	1 No.	
9	Ammeter (96 mm x 96 mm.)	3 Nos. & 1No	
10	Voltmeter (96 mm x 96 mm.) & selector switch.	1 Set	
11	16 window annunciation scheme with accept, reset and LED test push button with self resetting audible alarm.	1 No.	
	Auxiliary relay for main tank Buchholz Alarm/trip (2-element)	1 Set	
	Aux. relay for winding temp Alarm/trip (2-element)	1	

		Set	
	Aux. relay for OLTC Buchholz Alarm/trip (2-element)	1 Set	
	Aux. relay for low oil level alarm(Main tank) /OSR(OLTC)Trip (2-element)	1 Set	
	Aux. relay for oil temp alarm/trip (2-element)	1 Set	
	Aux. relay for Main tank PRV / OLTC PRV Trip (2- element)	1 Set	
Internally mounted			
1	Space heater and control switch	1 No.	
2	Cubicle illumination lamp with door switch.	1 No.	
3	Power plug with control switch	1 No.	
4	MCBs, fuses, links, control wiring, etc.	As required	
5	Fuse and Links	As required	
6	Control wire	As required	

NOTE: THE MANUFACTURERS MUST HAVE TO SUBMIT SEPARATE BILL OF MATERIAL FOR DIFFERENT TYPE OF PANELS WITH THE GUIDELINE AS MENTIONED ABOVE, FURNISHING THE TYPE AND MAKE OF EACH ITEM.

SCHEDULE - II

DETAILS OF RELAYS, METERS, EQUIPMENT & DEVICES AS OFFERED IN SCHEDULE OF 33 KV SIMPLEX TYPE CONTROL AND RELAYS PANEL – TO BE FILLED UP BY THE MANUFACTURERS ALONGWITH SUBMISSION OF SUPPORTING DOCUMENTS

Sl. No.	Description	Make And Country Of Manufacture	Type (Catalogue to be enclosed)	Brief Description, with CT/PT details, contact configuration, Input/Output details, characteristics, range, suitability etc. for clear perspective.
A	SURFACE MOUNTING DEVICES			
1	Circuit Level			
2	Mimic Diagram			
3	Circuit Breaker Control Switch Spring return lost motion type			
4	Ammeter 96 mm sq. for C.T. Secondary rated Current 1A Scale 0-100/0-200A Scale 0-200A / 0-400A			
5	Voltmeter 96 mm Sq. for P.T. Secondary 110 VAC (L/L) Scale 0-40 KV			
6	Voltmeter Selector Switch 6 way & off position having break before make contact			

7	<p>Test Terminal block suitable for 3 phase 4 wire system with wire rear connecting studs having provision of sealing arrangement</p>			
8	<p>Multi way micro processor based Electronic Annunciator with building- system watchdog first fault indications and red & yellow coloured windows with inscription for Trip & Non Trip Alarm functions</p>			
9	<p>Indicating Lamps led type 63.5 VAC for P.T. Supply indication with RED/YELLOW/ BLUE Colours</p>			
10	<p>Indicating Lamp LED type 230 VAC for Panel D.C. Fail Common Indication</p>			
11	<p>Indicating Lamp LED type 30 VDC for CB ON/OFF Auto up Spring Charge Trip Circuit Healthy Indication with RED/GREEN/ AMBER /BLUE Colours</p>			
12	<p>Push Button for Panel DC fail test</p>			
13	<p>Push Button for including AC fail test</p>			
14	<p>Push Button for non trip Panel DC</p>			

	fail Alarm Accept			
15	Push Button for Annunciator Alarm Test / Mute/Accept/Reset			
16	3 Element normal IDMTL over current Relay with instantaneous high set unit			
17	Single Element Instantaneous sensitive Earth Fault Relay with Timer			
18	Triple Pole Directional Voltage polarized Over Current Relay with Directional High Set Unit on all Element			
19	Single Pole Directional Voltage polarized Instantaneous sensitive E/F Relay with timer			
20	Hi balance Instantaneous Restricted Earth Fault Circulatory Current Fault Relay (a) HV side of Power Trf. (b) LV side of Power Trf.			
21	Single Element High Speed Tripping Relay with electrically reset Contact & H/R flag/indication with required numbers of contracts			

22	<p>Two Element 30 V DC Voltage Actuated Auxiliary Relay with HR Contacts & HR/LED Flag/indication for Transformer Internal Trouble functions</p>			
23	<p>Single Element 30V DC Voltage Actuated Auxiliary Relay with self Reset Contact & Reverse Flag indication for Panel DC Supply fail function</p>			
24	<p>Single Element 230V AC Voltage Actuated Auxiliary Relay with self Reset Contacts & Reverse Flag indication for incoming AC Supply fail function</p>			
25	<p>30 V DC Voltage operated Relay for Trip Circuit supervision purpose with self reset contact</p>			
26	<p>Single Element 230V AC Voltage Actuated Auxiliary Relay with self Reset Contacts without Flag indication for panel DC fail Alarm, Accept</p>			
27	<p>Additional Involvement of Single Element 30V DC Voltage Actuated Auxiliary Relay</p>			
28	<p>Extra Involvement of Auxiliary Relay</p>			

	for not having sufficient contacts to achieve required functions			
29	Space & wiring for housing purchaser's projection mounting type Energy meter(not within the scope of manufacturer			
30	Common Electronic DC bell/Buzzer Trip & Non-Trip Alarm functions			
31	Common Electronic AC Ball for Panel DC fail Alarm functions			
32	Biased differential relay for 10 MVA Trf. Control & Relay Panel			
B	Inside Mounting Devices			
1	230V AC Cubicle illuminating lamp with door operated Switch/Toggle Switch			
2	30V DC Emergency Lamp with Toggle Switch			
3	230C AC 60W space heater with thermostat & Toggle Switch			
4	15A Double V AC Combined 2/3 pin plug and socket with Switch			
5	15A Double Pole MCB for Incoming AC Supply			
6	Fuse			

7	Links			
8	Terminals			
9	Earthing Arrangement			
10	Interposing P.T. for Directional Relay if required			
11	Interposing Universal type CT for Differential Relay if required			

Note: All surface mounting devices excepting Energy meter,TTB & Bells are flush mounting type As per Schedule requirement.

Schedule-V

GTP for Numerical Feeder Protection Relay

Sl. No.	Feature and Function	Supplier's details
1.1	Make, Type, Model No and Version No and Ordering Code	
1.2	Conformance to i. IEC255-4 ii. IEC 61850	
1.3	No. of CT inputs for O/C and E/F Protection	
1.4	Type test report submitted(y/n)	
1.5	Relay shall be of Numeric Design	
1.6	Relay designed for bay protection and Control	
1.7	Size of Relay LCD screen	
1.8	Relay is equipped with CB close and open key/push buttons	
1.9	Relay has following protection functions: a. Three phase over current b. Earth fault c. Thermal overload function d. Broken conductor protection function e. Circuit Breaker Maintenance function	
2.	a. One time delayed element and	

	<p>two high set elements</p> <p>b. Setting range and step for IDMT element for both current and Time Multiplier Setting</p>	
	c. Selectable Current/Time Curve for IDMT element	
	d. Setting range and step for high set elements for both current and time delay	
10.	Sampling rate and frequency of analog signal	
11.	Whether remote controllable from SCADA	
12.	<p>a. No. of Digital Inputs</p> <p>b. Voltage rating of Digital Inputs</p> <p>c. Provision of testing without current injection</p>	
13.	Supervision for CB open and Closed status	
14.	No. of programmable LEDs and no. of Latched LEDs	
15.	Analog Measurement and display supported	
16.	Fault Record storage capacity	
17.	Event storage capacity	
18.	Disturbance record storage capacity	
19.	MMI with keypad and LCD provided	

20.	Rated DC Supply and tolerance	
21.	Rating of CT/PT secondary	
22.	Rated frequency	
23.	a. Operating ambient temperature & humidity	
	b. Withstanding capability of Electromagnetic Interference as per relevant part of IEC 61850	
24.	Mounting	
25.	Watchdog	
26.	a. Nominal Feeder current	
	b. CT Ratio setting	
	c. Earth fault current with time delay IEC Curves, 2 nd stage for instantaneous trip (less than 50 ms)	
	d. High set with delay	
	e. IEC Curves for all O/C and E/F have user selectable?	
27.	a. No. of Digital Output Contacts	
	b. Contact rating	
28.	Mode of Time Synchronization	
29.	Type of Lugs and terminators	
30.	MTBF	
31.	Lifespan	
32.	Compliance to Type Test	
33.	Communication Port	
	a. Rear port- details b. Front port- details	
34.	Whether Communication Ports are native to the Relay	
35.	Protocol supported for Rear Port	

36.	Protocol supported for Front port	
37.	Start and trip output contacts are freely programmable	
38.	Cable for connection of Relay to laptop(USB port) along with converter and power supply if required for relay local setting	
39.	Basic application software for setting change, parameterisation	
40.	CD with software(licensed) to download disturbance recorder, event logs and evaluation of those records	
41.	Graphical configuration tool for I/P, O/P and functional building block for protection and control	
	Any other software required for integration with SCADA.	

Schedule-VI

GTP for Master Trip Relay

Sl. No.	Description	Manufacturer's Response
01.	Manufacturer Name	
02.	Type and designation	
03.	Electrical reset	
04.	Mounting	
04.	High Burden relay	
05.	Operating Time	
06.	Rated DC supply and tolerance	
07.	No. of NO Contact	
08.	No. of NC Contact	

Schedule-VII

GTP for Numerical Based Differential Relay

Description	Manufacturer's Response
Manufacturer Name	
Type and designation	
Rated DC supply and tolerance	
C.T. secondary current	
Adjustable bias setting	
Operation philosophy	
Whether Programmable HV/LV CT ratio of T/F vector group provided	
Inbuilt REF protection provided	
Inbuilt HV & LV side over current & earth fault protection provided	
Inbuilt transformer trouble auxiliary relay provided	
Display Type and details	
Whether Harmonic restrain feature available	
Details of Event Recording and storing facility	
Password protection	
DC burden	
AC burden	
Contact arrangements	
Contact rating	
Current Input	
Self diagnosis feature provided	
Mounting Arrangement	

Communication port Details	
----------------------------	--

ANNEXURE-I

Technical specification for IEC 61850 compliant non- Directional O/C and E/F Relay with Bay control features

Sl. No.	Feature and Function	Technical requirement
1	Purpose and application	<p>It is intended to automate the Switchgears specified in the scope of supply and use Communicable Numeric relays for Protection, Control, Metering and Status monitoring. This specification is based on the understanding that an integrated Automation System along with protections shall be provided and same shall have provisions for Integration with SCADA system. All the feeders shall be remote controlled from EMPLOYER’s SCADA and from the local console of the numerical relays.</p> <p>Numerical multifunctional combined Microprocessor based Feeder protection and management relay to protect the 33kV Feeder from all electrical and other faults along with reporting system, Disturbance record for fault analysis. Manufacturer should comply with any especial requirement or feature asked for retrofitting the relays. Relay should be IEC 61850 compliant. Relay should have 4 CT input for O/C and E/F protection. There should be option for derivation of E/F internally.</p>
2.	Main Protection Feature	<ol style="list-style-type: none"> 1. Relay should have minimum two group of setting. Setting group changeover required from digital status input. 2. Electrical over load protection with selectable IEC curves with two stage, first stage to be used as Definite Time / IDMT and second stage to be used as high set for short circuit protection. 3. Earth fault protection in two stages with IEC characteristics. First stage to be used as IDMT/Definite

		<p>Time and second stage to be used as instantaneous elements. Earth fault element should be suitable for both CBCT and residual type CT connection.</p> <ol style="list-style-type: none"> 4. Negative phase sequence Protection with IEC Curves. 5. CB Fail Protection & time settable as per user. 6. The relay should be immune to DC switching while carrying current i.e. no spurious trip should be generated if relay DC is made On and Off 7. The relay should conform to the IEC255-4 or BS 142 for Inverse time characteristics. 8. The relay should have features to monitor for broken conductor and CB opening time
3.	Processor feature	<p>Relay shall be completely Numerical with protective elements having software algorithm based on sampling of Analog inputs. Sampling Rate of Analog Signal: The sampling rate should be 1000 Hz for 50 Hz signal or better for each analog channel. Hardware based measurements shall not be acceptable.</p>
4.	Operational Philosophy	<p>The operation of Relay shall be possible both locally from the Switchgear and remote & Local Work station. The local position shall be displayed in remote / local workstation and remote operation shall be blocked if the switch is in Local. Clear control priorities shall prevent initiation of operation of a single switch at the same time from more than one of the various control levels and there shall be interlocks among various control levels. The priority shall always be with the lowest enabled control level. Relay accuracy shall not be affected by system frequency fluctuation.</p>
5.	Status/Optical Inputs/Digital inputs	<ol style="list-style-type: none"> 1. Minimum 7 number status inputs are required 2. All status inputs should be 30 V DC/110 V DC (will be mentioned during detailed Engineering as per requirement). 3. Setting group is required to be changed with any Digital input status. 4. Trip circuit supervision with DI status 5. The digital inputs shall be acquired by exception

		<p>with 1ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state.</p> <ol style="list-style-type: none"> 6. Relay should have comprehensive self diagnostic feature with remote indication of relay failure and alarm shall be generated without tripping of circuit 7. Provision of Testing output relays without any current injection. 8. No. of programmable LEDs - at least 4 nos. with latching option.
6.	Main measuring and reporting feature	<p>All measurements should be in primary quantities. Minimum following displays are required in alpha numeric:-</p> <ol style="list-style-type: none"> 1. Three phase (Positive sequence) current 2. Neutral(zero sequence) current 3. All the trips should have clear indication on the relay terminals 4. Resetting should be selectable as hand reset or auto reset. 5. The default relay LCD shall be user defined to display primary circuit loading.
7.	Memory and Recording Feature	<ol style="list-style-type: none"> 1. The relay setting and programming should be stored in EEPROM so that during Aux. Power failure the said data is not lost. 2. Relay should have event log, trip log and DR record. All logs should go in to history. 3. All tripping of relay should initiate DR in auto without extra binary input. Triggering of DR with binary input should be user configurable.
		<ol style="list-style-type: none"> 4. The last 2 fault DR records should be in flash memory and DR will not erase in case of DC supply fail for more than 2 days. 5. Should be able to record at least 5 Oscillographic disturbances and 5 fault records and 250 event records. 6. Minimum Four no. of latest trip log with cause of trip should be stored in memory along with date and time stamping. The memory should not be lost with the switching off of DC. 7. The relay should have fault-recording feature

		<p>with current waveform and Digital Input status. The fault waveform should consist of minimum four current waveforms of three phase current and zero sequence current and DI status. Triggering time for Pre and Post should have user selectable. This record should be in flash memory for minimum 7(seven) days even after switching off the DC supply.</p> <p>8. The fault should be date and time stamped.</p> <p>9. Communication protocol IEC 61850.</p>
8.	Auxiliary Supply	<p>30 V or 110 VDC (will be mentioned during detailed Engineering as per requirement) to - 25% to + 10%, 2 wire unearthed system. Necessary software shall be in-built for proper shutdown and restart in case of power failure. Auxiliary supply burden will be around 20Watt.</p>
9.	Rated CT/PT secondary	<p>5/1 Amp(User selectable) , CTs used to be protection class</p>
10.	Rated frequency	<p>50 HZ +/- 5%</p>
11.	Ambient condition	<ol style="list-style-type: none"> 1. Operating ambient temperature upto 55 Deg C 2. Operating Humidity upto 100 % 3. Relay shall meet the requirement for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.
12.	Module and Mounting	<ol style="list-style-type: none"> 1. Relay should be flush mounted type 2. If module is drawout type then it should have CT shorting facility of make before break type. 3. Mounting in switchgears located in non AC rooms. 4. Galvanic isolation between field connection and relay hardware should be there.
13.	Watchdog and self monitoring	<p>The relay should have facility to monitor the healthiness of its circuits and components by own monitoring system. In case of any problems, the alarm should be generated by one of the output contacts. The alarm as soft signal to be sent to SCADA system as well. Necessary support</p>
		<p>documentation explaining the self diagnostic feature shall be furnished Watch dog contact shall be provided</p>

		in addition to required 7BI and 7 BO.
14.	Settings	<p>Approximate settings possible should be as follows:-</p> <ol style="list-style-type: none"> 1. Nominal Feeder current 2% to 110 % 2. CT Ratio setting 10-1000(approx.) 3. Earth fault current 5 to 40% with time delay IEC Curves, 2nd stage for instantaneous trip(less than 50 ms) 4. Over current trip- 50% to 200% of 1/5 Amp with time delay as per IEC Curves. 5. High set with delay 200% to 2000% 6. IEC Curves for all O/C and E/F have user selectable.
15.	Output Relays	<p>Minimum 7 number output relays are required out of which</p> <ol style="list-style-type: none"> 1. One potential free change over contact should be provided for start inhibit of relay. 2. All o/p contact should be freely programmable. 3. Rating of trip contacts:- <ol style="list-style-type: none"> a) Contact durability>10K operation b) 15 Amp make and carry for 3 sec for trip contact c) Make and carry for trip contacts L/R<=40ms Rating of Alarm contacts:- <ol style="list-style-type: none"> a) 8 Amp make and carry continuously for 5 sec. <p>Testing of Output relays through keypad on relay fascia and relay HMI software. Output relay dwell time shall be user programmable or fixed at 100ms.</p>
16.	Relay software and Man Machine Interface	<ol style="list-style-type: none"> 1. The relay should have native IEC 61850 Communication Protocol. 2. Should have password protected key padlock. 3. Necessary software for relay setting , retrieving DR, event log, trip log should be supplied by the Manufacturer. Necessary License is to be issued for EMPLOYER, if required. 4. Manufacturer has to supply communication hardware

		<p>for relay setting, DR downloading from front port. This device should be compatible to USB/Ethernet port.</p> <ol style="list-style-type: none"> 5. It shall be possible to transfer the data stored in the DFR to computer on IEEE/COMTRADE format. The data format shall be compatible for dynamic protection relay testing on relay test kit. COMTRADE data viewing software to be provided. 6. Multiuser/Corporate license for installation on minimum 7 nos. of PCs.
17.	Date and time	<p>Date and Time stamping with faults and record. The clock should be powered from internal cell and should not required setting after every DC switching. The internal cell life minimum 5 years. Time synchronization by IRIG-B or SNTP. For time synchronization through SNTP is to be provided from clock signal coming from RTU. In case of IRIG-B, time synchronization will be done with GPS clock signal from GPS receiver located at substation.</p>
18.	Lugs and terminators	<p>All CT and PT terminals shall be provided as fixed (screwed) type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. Necessary amount of lugs should be supplied along with each relay for CT connection and control wiring.</p>
19.	Manuals, Drawings and Literature	<ol style="list-style-type: none"> 1. The relays should be supplied with manuals with all technical and operating instructions. 2. All the internal drawings indicating the logics and block diagram details explaining principle of operation should be given at the time of supply. 3. Mapping details shall be submitted in IEC format.
20.	Standard documentation per Relay, according to IEC 61850	<ol style="list-style-type: none"> 1. MICS document (model implementation conformance statement) 2. PICS(protocol implementation conformance statement) 3. Conformance Test certificate from KEMA/CPRI. 4. PIXIT document <p>All the above mentioned certificates shall be submitted.</p> <ol style="list-style-type: none"> 5. ICD file

		6. SCD file
21.	Extendibility in Future	The Manufacturer shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SCADA by the User. These software tools shall be able to configure relay, add analog variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipments which shall be added in future.
22.	Lifespan	The supplier should mention following:- <ol style="list-style-type: none"> 1. Product maturity: The Manufacturer should mention the time period for which the product is in the market 2. Expected production life 3. Hardware/Firmware change notification process. Upgrades to be provided free of cost within the Guarantee period/5 years whichever is later, if needed. 4. Lifespan of standard tools and processes for relay configuration, querying and integration.
23.	Standards	The relay should conform to the IEC255-5 or equivalent BS / ANSI for following:- <ol style="list-style-type: none"> 1. Overload withstand test 2. Dielectric withstand: 2kV in common, 1 kV in differential mode 3. Impulse Voltage: 5kV in common, 1kV in differential mode 4. Insulation resistance >100 M-ohm. 5. Vibration: Shock and bump and Seismic 6. Storing and transportation 7. Radio Interference: IEC 61000 for high frequency disturbance, Transient disturbance, Electrostatic discharge 8. KEMA Certification for the particular model offered with respect to IEC61850 Protocol.
24.	Communication Port	<ol style="list-style-type: none"> 1. Two nos. IEC 61850 protocol compliant Ethernet RJ45/F.O port for communication with SCADA system through two managed Ethernet Switches operating in

		<p>redundant mode. The communication shall be made in 1+1 mode between individual IED to Switch, such that failure of one set of LAN shall not affect the normal operation of SCADA. However, it shall be alarmed in SCADA.</p> <ol style="list-style-type: none"> 2. Functioning of Relay shall not hamper to fault occurring any interconnected relay. 3. One Front port Ethernet RJ45/USB 2.0 for relay parameterization and configuration etc. with the help of PC. In case RS-232 port offered, suitable interfacing cable with one end having RS 232 port and other end USB 2.0 to be provided to connect with PC free of cost. 4. Relay should generate GOOSE message as per IEC 61850 standard for interlocking and also ensure interoperability with third party relays.
25.	Name Plate and marking	Each IED shall be clearly marked with manufacturer's Name, type, serial no. and electrical rating data. Name plates shall be made of anodized aluminium with white engraving on black surface.
26.	Performance Guarantee	Relays will be guaranteed for the period of five years from the date of last dispatch. Any problem in the said period should be attended free of charge inclusive of repair/replacement of relays/ component (both H/W, S/W).
27.	Type Test	<input type="checkbox"/> Dielectric Withstand Test—IEC 60255-5 <input type="checkbox"/> High Voltage Impulse Test, class III --- IEC 60255-5(5kV peak, 1.2/50
		<p>micro Sec;3 Positive and 3 negative shots at interval of 5 Sec.)</p> <input type="checkbox"/> DC Supply Interruption ----- EC 60255-11 <input type="checkbox"/> AC Ripple on DC supply----- EC 60255-11 <input type="checkbox"/> Voltage Dips and Short Interruptions----- IEC 61000-4-11 <input type="checkbox"/> High frequency Disturbance ---- IEC 60255-22-1, Class III <input type="checkbox"/> Fast Transient Disturbance ---- IEC 60255-22-4, Class-IV

		<p><input type="checkbox"/> Surge withstand capability-----IEEE/ANSI C 37.90.1(1989)</p> <p><input type="checkbox"/> Degree of Protection</p> <p><input type="checkbox"/> Electromagnetic compatibility</p> <p><input type="checkbox"/> Mechanical stress/vibration test</p> <p><input type="checkbox"/> Temperature withstand</p> <p>Type test reports for the above tests shall be submitted for the approval of EMPLOYER along with Tender, failing which order may be rejected. Wherever the above mentioned standards and IEC 61850 overlap, the latter will prevail.</p>
28.	Training	<p>Suitable training to be imparted to employer persons on the following items:-</p> <ol style="list-style-type: none"> 1. Relay setting and parameterization 2. Relay configuration with respect to I/P, O/P and functional block for protection. 3. GOOSE configuration. 4. Configuration and Interfacing required for third party SCADA System Integration. 5. Diagnostic features <p>The details of syllabus to be finalized with EMPLOYER.</p>
29.	Service Charge for Commissioning Engineer	<p>Firm rate shall be quoted separately for commissioning and integration of Relay with SCADA as per format. This rate shall be valid for three years from due date of submission of tender. However, the above cost will not be considered for evaluation.</p>

Inter-operability test:-

After fulfilment of the above Q.R. inter-operability test of the offered relay (other than Make & Model used in EMPLOYER) with the existing relay in EMPLOYER Network will be tested in EMPLOYER Distribution Testing Department, EMPLOYER for which due intimation for supply of sampled of offered relay will be given to the Manufacturer. The Manufacturer needs to submit the said relay to Distribution Testing Department, EMPLOYER within one week from the said intimation.

The offered relay will only be accepted after fulfilment of above Q.R. & successful inter-operability test at EMPLOYER system.

Checklist for Bill of Material for supply

Sl. No.	Material	
1.	Relay (Model No.)	Qty as per Tender
2.	Lugs suitable for current and control, wiring	Qty as per Tender X Number of TBs in relay + 20% extra.
3.	Cable for connection of Relay to laptop(USB port). Along with converter and power supply if required for relay local setting	10 set
4.	Manual, Hard copy in good quality paper properly bounded	10 set
5.	Copy of Type Test certificate along with manual	With offer
6.	Basic application software for setting change,	10 nos.
7.	CD with software(licensed) to download disturbance recorder, event log and evaluation of those records	10 nos.
8.	Graphical configuration tool for I/P, O/P and functional building block for	10 nos.

	protection	
9.	Any other software required for integration with SCADA.	10 nos.

N.B All the above tools/ Software should be compatible to WINDOWS XP/WINDOWS NT/WINDOWS 7 Operating System.

ANNEXURE-II

Technical specification for IEC 61850 compliant Directional O/C and E/F Relay with Bay control features

Sl. No	Feature and Function	Technical requirement
1	Purpose and application	<p>It is intended to automate the Switchgears specified in the scope of supply and use Communicable Numeric relays for Protection Control, Metering and Status monitoring. This specification is based on the understanding that an integrated Automation System along with protections shall be provided and same shall have provisions for Integration with SCADA system. All the feeders shall be remote controlled from EMPLOYER'S SCADA and from the local console of the numerical relays.</p> <p>Numerical multifunctional combined Microprocessor based Feeder protection and management relay to protect the 33 kV Parallel Feeder from all electrical and other faults along with reporting system, Disturbance record for fault analysis. Manufacturer should comply with any special requirement or feature asked for retrofitting the relays. Relay should be IEC 61850 compliant. Relay should have 4 CT input, 3 input for O/C and residual E/F protection will be derived internally. One CT input may be used for unbalanced current protection. Relay should have 4 voltage input, 3 input for VT element for directional O/C protection with internally derived residual voltage for E/F protection. Another VT input will be used for residual voltage protection. Relay should have two stage over voltage and under voltage protection.</p>
2	Main Protection Feature for directional O/C & E/F relay.	<ol style="list-style-type: none"> 1. Electrical over load protection with selectable IEC curves with two stage, first stage to be used as Definite Time / IDMT and second stage to be used as high set for short circuit protection. 2. Earth fault protection in two stages with IEC characteristics. First stage to be used as IDMT/Definite Time and second stage to be used as instantaneous elements. Earth fault element should be

		<p>suitable for both CBCT and residual type CT connection.</p> <p>3. Negative phase sequence Protection with IEC Curves.</p> <p>4. CB Fail Protection & time settable as per user.</p> <p>5. The relay should be immune to DC switching while carrying</p>
		<p>current i.e. no spurious trip should be generated if relay DC is made On and Off</p> <p>6. The relay should conform to the IEC255-4 or BS 142 for Inverse time characteristics.</p> <p>7. VT fuse fail detection on NPS current/NPS Voltage or zero sequence current/voltage based logic and blocking of undervoltage protection by VT fuse fail detection.</p> <p>8. Three phase VT fuses fail detection on current based logic.</p> <p>9. The relay should have features to monitor for broken conductor and CB opening time.</p> <p>10. The relay shall be designed for application in EMPLOYER's distribution network where the system is non effectively earthed through earthing transformer emanating a 33kV bus of 132/33 kV substation.</p> <p>11. Relay should have minimum two group of setting. Setting group changeover required from digital status input.</p>
3.	Processor feature	<p>Relay shall be completely Numerical with protective elements having software algorithm based on sampling of analog inputs. Sampling Rate of Analog Signal: The sampling rate should be 1000 Hz for 50 Hz signal or better for each analog channel. Hardware based measurements shall not be acceptable.</p>
4.	Operational Philosophy	<p>The operation of Relay shall be possible from both locally from the Switchgear and remote and Local Work station. The local position shall be displayed in remote / local workstation and remote operation shall be blocked if the switch is in Local. Clear control priorities shall prevent initiation of operation of a single switch at the same time from more than one of the various control levels and there shall be interlocks among various control levels. The priority shall always be with the lowest enabled control level. Relay accuracy shall not be affected by system frequency fluctuation.</p>

<p>5.</p>	<p>Status/Optical Inputs/Digital inputs</p>	<ol style="list-style-type: none"> 1. Minimum 7 number status inputs are required 2. All status inputs should be 30 V DC/110 V DC (will be mentioned during detailed Engineering as per requirement) 3. Setting group is required to be changed with any Digital input status. 4. Trip circuit supervision with DI status 5. The digital inputs shall be acquired by exception with 1ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state. 6. Relay should have comprehensive self diagnostic feature with remote indication of relay failure and alarm shall be generated without tripping of circuit 7. Provision of Testing output relays without any current injection. 8. No. of programmable LEDs- at least 4 nos. with latching option.
<p>6.</p>	<p>Main measuring and reporting feature</p>	<p>All measurements should be in primary quantities. Minimum following displays are required in alpha numeric:-</p> <ol style="list-style-type: none"> 1. Three phase (Positive sequence) current, Three phase voltage 2. Neutral (zero sequence) current, MW, MVAR, Frequency, Pf, MVA etc. 3. All the trips should have clear indication on the relay terminals 4. Resetting should be selectable as hand reset or auto reset.
<p>7.</p>	<p>Memory Recording Feature and</p>	<ol style="list-style-type: none"> 1. The relay setting and programming should be stored in EEPROM so that during Aux. Power failure the said data is not lost. 2. Relay should have event log, trip log and DR record. All logs should go in to history. 3. All tripping of relay should initiate DR in auto without extra binary input. Triggering of DR with binary input should be user configurable. 4. The last 2 fault DR records should be in flash memory and DR will not erase in case of DC supply fail for more than 2 days. 5. Should be able to record at least 5 Oscillographic

		<p>disturbances and 5 fault records and 250 event records.</p> <p>6. Minimum Four no. of latest trip log with cause of trip should be stored in memory along with date and time stamping. The memory should not be lost with the switching off of DC.</p> <p>7. The relay should have fault-recording feature with current waveform and Digital Input status. The fault waveform should consist of minimum four current waveforms of three phase current and zero sequence current and DI status. Triggering time for Pre and Post should have user selectable. This record should be in flash memory for minimum 7 days even after switching off the DC supply.</p> <p>8. The fault should be date and time stamped.</p> <p>9. Communication protocol IEC 61850.</p>
8.	Auxiliary Supply	<p>30 V or 110 VDC (will be mentioned during detailed Engineering as per requirement) to - 25% to + 10%, 2 wire unearthed system. Necessary software shall be in-built for proper shutdown and restart in case of power failure. Auxiliary supply burden will be around 20Watt.</p>
9.	Rated secondary CT/PT	<p>5/1 Amp(site selectable) , CTs used to be protection class.</p> <p>3PT input rated 110 Volt (L-L)</p>
10.	Rated frequency	<p>50 HZ +/- 5%</p>
11.	Ambient condition	<p>1. Operating ambient temperature up to 55 Deg C</p> <p>2. Operating Humidity up to 100 %</p> <p>3. Relay shall meet the requirement for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.</p>
12.	Module and Mounting	<p>1. Relay should be flush mounted type</p> <p>2. If module is draw out type then it should have CT shorting facility of make before break type.</p> <p>3. Mounting in switchgears located in non AC rooms.</p> <p>4. Galvanic isolation between field connection and relay hardware should be there.</p>
13.	Watchdog and self monitoring	<p>The relay should have facility to monitor the healthiness of its circuits</p>

		and components by own monitoring system. In case of any problems, the alarm should be generated by one of the output contacts. The alarm as soft signal to be sent to SCADA system as well. Necessary support documentation explaining the self diagnostic feature shall be furnished. Watch dog contact shall be provided in addition to required 7BI and 7 BO.
14.	Settings	<p>Approximate settings possible should be as follows:-</p> <ol style="list-style-type: none"> 1. Nominal Feeder current 2% to 110 % 2. CT Ratio setting 10-1000(approx.) 3. Earth fault current 5 to 40% with time delay IEC Curves, 2nd stage for instantaneous trip(less than 50 ms) 4. Over current trip- 50% to 200% of 1/5 Amp with time delays as per IEC Curves. 5. High set with delay 200% to 2000% 6. IEC Curves for all O/C and E/F have user selectable. 7. Selectable MTA for Directional features for O/C relay should cover 1st quadrant for effectively grounded system/ impedance grounded system/solid grounded system.
15.	Output Relays	<p>Minimum 7 number output relays are required out of which</p> <ol style="list-style-type: none"> 1. One potential free change over contact should be provided for start inhibit of relay. 2. All o/p contact should be freely programmable. 3. Rating of trip contacts:- <ol style="list-style-type: none"> a) Contact durability>10K operation b) 15 Amp make and carry for 3 sec for trip contact c) Make and carry for trip contacts L/R<=40ms Rating of Alarm contacts:- d) 8 Amp make and carry continuously for 5 sec. <p>Testing of Output relays through keypad on relay fascia and relay HMI software. Output relay dwell time shall be user programmable or fixed at 100ms.</p>
16.	Relay software and Man Machine	<ol style="list-style-type: none"> 1. The relay should have native IEC 61850 Communication

	Interface	<p>Protocol.</p> <ol style="list-style-type: none"> 2. Should have password protected key padlock. 3. Necessary software for relay setting, retrieving DR, event log, trip log, and downloading waveform should be supplied by the Manufacturer. Necessary Licensed is to be issued for EMPLOYER, if required. 4. Manufacturer has to supply communication hardware for relay setting, DR downloading from front port. This device should be compatible to USB/Ethernet port. 5. It shall be possible to transfer the data stored in the DFR to computer on IEEE/COMTRADE format. The data format should be compatible for dynamic protection relay testing on relay test kit. COMTRADE Data viewer software is to be provided. 6. Multiuser/Corporate license for installation on minimum 7 nos. of PCs.
17.	Date and time	<p>Date and Time stamping with faults and record. The clock should be powered from internal cell and should not required setting after every DC switching. The internal cell life minimum 5 year Time synchronization by IRIG-B or SNTP. For time synchronization through SNTP is to be provided from clock signal coming from RTU. In case of IRIG-B, time synchronization will be done with GPS clock signal from GPS receiver located at substation.</p>
18.	Lugs and terminators	<p>All CT and PT terminals shall be provided as fixed (screwed) type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. Necessary amount of lugs should be supplied along with each relay for CT connection and control wiring.</p>
19.	Manuals, Drawings and Literature	<ol style="list-style-type: none"> 1. The relays should be supplied with manuals with all technical and operating instructions. 2. All the internal drawings indicating the logics and block diagram details explaining principle of operation should be given at the time of supply.

		3. Mapping details shall be submitted in IEC format.
20.	Standard documentation per Relay, according to IEC 61850	<ol style="list-style-type: none"> 1. MICS document (model implementation conformance statement) 2. PICS(protocol implementation conformance statement) 3. Conformance Test certificate from KEMA/CPRI. 4. PIXIT document <p>All the above mentioned certificates shall be submitted along with Order copy</p> <ol style="list-style-type: none"> 5. ICD file 6. SCD file
21.	Extendibility in Future	The Manufacturer shall provide all necessary software tool along with source codes to perform addition of bays in future and complete integration with SCADA by the User. These software tools shall be able to configure relay, add analog variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipments which shall be added in future.
22.	Lifespan	<p>The supplier should mention following:-</p> <ol style="list-style-type: none"> 1. Product maturity: The Manufacturer should mention the time period for which the product is in the market 2. Expected production life 3. Hardware/Firmware change notification process. Upgrades to be provided free of cost within the Guarantee period/5 year whichever is later, if needed. 4. Lifespan of standard tools and processes for relay configuration, querying and integration.
23.	Standards	<p>The relay should conform to the IEC255-5 or equivalent BS / ANSI for following:-</p> <ol style="list-style-type: none"> 1. Overload withstand test 2. Dielectric withstand: 2kV in common, 1 kV in differential mode 3. Impulse Voltage: 5kV in common, 1kV in differential mode 4. Insulation resistance>100 M ohm 5. Vibration: Shock and bump and Seismic 6. Storing and transportation

		<p>7. Radio Interference: IEC 61000 for high frequency disturbance, Transient disturbance, Electrostatic discharge</p> <p>8. KEMA/CPRI Certification for the particular model offered with respect to IEC61850 Protocol</p>
24.	Communication Port	<p>1. Two nos. IEC 61850 protocol compliant Ethernet RJ45/F.O port for communication with SCADA system through two managed Ethernet Switches operating in redundant mode. The communication shall be made in 1+1 mode between individual IED to Switch, such that failure of one set of LAN shall not affect the normal operation of SCADA. However, it shall be alarmed in SCADA.</p> <p>2. Functioning of Relay shall not hamper to fault occurring any interconnected relay.</p> <p>3. One Front port Ethernet RJ45/USB 2.0 for relay parameterization and configuration etc. with the help of PC. In case RS-232 port offered, suitable interfacing cable with one end having RS 232 port and other end USB 2.0 to be provided to connect with PC free of cost.</p> <p>4. Relay should generate GOOSE message as per IEC 61850 standard for interlocking and also ensure interoperability with third party relays.</p>
25.	Name Plate and marking	<p>Each IED shall be clearly marked with manufacturer's Name, type, serial no. and electrical rating data. Name plates shall be made of anodized aluminium with white engraving on black surface.</p>
26.	Performance Guarantee	<p>Relays will be guaranteed for the period of five years from the date of last dispatch.</p> <p>Any problem in the said period should be attended free of charge inclusive of repair/replacement of relays/ component (both H/W, S/W).</p>
27.	Type Test	<ul style="list-style-type: none"> <input type="checkbox"/> Dielectric Withstand Test—IEC 60255-5 <input type="checkbox"/> High Voltage Impulse Test, class III --- IEC 60255-5(5kV peak, 1.2/50 micro Sec;3 Positive and 3 negative shots at interval of 5 Sec.) <input type="checkbox"/> DC Supply Interruption EC 60255-11 <input type="checkbox"/> AC Ripple on DC supply EC 60255-11

		<ul style="list-style-type: none"> <input type="checkbox"/> Voltage Dips and Short Interruptions --- IEC 61000-4-11 <input type="checkbox"/> High frequency Disturbance----- IEC 60255-22-1, Class III <input type="checkbox"/> Fast Transient Disturbance ---- IEC 60255-22-4, Class-IV <input type="checkbox"/> Surge withstand capability ---- IEEE/ANSI C 37.90.1(1989) <input type="checkbox"/> Degree of Protection <input type="checkbox"/> Electromagnetic compatibility <input type="checkbox"/> Mechanical stress/vibration test <input type="checkbox"/> Temperature withstand <p>Type test reports for the above tests shall be submitted for the approval of EMPLOYER along with Tender. Wherever the above mentioned standards and IEC 61850 overlap, the latter will prevail.</p>
28.	Training	<p>Suitable training to be imparted to employer’s persons on the following items:-</p> <ol style="list-style-type: none"> 1. Relay setting and parameterization 2. Relay configuration with respect to I/P, O/P and functional block for protection. 3. GOOSE configuration. 4. Configuration and Interfacing required for third party SCADA System Integration. 5. Diagnostic features
29.	Service Charge for Commissioning Engineer	<p>Firm rate shall be quoted separately for commissioning and integration of Relay with SCADA as per format. This rate shall be valid for three years from due date of submission of tender. However, the above cost will not be considered for evaluation.</p>
30.	Credential as pre-requisite of Tender	<ol style="list-style-type: none"> 1. Copies of performance certificate for two years successful operation as on the due date of bid opening for the offered relay in respect to implementation of IEC 61850 protocol to any SCADA/substation automation system from reputed Power Sector Utility in India shall have to be furnished along with the Bid. Copies of Purchase Orders and corresponding Delivery Challans /Stores Receipt vouchers/ Excise Duty Invoice, etc., i.e Proof of Execution of the Purchase Orders. <p>OR</p>

		<p>Successful testing and operation of minimum one year in EMPLOYER network..</p> <p>2. Documentary evidence for being manufacturers like registration Certificate issued by SSI/NSIC/Directorate of Industries/DGS&D, etc. for Qualifying requirement.</p> <p>3. The manufacturer should have testing facilities of all functional tests or should have arrangement of all functional tests at government approved testing laboratories.</p> <p><u>Inter-operability test:-</u></p> <p>After fulfilment of the above Q.R. inter-operability test of the offered relay (other than Make & Model used in EMPLOYER) with the existing relay in EMPLOYER Network will be tested in EMPLOYER Distribution Testing Department, EMPLOYER for which due intimation for supply of sampled of offered relay will be given to the Manufacturer. The Manufacturer needs to submit the said relay to Distribution Testing Department, EMPLOYER within one week from the said intimation.</p>
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Checklist for Bill of Material for supply

Sl. No.	Material	
1.	Relay (Model No.)	Qty as per Tender
2.	Lugs suitable for current and control, wiring	Qty as per Tender X Number of TBs in relay + 20% extra.
3.	Cable for connection of Relay to laptop(USB port). Along with converter and power supply if required for relay local setting	10 set
4.	Manual, Hard copy in good quality paper properly bounded	10 set
5.	Copy of Type Test certificate along with manual	With offer
6.	Basic application software for setting change,	10 nos.
7.	CD with software(licensed) to download disturbance recorder, event log and evaluation of those records	10 nos.
8.	Graphical configuration tool for I/P, O/P and functional building block for protection	10 nos.
9.	Any other software required for integration with SCADA.	10 nos.

N.B All the above tools/ Software should be compatible to WINDOWS XP/WINDOWS NT/WINDOWS 7 Operating System.

QUALITY ASSURANCE PLAN (Annexure-III)

The manufacturer shall invariably furnish following information along with his offer.

(1) Statement giving list of important raw materials including but not limited to

- (a) Contact material
- (b) Insulation
- (c) Sealing material
- (d) Contactor, limit switches, etc. in control cabinet.

Name of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Manufacturer's representative, copies of test certificates.

2) Information and copies of test certificates as in (i) above in respect of bought out accessories.

3) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

4) Special features provided in the equipment to make it maintenance free.

5) List of testing equipment available with the Manufacturer for final testing and associated combinations vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the relevant schedule i.e. schedule of deviations from specified test requirements. The supplier shall, within 15 days from the date of receipt of Purchase Order submit following information to the EMPLOYER :-

- i) List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- ii) Necessary test certificates of the raw material and bought out accessories.

iii) Quality Assurance Plan (QAP) with hold points for EMPLOYER's inspection. The quality assurance plan and hold points shall be discussed between the EMPLOYER and supplier before the QAP is finalized.

iv) The supplier shall submit the routine test certificates of bought out items and raw material, at the time of routine testing of the fully assembled Panel.

14. Batteries and Charger

Lead Acid or Ni-Cd, any one of these two can be used by contractor. Both the specification along with specification for their charger are given below:

I. Ni-Cd ALKALINE BATTERIES (PARTIAL RECOMBINATION TYPE) WITH CHARGERS FOR 33/11 kV AND 66/11 kV SUB-STATIONS

Part-A :Ni-Cd ALKALINE BATTERIES (PARTIAL RECOMBINATION TYPE) FOR 33/11 kV AND 66/11 kV SUB-STATIONS

1) SCOPE

This specification covers the requirements and tests for 24 V, 30 V 110 V, 220V partial recombination type Nickel-Cadmium alkaline batteries with chargers, for use in 33/11 kV and 66/11 kV sub-stations.

The batteries covered in this specification are for indoor use. For out-door application a suitable enclosure shall be provided, preferably made of an insulating material like FRP/SMC/DMC/Poly carbonate plastic material, heat/alkali/humidity/UV resistant, confirming to S1 or D1 grade of IS: 13410/IS: 13411 or other relevant international standard, in order to have rust free enclosure. The enclosure shall have rainproof ventilating louvers backed with fine brass wire mesh & suitable canopy. The enclosures shall confirm to IP: 52 degree of protection.

2. APPLICABLE STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. Unless otherwise modified in this specification, the Ni-Cd batteries shall comply with latest version of IEC 62259.

All work shall be carried out as per the following standards and codes.

Sl .No.	Internation al Standards	Indian Standar ds	Description

Sl .No.	International Standards	Indian Standards	Description
1	IEC: 62259	-	Secondary cells and batteries containing alkaline or other non-acid electrolytes-Nickel-cadmium prismatic secondary single cells with partial gas recombination
2	IEC: 60623	IS: 10918	Secondary cells and batteries containing alkaline or other non-acid electrolytes-vented Nickel_Cadmium prismatic rechargeable single cells
3		IS: 1146	Rubber & Plastic container for lead acid storage batteries
4	IEEE: 1106		Recommended practice for maintenance, testing & replacement of Ni-Cd storage batteries for generating stations & Substations
5	IEEE: 1115		Recommended practice for sizing of Ni-Cd batteries for stationary applications
6		IS 13410	Glass reinforced Polyester sheet moulding compounds.
7		IS: 1248	Voltmeter

3. STANDARD RATING

The recommended voltage ratings of batteries, for use at 33/11 KV and 66/11 KV sub-stations, shall be 24 volts or 30 volts. The batteries for the above application shall

have a rating of 45 Ah (Minimum) in case of 24 V battery system or as per the load requirement of the substation.

Note: Utilities may specify 110 or 220 V DC system if so required. For batteries intended for use with individual or groups of breakers or with higher DC System voltage, lower Ah ratings can be used depending upon the requirements.

4. CELL VOLTAGE

The nominal voltage of a single cell shall be 1.2 V

Nominal Voltage Rating of battery	Nominal single cell voltage	Float cell voltage	Number of cells (to be finalized)	Permissible D.C. System voltage variation	End of discharge cell voltage (Min.)
(V)	(V)	(V)	(V)	(V)	(V)
24	1.2	1.4 to 1.42	19	21.7 to 27	1.14
30	1.2	1.4 to 1.42	23	26.2 to 32.7	1.14
110	1.2	1.4 to 1.42	87	99.2 to 123.5	1.14
220	1.2	1.4 to 1.42	170	193.8 to 241.4	1.14

Note: As the nominal cell voltage is 1.2 V, nominal battery bank voltage may not exactly match nominal DC system voltage.

5. CAPACITY AT 20°C TEMPERATURE

Battery capacity shall be decided based on the following load cycle:-

- (a) 800W for 1/2 minute to end cell voltage of not less than 1.14 V per cell considering loads (i) to (iv) below.
- (b) 300 W for 1 hour to end cell voltage of not less than 1.14 V per cell considering loads (iii) & (iv) below.
- (c) 100W for 05 hrs to end cell voltage of not less than 1.14 V per cell considering loads (iv) below.

The load cycle has been decided based on the following considerations:-

- (i) Tripping of 03 Nos. circuit breakers simultaneously with battery for which a total load of 500 W has been considered.
- (ii) Closing of 3 circuit breakers one after the other for which a load of 500 W per circuit breaker has been considered.
- (iii) Emergency lighting load of 200 W for 01 hour.

- (iv) 100 W load for panel indication lamps, relays, PLCC/ VHF communication systems, computer etc. for a period of 06 hours.

6. BATTERY SIZING

The supplier shall carry out battery sizing calculations based on the load cycle specified in line with IEEE 1115 and submit the same to the owner justifying the type/number of cells considered against the requirement.

Following factors shall be considered while carrying-out battery sizing calculations:-

- a) Ageing factor – 1.25
- b) Design margin –1.0
- c) State of charge –0.9

The number of cells shall be determined as per load cycle and the battery system voltage level. The owner, if required for the battery system, may specify provision for the number of spare cells.

7. CONSTRUCTION

The cells shall have prismatic, spill-proof type of construction with partial recombination feature. The cells shall be flooded type containing sufficient reserve electrolyte. Battery shall be equipped with nickel-plated inter-cell connectors and terminals. The cells shall be housed in high-strength impact resistant & alkali-resistant containers and should be transparent / translucent to facilitate checking of electrolyte level. Container and Lid should be welded and should not cause leakage of electrolyte/gases during operation even in case of normal mechanical/electrical abuses. O-rings of nitrile rubber with Epoxy sealing shall be used to ensure proper sealing of bushings etc. Flip-top vent plugs/ valves with flame arrester feature shall be provided. The regulating valve type design shall be of self-resealing type. Construction of cells shall be so as to ensure proper air circulation between the cells for heat dissipation/ ventilation (by providing either insulated button separators integral with the outer surface of the cell container or by suitably designing the inter cell connectors). The containers shall be strong enough, so that excessive bulging of container does not occur during service. Cells shall be supplied in filled & charged state or otherwise electrolyte in dry form & battery water separately or electrolyte in liquid form shall be shipped as desired by the owner.

Battery shall have provision for water top up to ensure electrolyte level does not fall below recommended level.

8. ELECTRODES

Electrodes shall be deigned for maximum durability under all service conditions. + ve and –ve electrodes shall be made by encapsulating/impregnating active material in order to ensure that the battery is able to perform reliably over its life. +ve and –ve electrodes shall be separated by micro porous separators. The structure of electrodes shall be elastic enough to absorb mechanical stresses & volume changes during charge/discharge cycles.

9. ELECTROLYTE

The electrolyte shall be prepared from battery grade potassium hydroxide (KOH) confirming to IEC 60993. The cells shall contain sufficient reserve electrolyte for efficient heat dissipation &to reduce water topping up interval. Reserve electrolyte shall not be less than 06 ml/Ah.

10. CONNECTORS

Nickel-plated copper inter-cell connectors shall be used forconnecting up adjacent cells and rows. Bolts, nuts and washers shall be nickel-plated steel/stainless steel. All terminals and cell inter-connectors shall be fully insulated or have insulation shrouds.

11. TERMINALS

Separate terminals shall be provided on the end cell for connecting load through DCDB and for connecting charger leads. All terminals shall be of suitably sized nickel-plated steel. Suitable nickel-plated copper lugs shall be provided by the supplier for use of the purchaser for connecting up the load wiring. All connectors and leadsshall be suitable for carrying 30-minute discharge current continuously and rated for short circuit duty of 4kA for 01 second.

12. MANUAL OF INSTRUCTIONS

The manufacturer shall supply a copy of the instruction manual for commissioning & initial treatment of the battery and maintenance during service with every battery bank ordered.

13. RECOMBINATION EFFICIENCY

In order to reduce topping-up frequency, recombination of Hydrogen & Oxygen gases evolved during charging/discharging shall be achieved by using safe and reliable technology such as catalytic conversion/valve regulation technique or both. Minimum recombination efficiency shall be 80%. Recombination efficiency test shall be done in

accordance with IEC 62259. In case the batteries are operated at high temperatures & are frequently boost charged the water consumption may be higher & topping-up frequency may increase.

14. BATTERY RACKS

Suitable corrosion resistant battery racks and cable supports shall be provided. Metallic racks shall be properly earthed. The bottom tier of stand shall have a ground clearance of 150mm minimum above the floor. Racks shall be made of alkali resistant powder coated steel or stainless steel or FRP to ensure corrosion resistance.

15. TEMPERATURE RANGE

Battery must be capable of continuous operation in temperatures range of -15°C to +50°C for prolonged periods. No Air-conditioning shall be provided where batteries are to be installed.

16. ACCESSORIES

The following accessories (BIS certified) shall be supplied with each set of battery:-

- i) Clamp-on type digital multi-meter of AC/DC current range having ISI mark.
- ii) Pair of gloves
- iii) 10" Slide insulated wrench for opening terminal nuts
- iv) Plastic/glass syringe
- v) Alcohol thermometer
- vi) Hydrometer for use while filling electrolyte.

17. CHARGE RATE

Fully discharged batteries should be able to get recharged in 7 hours maximum to 90% of capacity with charging current in the range of 0.1 to 0.4CmA rate at 20°C. At higher temperatures, the charging time may be more. The trickle charge rate shall be 1-2 mA/Ah.

18. CELL DESIGNATION

The practice as per IS: 10918 (latest version) shall be followed.

19. POLARITY MARKING

The polarity of the terminals shall be marked for identification. Positive terminal may be identified by 'P' or a (+) sign or red colour mark and negative terminal may be

identified by 'N' or (-) sign or blue colour mark. Marking shall be permanent and non-deteriorating.

20. WARNING MARKING

The battery shall be furnished with a warning plate located at conspicuous place specifying the use of 'ALKALINE ELECTROLYTE ONLY' (in block letters) and specifying proper filling level of the electrolyte. Marking shall be permanent and non-deteriorating.

21. PACKING

The batteries shall be securely packed in wooden crates suitable for handling during transit by rail/road and secured to avoid any loss or damage during transit. Carton boxes duly palletized shall also be acceptable.

22. TESTS

The batteries shall be tested for type, acceptance and routine tests in line with IS: 10918 & IEC: 62259 (latest versions). The owner may at their discretion to accept the batteries based on type tests already carried-out. In such cases, Type test reports for tests carried out not earlier than 05 years from bid opening date from NABL accredited labs shall be acceptable.

Note : In case Type tests are repeated, life cycle test may not be insisted upon Ni-Cd battery of the specific ratings to be ordered, as this test takes a long time (2-3 years). However, satisfactory evidence is to be furnished for having made this test on cell of any other Ah capacity of the same design.

23. BUYBACK OF USED/UNSERVICEABLE BATTERIES

Manufacturer shall buyback used/unserviceable batteries from the substations where batteries are replaced. The owner shall confirm the following particulars of used/unserviceable batteries to enable the bidder to quote buyback rates:

- i) Type & number of cells for disposal
- ii) Make
- iii) Year of make/purchase
- iv) Capacity
- v) Condition of cells

The bidder should quote their rates for buyback considering the salvage value of the above cells.

24. SAFE DISPOSAL OF UNSERVICEABLE BATTERIES

The bidder shall have facilities for proper treatment & disposal of used/unserviceable batteries that are bought back from the users, in line with the environmental protection rules & regulations of the country.

25. GUARANTEE

The batteries shall be guaranteed for a period of 36 months from the date of commissioning.

Part B : CHARGER FOR Ni-Cd BATTERY (RECOMBINATION TYPE)

1. SCOPE

This specification covers the requirements and tests for Battery charger for partial recombination type Nickel-Cadmium alkaline batteries for use in 33/11 KV and 66/11 KV sub-stations.

2. CODES AND STANDARDS

2.1. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.

2.2.

Sl. No	International standards	Indian standards	Description
1		IS:5	Colours for ready mix paints.
2		IS : 1248	Direct acting indicating analogue electrical measuring instruments.
3	IEC : 947-1	IS : 13947 Prt-1	Low voltage switchgear and control gear - General.
4	IEC : 947-2	IS : 13947 Prt.-2	Low voltage switchgear and

Sl. No	International standards	Indian standards	Description
			control gear - Circuit Breaker
5	IEC : 947-3	IS : 13947 Prt-3	Specification for low voltage switchgear and control gear – Switches, Disconnectors, Switch disconnectors & Fuse combination units.
6	IEC : 947-4	IS : 13947 Prt-4	Specification for low voltage switchgear and control gear – Contactors
7		IS : 13947 Prt-5	Specification for low voltage switchgear and control gear – Control Circuit Devices & Switching Elements
8	IEC: 439	IS:8623	Low voltage switch-gear and control-gear assemblies
9		IS:8686	Static protective relays
10	IEC:225	IS : 3231	Electrical relays for power system protection.
11		IS : 3842	Application guide for Electrical relays for AC System
12	IEC 146	IS : 3895	Mono-crystalline semi-conductor Rectifier Cells and Stacks.
13	IEC 146	IS : 4540	Mono crystalline semi-conductor Rectifier assemblies and equipment.

Sl. No	International standards	Indian standards	Description
14		IS:6619	Safety Code for Semi-conductor Rectifier Equipment.
15		IS : 9000	Basic environmental testing procedures for electronic and electrical items.
16	IEC: 60269	IS:13703 Prt-4	Low voltage fuses for protection of semiconductor devices.
17		IS:1901	Visual indicating lamps
18		IS:6005	Code of practice for phosphating of Iron and Steel.
19	IEC: 227	IS:694 /IS: 1554	PVC Insulated Cable for working voltages upto and including 1100 V.

2.3. Equipment complying with other internationally accepted standards such as IEC, BS, VDE. etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3. EQUIPMENT DESCRIPTION

3.1. a) The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Float mode, i.e. Float charging the associated Ni-Cd Batteries (partial recombination type) while supplying the D.C. loads. The Batteries shall be Float charged at 1.4 to 1.5 Volts per cell. All chargers shall also be capable of Boost Charging the associated Batteries at 1.42 to 1.7 Volts per cell at the desired rate. The

Chargers shall be designed to operate, as mentioned above, up-to an ambient air temperature of 50°C. Tapping arrangement in the battery bank shall be provided to limit the over-voltage for supplying load within allowed voltage range under boost charge conditions. The charger should automatically switchover to float charge & to boost charge when the specified limit of voltage is approached. However, necessary timer circuit shall be used to allow a finishing charge before switching over to float mode, as recommended by battery manufacturer in order to ensure that battery gets fully charged. Recommended values of charger rating, tapping cell and specified voltages for automatic changeover to float/boost mode are given in table below, however, the manufacturer may suggest any changes in the recommended values with justification at the time of supply :

Rating of Charger	Charger Rating during Float Charging at 1.4 to 1.45 V per cell	Charger Rating during Boost Charging at 1.42 to 1.7 V per cell	Tapping to be provided at ---th cell	Switching Voltage to Boost Mode	Switching Voltage to Float Mode
Volt	Ampere	Ampere	N	Volt	Volt
24	10	25	15	22	32
30	10	25	18	26	38
110	5	5	69	94	146
220	5	5	136	194	285

Note : Charger rating shall be arrived at with charger in boost mode and also supplying 100% float load i.e. charger current shall be sum of float & boost rating.

- b) Battery Chargers shall automatically select the appropriate mode of operation i.e. Float or Boost. Means shall be provided to avoid current/voltage surges of harmful magnitude/nature, which may arise during changeover.

- c) Soft start feature shall be provided to build up the voltage to the set value slowly within fifteen seconds. The chargers shall have load limiters, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall neither damage the Charger nor shall it cause blowing of any of the charger fuses. The Charger shall not trip on overload or external short circuit. After clearance of fault, the Charger voltage shall build up automatically when working in automatic mode.

During external short circuit, output of the charger shall be automatically reduced to near zero volt till it is not isolated/disconnected & normal output voltage shall be restored by charger circuit on isolation with out any harm to source transformer/protection/ regulator circuit

- d) During Float charging, the Charger output voltage shall remain within $\pm 1\%$ of the set value for AC input voltage variation of $230 +10\% -15\%$, frequency variation of $\pm 5\%$, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from 5% to full load. Uniform and stepless adjustments of voltage setting shall be provided on the front of the Charger panel covering the entire Float charging output range specified. Stepless adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Float charging mode.
- e) During Boost charging, the Battery Chargers shall operate on constant current mode with maximum current limiter setting (When automatic regulator is in service).
- f) Energising the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilise, to within the specified limits in clause 3.1 (d), shall be less than five seconds.
- g) Momentary output voltage of the Charger, with the Battery connected shall be within 90% to 110% of the voltage setting during sudden load Change from 80% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified in clause 3.1 (d) in less than 1 second after the above-mentioned change.
- h) The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode, and the load limiter of the float charging mode is also used as Boost charging current setting device.

- i) Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 3% irrespective of the DC load, even when they are not connected to a battery.
- j) The DC System shall be ungrounded and float with respect to the ground potential when healthy.
- k) Battery shall be isolated in case of short circuit on the load side.
- l) Battery test circuit shall be provided with suitable resistance for discharging the battery for 30Sec at 5 hr rate.
- m) All potentiometers shall be electronically locked to contain the various parameters within allowable limits even if the setting position of potentiometers is changed to extreme positions.
- n) Insulation resistance shall be 5 M Ohm min.

3.2. MCB

AC MCCB shall be provided at the incomer. DC MCCB with provision of auxiliary contacts shall be provided at the output of the battery charger.

3.3. Rectifier-Transformers and Chokes

The rectifier transformer and chokes shall be dry and air cooled (AN) type. The rating of the rectifier-transformers and chokes shall correspond to the rating of the associated rectifier assembly. The rectifier-transformers and chokes shall have class-B insulation as per IS : 4540. Rectifier transformer shall conform to all type tests as specified in IS 4540/IS 2026. Type test & routine test reports shall be submitted to the owner.

3.4. Rectifier Assembly

The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger. The rectifier cells shall be provided with their own heat dissipation arrangement with natural air-cooling. The rectifier shall utilise diodes/thyristors with heat sinks rated to carry 130% of the load current continuously and the temperature of the heat sink shall not be permitted to exceed 85°C absolute duly considering the maximum temperature inside charger panel with ambient temperature of 50°C. The Contractor shall submit calculations to show what maximum junction temperature will be and what the heat sink temperature will be

when operating at 130% and 100% load current continuously duly considering the maximum surrounding air temperature for these devices inside the charger panel assuming ambient temperature of 50°C outside the panel. Necessary surge protection devices and rectifier type fast acting fuses shall be provided in each arm of the rectifier connections. Static silicon controlled rectifiers and diodes complete with resistor/capacitor network for surge protection shall be provided

Design having IGBT or superior technology shall also be acceptable for which full justification & experience shall be required for acceptance.

3.5. Instruments

Analog or digital D.C. voltmeter, D.C. ammeter and A.C. voltmeter with 96 mm square display shall be provided for all Chargers. The instruments shall be flush mounted type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustments. The instruments shall be of 1.5 accuracy class.

3.6. Control and Selector Switches

Control and selector switches shall be of rotary stayput type of reputed make, confirming to relevant IS with escutcheon plates showing the functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. The contact ratings shall be at least the following :

- i) Make and carry continuously - 10 Amps.
- ii) Breaking current at 220 V DC - 0.5 Amp. (Inductive)
- iii) Breaking current at 230 V AC - 5 Amp. at 0.3 p.f.

3.7. Fuses

Fuses shall be of HRC cartridge fuse link type. Fuses shall be mounted on fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on fuse carriers, they shall be directly mounted on plug in type bases. In such cases one insulated fuse pulling handle shall be supplied for each charger. Suitable fuse fail detector circuits with alarm contacts shall be provided for all D.C. fuses.

3.8. Indicating Lamps

The indicating lamp shall be of panel mounting, LED type and capable of clear status indication under the normal room illumination. The lamp covers shall be preferably screwed type, unbreakable and moulded from heat resistant material.

3.9. Blocking Diode

Blocking diode, wherever required, with full redundancy shall be provided in the output circuit of each Charger to prevent current flow from the D.C. Battery into the Charger.

3.10. Annunciation System

Visual indications through indicating lamps/LEDs or annunciation facia shall be provided in all Chargers for the following:

- i. A.C. supply failure
- ii. Rectifier fuse failure
- iii. Surge circuit fuse failure
- iv. Filter fuse failure
- v. Load limiter operated
- vi. Input AC MCCB trip
- vii. Output DC MCCB trip
- viii. Battery on Boost
- ix. Load-side DC under-voltage & over-voltage alarm
- x. Battery side DC over-voltage alarm
- xi. AC available – Battery discharge (Mains available battery discharge) alarm
- xii. Potential free NO contacts shall be provided for following remote alarms:
 - a) Battery on boost
 - b) Charger trouble (this being a group alarm initiated by any of the faults other than ‘Battery on Boost’)

3.11. Name Plates and Marking

The nameplates shall be made of non-rusting metal/3 ply Lamicoid and shall have black background with white engraved letters and secured by screws. These shall be provided near top edge on the front as well as on rear side of Charger. Nameplates with full and clear inscriptions shall also be provided on and inside the panels for identification of various equipment.

- 3.12.** Detailed dimensional drawings, commissioning and operating instructions and Test Certificates of the manufacturer shall be supplied with the equipment.

3.12.1. CONSTRUCTION

- 3.13.** The Chargers shall be indoor, floor mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Charger shall be fabricated using cold rolled sheet steel not less than 1.6 mm thick. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. Removable un-drilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be supplied by the Contractor. The lugs for cables shall be made of electrolytic copper with tin plating. Cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and gland plates. Ventilating louvers shall be backed with fine brass wire mesh. All doors and covers shall be fitted with nitrile/neoprene/PU rubber gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42. The construction shall meet the requirements of IS 6619. All equipment mounted in the cabinet shall be provided with individual labels with equipment designation engraved.
- 3.14.** In case of outdoor mounting, the charger shall be provided with double doors on both front & back and shall pass IP-42 requirement with one door open on both sides. The enclosure shall be provided with a canopy.
- 3.15.** The layout of Charger components shall be such that their heat losses do not give rise to excessive temperature within the Charger panel. Location of the electronic modules will be such that temperature rise, in no case, will exceed 10°C over ambient air temperature outside the Charger.
- 3.16.** Each Charger panel shall be provided with an illuminating lamp (CFL or tube-light) and one 5 Amp. socket. Switches and fuses shall be provided separately for each of the above.
- 3.17.** Locking facilities shall be provided as following:
- a) For locking Float/Boost selector switch in the float position only.
 - b) The Charger enclosure door shall have provision for padlocks. Padlocking arrangement shall allow ready insertion of the padlock shackle but shall not permit excessive movement of the locked parts with the padlock in position.

4.6 WIRING

- 3.17.1.** Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks, ready for external connection. The power wiring shall be carried out

with 1.1 kV grade PVC insulated cables conforming to IS:1554 (Part-I). The control wiring shall be of 1.1kV grade PVC insulated stranded copper conductors of 1.5 sq.mm. minimum, conforming to IS:694. Control wiring terminating at electronic cards shall not be less than 0.75 sq. mm. Control terminal shall be suitable for connecting two wires of 1.5 sq.mm. stranded copper conductors. All terminals shall be numbered for ease of connections and identification. At least 20% spare terminals shall be provided for circuits.

- 3.17.2.** Power and control wiring within panels shall be bundled separately. Any terminal or metal work which remains alive at greater than 415 V, when panel door is opened, shall be fully protected by shrouding.

An air clearance of at least ten (10) mm shall be maintained throughout all circuits, except low voltage electronic circuits, right upto the terminal lugs. Whenever this clearance is not available, the live parts should be insulated or shrouded.

3.18. Painting

Pre-treatment & phosphating with 7 tank process shall be provided as per IS: 6005. The phosphate coating shall be ‘class-C’ as specified in IS: 6005. Electrostatic powder painting with final shade – 692 (smoke grey) of IS: 5 shall be provided. The thickness shall not be less than 50 microns.

3.19. PACKING & DISPATCH

The equipment shall be dispatched securely packed in wooden crates suitable for handling during transit by rail/road so as to avoid any loss or damage during transit.

4. QUALITY ASSURANCE PLAN

- 4.1.** The vendor shall furnish the following information along with his bid; failing which the bid shall be liable for rejection. Information shall be separately given for individual type of material offered.
- i) The structure of Organization
 - ii) The duties and representatives assigned to staff ensuring Quality of work
 - iii) The system of purchasing, taking delivery and verification of materials
 - iv) The system for ensuring quality of workmanship
 - v) The quality assurance arrangements shall conform to the relevant requirement of ISO 9001 or ISO 9002 as applicable
 - vi) Statement giving list of important raw materials/components, list of sub-suppliers, list of standards according to which the raw materials are tested.
 - viii) List of manufacturing facilities available.

- ix) Level of automation achieved and list of areas where manual process exists.
- x) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- xi) Lists of testing equipment available with the bidder for final testing of equipment specified and test plant limitation if any, vis-à-vis the type, special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

4.2. The contractor shall also submit following information after award of contract:

- i) Sub-suppliers of raw materials as well as bought out accessories & components. The equipment supplied shall adhere to the list of components submitted & as per type-tested equipment.
- ii) Type test certificates of the raw materials and bought out accessories as required by the owner.
- iii) Manufacturing Quality Plan (MQP) shall be submitted. The owner hold points for stage inspection shall be discussed between the owner and contractor at the time of award of contract before the MQP is finalized.

4.3. Makes of the following components (not restricted to) shall be subject to owner's approval.

- i) Relays
- ii) Instruments
- iii) SCR/IGBT
- iv) Diodes
- v) Annunciator

5. TESTS

Battery chargers including the components shall confirm to all type tests including heat run test as per relevant Indian standards. Performance test on the chargers as per specification shall also be carried out on each charger.

5.1. TYPE TESTS

5.1.1. Following type tests, in addition to the requirement of IS : 4540, should have been carried out on each rating and type of Battery Charger for which reports are to be submitted.

- i. Complete physical examination.
- ii. Temperature rise test at full load (at highest voltage & highest current).

- iii. Insulation resistance test.
- iv. High voltage (power frequency) test on power and control circuits except low voltage electronic circuits.
- v. Ripple content test at
 - vi. No load
 - vii. Half load
 - viii. Full load
- ix. Automatic voltage regulator operation test at specified A.C. supply variations at
 - a) No load
 - b) Half load
 - c) Full load
- x. Load limiter operation test
- xi. Short circuit test at full load and at no load for sustained short circuit of 1-minute minimum shall be carried out. The charger shall not trip, no fuse shall blow and charger current shall be limited to 150% of the rated current.
- xii. Efficiency and power factor measurement.

xiii. Environmental Tests

Steady state performance tests (clause 7.2.2 (f) and (g)) shall be carried out before and after the following tests.

- i) Dry heat, Damp Heat, Vibration, Low temperature, Transportation, shock as per IS : 9000.
- ii) Degree of protection test (IP-42).
- xiv. Rectifier transformer – As per IS 4540.

5.1.2. If type tests are carried out against the contract, minimum 15 days notice shall be given by the contractor. The contractor shall obtain the owner's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type tests to be carried out.

5.1.3. In case the contractor has carried out the type tests within last five years as on the date of bid opening, he may submit the type test reports from NABL accredited laboratory to the owner for waiver of conductance of such type tests. These reports should be for the tests conducted on the equipment with identical design to that proposed to be supplied under this contract. The owner reserves the right for conducting any or all of the specified type tests under this contract.

5.2. ROUTINE TESTS :

5.2.1. Following routine tests shall be carried out on all Rectifier transformers in addition to tests required as per IS-4540.

- a) Insulation resistance test.
- b) High voltage (power frequency) test.

5.2.2. Following routine tests shall be carried out on all Battery Chargers in addition to tests required as per IS-4540 :

- a) Complete physical examination.
- b) Short circuit test at full load and at no load for sustained short circuit of 1-minute minimum shall be carried out. The charger shall not trip, no fuse shall blow and charger current shall be limited to 150% of the rated current.
- c) Insulation resistance test.
- d) High voltage (power frequency) test.
- e) Ripple content test at
 - i) No load
 - ii) Half load
 - iii) Full load
- f) Automatic voltage regulator operation test at specified A.C. supply variations at
 - i) No load
 - ii) Half load
 - iii) Full load
- g) Load limiter operation test
- h) Checking of proper operation of annunciation system.
- i) Dynamic response test Overshoot/Undershoot in output voltage of the charger as a result of sudden change in load from 100% to 20 % and 20% to 100% shall be measured.
- j) Soak Test - All electronic modules shall be subjected to continuous operation for a minimum period of 72 hours. During last 48 hours, the ambient temperature shall be maintained at 50 deg. C. The manufacturer shall submit the record of carrying out this test to the owner's engineer at the time of inspection.
- k) The charger shall be checked for gasketing arrangement as per drawing.

5.2.3. Following routine tests shall be carried out on annunciation system.

- a) Soak test shall be carried out as per Cl. 7.2.2 (j).

5.3. ACCEPTANCE TESTS:

5.3.1. Following acceptance tests and checks shall be carried out by the owner at the manufacturer's works:

- a) Complete physical examination.
- b) Checking of proper operation of annunciation system.
- c) Temperature rise test at full load.
- d) Insulation resistance test.
- e) Automatic voltage regulator operation.
- f) Load limiter operation.
- g) Dynamic response test.
- h) Ripple content test

5.3.2. Overshoot/Undershoot in output voltage of the Charger as a result of sudden change in load from 100% to 20% and 20% to 100% shall be measured with the Batteries connected/disconnected. Output voltage of the Charger connected with Battery shall be within 90 % to 110 % of the voltage setting in above conditions and shall return to, and remain, within the limits specified in clause 3.1 (d) in less than 2 seconds.

5.3.3. The Contractor shall furnish for inspection, the type and routine tests certificates for Chokes and transformer whenever required by the Employer.

6. GUARANTEE

The battery charger shall be guaranteed for a period of 24 months from the date of commissioning.

II. 30 VOLT 100 AH LEAD ACID BATTERY

Part A : 30 Volt 100 Ampere-Hour Lead Acid stationary Battery

1. SCOPE

This specification covers 30 Volt 100 Ampere-Hour Lead Acid stationary Battery, for use at 33/11KV substations for feeding auxiliary supply to Switchgear equipment at the time of interruption in mains supply. The battery is to be supplied along with wooden stand/rack as per description given below. Specifications of battery rack are indicated separately.

2. APPLICABLE STANDARDS

The cells of Lead Acid Battery shall conform to the requirements of IS 1651: 1991 with latest amendment thereof.

3. STANDARD RATINGS

The standards rating for 30 Volt Lead Acid Battery shall be 100 AH.

4. CELL VOLTAGE

The nominal voltage of a single cell shall be 2.1 to 2.2 Volts.

5. CAPACITY AT ROOM TEMPERATURE

The battery shall comprise of 15 cells with capacity not less than 100 AH at 10-hour rate of discharge to end voltage of 1.85 Volts per cell at room temperature not exceeding 32 degree C.

6. GENERAL DESCRIPTION

Cells shall be supplied in glass containers having ample space provided below the plate for accumulation of deposit. The glass containers shall be sufficiently robust, transparent and free from flaws. The bidder may also quote for battery with hard rubber containers, which shall conform to IS 1146: 1981.

Lead acid battery, comprising of closed type cells shall be complete with plate / tubular type positive plate assemblies, glass boxes, lids, micro porous plastic separators, polystyrene dowels and buffers, inter cell connectors and bolts & nuts. The battery shall be complete with (i) inter row connectors and bolts & nuts, acid jars and packing case, (ii) stands (iii) stand insulators (iv) cable sockets for end and tapping connections.

The sulphuric acid and water used for the preparation and maintenance of electrolyte shall conform to IS 266: 1977 and IS 1069: 1964 respectively.

The separators used shall be either wooden or synthetic. The wooden separators when used shall conform to IS 652:1960 and the synthetic separators to IS 6071: 1986.

The venting device shall be of anti-splash type with more than one exit hole and shall allow the gases to escape freely but shall effectively prevent acid particles or spray from coming out.

A suitable electrolyte level indicator indicating lower and upper limits shall be fitted to facilitate checking of electrolyte level in opaque containers. The materials used shall be acid proof and shall not deteriorate during service.

The manufacturer's identification shall be embossed/impressed on the connectors. Where it is not possible to bolt the cell terminals directly to assemble a battery, separate lead, copper or aluminium connectors of suitable size shall be provided to enable connection of the cells.

The material for bolts and nuts shall be brass. Bolts and nuts for connecting the cells shall be effectively lead-coated to prevent corrosion.

Open cells shall be provided with spray arrestors of adequate area over the plates. These may be of glass sheet at least 3 mm thick and shall be adequately supported.

7. MOUNTING STAND

The cells shall be accommodated in double tier stand constructed of "SAL" wood and painted with 3 coats of acid proof paint. Necessary paint for this purpose shall be supplied. No metal fastenings shall be used. Stand should be self-supported and free from wrap & twist. The assembled stand / rack should be suitable for bolting end to end to form continuous row. The stands shall be supported on insulators to obtain necessary insulation from earth and there shall be insulators between each cell and stand. The price of stand shall be included in the cost of the battery.

8. TERMINALS

Separate terminals shall be provided for connecting load and charger leads to the battery terminals. All terminals shall be of M 12 size. The agency shall provide suitable copper lugs for use of the owner for connecting the load wiring.

9. ACCESSORIES

The following accessories shall be supplied along with each battery and price for the same shall be included in the cost of the battery:-

1. One battery logbook
2. Two copies of printed instruction sheet
3. One no. cell testing voltmeter (3-0-3 volts) complete with leads
4. One no. floating hydrometer
5. One no. syringe hydrometer
6. One no. thermometer (0 to 100 degree C) with specific gravity correction scale
7. One set of suitable insulated spanners
8. One no. acid resisting funnel
9. One no. acid resisting jar
10. One pair of rubber gloves
11. Lead plated 2 nut – bolts and 2 washers set = 30 + 4 extra = 34 Nos.

12. Cell insulators for mounting of cells = $15 \times 4 + 6$ extra = 66 Nos.

13. Rack insulator for mounting of battery rack = 8 Nos. minimum

10. CHARGE RATE

Fully discharged batteries should normally be recharged at 10 Amps. for 10 hours at room temperature. New batteries and old batteries at high temperatures may need more time. Trickle charge rate shall be about 50 to 100 mA,

11. CELL DESIGNATION AND MARKING

The practices indicated in relevant IS shall be followed for cell designation purpose.

The following information shall be indelibly and durably marked on the outside of the cell:-

1. Indicating the source of manufacture
2. Ah capacity at 10-hour rate
3. Upper and lower electrolyte level in case of transparent containers
4. Year of manufacture and
5. Country of origin
6. Each cell and battery may also be marked with the Standard Mark.

The polarity of the terminals shall be marked for identification. The positive terminal may be identified by “P” or (+) sign or Red colour mark and the negative terminal may be identified by “N” or (-) sign or a Blue colour mark. Terminal marking shall be permanent and non-deteriorating.

The battery shall be supplied with a warning plate located at conspicuous place specifying the use of “PARTICULAR ELECTROLYTE ONLY” (in block letters) & specifying the proper filling level of the electrolyte. Marking shall be permanent and non-deteriorating.

12. TESTS

The following tests shall be carried out in accordance with IS 1651:1991 with latest version thereof.

13. TYPE TESTS

1. Verification of constructional requirements
2. Verification of marking

3. Verification of dimensions
4. Test for capacity
5. Test for voltage during discharge
6. Ampere-hour and watt-hour efficiency tests
7. Test for loss of capacity on storage
8. Endurance test

14. ACCEPTANCE TESTS

The following shall constitute acceptance tests: -

1. Marking and packing
2. Verification of dimensions
3. Test for capacity, and
4. Test for voltage during discharge

15. ROUTINE TESTS

The battery shall be tested after manufacture as per the requirement of IS: 1651-1991 (with latest amendment, if any). Two copies of test certificates indicating the results obtained during the tests shall be submitted.

16. MANUAL INSTRUCTIONS

The manufacturer shall supply one copy of instruction manual for initial treatment and routine maintenance during service with each battery.

The following information shall be provided on the instruction cards:-

1. Designation of cell or battery
2. Ampere – Hour capacity
3. Nominal voltage
4. Manufacturer's instructions for filling, initial charging
5. Normal and finishing charging rates and
6. Maintenance instructions

17. GUARANTEE PARTICULARS

Expected life span of battery shall be minimum 10 years. Loss of capacity on storage of a fully charged battery stored for 28 days should not be more than 3%. Battery should be capable to bear under floating & over floating conditions.

The bidders shall essentially fill up the enclosed Schedule of Guaranteed Technical Particulars of Battery offered by him.

18. PACKING

The battery shall be suitably packed in wooden crates suitable for handling during transit by rail/road, and secured to avoid any loss or damage during transit.

Part B: Battery Charger

1. SCOPE

This specification covers design, manufacturing, testing at manufacturer's works before dispatch and supply of 30 Volt 10 Ampere Single Phase Battery Charger required for charging of 30 Volt 100 Ampere-Hour Lead Acid Battery and for feeding auxiliary supply to Switchgear equipments at 33/11 kV substations.

2. STANDARDS

Unless otherwise specified, the equipment shall conform to the latest applicable Indian standards and in particular to the following standards:-

1	IS: 3895	Specification for Rectifier equipment's in general
2	IS: 13947(Part II)	Specification for MCB
3	IS: 1248	Indication instruments
4	IS: 2147	Degree of protection for cubicles
5	IS: 375	Specification for wiring
6	IS: 4540	Mono crystalline semiconductor rectifiers assemblies & equipment
7	IS: 6619	Safety code for semiconductor rectifier equipment
8	IS: 2026	Transformers
9	IS: 4237	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts
10	IS: 4064	Air Break switches and fuse combination units

11	IS: 6005	Code of practice for phosphating of Iron & Steel
12	IS: 5	Colour for ready mix paints
13	IS: 5921	Printed circuit Board
14	IS: 249	Printed circuit Board
15	IS: 5578	Guide for making insulated conductor

The agency shall clearly state the standards to which the equipment offered by him conforms.

3. DRAWING AND LITERATURE

The bidder shall furnish all such drawings, instruction manuals, descriptive literature etc., as may be necessary for the proper understanding of the functioning of the charger.

The write-up should include the following:-

1. Technical specification of the charger.
2. Detailed circuit description of the charger. It should also include the functions of various components, protection circuits/cards, and relays along with their individual brief write-ups/leaflets.
3. List of the main components of the charger.
4. Following details are to be clearly indicated in the circuit diagram:-
 - a. Make and Rating of components used
 - b. All the fuses should be numbered and individual rating should be indicated.

4. GENERAL DESCRIPTION

The Charger shall be of simple design so as to ensure its reliable functioning and ease in maintenance/repairing. Complicated circuitry shall be avoided, as far as possible. The bidder shall indicate, as to how reliable functioning of the charger is achieved. He shall also indicate the quality control adopted for the reliable product.

The battery charging equipment shall comprise of a selenium/solid state silicon rectifier suitable for operation on 230/250 Volt Single Phase AC system. Associated transformer, regulatory resistance, switches etc. shall be accommodated in a sheet steel cubicle arranged for continuous load of 3 Amps. Adjustable from 0 to 3 Amps trickle

charge of the battery and manual provision to operate at a higher voltage to recharge the battery of 100 AH capacity quickly at 10 Amp rate.

The equipment shall comprise of:-

1. AC mains switch/MCB 230/250 Volt Single Phase with fuses/MCB
2. Pilot lamp/LED type to indicate AC supply ON.
3. Ballast choke
4. Single Phase Double Wound Transformer for rectifiers
5. Main transformer single phase variac with rough and fine control to charge battery in steps of 6-12, 12-18, 18-24, 24-30, 30-36, 36-42 volts.
6. Full wave bridge connected plate/solid state silicon rectifier
7. Fuses for rectifier output
8. Moving Coil Ammeter 96-mm sq. flush mounting type (0-15 Amps.)
9. Moving Coil Voltmeter 96 mm sq flush mounting type (0-50 Volts)
10. Voltmeter fuses
11. DC ON/OFF switches with fuses.

The sheet steel cubicle of the rectifier unit shall also accommodate the switches for charge rate selection, incoming from battery and various apparatus for battery control.

The chargers should have in-built automatic input voltage stabilizer in the range of 180 volt to 275 volt to facilitate steady output voltage and current from the charger.

5. CABINET

The charger shall be enclosed in a cabinet made of sheet steel of not less than 1.5 mm thickness and should be suitable for mounting on a plane surface/floor with ventilation louvers on two sides and finish painted with synthetic enamel paint of white on inside and opeline green on outside. Two coat of zinc primer shall be applied before finishing synthetic enamel paint. The cabinet shall have vermin proof construction. The cabinet legs shall be of adequate height and strength and should provide minimum clearance of 100 mm from ground.

6. FRONT PANEL MOUNTINGS

The following provisions conforming to relevant ISS shall be made on the front panel:

1. Voltmeter to indicate battery/charger DC voltage
2. Voltmeter to indicate incoming AC voltage
3. Ammeter to indicate charging/load current
4. Indicating LEDs to indicate:-
 - a. Supply of power;

- b. Charger on;
- c. Input voltage less than 180 Volt

5. Audio/Visual alarm to indicate:-

- a. Power failure;
- b. Charger failure;
- c. Battery disconnection/failure;
- d. Battery reverse; and
- e. DC under/Over voltage.

In case of failure of charger on fault, it should give buzzer as well as LED indication. However, the buzzer alarm should be provided with a reset switch. The indicating instruments shall be of class 1.0 accuracy

7. TRANSFORMER

The power transformer rectifier unit of the battery charger shall be designed for adequate VA rating but in any case it should not be less than 700 VA and should be rated for 300 V at factor of safety of 3. The heat dissipation and power control system should be designed with a factor of safety of 8. Rating of silicon diode should not be less than 15 A.

Please note, necessary documentary evidence, showing transformer rating of 700 VA along with test certificate from manufacturer, if bought-out, shall be enclosed, for approval of the owner.

8 PROTECTION

The charger should have built-in reverse polarity protection with indication lamp so as to protect the battery from high drains. The charger should also have MCB in the output circuit for protection from short circuits.

9. LIGHT EMITTING DIODES

For the purpose of indication LED indicators shall be provided.

10. SWITCHES AND FUSES

Control and instruments switches shall be of toggle type. All fuses shall be of HRC type and of English Electric/L&T make only.

11. LABELS

All front panel mounted equipment as well as the equipment mounted inside the cabinet shall be provided with individual labels with equipment designation engraved on aluminium plate (stickers are not acceptable).

12. WIRING

The charger shall be supplied completely wired ready for external connections at the terminal blocks. All the wiring shall be carried out with 1100 V Grade PVC insulated standard copper conductor of 2.5 Sq.mm. Colour coded wires should be used to facilitate easy tracing, as under :-

A. Single Phase AC Circuit:-

1. Red for Phase
2. Green for Earthling
3. Black for Neutral

B. D.C. Circuit:-

1. Red for Positive
2. Black for Negative

C. Control Wiring:- Gray for annunciation and other control circuits.

13. FERRULES

Engraved core identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.

14. EARTHING TERMINALS

The battery charger cabinet shall be provided with two separate suitable earthing terminals of good quality and adequate size.

15. TESTING

The manufacturers on each battery charger shall carry out the following tests and copy of the tests certificate for each charger shall be submitted:-

1. Checking of wiring and continuity of circuits and visual inspection

2. High voltage test on the equipment with accessories. (All equipment and wiring should be tested for with-standing the power frequency voltage of 2 KV r.m.s. for 20 seconds.)
3. Checking of charging current and load currents.
4. Checking of relays operation, alarm circuit operation, lamp indication, charger failure, mains failure, load fuse failure and annunciation (manufacturer's test certificate for the instruments shall also be furnished).
5. Regulation and Ripple tests.
6. Efficiency test.
7. Burn-out/Heat-run test (for 10 Hrs.)

16. CIRCUIT DIAGRAM AND WRITE-UP

It is desired that the complete schematic of the charger is provided on a permanently laminated/engraved plate of suitable thickness, which has to be bolted/riveted at the four corners on the inside face of rear door. In addition, one more plate of similar type and dimension shall be provided on the outside of the rear door providing guidelines and instructions for operation of the charger. The guidelines and schematic to be provided on the plates shall be as per our approval for which separate drawings shall furnish, after award of contract.

17. TERMINALS

Separate terminals shall be provided for connecting load and battery leads to the charger. All terminals shall be of M12 size. Suitable copper lugs for connecting the load wiring are to be provided.

It would be the bidder responsibility to prove the adequacy of its design by submitting all technical particulars and relevant graphs to show suitability of charger for supplying load on continuous basis.

18. PRINTED CIRCUIT BOARD

The printed circuit boards should be made out of glass fiber re-in forced epoxy boards and should be coated with suitable protective coating for protection against humidity and corrosion.

19. POLARITY MARKING

The polarity marking of the terminals shall be marked for identification. The positive terminal may be identified by "P" or (+) sign or red colour mark and the

negative terminal may be identified by “N” or (-) or blue colour. Terminal marking shall be permanent and non-deteriorating.

20. MANUAL OF INSTRUCTIONS

The manufacturer shall supply a copy of the Instruction Manual for commissioning and initial testing of the charger and maintenance during service with every charger supplied.

21. PACKING The charger shall be securely packed in wooden crates suitable for handling during transit by rail/road so as to avoid any loss or damage during transit.

Guaranteed Technical Particulars of 30 V, 100 Ah/200 Ah Lead Acid Battery Sets and BATTERY CHARGER		
Sr.NO	GTP Parameters	
1	Name of manufacturer	
2	Type of Battery (As per specifications)	
3	Reference Standard IS : 1651 / 1991 or latest version amended upto Date	
4	Whether one - acid level indicating float to each cell is fitted (Yes / No)	
5	Whether batteries terminals have suitable cable lugs (Yes /No)	
6	Arrangement of Battery cells (15 nos of 2 V , 100 AH cells connected in series to form one sets of 30 V, 100 AH or 15 nos of 2 V , 200 AH cells connected in series to form one sets of 30 V, 200 AH)	
7	Whether following accessories shall be supplied with each battery set (Yes / No)	
8	i) Inter Batteryconnector of lead plated copper with cross section not less than <u>50 sq.mm</u> : 14 nos + 2 extra (Yes /No)	
9	ii) Lead plated 2 nut bolts and 2 washers sets : 30 sets + 4 extra (Yes / No)	
10	iii) Syringe type Hydrometer with specified gravity correction scale : 1 No (yes /No)	
11	v) Thermometer : 1 No (Yes /No)	
12	v) Voltmeter of range 3-0-3 with leads or Digital voltmeter : 1 No (Yes/No)	
13	vi) Set of spanners suitable to used nutbolts (2 spanners) : 1 set (Yes /No)	

14	vii) Rubber syringe: 1 No (Yes /No)	
15	viii) Log Book : 1 No(Yes / No)	
16	ix) Inspection sheet : 1 No (Yes / No)	
17	x) Electrolyte of dilute sulphuric acid in non - returnable carboy including 10% extraelectrolyte: 1st lot (Yes /No)	
18	xi) Cell insulators of Hard rubber (for mounting) (15 + 6 extra) : 66 nos (Yes/No)	
19	xii) Stand Insulators of stand of Hard rubber not less than 6 Nos (Yes/No)	
20	xiv) Cell number indicating plates with fixing pins : 15 Nos (Yes/No)	
21	xv) Acid Resistance Funnel : 2 nos (Yes/No)	
22	xvi) Acid Resistance Jug : 2 Nos (Yes/No)	
23	xvii) Rubber aprons : 2 nos (Yes /No)	
24	xviii) Rubber Hand Gloves (Yes /No)	
25	xix) Rubber Syphons : 1 No (Yes / No)	
26	xx) Wooden stand of teak wood : 1 No (Yes /No)	
27	The expected life span of the batteries shall be minimum 10 years (Yes/No)	
28	A. Loss of capacity on storage of fully charged battery stored for 28 days shall be not be more than 3 % (Yes /No)	
	B.If Yes , State the percentage	
29	A. Ampere hour efficiency shall not be less than 97 % (Yes /No)	
	B. If yes. State the percentage	
30	Whether battery withstand under floating and over floating conditions (Yes / No)	
31	Whether the battery is capable of being maintained at a higher Electrolyte specific Boolean gravity of 1.230 ± 0.005 without deterioration to Grid corrosion (Yes / No)	
32	Whether following type tests are performed on 2V , battery cell : (Yes /No)	
33	i) Verification of constructional requirement (Yes /No)	
34	ii) Verification of marking (Yes /No)	
35	iii) Verification of dimensions (Yes/No)	
36	iv) Test of capacity (Yes /No)	
37	v) Test for voltage during discharge (Yes / No)	
38	vi) Ampere- hour and watt hour efficiency test (yes /No)	
39	vii) Test for loss of capacity on storage (Yes/No)	
40	viii) Endurance Test (Yes/No)	

41	Whether above type tests are carried out within 5 years (Yes / No)	
42	Whether it is agreed to perform Acceptance tests at manufacturer's site in presence of purchaser's representative from the sample selected from the lot offered for supply (Yes / No)	
43	Dimensions of wooden stand(LX BX H) in mm	
44	Material of container (Yes/ No)	
45	Overall dimensions of each cell (L X B X H)	
46	Distance between the centers of cells when erected (in MM)	
47	Weight of cell complete with Acid (in KG)	
48	Type and material of cell separator	
49	Amount and specific gravity (1.230 ± 0.005) of electrolyte at the end of full charge	
50	Loss of capacity on storage of fully charged battery stored for 28 days	

15. LT upto (1100 V) XLPE Insulated

1.0 SCOPE:

1.1 The scope of this specification covers the design, manufacture inspection and testing the finished ISI marked LT (1100 volts, 31/2 x25 Sq.mm to 400 Sq.mm stranded, compact aluminum conductor, with XLPE insulated, PVC inner sheathed, galvanized steel strip armored/unarmored and overall PVC sheathed Black colour cable conforming to IS:7098 /88 with latest amendments and as per specification detailed.

2.0 RATED VOLTAGE:

2.1 The rated voltage of the cable shall be 1100 Volts AC with the highest system voltage of 1100 Volts between phases of the effectively earthed three-phase transmission system.

2.2 The cables shall be capable of operating continuously under the system frequency variation of ± 3 Hz, voltage variation of $\pm 10\%$ and a combined frequency – voltage variation of $\pm 10\%$.

3.0 APPLICABLE STANDARDS:

- i) Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable:

IS 7098 (Part 2)-Cross-linked Polyethylene insulation for Cables.

IS 8130-Conductors for insulated electrical cables and flexible cords.

IS 10810(series)-Methods of tests for cables.

IS 10418-Drums for electric cables.

IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables.

IS 5831-Specification for PVC insulation sheath for electric cables.

IS 10462-Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables.

- ii) The cables manufactured to any other International Standards like BSS, IEC or equivalent standards not less stringent than Indian Standards are also acceptable. In such cases the Manufacturer shall enclose a copy of the equivalent international standard, in English language.

4.0 CONSTRUCTION:

4.1 Conductor: - The cable conductor shall be made from stranded aluminum to form compact sector shaped conductor having resistance within the limits specified in IS:8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay. Stranded Class 2 – as per the IS:8 130 / IEC 60228/ BS 6360 standards.

4.2 Insulation: - The insulation shall be cross linked polyethylene applied by extrusion and shall be steam (wet) cured as per IS:7098(1)1988 and curing in hot water tank/bath is not accepted.:

Sl.No.	Properties	Requirements
1.	Tensile Strength	12.5N/mm ² , Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven: a) Treatment: Temperature: Duration: b) Tensile Strength variation: c) Elongation variation:	135±3°C 7 days ±25 percent, Max ±25 percent, Max
4.	Hot set: a) Treatment: Temperature: Time under load Mechanical stress b) Elongation under load Permanent elongation (set) after c) cooling	200±3°C 15 min 20N/cm ² 175 percent, Max 15 percent, Max
5.	Shrinkage:	

	a) Treatment: Temperature Duration b) Shrinkage	130±3°C 1 hour 4 percent, Max
6.	Water absorption (Gravimetric): a) Treatment: Temperature: Duration b) Water absorbed	85±2°C 14 days 1 mg/cm ² , Max
7.	Volume Resistivity a) at 27°C b) at 70°C	1x10 ¹⁴ ohm-cm, Min 1x10 ¹³ ohm-cm, Min
8	Thermal Resistivity	350 degrees C cm/W
9	Power factor at maximum conductor temperature	0.008
10	Dielectric strength	22 kV/mm

4.3.1 The XLPE insulation should be suitable for specified 1.1 KV system voltage.

4.3.2 The manufacturing process shall ensure that insulations shall be free from voids.

4.3.3 The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.

4.3.4 The insulation of the cable shall be high stranded quality, specified in IS:7098 (Part-II/1985). Withstand continuous conductor temperature of 90 deg C, which means higher continuous rated current carrying capacity.

4.3.5 The cables can operate even at conductor temperature of 130 deg C continuously and 250 deg C during a Short Circuit condition

4.4 SHEATH :

The sheath shall be suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness, consistent quality and free from all

defects. The PVC sheath shall be extruded as per IS:7098 (Part – I/1988). IEC:60502 Part– I,BS:6622, LSOH to BS:7835.

4.5 ARMOUR :

Armoring shall be applied over the inner sheath with single galvanized steel complying with the requirements of IS:3975/1979. The dimensions of the galvanized strip shall be as specified in table 4 of the IS:7098/Part-I/1988. The armour wire shall be applied as closely as practicable. The direction of the lay of the armour shall be left hand. The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire shall be atleast 300mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS:7098 Part 1, IS: 3975.

The cable without armoring shall also be accepted of type detailed in price schedule.

4.6 OUTER SHEATH : Extruded PVC ST2, outer sheath as per IS:5831/1984, IS:7098

Part 1, IEC:60502 Part – 1, BS:6622, LSOH to BS:78 35. shall be applied over armoring with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the PVC sheathing material used.

4.7 The cables should be suitable for use in solidly earthed system.

4.8 The power cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The Manufacturer shall furnish the quality plan, giving in detail the quality control procedure / management system.

4.9 The cable shall be suitable for laying in covered trenches and/or buried underground to meet the outdoor application purposes.

4.10 The parameters of the LT power cables to be supplied shall be as specified below

Nom. cross sectional area (Sq.mm)	Nom. Thickness of XLPE Insulation mm main	Armoured			Max.DC Conductor Resistance at 20°C	AC current rating	
		Nom. Steel Armour	Approx. Overall dia.	Approx, Weight (kg/km)		In air (amps)	In Grpund (amps)

	core	size (mm)	(mm)		(ohm/km)		
25	0.90	4 X 0.8	22.8	821.0	1.200	95	97
35	0.90	4 X 0.8	24.9	961.0	0.868	117	116
50	1.00	4 X 0.8	28.1	1195.0	0.641	140	134
70	1.10	4 X 0.8	33.0	1569.0	0.443	176	167
95	1.10	4 X 0.8	35.8	1903.0	0.320	221	199
120	1.20	4 X 0.8	39.0	2303.0	0.253	258	227
150	1.40	4 X 0.8	42.9	2720.0	0.206	294	255
185	1.60	4 X 0.8	47.5	3276.0	0.164	339	287
240	1.70	4 X 0.8	52.7	4048.0	0.125	402	333
300	1.80	4 X 0.8	58.4	4872.0	0.100	461	375
400	2.00	4 X 0.8	65.6	6101.0	0.0778	542	426

4.11 The short circuit current of the LT cable to be as specified below

Sq.mm of LT Cable	Short Circuit Current(KA)
25	2.420
35	3.370
50	4.790
70	6.680
95	9.030
120	11.400
150	14.200
185	17.500
240	22.600
300	28.200
400	37.600

5.0 **SYSTEM DETAILS:**

General Technical particulars

Nominal system voltage (rms) (U)	0.44KV
Highest system voltage (rms) (U _m)	1.1 KV
Number of Phase	3
Frequency	50Hz
Variation in Frequency	+/- 3%
Type of Earthing	Solidly Earthed
Total relay & circuit breaker Operating time	15 – 20 cycles

6.0 CLIMATIC CONDITIONS:

(a) Maximum ambient air temperature (in shade)	45 ⁰	C
(b) Maximum ambient air temperature (under sun)	50 ⁰	C
(c) Maximum daily average ambient air temperature	35 ⁰	C
(d) Maximum yearly average ambient air temperature	30 ⁰	C
(e) Maximum humidity	100%	
(f) Altitude above M.S.L.	Up to 1000M	
(g) Average No. of thunder storm days per annum	50	
(h) Average No. of dust storm days per annum	Occasional	
(i) Average No. of rainy days / annum	90	
(j) Average Annual Rain fall	925mm	
(k) Normal tropical monsoon period	4 months	
(l) Maximum wind pressure	150 kg/Sq.M	

7.0 DESIGN CRITERIA:

- i. The cables that are covered in these specifications are intended for use outdoor , under the climatic conditions and installation conditions described in the technical specification.
- ii. For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit conditions.
- iii. The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.
- iv. The materials used for outer sheaths shall be resistant to oils, acids and alkalis.

- v. The cables shall have the mechanical strength required, during handling and laying.
- vi. The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.
- vii. The cables shall be designed to have a minimum useful life span of Thirty-five years.
- viii. The detailed design drawings shall be submitted along with Purchase order.

8.0 MANUFACTURE PROCESS:

Cross-linking of the insulation materials (pre compounded polyethylene) shall be conforming to IS: 7098 (Part – II) and the proof of purchase of the above insulating material shall be submitted and is to be offered for stage inspection..

9.0 MATERIALS:

9.1 Conductor: -The conductor shall be of stranded construction. The material for conductor shall consist of the plain aluminum of H2 or H4 grade as per clause – 3 of IS 8130/ 1984.

9.2 The minimum number of wires shall be 53 for circular compacted 400 sq. mm aluminum conductor as per table – 2 of IS 8130/ 1984.

10.0 CORE IDENTIFICATION:

10.1. The core identification for 31/2 core cables shall be provided, by suitable means, like, by application of individual colour or colored stripes, or by numerals or by printing on the cores as per clause 13 of IS: 7098 - Part 2

10.2. For identification of different coloring of XLPE Insulation, or by using colored strips, red, yellow and blue colors respectively shall be used to identify the phase conductors.

11.0 LAYING UP OF CORES:

The cores shall be laid together with a suitable right hand lay. The interstices at the center shall be filled with a non- hygroscopic material.

12.0 INNER SHEATH (COMMON COVERING):

12.1 The laid up cores shall be provided with inner sheath applied either by extrusion. It shall be ensured that the shape is as circular as possible. The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

12.2 The thickness of the inner sheath (common covering) shall be given as follows:

CALCULATED DIAMETER IN MM OVER LAID UP CORES [REF IS 10462 (PART 1)]		THICKNESS OF INNER SHEATH (Min) mm
Over	Up to and including	
–	25	0.3
25	35	0.4
35	45	0.5
45	55	0.6
55	–	0.7

12.3 When one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as a part of inner sheath.

13.0 ARMOURING:

13.1 Armouring shall be single strip steel wire applied over the inner sheath as closely as practicable. The direction of the lay of the armour shall be left hand.

13.2 The armour shall consist of galvanized strip steel The dimensions of the galvanized steel wires shall be 4 X 0.8 mm (Nominal)

13.3 The joints in the armour strip shall be made by brazing or welding and the surface irregularities shall be removed. A joint in the wire shall be at least 300-mm from the nearest joint in any other wire in the complete cable.

13.4 Manufacturers shall furnish the calculation / data sheet for the short circuit carrying capability of the Armour.

14.0 OUTER SHEATH:

14.3 The outer sheath shall be applied by extrusion. It shall be applied over the armouring

shall consist of poly-vinyl chloride (PVC) compound, conforming to the requirements of type ST-2 of IS 5831. Suitable additives shall be added to give anti termite protection.

14.4 The minimum thickness of the PVC outer sheath shall be as per IS:10462 and as detailed.

Calculated diameter under the outer sheath [IS 10462 Part 1] – mm		Nominal thickness of the outer sheath (ts) - mm
Over	Up to and including	
–	15	1.24
15	25	1.40
25	35	1.56
35	40	1.72
40	45	1.88
45	50	2.04
50	55	2.20
55	60	2.36
60	65	2.52
65	70	2.68
70	75	2.84
75	–	3.0

14.5 IDENTIFICATION:

The outer sheath shall have the following information embossed or indented on it; ISI marking, the manufacturer’s name or trade mark, the voltage grade, the year of manufacture and the letters “RDSS, Name of Employer” The identification shall repeat every 300/350mm along the length of the cable. Outer sheath of cable shall be black in permanent colour.

15.0 INSPECTION AND QUALITY CONTROL:

The Manufacturer shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement. During the manufacturing process, at all stages, inspections shall be made to check the physical and dimensional parameters, for verification to compliance to the standards. The Manufacturer shall arrange, for inspection by the purchaser, during manufacture with

one month advance notice for verifying the various stage inspections as specified in the quality assurance plan enclosed to verify the quality control process of the Manufacturer.

16.0 TYPE TESTS:

Type test certificates from Accredited NABL Testing Laboratories for 1.1 kV XLPE, shall be submitted along with Purchase order. The Type Tests should have been conducted not later than 5 years as on the date of supply.

16.1 Stage wise Inspection: The Manufacturer shall offer the stage wise inspection as detailed in the in the quality assurance plan

16.2 All acceptance tests shall be conducted in the presence of the Employer’s representative.

16.3 The supplier shall give 10 days advance notice for inspections, and witnessing of tests by the Employer representative.

16.4 The following type tests shall be conducted on the cable.

Sl. No.	Test	Requirement	Test method Ref Part no o IS: 10810
a)	Tests on conductor		
	i) Tensile test	IS:8130	2
	ii) Wrapping test	IS:8130	3
	iii) Resistance test	IS:8130	4
b)	Tests for armoured wires and strips	Clause 15.2 & IS:3975	36 to 42
c)	Test for thickness of insulation and sheath	Clause 4.3, 14.2 & 16.2	6
d)	Physical tests for insulation:	Clause 4.2	
	i) Tensile strength and elongation at break		7
	ii) Aging in air oven		11
	iii) Hot test		30
	iv) Shrinkage test		12

	v) Water absorption (gravimetric)		33
e)	Physical tests for outer sheath	IS: 5831	
	i) Tensile strength and elongation at break		7
	ii) Aging in air oven		11
	iii) Shrinkage test		12
	iv) Hot deformation		15
f)	High voltage test	Clause 22.7	45
g)	Flammability test	Clause 22.8	53

17.0 **ACCEPTANCE TEST:**

17.1 The sampling plan for acceptance test shall be as per IS 7098 part -II, Appendix 'A'.

17.2 The following shall constitute the acceptance test.

- a. Tensile test for aluminum.
- b. Wrapping test for aluminum.
- c. Conductor resistance test.
- d. Test for thickness of insulation.
 - (i) Test for thickness of inner and outer sheath.
 - (ii) Hot-set test for insulation.
 - (iii) Tensile strength and elongation at break test for insulation and outer sheath.
 - (iv) High voltage test.
 - (v) Insulation resistance (volume resistivity) test.

18.0 **ROUTINE TEST:**

The following shall constitute routine tests:

- Conductor resistance test.
- High voltage test.

19.0 DETAILS OF TESTS:

19.1 Unless otherwise mentioned in this specification, the tests shall be carried out in accordance with appropriate part of IS: 10810.

19.2 High Voltage Test at room temperature:

The cables shall withstand a voltage of 3KV AC (rms) at a frequency of 40 to 60 Hz or an AC voltage of 7.2kV , between conductors and between conductors and ECC (if any) for a period of 5 minutes each test connection.

19.3 Flammability test: Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected (uncharred) portion from the lower edge of the top clamp shall be at least 50-mm.

Employer reserves the right to select a random sample of 1.1 kV UG cable from the Manufacturer's end which are ready to dispatch and also ongoing cable laying works and the same samples will be sent to any testing laboratory as desired by Employer. If the testing results are found to be not satisfactory Employer reserves the right to reject the entire batch of cable received and insists for replacement of material free of cost. The decision of Employer in this regard is final.

20.0 PACKING:

20.1 The cables, as per specified delivery lengths, shall be securely wound /packed in non-returnable wooden drums, capable of withstanding rough handling during transport by Rail, Road, etc. The packing should withstand storage conditions in open yards. The cable drums shall conform to IS 10418-1982 or equivalent standard. The dimensional drawings of wooden drums shall be furnished with the Purchase order. The drum shall be provided with circumferential lagging of strong wooden planks. The end of the cable shall be sealed with good quality heat shrink sealing caps. The sufficiently required additional sealing caps shall be supplied for use of testing during laying and jointing at site and to seal spare lengths of cable. The packing should be able to withstand the rigorous of transport. The following information in bold letters in English shall be painted on the flanges.

- a. Name & Address of the manufacturer, Trade name/Trade mark/Brand
- b. ISI Marking
- c. Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., and year of manufacture.
- d. Length of cables (Meters)
- e. Direction of rolling
 - i) Net weight (in Kg)
 - ii) Gross weight (in Kg)
 - iii) Owners purchase order reference.

21.0 SEALING OF CABLE ENDS ON DRUMS:

21.1 The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a heat shrinkable or push-on or Tapex or cold shrinkable type cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

21.2 The three cores should have an overall heat shrinkable or push-on or Tapex or cold shrinkable type cap with adequate end clearance, and sufficient cushioning to prevent puncturing of the overall sealing cap due to stretching of the cores. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable. The ends of single core cables shall also be sealed on the same lines to prevent entry of moisture.

22.0 CABLE LENGTHS:

The cables shall be supplied in continuous lengths of 500 m or more with 5% tolerance and cable shall be on the wooden drums only.

23.0 QUANTITY TOLERANCE:

A +3% tolerance shall be allowed on the ordered quantity including 300-m cable as spare.

24.0 MARKING:

24.1 The packed cable drum shall carry the following information, clearly painted or stenciled.

- a. The letters 'RDSS, Name of Employer'
- b. Reference to Standard and ISI mark.
- c. Manufacturer's Name or trade mark.
- d. Type of cable & voltage grade.
- e. Number of cores.
- f. Nominal cross- sectional area of conductor.
- g. Cable code.
- h. Length of cable on the drum.
- i. Direction of rotation.
- j. Gross weight.
- k. Country of Manufacture.
- l. Year of Manufacture.
- m. Purchase order and date.
- n. Address of consignee.

25.0 GUARANTEED TECHNICAL PARTICULARS:

The manufacturer, shall furnish the guaranteed technical particulars of the cable

offered in the GTP format provided.

26.0 DRAWING & LITERATURE:

(i) The following shall be furnished along with the tender

Cross sectional drawings of the cables, giving dimensional details.

An illustrated literature on the cable, giving technical information, on current ratings, cable constants, short circuit ratings, de rating factors for different types of installation, packing date, weights and other relevant information.

27.0 GUARANTEE: The cable manufactured shall be guaranteed for the period of 18 months from the date of receipt at stores.

28.0 The Manufacturer shall furnish a copy of valid BIS licence for ISI marking without which the cable shall not be accepted.

GUARANTEED TECHNICAL PARTICULARS FOR 1.1 KV

	Manufacturer's Name		
	Class of Power Cable		
1	Name of the Manufacturer and country of origin		
2	Country of Manufacture		
3	Type of cable / cable code		
4	Applicable standard		
5	Voltage		
	a. Rated Nominal voltage		
	b) Rated Maximum voltage		
6	Suitability for :		
	a. Earthed system		
7	Conductor		
	a) Nominal cross section (sq.mm)		
	b) Material		
	c) Shape		
	d) Diameter of conductor (mm)		

	e) Number of wires per conductor (Nos.)		
	f) Nominal diameter of wire in conductor (mm)		
8	Insulation XLPE		
	a) Curing process (furnish details separately)		
	b) Material/Composition		
	c) Dia over insulation		
	i. Nominal (mm)		
	ii. Average (mm)		
	iii. Minimum (mm)		
9	Inner sheath		
	a) Type / composition		
	b) Material		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
10	Armouring		
	a) Material		
	b) Dia of wire		
	Nom. (mm)		
	Min. (mm)		
11	Outer sheath		
	a) Type / composition		
	b) Material		
	c) Nominal thickness		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
12	Anti-thermite treatment to outer sheath		
	a) Material		
	External overall dia of cable		
	Short circuit rating of conductor 90 deg. C operating temperature for 1 Sec.		
13	Minimum cable bending radius (in terms of cable diameter)		
14	Permissible maximum tension		
15	Continuous current rating under specified insulation conditions at conductor temperature of 65		

	deg. C and 90 deg. C.		
16	Ground Temperature 30 deg. C		
17	Thermal resistivity of soil 150 deg. C CM/W		
18	Depth of laying 200 mm		
19	Ambient Air temperature 40 deg. C		
20	No. of circuits 1 OR 2		
21	Spacing between two circuits		
22	Formation		
23	Maximum permissible conductor temperature fo continuous operation under specified installation conditions (deg. C)		
24	Conductor temperature at rated current (deg. C)		
25	Basic impulse level at conductor temperature of 90 deg. C (KV)		
26	Impulse wave shape		
27	Power frequency with stand voltage (KV)		
28	Tan Delta at 50 Hz (at U.KV and 90 (-5/+10) deg. C		
29	Sheath voltage at max. load		
30	Withstand voltage of sheath on spark test		
31	Permissible short circuit current ratings of conductor		
	i) 0.1 Sec KA		
	ii) 0.2 Sec KA		
	iii) 0.5 Sec KA		
32	Conductor resistance DC & AC		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 105 deg. C (d.c)/A.C. ohm/KM over load		

	temp) a.c. (ohm)		
33	Equivalent star resistance at 50 Hz of 3 phase current		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 10% continuous overload temperatur (ohm/KM)		
34	Star reactance at 50 hz (ohm/KM)		
	Approximate impedance at 50 hz per KM		
	a. at 20 deg. C ohm/KM		
	b. at 90 deg. C ohm/KM		
	c. at 10% continuous overload temperatur (ohm/KM)		
35	Self-electrostatic capacitance per phase (Micro farad/KM)		
36	Maximum power factor at charging KVA of cable when laid direct in ground at normal voltage & frequency		
	a) at ambient Temperature		
	b) at Maximum conductor Temperature		
37	Impedance		
	a) Positive and negative sequence impedance 37 (ohm/KM)		
	b) Zero sequence impedance (ohm/KM)		
	c) Zero sequence data		
38	Series reactance / Resistance		
	a) Series resistance (ohm/KM)		

	Series reactance (ohm/KM)		
	Shunt capacitive reactance (ohm/KM)		
39	Sheath resistance at 20 deg. C ohm/KM		
40	Surge impedance of cable (ohm/KM)		
41	IR value at ambient temperature per KM		
	Maximum magnitude of partial discharge at 1.5 U.o		
	At Ambient Temperature (Po)		
	At High Temperature (Po)		
	Losses per Km.		
	NOTE : (i) Cable Conductor size 400 sq. mm		
	a) Total 3 phase dielectric loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	b) Total 3 phase resistive loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	c) Total 3 phase sheath / screen loss		
	i. One circuit alive Kw/KM		
ii. Both circuits alive load KW/KM on each circuit			
42	d) Other losses due to reinforcement		
43	One circuit alive KW/KM		
44	Both circuits alive KW/KM on each circuit		
	Total losses		
	i. One circuit alive KW/KM		
	ii. Both circuits alive KW/KM		

	Charging current at rated voltage per Km (Amps)		
45	Short circuit capacity of conductor for one second at 90 deg. C prior to short circuit and 250 deg. C during short circuit (KA)		
46	Screening factor of cable for calculating interference on control and communication cables :		
	Approximate value of attenuation of carrier current signals operating over a frequency range		
	i. 50 KC/s- dB/KM		
	ii. 100 KC/s- dB/KM		
	iii. 150 KC/s- dB/KM		
47	Shipping weight and size of cable drum		
	a) Size of Drum		
	i. Dia of Drum (M)		
	ii. Width of Drum (M)		
	iii. Gross Weight (Kgs)		
	iv. Length of cable per Drum(M)		
	v. Weight of Cable (Kg/M)		

Current Rating Factor

Particulars	Single Point Bonded		Both End Bonded	
	65 deg. C Amps	90 deg C Amps.	65 deg. C Amps	90 deg. C Amps
Current Rating conductor size 400 Sq. mm				
a) In Ground				
i. Of each circuits (when both the circuits alive)				
b) In Duct				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				

c) In pipe, one cable per pipe.				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
d) In Air				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				

Derating Factors

1. VARIATION IN GROUND TEMPERATURE :							
Ground Temperature (deg. C) :	15	20	25	30	35	40	45
Rating Factor							
2. VARIATION IN DEPTH OF LAYING :							
Depth of Laying (Meters):	0.7	0.9	1.0	1.2	1.3	1.5	
Rating Factor							
3. VARIATION IN THERMAL RESISTIVITY OF SOIL							
Thermal Resistivity of Soil : (deg. C cm/watt)	100	120	150.0	200	250		
Rating Factor							
4. VARIATION IN AIR TEMPERATURE :							
Air Temperature (deg. C) :	25	30	35	40	45	50	55
Rating Factor							
5. VARIATION DISTANCE (MM) :							
Axial Distance (mm) Between circuits :	100	200	300.0	400	600	800	
Rating Factor							

16. AB CABLE

A. AERIAL BUNCHED CABLES FOR 33kV LINES

SCOPE:

This specification covers requirements of XLPE insulated, 33 kV Aerial Bunched Cables for overhead lines.

1. Qualifying Requirement of AB Cable Manufacturer/Supplier

The manufacturer should have manufactured, successfully type tested and supplied at least one hundred (100) kms of 33 kV or above voltage grade XLPE armoured and/or AB Cable in the last five (5) years as on the date of bid opening.

2. COMPOSITION OF THE CABLE

The Composite cable shall comprise three single-core cables twisted around a bare aluminium alloy messenger wire, which will carry the weight of the cable.

3. RATED VOLTAGE

The rated voltage of the cables shall be 33 kV and the maximum operating voltage shall be 36 kV.

4. APPLICABLE STANDARDS

Unless otherwise stipulated in this Specification, the following standards shall be applicable:

- i) IS: 7098 (part-II) – 1985 – Cross linked Polyethylene Insulated PVC Sheathed Cables.
- ii) IS:9130-1984-Conductors for Insulated Cables
- iii) IS: 398 (Part-IV) – 1979 – Aluminium Alloy Conductors.

5. DETAILS OF SINGLE CORE CABLE

5.1 The cable conductors shall be or round standard and compacted aluminium, of nominal cross sectional area 95 mm².

5.2 Conductor Screen

The conductor screen shall be of extruded semi-conducting cross linked polyethylene compound of thickness as per relevant IS.

5.3 Insulation

The Insulation shall be of extruded cross linked polyethylene (XLPE) of nominal insulation thickness as per relevant IS and its properties shall conform to IS:7098 (Part-II).

5.4 Insulation Screen

The insulation screen shall be as per IS:7098 (Part-II).

5.5 Outer Sheath

The outer sheath shall be black polyethylene.

6. MESSENGER (NEUTRAL CONDUCTOR)

- 6.1 The bare messenger wire shall be of 120 mm² (nominal area) aluminium alloy, generally conforming to IS:398 (Part IV) – 1979, comprising multi strands and shall be suitably compacted to have smooth round surface to avoid damage to the outer insulating sheath of single-core phase cables twisted around the messenger.
- 6.2 There shall be no joints in any wire of the stranded messenger conductor except those made in the base rod or wire before finally drawing.

7. TESTS

- 7.1 The following tests shall be carried out on the single-core cables as per IS-7098 (Part-II).

7.1.1 Type Tests

- a) Tests on conductor:
- i) Tensile test
 - ii) Wrapping test
 - iii) Resistance test
- b) Tests for thickness of insulation and sheath
- c) Physical tests for insulation:
- i) Tensile strength and elongation at break
 - ii) Ageing in air oven
 - iii) Hot test
 - iv) Shrinkage test
 - v) Water absorption
- d) Tests for outer sheath:
- i) Tensile strength and elongation at break
 - ii) Ageing in air oven
 - iii) Shrinkage test
 - iv) Hot deformation
 - v) Bleeding and blooming test.
- e) Partial discharge test
- f) Bending test
- g) Dielectric Power factor test:
- i) As a function of voltage
 - ii) As a function of temperature
- h) Insulation resistance test
- g) Heating cycle test
- k) High voltage test
- l) Flammability test

7.1.2 Acceptance Test

- a) Tensile Test
- b) Wrapping Test
- c) Conductor resistance test
- d) Test for thickness of insulation and sheath
- e) Hot set test for insulation
- f) Tensile strength and elongation at break test for insulation and sheath
- g) Partial discharge test
- h) High voltage test
- i) Insulation resistance (volume resistivity) test

7.1.3 Routine Tests

- a) Conductor resistance test
- b) Partial Discharge Test
- c) High voltage test

7.2 The following tests shall be carried out on the bare messenger wire in accordance with IS:398 (Part-IV).

Type Tests/Acceptance Test

- a) Breaking Load Test (on finished wire)
- b) Elongation Test
- c) Resistance Test

8. PACKING AND MARKING

8.1 Packing

Cables shall be supplied in returnable wooden drums conforming to IS: 10418. The standard length of the bunched cable in each drum shall be 250 meters (+/-) 10%. Other lengths may be acceptable subject to the approval of employer/purchaser.

8.2 Marking

The Cable drum shall carry the information as per the requirements of IS: 7098 (Part-II). However, exact details of marking/embossing, color of outer sheath etc. will be as per the detailed purchase order.

8.3 Suitable identification marks shall be given on the outer sheath to clearly distinguish three phases of the bunched cable.

AB CABLE

B. AERIAL BUNCHED CABLES FOR 11kV LINES

SCOPE : This specification covers requirements of XLPE insulated, 11kV Aerial Bunched Cables for overhead lines.

1.0 Qualifying Requirement of AB Cable Manufacturer/Supplier

The manufacturer should have manufactured, successfully type tested and supplied at least one hundred (100) kms of 11k V or above voltage grade XLPE armoured and/or AB cable in the last five (5) years as on the date of bid opening.

2. COMPOSITION OF THE CABLE

The composite cable shall compose three single-core cables twisted around a bare aluminium alloy messenger wire, which will carry the weight of the cable.

3. RATED VOLTAGE

The rated voltage of the cables shall be 6.35 kV/11kV and the maximum operating voltage shall be 12 kV

4. APPLICABLE STANDARDS

Unless otherwise stipulated in this specification, the following standards shall be applicable:

- i) IS:7098 (part-II) – 1985 – Cross linked Polyethylene Insulated PVC Sheathed Cables
- ii) IS:8130-1984-Conductors for Insulated Cables
- iii) IS:398 (Part-IV) – 1979 – Aluminium Alloy Conductors

5. DETAILS OF SINGLE CORE CABLE

5.1 The cable conductors shall be of round, stranded and compacted aluminium of nominal cross sectional area 35 mm² and 70 mm². Corresponding nominal conductor diameter and number of wires in the conductor shall be as given in clause 5.7.

5.2 Conductor Screen

The conductors screen shall be of extruded semi-conducting cross linked polyethylene compound of thickness not less than 0.5 mm.

5.3 Insulation

The Insulation screen shall be as per IS:7098 (Part II).

5.4 Insulation screen

The Insulation screed shall comprise extruded semi-conducting compound and/or semi- conducting tape. Thickness of the screen shall be not less than 0.6 mm.

5.5 Outer Sheath

The outer sheath shall be black polyethylene. The nominal thickness of sheath shall be 1.8mm and it shall conform to the technical requirements of ST-3 of EIC-502

5.6 Dimensional and Electrical Data

The Dimensional and Electrical Data for single –core cable is given below:

S.No.	Description	Nominal area of conductors	
		35 mm ²	70mm ²
I.	Nominal conductor diameter(mm)/No. of wires in conductor	6.8/6	10/12
II.	Approx over dia of cable (mm)	22	25
III.	Max D.C. resistance at 200c Ohm/Km	0868	.443
IV.	Max SC current for 1 Sec. KA	3.4	6.7
V.	Max continuous load (amps)	106	156

Note: Due to limitation of short circuit current rating, it is recommended that 70mm² cable is used the base line for the first 4-5kms from the 33/11kV substation and thereafter the lower size of cable i.e. 35mm² can be used depending upon the line loading .Normally the current loading of 70mm² cable should not exceed 145amps and that of 35mm² cable as 95 amps .For a maximum ambient temperature of 50⁰C.

6. MESSENGER (NEUTRAL CONDUCTOR)

- 6.1 The bare messenger wire shall be of 70 mm² (nominal area) aluminium alloy, generally conforming to IS:398 (Part IV) – 1979, comprising of seven(7) strands and shall be suitably compacted to have smooth round surface to avoid damage to the outer insulating sheath of single-core phase cables twisted around the messenger.
- 6.2 There shall be no joints in any wire of the stranded messenger conductor except those made in the base rod or wire before finally drawing.
- 6.3 The technical characteristics of messenger wire shall be as follows:

i.	Nominal sectional area(mm ²)	70
ii.	Nos. of wire	7
iii.	Nominal dia of wires /compacted conductor (approx.)mm	3.5/10
iv.	Approx. Mass kg/Km	184
v.	D.C resistance at 20°C Ohm/Km	0.493
vi.	Breaking load(KN)	20
vii.	Modulus of elasticity (approx) KN/mm ²	59
viii.	Coefficient of linear expansion	23X10 ⁻⁶ oC

Note: the value of item v above is to be guaranteed. A tolerance of (-) 5% is permissible on the value in item vi above.

7. DESIGNATION AND PARAMETER OF FINISHED CABLES

The designation and parameter of finished cables are given in the following table:

S.N o.	Designation	Complete bunched cables	
		Overall approx mm	dia Total mass(Approx.)Kg/Km
I.	3 x 35+70	53	1450
II.	3 x 70+70	59	1900

Note: the first part of the designation refers to the number and size of phase conductor and the second to the size of messenger wire .The sizes shown represent the nominal cross sectional area in mm.

8. TESTS

8.1 The following tests shall be carried out on the single-core cables as per IS-7098 (Part-II).

8.1.1 Type Tests

- a) Tests on conductor:
 - i) Tensile test
 - ii) Wrapping test
 - iii) Resistance test
- b) Tests for thickness of insulation and sheath
- c) Physical tests for insulation:
 - i) Tensile strength and elongation at break
 - ii) Agency in air oven
 - iii) Hot test
 - iv) Shrinkage test
 - v) Water absorption
- d) Tests for outer sheath:
 - i) Tensile strength and elongation at break
 - ii) Ageing in air oven
 - iii) Shrinkage test
 - vi) Hot deformation
 - vii) Bleeding and blooming test.

- e) Partial discharge test
- f) Bending test
- g) Dielectric Power factor test:
 - i) As a function of voltage
 - ii) As a function of temperature
- h) Insulation resistance test
- g) Heating cycle test
- k) High voltage test
- l) Flammability test

8.1.2 Acceptance Test

- a) Tensile Test
- b) Wrapping Test
- c) Conductor resistance test
- d) Test for thickness of insulation and sheath
- e) Hot set test for insulation
- f) Tensile strength and elongation at break test for insulation and sheath
- g) Partial discharge test
- h) High voltage test
- i) Insulation resistance (volume resistivity) test

8.1.3 Routine Tests

- a) Conductor resistance test
- b) Partial Discharge Test
- c) High voltage test

8.2 The following tests shall be carried out on the bare messenger wire in

accordance with IS:398 (Part-IV).

Type Tests/Acceptance Test

- a) Breaking Load Test (on finished wire)
- b) Elongation Test
- c) Resistance Test

9. PACKING AND MARKING**9.1 Packing**

Cables shall be supplied in returnable wooden drums conforming to IS: 10418. The standard length of the bunched cable in each drum shall be 1000 meters (+/-) 10%. Other lengths may be acceptable subject to the approval of employer/purchaser.

9.2 Marking

The Cable drum shall carry the information as per the requirements of IS: 7098 (Part-II). However, exact details of marking/embossing, color of outer sheath etc. Will be as per the detailed purchase order.

- 9.3** Suitable identification marks shall be given on the outer sheath to clearly distinguish three phases of the bunched cable.

GUARANTEED TECHNICAL PARTICULARS FOR 1.1 KV

	Manufacturer's Name		
	Class of Power Cable		
1	Name of the Manufacturer and country of origin		
2	Country of Manufacture		
3	Type of cable/ cable code		
4	Applicable standard		
5	Voltage		
	a. Rated Nominal voltage		
	b) Rated Maximum voltage		
6	Suitability for:		
	a. Earthed system		
7	Conductor		
	a) Nominal cross section (<u>sq.mm</u>)		
	b) Material		
	c) Shape		
	d) Diameter of conductor (mm)		
	e) Number of wires per conductor (Nos.)		
	f) Nominal diameter of wire in conductor (mm)		
8	Insulation XLPE		
	a) Curing process (furnish details separately)		
	b) Material/Composition		
	c) Dia over insulation		
	i. Nominal (mm)		
	ii. Average (mm)		
	iii. Minimum (mm)		
9	Inner sheath		
	a) Type / composition		
	b) Material		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
10	Armouring		
	a) Material		
	b) Dia of wire Nom. (mm)		
	Min. (mm)		
11	Outer sheath		

L.T. AERIAL BUNCHED CABLE
(3x120+1x95+1x16 SO MM)

1. SCOPE:

This specification provides for manufacture, testing & supply of Aerial Bunched Cable (3x120+1x95+1x16) mm² as per the quantities mentioned.

- 1.1.** It is not the intent to specify completely herein all the details of the design and construction of material. However the material shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith.

2. STANDARDS:

This Aerial Bunched Cable shall comply with the following standards with latest amendments unless otherwise stipulated in this specification.

- | | |
|----|---|
| 1 | IS: 7098-Part-I XLPE Cable |
| 2 | IS: 8130-Conductors for cable |
| 3 | IS: 398 (Part-IV)-Aluminium Alloy Conductors |
| 4 | IS: 10810- Test methods |
| 5 | IS: 5484-E.C. Grade Aluminium Rods |
| 6 | IS: 9997- Aluminium Alloy Rods |
| 7 | IS:IEC: 207- Aluminium Alloy Standard Conductor |
| 8 | IS:IEC: 502: Excluded Solid Di-electric insulated Cable |
| 9 | IS:IEC: 540 Test methods for insulation & sheath of cable |
| 10 | IS: 14255:1995 for Aerial Bunched Cable |
| 11 | IS: 10418:1982 Drums of electric Cables |

3.0 CONSTRUCTION OF L.T. AERIAL BUNCHED CABLE:

MAIN FEATURES:

The ABC cables shall be of LT 1.1 kV Grade, stranded compacted, high conductivity, aluminum conductor, XLPE insulated, conforming to relevant standards suitable for LT AC three phase, 50 c/s, effectively earthed distribution system.

In the ABC System, the insulated conductors are twisted around the bare Aluminium Alloy messenger conductor.

3.1 PHASE CONDUCTOR/STREET LIGHT CONDUCTOR:

The Phase conductors are made of hard drawn Aluminium wires having tensile strength not less than 90N/mm² Stranded circular compacted Aluminium Conductor is Insulated with cross-linked polyethylene (XLPE). Three such phase conductors and street light conductors are twisted around bare stranded Aluminium Alloy Messenger Conductor of size 95 mm²

The power/outer insulated neutral/street lighting conductors shall be made from stranded Aluminium to form compact circular conductor having resistance within limits as specified in table-2 of IS: 8130/1984 and any amendment there of. **The total Minimum Guaranteed weight of Aluminium in phase as well as Street**

light conductors shall be 1016.3 kg/ km.

3.2 CONSTRUCTION:

- 1) All materials used in the manufacture of cable shall be new, unused and of finest quality. All materials shall comply with the applicable provisions of the tests of the relevant Standards.
- 2) The XLPE material used in the manufacture of cable shall be of reputed make. The purchaser reserves the right to ask for documentary proof of the purchase of various materials to be used for the manufacture of cable and to check that the conductor is complying with quality control.
- 3) The XLPE insulating material should be UV resistant weather proof. Black carbon content should be minimum 2.5% - 3% as per IS: 14255.
- 4) A sample of the material supplied by the manufacturer may be sent by the purchaser for type testing at the Govt. approved test lab at the cost of the contractor which shall be refunded in case sample passes the type test otherwise no refund shall be made and the supplied material shall be rejected and contractor/ manufacturer shall be debarred from participation in further three consecutive tenders.

3.4 CORE IDENTIFICATION: For the identification of individual cores longitudinal ridges or number printing over cores shall be used at regular intervals to identify phase conductors.

3.5 MESSENGER/NEUTRAL CONDUCTOR:

Messenger/Neutral Conductor is made of Aluminium Alloy Consisting of 7 strands each having tensile strength not less than 294 N/mm² with elongation 4% and suitably compacted to smooth round surface to avoid damage to XLPE Insulation of phase conductor. The conductor shall be of heat treated aluminium-magnesium-silicon alloy wires containing approximately 0.5 percent magnesium and approximately 0.5 percent silicon conforming to IS: 398 (Part-IV)-1979. There shall be no joints in any wire of messenger conductor except those made in base rod or wires before final drawing. The direction of the outer layer of wires in messenger conductor shall be right hand. **The Minimum Guaranteed weight of messenger wire (Aluminium alloy) shall be 256.7 kgs/ km.**

4.0 INSULATION:

The XLPE Insulation shall be suitable for specified LT System voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical stress under steady state and transit operating conditions.

5.0 The insulation of the cable shall be of high standard quality and conform to clauses 11 of IS: 7098 (Part-1)/1985 of test amendment thereof.

The make of XLPE material to be used by manufacturer in production of ordered LT ABC shall be as follows:

Sl. No.	Make
1.	M/s Kalpana Industries
2.	M/s Polylink Polymer, Vadodra
3.	M/s Borealis Polymer Industries.
4.	M/s Sun Petrochemicals Pvt. Ltd., Mumbai.
5	M/s DOW

6.0 WORKMANSHIP AND QUALITY ASSURANCE

The workmanship shall be neat clean and of highest grade/quality.

7.0 CURRENT RATING

The Conductor will have current rating and derating factors as per relevant Indian Standards.

7.1 The current rating shall be based on maximum conductor temperature of 90⁰ c with ambient site conditions specified in General Requirement of specification for continuous operation at the rated current.

8.0 OPERATION

8.1 Cable shall be suitable for laying overhead.

8.2 Cable shall have heat and moisture resistant proven with proven record of distribution network service.

9.0 LENGTHS

The cable shall be supplied in standard drum lengths i.e. 500 ±5% meters Non-standard lengths of not less than 100 meters is acceptable. Total non-standard length should not exceed 5% of the ordered quantity.

10.0 PACKING

The cable shall be supplied on non-returnable wooden drums of heavy standard construction conforming to IS: 10418: 1982 and latest amendment thereof and being suitable for transport by goods train or truck and for storage at site. The wood used for construction of the drums shall be properly seasoned and wood preservative shall be applied to the entire drum.

All ferrous parts shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit of storage. Each drum shall have the following information marked on its with indelible in along with other important information including technical date:-

- I) PVVNL. Specn. No.
- II) Consignee & Destination Railway Station
- III) Trade name of trademark .if any
- IV) Name of the manufacturer
- V) Nominal sectional area of the conductor of the cable
- VI) Drum No.
- VII) No. of cores
- VIII) Type of cable & Voltage for which it is suitable
- IX) Gross weight of the drum (Approx.)
- X) Length of cable in the drum with individual lengths if more than one.
- XI) Net weight of the cable

XII) ISI certification mark, if available

A layer of waterproof paper shall be applied to the surface of the drum and over the outer cable layer. A clear space of at least 40 mm shall be left between the cable and the lapping. The packing shall be adequate to protect the cable from damage in transit and contractor shall be responsible for it and make good at his own expenses any and all damage due to improper packing etc.

11.0 IDENTIFICATION MARKING:

For the identification of individual cores longitudinal ridges or number printing over cores used to identify phase conductors.

EMBOSSING:

The manufacturer shall emboss

- 11.1** Property of PVVNL
- 11.2** Name of manufacturer
- 11.3** Year of Manufacturer
- 11.4** Specification No.
- 11.5** Voltage grade and
- 11.6** Size of cores at the interval of one-meter length throughout the length of the cable.

The identification embossing shall be done on only one of the insulated phase conductor.

12.0 GUARANTEED TECHNICAL PARTICULARS:

The guaranteed technical particulars as detailed in the specification shall be guaranteed and a statement of guaranteed technical particulars shall be furnished in the format along with the bid **without which the Bid shall be treated as Non -Responsive.**

13.0 TEST CERTIFICATE:

The tenderer shall furnish an authenticated copy of results of successful type test report. The successful type test report as carried out over the cable of same design, size, type & manufacturing process during last five years (Counted from the date of tender opening) testing laboratories of CPRI/ERDA/NTH shall be acceptable

The purchaser reserves the right to get the cable type tested at any stage during the pendency of the contract at its own expenses in any government recognized testing laboratory.

The transportation and arrangement of testing of sample to test laboratory shall be responsibility of the contractor.

14.0 INSPECTIONS AND TESTING

- 14.1** The inspection shall be carried out by the purchaser's representative during manufacture and before dispatch. The supplier shall keep the purchaser informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

The manufacturer shall grant free access to the purchaser's representative, at a reasonable time, when

the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser, shall not relieve the supplier of his obligation of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

- 14.2** All Acceptance tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the Bidder and purchaser at the time of purchase.

The purchaser reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items. The supplier shall give 15 days (for local supply)/ 30 days (incase of foreign supply) advance intimation to enable the purchaser to depute his representative for witnessing the acceptance and routine tests. Material shall be dispatched only after getting the dispatch authorization from Inspectors representing purchaser, after successful testing.

- 14.3** If successful type tests have been carried out on the offered design during last five years (counted from the date of tender opening), repetition of type tests is not required.

On the other hand, if the offered design is not type tested during last five years, the cable shall be subjected to all type test in accordance with IS: 1554 (Part-I)/1988 and amendment thereof at recognized test house of repute. All charges/fee/transportation etc. to conduct these tests shall be borne by Contractor.

Regular supply of the material shall commence only after successful type testing and dispatch authorization from the competent authority.

However, the purchaser reserves the right to get cable type tested at any stage during the currency of contract at his own expenses in any reputed test house. The transportation and arrangement of testing of sample to test laboratory shall be the responsibility of the contractor.

- 14.4** Routine tests report shall be sent by the manufacturers with their offer for inspection, the acceptance tests as laid down in the referred ISS (with latest amendments) shall be carried out by the inspecting officer of the PVVNL on Samples selected at random.

15.0 CHECKING OF CABLE LENGTH

Sufficient facilities should exist at contractor's premises to measure the cable length by the inspecting officers For this purpose motorized system to facilities quick measurement should be available at works.

17. XLPE Power Cables (11kV & 33 kV)

STANDARD TECHNICAL REQUIREMENT

1.0 SCOPE:

This section covers the standard technical requirements of design, manufacturing, testing, packing and dispatching of 11 kV and 33 kV XLPE HT Power Cable.

2.0 APPLICABLE STANDARDS

The materials shall conform to the latest editions of the following Indian/International Standards :

IS 7098 Part 2 : 1985 XLPE insulated PVC sheathed cables For working voltages from 3.3 kV up to and including 33 kV

IS 5831 : 1984 PVC Insulation and Sheath of electric Cables

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

613:1984 Copper rods and bars for electrical purposes.

IS 3975:1988 Mild steel wires, formed and tapes for armouring of cable. IS

10810:1984 Method of tests for cables.

IEEE-383:1974 Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.

ASTM-D2843,1993 Standard test method for density of smoke from burning or decomposition of plastics.

ASTM-D2863, 1991 Standard test method for measuring minimum oxygen concentration to support candle - like combustion of plastics (oxygen index).

NEMA-WC5,1992 Thermoplastic Insulated Wire and cable for the transmission and distribution of Electrical Energy.

IEC:754 Test on gases evolved during combustion of electric cables -

(Part-1):1994 Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables.

IEC:332 Test on electric cables under fire conditions

(Part I):1993 Test on a single vertical insulated wire or cable. IS 3961

Recommended current rating for cables -

(Part II):1967 PVC insulated and PVC sheathed heavy duty cables.

IS 10418:1982 Drums for electric cables.

3.0 GENERAL REQUIREMENTS

All cables shall be suitable for high ambient, high humid tropical Indian Climatic conditions. Cables shall be designed to withstand the mechanical, electrical and thermal stresses under the unforeseen steady state and transient conditions and

shall be suitable for proposed method of installation.

Conductor shall be of uniform, of good quality, free from defects Aluminium copper.

Insulation shall be Cross Linked Polyethylene (XLPE) .

For 33 kV and 11 kV cables, conductor screen and insulation screen shall both be extruded, semi-conducting compound and shall be applied along-with XLPE insulation in a single operation by triple extrusion process. Method of curing for 33 kV cable shall be "Dry curing/ gas curing " only, whereas for 11 kV and 3.3 kV cables it shall be "Dry curing/ gas curing / Steam curing".

Extruded Semi-conducting screening and metallic screening of copper tape shall be generally as per IS 7098 (Part-II) with latest amendments. The semi conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

The insulation screen shall be an extruded layer of black semi-conducting compound and continuously covers the whole area of insulation. The semi-conducting screens should be effectively cross linked to achieve 90 ° C cable rating. The contact surface between insulation and insulation screen shall be smooth and free from protrusion and irregularities.

The interface between insulation and insulation screen shall be free of any voids. Insulation screen shall be strippable type.

The metallic screen shall consist of a layer of copper cable applied in helical form. Inner sheath - All armoured and multi-core un-armoured cables shall have distinct extruded inner PVC sheath of black colour.

Armouring - Material for armour for Single Core Cable shall be Aluminum wire. For Multicore cable it shall be GS wire / flat. Armouring shall be as per relevant IS and it shall have minimum 90% coverage.

Breaking Load of the joints shall be minimum 95% of the normal armour.

Outer Sheath – It shall be of black colour PVC (type ST2 as per IS 5831) with Cable size and Voltage grade embossed on it. Sequential marking shall be at every 1 (one) Meter distance. Word "FRLS" shall also be embossed on it at every 5 (Five) meter distance.

FRLS Properties - All cable shall be Flame Retardant, Low Smoke (FRLS) type.

Outer sheath shall have the following properties –

Acid Gas Generation – Max 20% (as per IEC 754-1)

Smoke density rating: 60% (As per ASTM D 2843)

Flammability test - As per Swedish chimney test F3 as per SEN 4241475

As per IEC 332 part-3 (Category B)

Minimum bending radius shall be 10 D

Repaired cables shall not be acceptable.

4.0 CURRENT RATING OF CABLES

- 1) Normal current rating shall not be less than that covered by IS 3961. Vendor shall submit data in respect of all cables in the prescribed format.
- 2) Tables given de-rating factors for various conditions of cable installation including the following, for all types of cables shall be furnished.
 - Variation in ambient air temperature. - Variation in ground temperature.
 - Depth of laying.
 - Cables laid in the ground - Cables laid in trench
 - Cables laid in ducts - Soil resistivity.
 - Grouping of cables.
- 3) The value of short circuit withstand current ratings of all cables shall be indicated for a short circuit for 1 second duration and should also specify the maximum temperature during short circuit.
- 4) The following factors shall also be accounted for, while specifying the maximum short circuit withstand of the cables.
- 5) Deformation of the insulation, due to thermo-mechanical forces produced by the short circuit conditions, can reduce the effective thickness of insulation.
- 6) Conductor and core screens can be adversely affected with loss of screening effect. Likewise the thermal properties of the outer sheath material can be the limitation.
- 7) It is essential that the accessories which are used in the cable system with mechanical and/or soldered connections are suitable for the temperature adopted for the cables.
- 8) Formula for calculating short circuit current for different duration or curve showing short time current v/s time for different sizes of cables shall be furnished by vendor.

5.0 CABLE DRUMS

5.1 Cables shall be supplied in non-returnable wooden, or steel drums of heavy construction and drum shall be properly seasoned, sound and free from defects. Wood preservative shall be applied to the entire drum.

5.2 All Power Cables shall be supplied in drum length of 200/300/500m as per requirement of utility/Discom.* Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. The

cable length per drum is allowed a tolerance of $\pm 5\%$. The tolerance allowed on total quantity of each size is as given below.

- 3.1 50 meters for cable length upto 10 kms.
- 3.2 100 meters for cable length more than 10 kms. and up to 20 kms.
- 3.3 150 meters for cable length more than 20 kms.

Where the ordered quantity is not multiple of 1000 m and the incremental quantity is very small, the same may be included in one of the drums. Otherwise, an additional length for the incremental quantity will be supplied.

* Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091
Dated 25.08.2017

- 5.3 A layer of waterproof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 5.4 A clear space of at least 40mm shall be left between the cables and the logging.
- 5.5 Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wordings shall be marked on one end of the reel indicating the direction in which it should be rolled.
- 5.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

6.0 TESTS

6.1 Type Tests

The following shall constitute type tests:

- i) Tests on conductor
 - a. Annealing test (for copper)
 - b. Tensile tests (for aluminum)
 - c. Wrapping tests (for aluminum)
 - d. Resistance test
- ii) Tests for armouring wires/strips
- iii) Test for thickness of insulation and sheath

- iv) Physical tests for insulation
 - a. Tensile strength and elongation at break
 - b. Ageing in air oven
 - c. Hot test
 - d. Shrinkage test
 - e. Water absorption (gravimetric)
- v) Physical tests for out sheath
 - a. Tensile strength and elongation at break
 - b. Ageing in air oven
 - c. Hot test
 - d. Shrinkage test
- vi) Partial discharge test
- vii) Bending test
- viii) Dielectric power factor test
 - a. As a function of voltage
 - b. As a function of temperature
- ix) Insulation resistance (volume receptivity) tests
- x) Heating cycle test
- xi) Impulse withstand test
- xii) High voltage test
- xiii) Flammability test

6.2 Acceptance tests

The following shall constitute acceptance tests:

- a. Annealing test (for copper)
- b. Tensile test (for aluminum)
- c. Wrapping tests (for aluminum)
- d. Conductor resistance test,

- e. Test for thickness of insulation
- f. Hot set test for insulation,
- g. Tensile strength and elongation at break test for insulation and sheath
- h. Partial discharge test (for screened cables only)
- i. High voltage test and
- j. Insulation resistance (volume resistivity) test

6.3 Routine test

The following shall constitute routine tests:

- i) Conductor resistance test
- ii) Partial discharge test (for screened cables only) and
- iii) High voltage tests.

6.4 Optional tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests.

SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES.

1.0 SCOPE

This section of the specification covers project information, site condition, desired Technical parameters, and quantity of XLPE Cable.

1.1 Project Information

- a. Customer:
- b. Engineer/Consultant:
- c. Project Location:
- d. Transport facilities
 - i) Nearest Railway station: /Gauge
 - ii) Distance from site:
- e. Access Roads:

1.2 SITE CONDITIONS

- (i) Ambient air temp. (max.) °C :
- (ii) Ambient air temp. (min.) °C :
- (iii) Design ambient temp. °C :

- 1.2.1 Relative humidity for design : purposes
- 1.2.2 Height above mean sea level in : meters
- 1.2.3 Earth quake data

- i) Seismic zone : IS:1893-84
- ii) Seismic acceleration : As per IS 2.2.4

- 1.2.4 Wind data
Site Wind Pressure Kgf/m² : As per IS 2.3

1.3 System Particulars

a.	Line Voltage (kV)	11/33
b.	Highest System Voltage (kV)	12/36
c.	Number of Circuits	1
d.	Frequency	HZ50
e.	Neutral	effectively earthed
f.	Short circuit level (KA)	22.77 KA, 31.8KA / 22.5KA,45KA

1.4 SPECIFIC TECHNICAL REQUIREMENTS

Technical Parameters of the cable shall be as follows:

S. No.	PARTICULAR	Unit	DATA	DATA
1	Rated Voltage	kV	6.35/11	19.0/33
2	Type of Insulation	-	XLPE	XLPE
3	Single core/ Multi core	-	Single/Three core	Single/Three core
4	Armoured / Unarmoured	-	Armoured	Armoured
5	Material of Conductor	-	Aluminium/Copper	Aluminium/Copper
6	System	-	11 kV Earthed	33 kV Earthed
7	Highest System Voltage	kV	12	36
8	Conductor size	sq. mm	120, 150, 185, 240, 300, 1000	150, 185, 240, 300, 400
9	Material		Stranded Aluminium/copper	Stranded Aluminium/copper
10	Shape of Conductor		Circular	Circular
11	Short Circuit Current	kA	13.12, 18.35 for 3 secs.	13.12, 26.24 for 3 secs
12	Power Frequency	KV rms	28	70

Employer's Requirements			592	
13	Withstand Voltage Lightning Impulse Withstand Voltage	kVp	75	170
14	Continuous Withstand Temperature	Deg C	90	90
15	Short Circuit withstand Temperature	Deg C	250	250
16	Oxygen Index		Min 29 (as per ASTMD 2863)	Min 29 (as per ASTMD 2863)
17	Acid Gas Generation		Max 20% (as per IEC 754-1)	Max 20% (as per IEC 754-1)
18.	Smoke Density Generation		60% (As per ASTMD 2843)	60% (As per ASTMD 2843)
19.	Flammability Test		As per Swedish Chimney test	As per Swedish Chimney test

**SECTION-III
GUARANTEED TECHNICAL PARTICULARS**

Sl. No.	Item Particulars	Unit
1	Manufacturers Name & Address	
2	Country of manufacturer	
3	Type of cable	
4	Applicable standards for manufacturing	
5	Applicable standards for testing	
6	Rated voltage	kV
7	Maximum service voltage	kV
8	Maximum continuous current carrying capacity per cable when lain in air at an ambient air temperature of 50 deg. (single core cables solid bonded)	A
9	Maximum continuous current carrying capacity per cale when lain in ground at a depth of 1.0 m (ground temp. 40 deg. C and soil thermal resistivity of 150 deg.c/watt/cm max. Conductor temp. 90 deg. C) (single core cables solid bonded)	A

10	Maximum continuous current carrying capacity per cable when drawing into duct./pipes (single core cables solid bonded)	A
11	Maximum continuous current carrying capacity per cable	A
Sl. No.	Item Particulars	Unit
	when lain in covered RCC trenches at an ambient temperature of 50 Deg. C laying conditions to be specified (Single core cables solid bonded)	
12	Short circuit withstand capacities for 1 second of (With a conductor temperature of 90 Deg. C at the commencement	
i)	Conductor	KA
ii)	Screen	KA
iii)	Armour	KA
13	Conductor	
i)	Material & Grade	
ii)	Nominal cross – sectional area	sq.mm
iii)	No. of strands	
iv)	Diameter of each strand (Nominal)	mm
v)	Max. DC resistance of conductor at 20 Deg. C	ohm/km
vi)	Max. AC resistance of conductor at 90 Deg. C	ohm/km
14	Reactance of cable at normal frequency (Approx)	ohm/km
15	Electrostatic capacitance at normal frequency	microrfarads per km
16	Charging current	
17	Loss tangent at normal frequency at U _o	
18	Conductor screen	
i)	Material	
ii)	Nominal thickness	mm
19	XLPE Insulation	
i)	Composition	
ii)	Type of curing	
iii)	Thickness of insulation (nominal)	mm
iv)	Tolerance on thickness	mm
v)	Dielectric constant at normal frequency	
vi)	Specific insulation resistance at 20 deg. C	ohm/km
vii)	Min. Volume resistivity at 20 deg. C	
viii)	Min. volume resistivity at 90 deg. C	
ix)	Min. Tensile strength	kg/sq.cm
x)	Min. Elongation percentage at rapture	%
xi)	Identification of cores	

20	1.2/50 microsecond impulse wave withstand voltage	kVp
21	5 min. power frequency withstand voltage	kV
22	Max. Dielectric stress at the conductor	kV/cm
23	Max. Dielectric stress at the conductor screen	kV/cm
24	Insulation screen	
i)	Material	
ii)	Extruded/wrapped	
iii)	Nominal thickness	mm
iv)	Colour	
25	Metallic screen	
i)	Material / composition	
ii)	Nominal radial thickness / dia	
26	Nominal diameter over metallic screen	mm
27	Nominal radial clearance allowed under metal sheath	mm
28	Type and material of filler	
29	Armour	
i)	Material and type	
ii)	Dia	

18. 10kVA 1-Phase, 16 KVA (1/ 3-Phase) & 25 KVA 3-Phase L.T. Distribution Box (with MCCBs)

1. SCOPE:

This specification covers the design, manufacture, inspection, testing at manufacturer place and supply of L.T. Distribution Box with energy meter. Distribution Boxes shall be used for controlling the L.T. feeders from the L.T. side of Distribution Transformers. The system shall be A.C. 3phase, 4 wires, 433V or AC single phase 2 wire, 230V, 50 Hz with effectively grounded neutral.

2. SERVICE CONDITIONS:

The equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the climatic conditions of the State.

3. SYSTEM DETAILS:

Distribution Boxes are meant for metering, control and protection of Distribution Transformers with relevant parameters as under:

S.No.	Transformer Capacity kVA	Full Current Amps	Incoming Circuit Configuration	Outgoing Circuits Configuration
1	10 KVA (1-Phase)	43 Amp	45 A SPN MCCB	2 x 32A SP MCCB
2	16 KVA (1-Phase)	70 Amp	80 A SPN MCCB	2 x 50 A SP MCCB
3	16 KVA (3-Phase)	22 Amp	25 A TPN MCCB	6 x 16 A SP MCCB
4	25 KVA (3-Phase)	34 Amp	40 A TPN MCCB	6 x 25A SP MCCB

Each Distribution box shall have provision for fixing of three phase tri-vector energy meter/single phase meter for DT metering depending upon capacity and type of transformer, 1No. single pole Neutral (SPN)/Three Pole Neutral (TPN) MCCB at incoming and 2 & 6 Nos. single pole MCCB at outgoing circuit as per above table. Incoming and Outgoing MCCB shall be connected through insulated connectors. Cable from the Distribution Transformer shall be connected to the incoming MCCB through energy meter. Cables from the outgoing terminals of the incoming MCCB shall be connected respectively to the R-Y-B Phase and Neutral terminals of the insulated bus bars or insulated Multiple Outgoing Connectors. Cables from insulated bus bars or insulated Multiple Outgoing Connectors shall be connected to the outgoing MCCBs.

Aluminium cable of 16mm² for 10 KVA / 16KVA and 35mm² for 25KVA transformer shall be used. Cable shall be fixed with bus bar or connectors with minimum two screws of size not less than M6. Insulation provided shall be such that no live part including the screws for holding the cable shall be accessible by hand/finger.

4. MCCB:

MCCB shall be of reputed make and shall conform to latest IS. MCCB shall be of fixed rating type. MCCB shall have rated service short circuit breaking capacity of 10 KA at 0.4 P.F. (lag) with rated insulation voltage of 660 V. The time current characteristics of MCCB shall be as per the following details:

Multiple of normal Current Setting	Tripping Time
1.05	More than 2.5 hrs.
1.2	More than 10 minutes and less than 2 hrs.
1.3	Less than 30 minutes
1.4	Less than 10 minutes
Multiple of normal Current Setting	Tripping Time
2.5	Less than 1 minute
6.0	Less than 5 Seconds

For above test, the reference calibration temperature of the MCCB shall be 50⁰C.

5. ENCLOSURE:

- (i) The enclosure shall be made up of CRCA MS sheet of 18 SWG sheet thickness for 10/16KVA single phase and of 16SWG for 16/26KVA three phase. The manufacturing process of Box shall be Deep Drawn Process /Sheet Bending Process.
- (ii) The inside dimensions of Distribution Box shall be 300 x 500 x 160mm for 10 & 16 kVA single phase transformer and 1000 x 500 x 170 mm for 16 & 25 kVA three phase Transformer. However, the dimensions of the box is for reference only, internal clearance as per our requirement shall be strictly maintained. Overall dimensions of the box shall be such that the box will withstand temperature rise limits as per IS and Company's Specification and to have sufficient space for working during maintenance. The size of the box will depend on the size of Electrical components and other relevant provision made in IS:13947/(P1,2&3), IS 2086 and IS:4237 with latest amendment if any. Adequate slope on the top of box (as shown in the drawing) shall be provided to drain out rainwater from the top. The body and door of enclosure shall be individually in one piece without any welding, except for fixing of the accessories like hinges, clamps, mounting clamps, bolts etc. which shall be spot welded or MIG welded only. The door of Distribution box shall be fixed on three tamper proof inside hinges not

visible from outside. Hinges shall be welded from inside of the box and door shall be fixed with the two screws in each hinge. Hinges shall be made from 1.6mm MS sheet with hinge pin of diameter 3mm. The hinge pin shall have head on top so that it does not fall down during the normal usage. Base and door shall have flange / collars as shown in drawing. Collar of Base and door shall overlap by minimum 8mm. Rubber gasket shall be provided in between base and doors, such that it provides proper sealing between the door and base of box to avoid ingress of water. Degree of protection shall be **IP- 33** as per IS-13947 (amended up to date). Rubber Gasket shall be fixed with suitable adhesive. Two numbers 'U' shaped latch arrangement shall be provided to Seal the door with body for 10/16KVA single phase and three numbers 'U' shaped latch arrangement shall be provided for 16/25KVA three phase. 2.5mm & 8mm diameter hole shall be provided in U-shaped latch for sealing wires & padlock. Holes provided for sealing & padlock should be aligned when latch is in closed position. 'U' shaped latch arrangement shall be made from 1.6 mm thick MS sheet and shall be welded from inner side of the box. U-latch shall be joined with stainless steel rivet.

- (iii) Viewing window opening of 80mm x 90mm shall be provided with toughened glass of 5mm thickness as shown in drawing. Size of glass shall be 100mm x 110mm. Glass shall be provided with a wraparound single piece rubber gasket (without joint) having minimum depth of 8mm made from good quality rubber so that it can withstand weather effect. Glass along with rubber gasket shall be fixed from inside of the door of distribution box with powder coated glass holder made of 20 SWG MS sheet without any welding joint and by draw process. Glass holder shall be fixed with minimum four welded screws & nuts from inside and not visible from outside.
- (iv) Mounting arrangement of the meter shall be as shown in the drawing. It should be raised from the base of box by 15mm (minimum). It should be suitable for different makes of meters. Galvanized/Zinc Plated adjustable strip shall be provided on meter mounting arrangement for fixing of the meter. Three mounting MS screws, one for upper hanger (M4 threads x length 12mm) & two (M4 threads x 25 or 35mm length) in moving slotted flat shall be provided for fixing of the meter.
- (v) Two sets of Louvers (One set on each side) shall be provided. The perforated sheet of 20 SWG CRCA MS shall be welded from inside of the louvers.
- (vi) The surface of the enclosure shall be properly Pre-treated / Phosphated in a 7-Tank process and shall be applied with a powder coating of about 40 micron thickness. The powder coating shall be of Light Admiralty Grey colour shade (IS-5:1993 Colour No. 697). Powder coating shall be suitable for outdoor use. Rating and Type of distribution box shall be printed or embossed on the door of the distribution box.

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- (vii) EC grade Aluminium Bus bars of 100mm^2 (minimum) for Phase and Neutral, capable of carrying full load current shall be provided. Bus bar shall be completely insulated such that no live part including screws are accessible by hand/finger after fixing of cables. Insulation shall be Fire retardant. Bus bars shall be isolated with respect to body.
 - (viii) Two earthing bolts of diameter 10mm and 25mm long shall be welded from inside of the box and shall be provided with 2 nuts & washer. Earth marking shall be duly embossed near the earth bolts. There shall be no powder coating on the earthing bolts.
 - (ix) One No. Incoming & 2 Nos. outgoing cable holes shall be provided as shown in drawing. Cable holes shall be provided with superior quality rubber cable glands of internal diameter 30mm. Rubber glands shall be made such that internal diameter of glands provided for cables should be closed with the rubber film of minimum 1mm thickness. Cable will go through the glands by piercing the film of the glands.
 - (x) For mounting of box on pole, four holes shall be provided the back side of the box as shown in drawing.
 - (xi) Danger marking shall be provided on the box in red color.
 - (xii) Name of Utility and name of scheme i.e. RDSS shall be embossed on the distribution box.
 - (xiii) Each distribution box shall be supplied with proper packing in 3 ply corrugated box.
 - (xiv) Tolerance permissible on the overall dimensions of box shall be $\pm 3\%$.

6. FINISHING OF DISTRIBUTION BOX:

The surface of the box shall be properly pretreated / phosphated in 7-tank process and shall be applied with powder coating. The process facility shall be in house of the manufacturer to ensure proper quality for outdoor application.

7. ACCEPTANCE TESTS :

Following acceptance tests shall be carried out while inspecting lot of material offered.

1) Visual Examination:

The Distribution box shall be inspected visually, externally and internally for proper Powder Coating layer, fitting of all the components in accordance with technical Specification.

2) Verification of dimensions:

Verification of dimensions, external / internal clearances will be carried out as per technical specifications.

3) Verification of fittings:

Components like insulated bus bars, MCCBs, Hinges, Rubber Glands etc will be verified as per technical specification.

4) High voltage withstand test at 2.5KV:

The A.C. voltage of 2.5KV, 50HZ shall be applied for one minute as follows:

- i) Between Live Parts of each insulated bus bar
- ii) Between each insulated bus bar and earthing Screw/bolts
- iii) On bus bar insulation.
- iv) On PVC coating of PVC cables.

There shall not be any puncture or flash over during this test.

5) MCCB:

Time current characteristics of each rating of MCCB shall be checked as per the requirement of the specifications.

6) Current Carrying Capacity:

The current of 200 Amp shall be applied for 30 minutes through high current source on each insulated bus bar. There shall not be overheating of the insulated bus bars during this test.

8. TESTING & MANUFACTURING FACILITIES:

The Tenderer must clearly indicate what testing and manufacturing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out all Routine & Acceptance Tests. These facilities should be available to inspection Engineers, if deputed to carry out or witness the tests in the manufacturer's works. The tenderer must have all the in-house testing facilities to carry out the acceptance tests on the Box.

9. TESTS:

The Distribution box shall comply with the requirement of IP33. Each type of LV Switchboard shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards and during manufacture and on completion.

i) Routine Test

The tests shall be carried out in accordance with IS 13947 and 8623 include including but not necessarily limited to the following:

- (a) Visual Check
- (b) Verification of Component Rating
- (c) Other Checks
 - i) Easy Accessibility and Maintenance
 - ii) Color Coding provided by colored tapes.
 - iii) Bus bar dimensions
 - iv) Degree of Protection check by paper.
- (d) Dimension check

- (e) Insulation Resistance Tests
- (f) Mechanical Operation Tests
- (g) Bus bar support and clearances
- (h) Continuity of circuits and Function
- (i) Powder Coating
- (j) Overload Release setting of the Circuit Breakers

ii) Type Test

The box shall be fully type tested as per the requirement of IS 13947 (Part-1):1993 with latest amendment. The type test shall be carried out from the Govt. approved laboratories duly accredited by National Board of Testing & Calibration Laboratories (NABL) of Govt. of India.

10. Prototype & Drawings:-

The manufacturer has to manufacturer the prototype Unit for each rating as per this specification before bulk manufacturing. The manufacturer should intimate the readiness of prototype to employer. The Project Manager will inspect the prototype for approval. The manufacturer should submit the final drawings in line with this specification and prototype to employer for approval before bulk manufacturing. The approval of prototype & drawings shall be a responsibility of manufacturer/Contractor. Tentative drawing of box is enclosed herewith.

19. 63,100,200 & 250 kVA L.T. Distribution Box

1. SCOPE:

This Specification covers the design, manufacture, testing at works and supply of Distribution Boxes made out of **CRCA MS** for controlling the L.T. feeders from the L.T. side of Distribution Transformers. The system shall be A.C. 3 phase, 4 wire, 433 V, 50 HZ with effectively grounded neutral.

2. SERVICE CONDITIONS:

The equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as specified by employer which is as hereunder;

- 2.1 Maximum ambient temperature (Degree C)
- 2.2 Maximum temperature in shade (Degree C)
- 2.3 Minimum Temperature (Degree C)
- 2.4 Relative Humidity (percent)
- 2.5 Maximum Annual rain fall (mm)
- 2.6 Maximum wind pressure (kg/sq.m)
- 2.7 Maximum altitude above mean sea level (Meter)
- 2.8 Isoceranic level (days per year)
- 2.9 Siesmic level (Horizontal Acceleration)

Moderately hot and humid tropical climate conducive to rust and fungus growth

3. SYSTEM DETAILS:

Distribution Boxes are meant for control and protection of Distribution Transformers with relevant parameters as under:-

S.N.	Particulars	Details			
1.	KVA rating	63 KVA	100 KVA	200 KVA	250 KVA
2.	Voltage	433 V, 3 Ph, (3x 250 V)			
3.	Frequency	50 HZ			
4.	Phases	3 phase, solidly grounded neutral			

5.	Approximate full load current of transformer	84 A	133 A	270 A	400 A
6.	No. of Outgoing circuits	2 nos		3 nos	4 nos

3.4 Applicable Standards:

IS :13947/ (Part 3) (amended upto date) for Isolator (Switch Disconnecter)

IS: 13947/ (Part2)(amended upto date) for L.T. MCCBs.

IS: 8623 (amended upto date) for enclosure Box & for degree of protection provided by enclosures of electrical equipments.

IS: 4237, IS:8623 (amended upto date) – for general requirement of L.T. switchgears.

IS 13703 (Part I & II amended upto date) for HRC Fuse Base and HRC Fuse Link.

IS: 5 /2007 - Colours of Ready Mixed paints and Enamels.

IS: 13871/1993 (amended upto date) – Powder coatings – specifications

IS : 6005/1998 (amended upto date) – Code of Practice for phosphating of iron and steel.

IS: 13411/1992 (amended upto date) – Glass Reinforced Polyester Dough Moulding Compounds

3.5 MANUFACTURE/CONSTRUCTION OF BOXES:

Distribution Boxes shall have Isolator (Switch Disconnecter) and HRC fuse base with links on incoming circuit and single pole MCCBs & Link Disconnecter on outgoing circuits with necessary interconnecting Bus Bars/ Links.

Standard General Arrangement of Isolators, HRC fuse base with links, MCCBs, Link Disconnecter, Neutral Links, Bus Bars, connecting links, Cable termination arrangement etc inside the Box is shown in the enclosed drawings.

3.6 INCOMING CIRCUIT –

6.1 Isolator (Switch Disconnecter) -

Each distribution box shall have one triple pole Isolator (Switch Disconnecter), conforming to relevant latest IS. The supplier shall indicate makes and types of offered isolator in GTP. The supplier shall submit Type Test Report of the Isolator as specified in Cl. No. 12.3 (II) for approval of Employer before commencement of supply. The Switch disconnecter to be provided in the Distribution Box will be as per Employer specification.

The Isolator should be front operated triple pole type. The casing of Isolator shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D₃ Grade as per IS:13411 (amended upto date), no separate enclosure is required. Isolator Base should withstand the breaking capacity of 80 kA. To extinguish the arc immediately in isolators, in each phase arc-chutes with minimum 12 strips shall be provided.

The isolator should be front operated triple pole type. The isolator shall be robust in construction and easy for operation. The handle of the isolator should be detachable easily for security purpose while working on L.T. circuits.

The characteristics of Isolator shall be as follows:

S.N.	Characteristics	Rating			
		63 KVA	100 KVA	200 KVA	250 KVA
1.	Basic uninterrupted duty	200 A		600A	
2.	Mechanism	Manual quick make quick break			
3.	Standard applicable	IS : 13947 amended upto date			
4.	Utilization category	AC –23 A			
5.	Mechanical Endurance	As per IS 13497 amended upto date			
6.	Electrical Endurance	As per IS: 13947 amended upto date			
7.	Rated Duty	Uninterrupted			
8	Making /Breaking capacity	Not less than requirement of AC –23 A category			
9.	Two seconds rating	4 KA		8 KA	
10.	Rated insulation voltage	660 V			

The terminal connector strips of the isolator shall be projecting out of isolator

of 80 mm (minimum) in length on cable connection side and 60mm (minimum) on HRC fuse base side as shown in the drawings. In 63 /100/200/250 KVA distribution box, the cross section of the strips on outside of the isolator shall be provided as below:

63/100 KVA -	25X5 mm.
200 KVA-	50X 6 mm
250 KVA-	50X 6 mm

The material of isolator strips shall be EC grade tin-plated copper. The terminal strips shall be continuous from the point of contact separation inside the Isolator with cross section as mentioned above throughout the length. Gap of 50mm shall be maintained between each terminal throughout the length.

6.2 HRC FUSE

HRC Fuse of suitable capacity shall be provided between outgoing terminal of Switch Disconnector (Isolator) and incoming Busbar to facilitate electrical breaking of the circuit. Each Distribution Box shall have 3 Nos. of HRC Fuse Base with HRC Fuse Links (Blade type Contacts).

The supplier shall indicate in GTP, the make, type and capacity of HRC Fuse Base and Fuse Links offered.

(i) HRC FUSE BASE

The base of the HRC Fuse shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D₃ Grade as per IS:13411/1992. The Fuse Base shall be sturdy in construction.

The extension terminal connector strips of the Fuse Base shall be projecting out on both sides, made with two pieces (half portion of the terminal contact and extension strip should be continuous in one piece), as shown in the drawing. The dimensions shall be as shown in the drawing. The material for both strips shall be tin plated EC Grade copper. HRC Fuse Base & fuse link should have withstand the breaking capacity of 80 kA.

HRC Fuse base shall be suitable for fuse of 200A for 63/100 KVA distribution box and

400 A for 200 KVA and 630A for 250 kVA distribution box.

(ii) HRC FUSE LINK

The HRC Fuse Links shall be sturdy in construction of “Din Type”. Breaking Capacity shall be 80 kA. For fault indication red pop up indicator should come out instantly on fusing. Manufacturer’s name, current rating, breaking capacity and type shall be marked on HRC fuse link.

HRC Fuse link Current rating for 63/100 /200/250 KVA distribution box shall be as follows:

63 KVA	-	100 A
100 KVA	-	160 A
200 KVA	-	315 A.
250 KVA	-	400 A

The supplier shall submit Type Test Report of the HRC fuse base and HRC fuse link as specified in Cl. No. 12.3 (III) for approval of Employer before commencement of supply. The HRC fuse base with links to be provided in the Distribution Box will be as per Employer approval given in the detailed purchase order.

3.7 OUTGOING CIRCUITS:

(i) MCCBs

Each distribution box shall have 6 nos. of single-pole MCCBs in 63 KVA /100 KVA Box, 9 nos of single-pole MCCBs in 200 KVA box and 12 nos of single-pole MCCBs in 315 KVA box to protect outgoing circuits. MCCB shall be of reputed make and shall conform to latest IS. The supplier shall indicate the makes and types of MCCBs offered in GTP. The supplier shall submit Type Test Report of the MCCB as specified in Cl. No. 12.3 (IV) for approval of Employer before commencement of supply. The MCCBs to be provided in the Distribution Box will be as per Employer approval as given in the detailed purchase order.

MCCB shall have quick make quick break mechanism. Making of MCCB shall only be manual but breaking of MCCBs shall be electrical as well as manual.

The detailed specification for MCCBs shall be as under.

S.No	Particulars	Details			
1.	KVA rating	63 KVA	100 KVA	200 KVA	250 KVA
2.	Rated current	150 A		200 A	
3.	Fixed overload release setting (A)	60 A	90 A	120 A	120 A
4.	No. of poles	Single pole			
5.	Rated service short circuit breaking capacity (kA) which is equal to ultimate breaking capacity as per IS 13947 (amended upto date)	10 KA at 0.4 p.f . (lag)			
	The sequence of operation for this test shall be, O - t - CO - t - CO, and t = 3 min.). The test shall be done at 250V at 0.4 p.f. (lag). Voltage rating phase to phase 433 V and phase to earth 250V.				
6.	Power factor for short circuit (Max.)	0.4 lag			
7.	Utilization category	A			
8.	Rated Insulation Voltage	660 V			

The Busbar dropper and Terminal connection strip of Link Disconnecter shall be placed in contact terminal of MCCB as shown in the drawing.

The rated service short circuit breaking capacity as specified above, shall be based on the rated service short circuit test carried out at specified power factors.

To extinguish the arc immediately in MCCBs, arc-chutes with minimum 8 strips shall be provided.

While the above stipulation regarding the test power factor and the sequence of operation shall be binding, the other procedure for making the short circuit test and circuit etc. shall generally be in accordance with the Indian Standard applicable to the type of circuit breakers under test.

7.2 TIME CURRENT CHARACTERISTICS of MCCBs:

The L.T. MCCBs shall have time current characteristics as follows:

Multiple of normal Current setting	Tripping time
1.05	More than 2.5 hrs.
1.2	More than 10 minutes and less than 2 hrs.
1.3	Less than 30 minutes
1.4	Less than 10 minutes
2.5	Less than 1 minute
4.0	Not less than 2 seconds
6.0	Less than 5 seconds
12.0	Instantaneous (less than 40 milli seconds.)

For above time/current characteristic, the reference calibration temperature of the breaker shall be 50°C. Deration, if any, up to 60°C. Ambient temperature shall not exceed 10% of the current setting indicated above.

c. LINK DISCONNECTOR :

Link Disconnecter of 200 A capacity shall be provided between outgoing terminal of MCCB & cable connection to facilitate mechanical breaking (manual isolation) of the circuit. 63 /100 kVA Distribution Box shall have 6 Nos. of link Disconnectors, 200 kVA distribution box shall have 9 nos of link Disconnectors and 250 kVA distribution box shall have 12 nos of link Disconnectors.

The supplier has to indicate the makes and types of Link Disconnecter offered in GTP. The supplier shall submit Type Test Report of Link Disconnecter as specified in Cl. No. 12.3 (V) for approval of Employer before commencement of supply. The link Disconnectors to be provided in the Distribution Box will be as per EMPLOYER's approval as given in the detailed purchase order.

The base of the Link Disconnecter shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D₃ Grade as per IS:13411 (amended upto date). The Link Disconnecter shall be sturdy in construction and easy in operation.

The link of Link Disconnecter shall be of Tin-plated E.C. grade copper. The construction of the Link Disconnecter shall be such that it shall be hinged type on

cable connection end and disconnectable at the MCCB end. The disconnection will be with the help of special handle/puller. One handle/puller shall be supplied along with each Distribution Box. The terminal connector strips of the Link Disconnecter of 25 x 3 mm cross section, shall be projecting out of Link disconnecter for minimum length of 80 mm. on cable connection side and 40 mm on MCCB outgoing side. The cross section of knife edge link shall be 20 x 5 mm. The material for both the strips and links shall be tin-plated E.C. grade copper. The size of bimetallic lugs hole & the hole on the disconnectors strip on cable side should be same.

3.8 BUSBARS AND CONNECTIONS:

The Incomer feeder should be on right side of the distribution box and all outgoing feeders will be on left side of the distribution box, with phase sequence RYB to be maintained. The phase busbars, incoming droppers and feeder droppers from busbars shall be of EC Grade Aluminium. The phase busbar strips shall be of size 25X8 mm for 63 KVA/100 KVA and 40X10 mm for 200 and 40X15 for 250 KVA box. Feeder droppers shall be 25X8 mm. Incomer dropper of 25 x 8 mm cross section for 63 /100 KVA box and 40 x 10 mm cross section for 200KVA box and 40X15 for 250 KVA box be provided. All busbars and droppers shall be properly drilled and de-burred. Each bus bar shall be of one single strip without any joint.

Busbars shall be provided with durable PVC insulating sleeves of standard colour code for different phases. Corrugated/Spring & Plain washers shall be used for Nut-Bolt connections.

Busbars shall be mounted on suitable size support insulators which should be tightened from inside. i.e. once fitted, should not be able to removed.

Minimum clearances, wherever shown, shall be as per General Arrangement Drawing enclosed with this specification. Other clearances shall be as per requirement of IS: 4237 amended upto date.

3.9 ENCLOSURE:

- 9.1 The Box & Doors shall be made up of CRCA MS sheet of 2mm thickness.
- 9.2 The manufacturing process of Box shall be Deep Drawn / Sheet Bending Process (Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017)

- 9.3 In case of distribution boxes, the rounding of corners and slope on top shall be as shown in the drawing.
- 9.4 The welding process of distribution boxes shall be done by MIG (Metal Inert Gas) welding and workmanship/finishing should be good enough.
- 9.5 **For Deep Drawn/ Sheet Bending Process (Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017) **Box:**** the general clear dimensions of 63 / 100 KVA Distribution Box shall be 1000 x 1010 x 325 (LXHXW)mm. The center height of distribution box on front side shall be 1000 mm The general clear dimensions of 200 kVA distribution box shall be 1305 x 1050 x 325 (LXHXW) mm and for 250 kVA distribution box shall be 1545 x 1050 x 325 (LXHXW) mm. The center height of the distribution box on front side shall be 1050 mm
- 9.6 The Base and doors of enclosure shall be individually in one piece without any welding, except for fixing of the accessories like hinges, clamps, mounting clamps, bolts etc.
- A. 63/100 kVA boxes shall have two doors as shown in the drawing fixed on right & left side of the box with four hinges provided from inside of box. On closing of doors, right door shall rest on the left door. Hinges shall not be visible and approachable after closing the box.
- B. 200/250 kVA boxes shall have two doors as shown in drawing fixed on right side & left side of the box with four hinges on both sides shall be provided from inside of box. On closing of doors, right door shall rest on the left door. Hinges shall not be visible and approachable after closing the box.

Base and doors shall have flange / collars as shown in drawing. Collar of Base and doors shall overlap by 10mm. Rubber gasket of suitable size shall be provided in between base and doors, such that it provides proper sealing between the door and base of box to avoid penetration of dust & ingress of water. Degree of protection shall be **IP- 33** as per IS-8623 (amended up to date). Rubber Gasket shall be fixed with suitable adhesive. Four hinges on each side shall be provided from inside of the box to fix the doors. Hinges shall be minimum 50 mm in length & made from 2mm thick sheet. Hinge stainless steel pin diameter shall be 4mm. The hinges shall not be

visible from outside.

- 9.7 The MCCBs, Link Disconnecter, Isolator and HRC fuse base with link shall be housed inside the enclosure. Isolator operating handle shall be accessible only after opening of the doors.
- 9.8 Four set of Louvers (two sets on each side) of suitable size shall be provided as shown in drawing. The louvers shall be provided such that heat dissipation is proper. The perforated sheet of 20 SWG with 2.5 mm holes shall be welded from inside of the louvers.
- 9.9 Mounting of components inside the enclosure shall allow free air circulation keeping the clearances as per drawings attached with specification.

9.10 Locking Arrangement to the Box:

The doors shall be closed with a push fit locking arrangement such that on pressing/pushing the right door, the distribution box gets locked from inside from top & bottom. This arrangement shall be operational for opening of the door with a handle provided outside the door. Handle shall be removable type only. A Nylon washer shall be provided between the handle and door to avoid penetration of water. One central lock with brass levers shall be provided inside the door. Key way shall be provided on the door for operating the central lock from outside. Key way shall be provided with cover.

- 9.11 A suitable cable termination arrangement with support insulators shall be provided on Isolators and Link Disconnectors. The bimetallic lugs of adequate size, as per enclosed specification & drawing, shall be provided. Clearances, Creepages and convenience in making connections shall be ensured.
- 9.12 EC grade Aluminium Neutral Busbar of 300 x 25 x 8 mm for 63/100 KVA box and 525 x 40 x 10 mm for 200 KVA and 40 x 15mm for 250 KVA Box capable of carrying for full load current. Neutral Busbar shall be isolated with respect to body. The bimetallic lugs of adequate size, as per enclosed specification & drawing, shall be provided. Neutral Busbar shall be as shown in the drawing attached with the specifications.
- 9.13 Bolts of M10 mm and 35 mm length with 2 Nos. plain washer and two Nos. nut are to be provided on both the sides for earthing of the distribution box. Earthing bolt is to be

fixed on U-structure (Earth Clamp) welded on both sides of the distribution box. Thickness of earth clamp shall be 2mm. The top surface of the earth clamp shall be properly Zinc plated. Earthing nut bolt and washer should be zinc plated. There should be no powder coating on top surface of the earthing clamps.

- 9.14 Three bottom plates for 63/100 KVA and 4 bottom plates for 200 KVA and 5 bottom Plates for 250 KVA shall be provided for incoming and outgoing cables as shown in the drawing. Bottom plate of size 125mm x 125mm fixed with four screws from inside shall be provided for incoming and outgoing cables. Bottom plates shall be provided with suitable holes and rubber glands for the cables. Rubber glands shall be made such that internal diameter of glands provided for cables should be closed with the rubber film of minimum 1mm thickness. Cable will go through the glands by cutting the film of the glands. Bottom plates shall also be provided with cable clamps as shown in drawing.
- 9.15 Necessary fixing arrangement shall be provided at the back of the enclosure to ensure proper fixing on double pole structure by means of suitable clamps at 4 places.
- 9.16 Danger marking shall be provided in red colour on the right door of the distribution box. Marking shall be scratch proof and properly readable.
- 9.17 All the components inside the Box shall be mounted on CRCA MS strips of 2mm thickness. The mounting strips shall be provided with required bends or ribs to give the extra strength and shall be powder coated or zinc plated.
- 9.18 All joints of current carrying parts shall be bolted with 8.8 grade High Tensile MS Nuts & Bolts, Corrugated/spring & Plain Washers. The nuts & bolts should be of hexagonal type. All the nuts, bolts & washers should be properly zinc plated.
- 9.19 Each distribution box shall be supplied with proper packing in five ply - corrugated box.
- 9.20 Name plate having details such as Month & year of manufacturing, , Sr.No, and rating of Distribution box, XXXXX”Name of Employer” shall be riveted on the Distribution box door. Name of Manufacturer shall be duly embossed on the door of the distribution box. The name plate should be of stainless steel of thickness 1 mm.
- 9.21 Incoming and outgoing circuit should be duly highlighted with paint by stencil printing.

- 9.22 Adequate slope on the top of box shall be provided to drain out rainwater from the top.
- 9.23 3 Nos. MCCBs and 3 Nos. HRC fuse links in spare should be invariably provided with each box.
- 9.24 Good-quality plastic sticker leaflet should be pasted inside of distribution box door. The matter of instruction leaflet shall be provided by the employer. All the instructions in leaflet should be in Hindi/English/Local language.

3.10 CABLE TERMINATION:

Adequate size of Bimetallic lugs shall be provided for 3½ core, LT XLPE cable on incoming side and out going side for 63/100/200/250 KVA boxes as below :

	Incoming side	Outgoing Side
63 KVA	70 sq.mm	50/ 70 sq.mm
100 KVA	150 sq.mm	50/70 sq.mm
200 KVA	300 sq.mm	150 sq.mm.
250 KVA	300 sq.mm	150 sq.mm.

- 3.11 **LUG :** Bimetallic lug should be made for electrolytic grade aluminum. Each lug should be copper coated by electrolytic process and rich layer of tin should be mounted through out the lug to protect from Galvanic Corrosion. The lugs shall be such that the rich layer of tin should not peel of during operation. Individual lot should be pre filled with conductive inhibition compound and lug should be duly capped to prevent oozing of compound. The ductility of material should be such that flow ability of material be adequate to flow in to the strand of the conductor and withstand on crimping pressure of 8500 PSI. The cut cross section of the joints shall be homogeneous.

3.12 FINISHING OF DISTRIBUTION BOX:

The outer side and inside surface of the box shall be properly Pre-treated /Phosphated in seven tank process as per IS: 6005 and shall be applied powder coating of minimum 40 micron thickness. The Colour shade of light Admiralty gray (as per employer requirement) for 63, 100, 200 and 250 KVA box as per IS: 5/2007 (Colours of Ready Mixed paints and Enamels) shall be applied inside & outside surface of the box or as per state practice. Powder coating shall be suitable for outdoor use, conforming IS: 13871 (amended upto date) – Powder coatings. The process

facility shall be in-house to ensure proper quality for outdoor application.

3.13 TESTS & TEST CERTIFICATES:

In case of bought out items, routine and acceptance tests as per relevant IS and this specification shall be carried out at the original manufacturers' works.

a) Routine Test (Carried out on all boxes):

Overall Dimensions Checking.

Insulation Resistance Tests.

High Voltage Test at 2500 V, 50 Hz AC for one minute.

12.1.4. Operation Test on MCCB/Isolator/Link Disconnecter / HRC fuse base and fuse links.

b) Acceptance Tests (on complete Distribution Box):

Following tests shall be carried out as per acceptance tests in addition to routine tests on one random sample of each rating out of the lot offered for inspection:

i) Temperature rise test on one sample of each rating.

Temperature rise test will be carried out as per the procedure given below:

For temperature rise test, a distribution box with all assembly of MCCBs / Link Disconnectors / Isolator / HRC fuse base with link shall be kept in an enclosure such that the temperature outside the box shall be maintained at 50 ° C.

20% more current than transformer secondary capacity i.e. for 63 KVA Distribution Transformers full load current 84A, 20 % more is 100 A shall be kept in incoming circuit keeping outgoing circuits short, till the temperature stabilizes and maximum temperature rise should be recorded.

ii) Time-Current Characteristics

The MCCB should be tested for time current characteristics at 1.05 & 1.2 times of overload release setting current and should pass the requirement given in clause- 7.2.

c) **TYPE TESTS :**

1 ON COMPLETE BOX:

a. Temperature rise test:- The temperature rise test should be carried out as per IS: 8623

High voltage test shall be carried out as per IS:8623 amended upto date.

Short Time Withstand Current Test on Distribution Box shall be carried out as per IS 8623 or latest version.

The Distribution Box should be subjected to Short Time Withstand Current Test for 4KA for 2 seconds for 63/100 KVA Box and 8 KA for 2 second for 200/250 KVA box) all the circuits independently. The test should be carried out after by-passing MCCBs.

Degree of protection for **IP- 33** on complete box shall be carried out as per IS: 13947/1993 or the latest version thereof.

Time /current characteristic test on MCCBs shall be carried out as per clause **7.2** of this specification as stated above.

2 ON ISOLATOR (SWITCH DISCONNECTOR):

All type tests on Isolator (Switch Disconnecter) as per IS: 13947 (Part III) amended up to date shall be carried out.

3 ON HRC fuses base and HRC fuse links :

All type tests on HRC fuses and HRC fuse links IS 13703 (Part I & II amended upto date) for HRC Fuse Base and HRC fuse link shall be carried out.

4 ON MCCB:

All type tests on MCCB as per IS-13947 amended upto date shall be carried out.

5 ON Link Disconnecter:

Following tests shall be carried out on link disconnectors as per IS:

Short Circuit Withstand Strength

Temperature rise Limits

Mechanical Operations

12.4 TYPE - TEST CERTIFICATES:

The Distribution Box, Isolator (Switch Disconnector), HRC fuse, HRC Fuse Link and MCCB offered shall be fully type tested as per relevant IS and this specification. The Supplier shall furnish detailed type test reports before commencement of supply. The detailed Type Test Reports shall be furnished with relevant oscillogram and certified Drawings of the equipment tested. The purchaser reserves the right to demand repetition of some or all the Type Tests in presence of purchaser's representative at purchaser's cost.

All the type tests shall be carried out from laboratories accredited by National Accreditation Board of Testing And Calibration Laboratories (NABL), Department of science & technology, Govt. of India to prove that the complete Box, Isolator, HRC fuse, Link Disconnector & MCCB meet the requirements of the specification. The Manufacturer should also furnish certificate from laboratories that laboratories are having all the requisite test facility available in house. The type test Reports conducted in manufacturers own laboratory and certified by testing institute shall not be acceptable.

The Supplier should furnish the particulars giving specific required details of Distribution Boxes, MCCBs, Isolator and Link Disconnector.

3.14 TESTING & MANUFACTURING FACILITIES :

Supplier must be an indigenous manufacturer. The Supplier must clearly indicate what testing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out all Routine & Acceptance Tests. These facilities should be available to Employer's Engineers, if deputed to carry out or witness the tests in the

manufacturer's works. The supplier must have all the in-house testing facilities to carry out the acceptance tests on the Box.

The supplier shall furnish detailed process of manufacturing & Powder coating.

3.15 PROTOTYPE & DRAWINGS:-

The manufacturer has to manufacturer the prototype Unit for each rating as per this specification before bulk manufacturing. The manufacturer should intimate the readiness of prototype to employer. The Project Manager will inspect the prototype for approval. The manufacturer should submit the final drawings in line with this specification and prototype to employer for approval before bulk manufacturing. The approval of prototype & drawings shall be a responsibility of manufacturer/Contractor. Tentative drawing of box is enclosed herewith.

20. 11kV Porcelain Insulators and Fittings

INSULATORS

1. SCOPE

This specification covers details of porcelain insulators (Pin and Strain Insulators) for use on 11 KV overhead power lines in rural electric distribution system.

2. APPLICABLE STANDARDS

Except when it conflicts with the specific requirements of this specification, the insulators shall comply with IS:731 and IS:3188 as amended from time to time.

3. GENERAL REQUIREMENTS

- 3.1** The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.
- 3.2** Unless otherwise specified, the glaze shall be brown in colour. The glaze shall cover all the porcelain parts of insulators except those areas which serve as support during firing or are left unglazed for the purpose of assembly.
- 3.3** The design of insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.
- 3.4** Cement used in construction of insulators shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.
- 3.5** The insulators should preferably be manufactured in automatic temperature - controlled kilns to obtain uniform baking and better electrical and mechanical properties.

4. CLASSIFICATION AND DIMENSIONS

- 4.1** Both pin and strain insulators shall conform to Type B of IS:731.
- 4.2** The dimensions of pin insulators shall be as shown in Fig. 1.
- 4.3** The strain insulators shall be of Ball and Socket type or Tongue and Clevis type, as required by the Purchaser. The dimensions of these insulators shall be as per Fig. 2.

5. TEST VOLTAGES

- 5.1** The test voltages of insulators shall be as under:

Highest	Visible	Wet Power Frequency	Power	Frequency	Impulse
---------	---------	---------------------	-------	-----------	---------

System voltage	Discharge Test	withstand Test	puncture withstand test		voltage withstand Test
			Pin Insulator	Strain Insulator	
kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(Peak)
12	9	35	105	1.3 times of the actual dry flash over voltage of the Insulator	75

6. FAILING LOAD

- 6.1** Mechanical Failing Load (For Pin Insulators only) The insulators shall be suitable for a minimum failing load of 5 KN applied in transverse direction.
- 6.2** Electro-Mechanical Failing Load (For Strain Insulators) The insulators shall be suitable for a minimum failing load of 45 KN applied axially.

7. CREEPAGE DISTANCE

The minimum creepage distance shall be as under :

Highest System Voltage	Normal and Moderately polluted atmosphere	Heavily Polluted atmosphere	
		Pin insulator	Strain insulator
KV	mm	mm	Mm
12	230	320	400

Note : Higher value of creepage distance has been specified for strain insulators as these are normally used in horizontal position in 11 KV lines.

8. TESTS

The insulators shall comply with the following tests as per IS:731 :-

8.1 Type Tests

- a) Visual examination
- b) Verification of dimensions
- c) Visible discharge test
- d) Impulse Voltage Withstand Test
- e) Wet Power Frequency Voltage Withstand Test

- f) Temperature cycle test
- g) Mechanical Failing load test (for Pin Insulators only) to be carried out as per procedure described at Sub-clause 8.4
- h) 24-hour Mechanical strength Test for Strain Insulators
- i) Puncture Test
- j) Porosity Test
- k) Galvanizing Test
- l) Electro-mechanical failing load test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4.
- m) Thermal Mechanical Performance Test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4

8.2 ROUTINE TESTS:

- a) Visual examination
- b) Mechanical routine test (for strain insulator only)
- c) Electrical routine test (for strain insulator only)
- d) Hydraulic Internal Pressure test on shells for strain insulators to be carried out as per procedure described at Sub-clause 8.4

8.3 ACCEPTANCE TEST:

- a) Verification of Dimensions
- b) Temperature cycle Test
- c) Electro-mechanical failing load test (for strain insulators only) to be carried out as per procedure described at Sub-clause 8.4
- d) Puncture test (for strain insulators only)
- e) Porosity test
- f) Galvanizing test

8.4 Following procedure shall be used for conducting tests on insulators :

1 Hydraulic Internal Pressure Test on Shells (For Disc Insulators)

The test shall be carried out on 100% shells before assembly.

Thermal Mechanical Performance Test (if applicable):

Thermal Mechanical Performance Test shall be performed in accordance with IEC- 383-1-1993 Clause 20 with the following modifications:

- (1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.
- (2) The acceptance criteria shall be

- (a) X greater than or equal to $R + 3S$.

Where

X - Mean value of the individual mechanical failing load.

R - Rated electro-mechanical / mechanical failing load.

S - Standard deviation.

- (b) The minimum sample size shall be taken as 20 for disc insulator units.

- (c) The individual electromechanical failing load shall be at least equal to the rated value. Also puncture shall not occur before the ultimate fracture.

2 Electromechanical/Mechanical Failing Load Test.

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance

- (i) X greater than or equal to $R + 3S$, Where
 X - Mean value of the electro-mechanical/mechanical/ failing load.
 R - Rated electro-mechanical / mechanical failing load.
 S - Standard deviation.
- (ii) The minimum sample size shall be taken as 20 for disc insulators units. However, for larger lot size, IEC 591 shall be applicable.
- (iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.

9. MARKING

9.1 Each insulator shall be legibly and indelibly marked to show the following:

- a) Name or trademark of manufacturer
- b) Month and year of manufacture
- c) Minimum failing load in KN
- d) ISI certification mark, if any

9.1.1 Markings on porcelain shall be printed and shall be applied before firing.

10. PACKING

All insulators (without fittings) shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail transport. Where more than one insulator is

packed in a crate, wooden separators shall be fixed between the insulators to keep individual insulators in position without movement within the crate.

11. INSPECTION

- 11.1** All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.
- 11.2** The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

INSULATOR FITTINGS

1. SCOPE

This specification covers details and test requirements for (i) Pins for 11 KV Insulators, (ii) Helically Formed Pin Insulator Ties (iii) Fittings for Strain Insulators with Helically Formed Conductor Dead-Ends and (iv) Fittings for Strain Insulators with conventional Dead-End Clamps.

2. APPLICABLE STANDARDS

Pins shall comply with the requirements of IS:2486 (Pt. I & II). Helically formed fittings shall comply with IS:12048-1987. Fittings for strain insulators shall comply with the requirements of IS:2486 Pt. I to IV.

3. PINS FOR INSULATORS

3.1 General Requirements

The pins shall be of single piece obtained preferably by the process of forging. They shall not be made by joining, welding, shrink fitting or any other process using more than one piece of material. The pins shall be of good finish, free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided. All ferrous pins, nuts and washers, except those made of stainless steel, shall be galvanized. The threads of nuts and tapped holes, when cut after galvanizing shall be well oiled or greased.

3.2 Dimensions

Pins shall be of small steel head type S 165P as per IS:2486 (Part-II) having stalk length of 165mm and shank length of 150mm with minimum failing load of 5 KN. Details of the pins are shown in Fig. 3.

3.3 Tests

Insulator pins shall comply with the following test requirements as per IS:2486 (Part-I)-1993 or latest version thereof:

3.3.1. Type Tests

- a) Checking of threads on heads
- b) Galvanizing test
- c) Visual examination test
- d) Mechanical test

3.3.2 Acceptance Tests

- a) Checking of threads on heads
- b) Galvanising test
- c) Mechanical test

3.3.3 Routine Test

Visual examination test

4. HELICALLY FORMED PIN INSULATOR TIES

4.1 Helically formed ties used for holding the conductor on the pin insulator (Fig.4) shall be made of aluminum alloy or aluminized steel or aluminum-clad steel wires and shall conform to the requirements of IS:12048-1987.

4.2 The ties shall be suitable for pin insulator dimensions as per Fig. 1 of Pt. I and conductor sizes to be specified by the purchaser.

Note: Helically formed insulators ties are made to suit specific sizes of conductors, which should be clearly specified by the purchaser.

4.3 Elastomer pad for insulator shall be used with the ties to avoid abrasion of the conductor coming into direct contact with the insulator.

4.4 Tests

The ties shall be subjected to the tests specified in IS:12048-1987.

5. FITTINGS FOR STRAIN INSULATORS WITH HELICALLY FORMED CONDUCTOR DEAD-ENDGRIPS

5.1 Fittings for Strain Insulators of Tongue & Clevis Type

5.1.1 The fittings shall consist of the following components:

- a) Cross arm strap conforming to IS: 2486 (Pt.II)-1989.
- b) Aluminium alloy die cast thimble-clevis for attaching to the tongue of strain insulator on one end and for accommodating the loop of the helically formed dead-end fitting at the other end in its smooth internal contour. The thimble shall be suitable for all sizes of conductors ranging from 7/2.11mm to 7/3.35mm ACSR. The thimble clevis shall be attached to the insulator by a steel cutter pin used with a non-

ferrous split pin of brass or stainless steel. The thimble shall have clevis dimensions as per IS:2486 (Pt.II)-1989.

- c) Helically formed dead-end grip having a pre-fabricated loop to fit into the grooved contour of the thimble on one end and for application over the conductor at the other end. The formed fitting shall conform to the requirement of IS:12048-1987.

Note : As the helically formed fittings are made to suit specific sizes conductors, the purchase should clearly specify the number of fittings required for each size of conductor.

5.1.2 Nominal dimensions of the T&C type insulator fittings are shown in Fig. 5.

5.2 Fittings for Strain Insulators of Ball & Socket Type

5.2.1 The fittings shall consist of the following components:

- a) Cross arm strap conforming to IS:2486 (Pt.II)-1989.
- b) Forged steel ball eye for attaching the socket end of the strain insulator to the cross arm strap. Forgings shall be made of steel as per IS:2004-1978.
- c) Aluminium alloy thimble-socket made out of permanent mould cast, high strength aluminium alloy for attaching to the strain insulator on one end and for accommodating the loop of the helically formed dead-end fittings at the other end in its smooth internal contour. The thimble-socket shall be attached to the strain insulator with the help of locking pin as per the dimensions given in IS:2486 (Pt.II)-1989 and
- d) Helically formed dead-end grip as per clause 5.1.1(c) above.

5.2.2 Nominal dimensions of the Ball & Socket type insulator fittings are shown in Fig. 6.

5.3 Tests

The helically formed fittings for strain insulators shall be subjected to tests as per IS:12048-1987. The other hardware fittings shall be tested as per IS:2486 (Part-I).

6. FITTINGS FOR STRAIN INSULATORS WITH CONVENTIONAL DEAD-END CLAMPS ALTERNATIVE TO FITTINGS COVERED IN CLAUSE 5)

6.1 Fittings for strain insulators with conventional dead-end clamps for use with tongue & clevis or ball & socket type insulators shall consist of the following components:

- a) Cross arms strap conforming to IS:2486 (Pt.II)-1989
- b) Dead-end clamp made of aluminum alloy to suit ACSR conductors from 7/2.11mm to 7/3.35mm. The ultimate strength of the clamp shall not be less than 3000 Kg. The shape and major dimensions of clamps suitable for B&S and T&C insulators are shown in figures 7 & 8 respectively.

6.2 Tests

The fittings shall be subjected to type, routine and acceptance tests in accordance with the stipulations of IS:2486 (Pt.I).

Note: Fittings for strain insulators as stipulated in Clause 5 are preferable to the fittings stipulated in Clause 6 both from the point of view of better quality of construction and ease of application.

7. PACKING

7.1 For packing of GI pins, strain clamps and related hardware, double gunny bags or wooden cases shall be used. The heads and threaded portions of pins and the fittings shall be properly protected against damage.

7.2 The gross weight of the packing shall not normally exceed 50 Kg. Helically formed fittings shall be packed in card-board / wooden boxes. Fittings for different sizes of conductors shall be packed in different boxes and shall be complete with their minor accessories fitted in place and colour codes on tags/fittings shall be marked to identify suitability for different sizes of conductors as per IS:12048-1987.

8 . INSPECTION

8.1 All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.

8.2 The purchaser has the right to have the test carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

ANNEXURE-I

HYDRAULIC PRESSURE TEST ON DISC INSULATOR SHELL

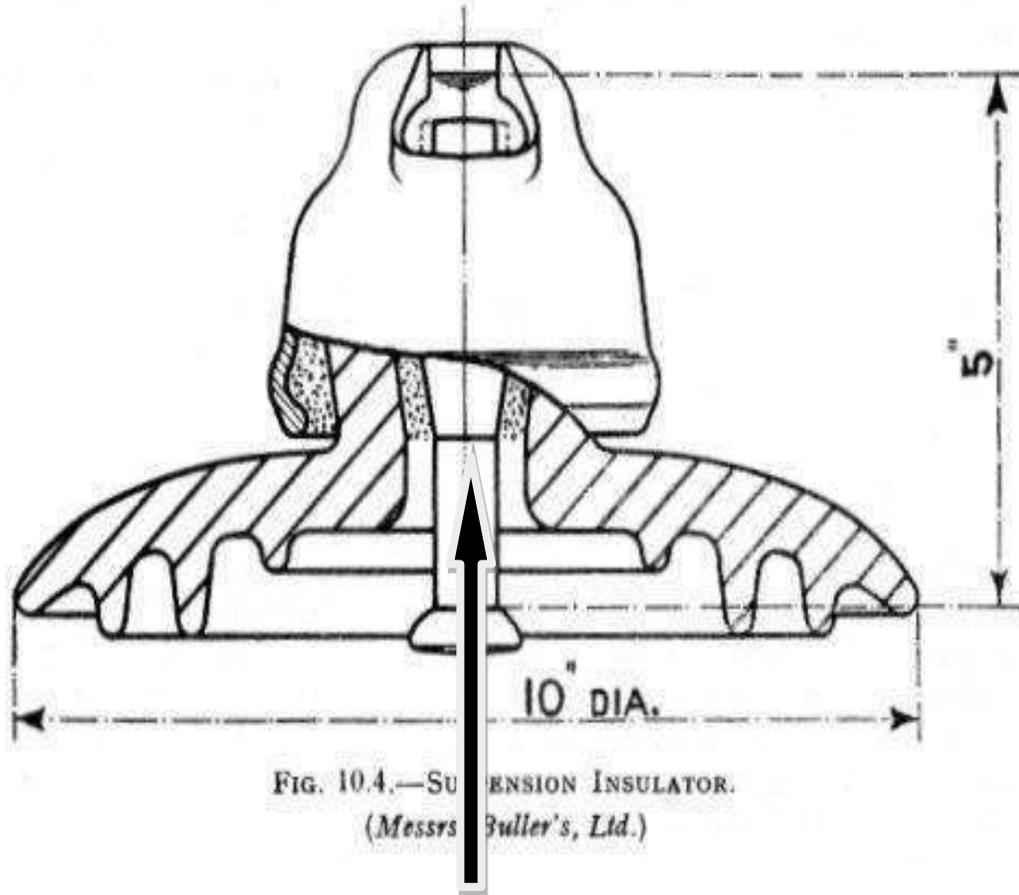


FIG. 10.4.—SUSPENSION INSULATOR.
(Messrs Buller's, Ltd.)

120 KG C/ M sq +/- 10 on the shell before cap and pin assembly to check the integrity of Porcelain

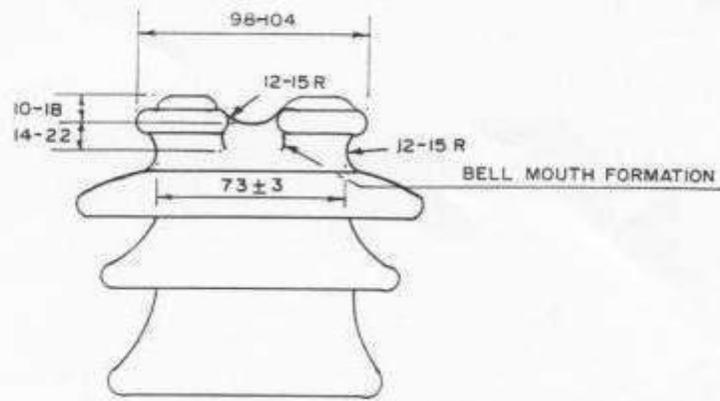


FIG-1.

११ के० वी० पिन विद्युत्रोधक का विस्तार
DIMENSIONS OF 11 KV. PIN INSULATOR

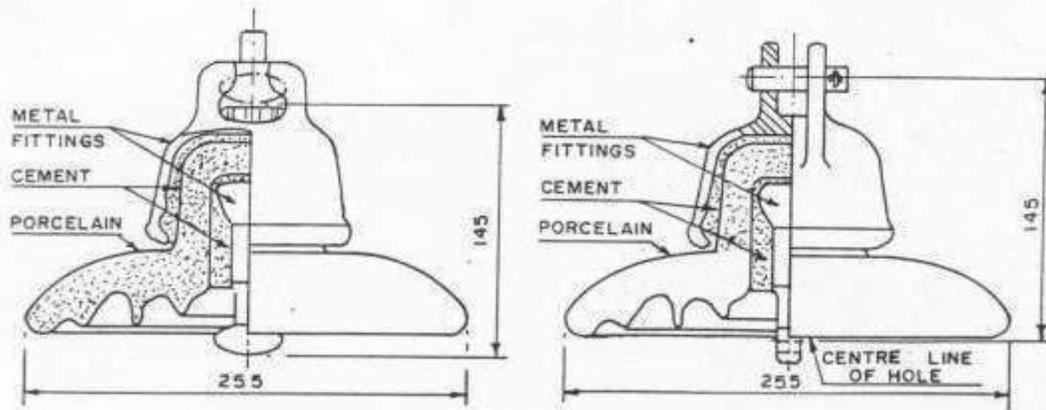
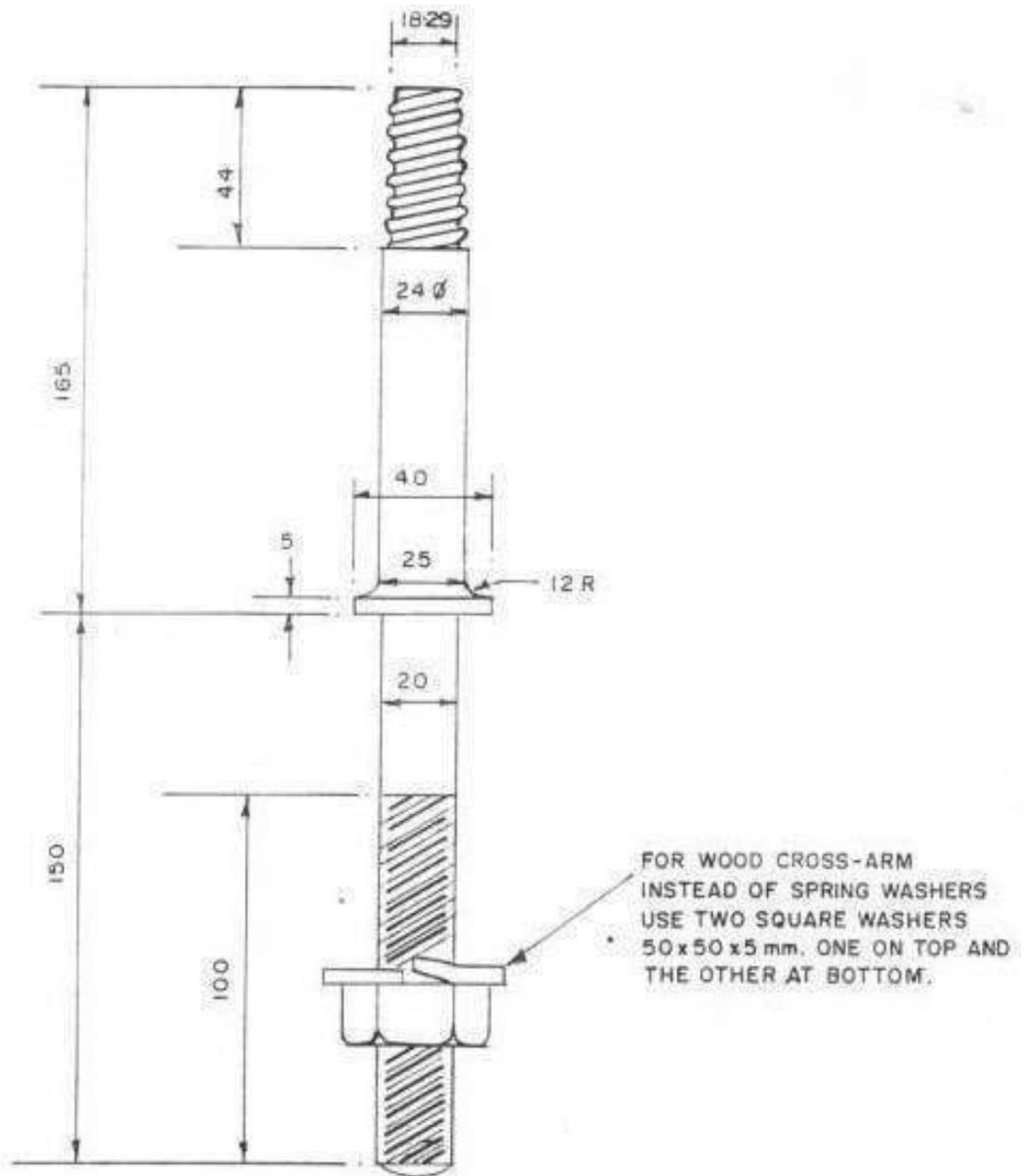


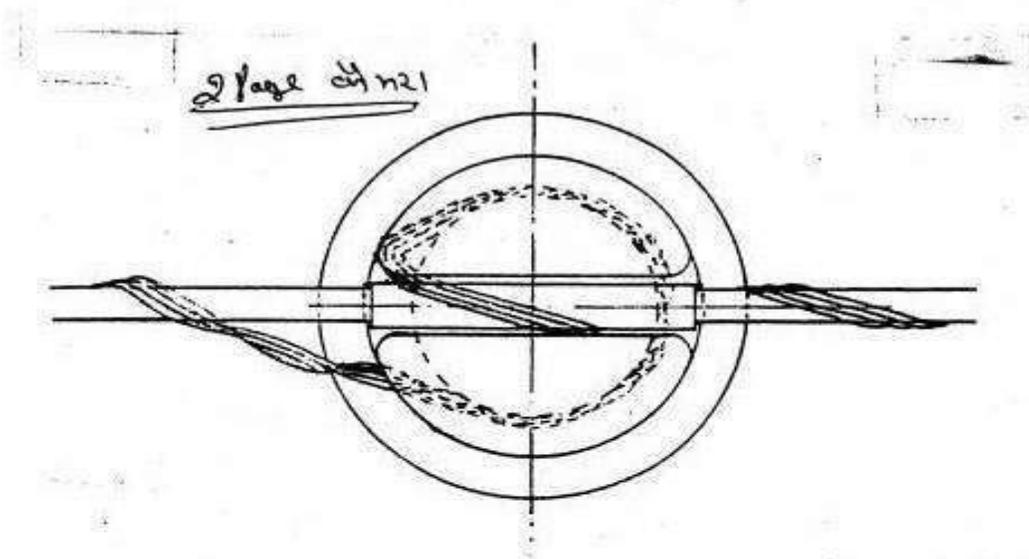
FIG-2. BALL AND SOCKET TYPE. TONGUE AND CLEVIS TYPE.

विकृत विद्युत्रोधक का विस्तार
DIMENSIONS OF STRAIN INSULATORS



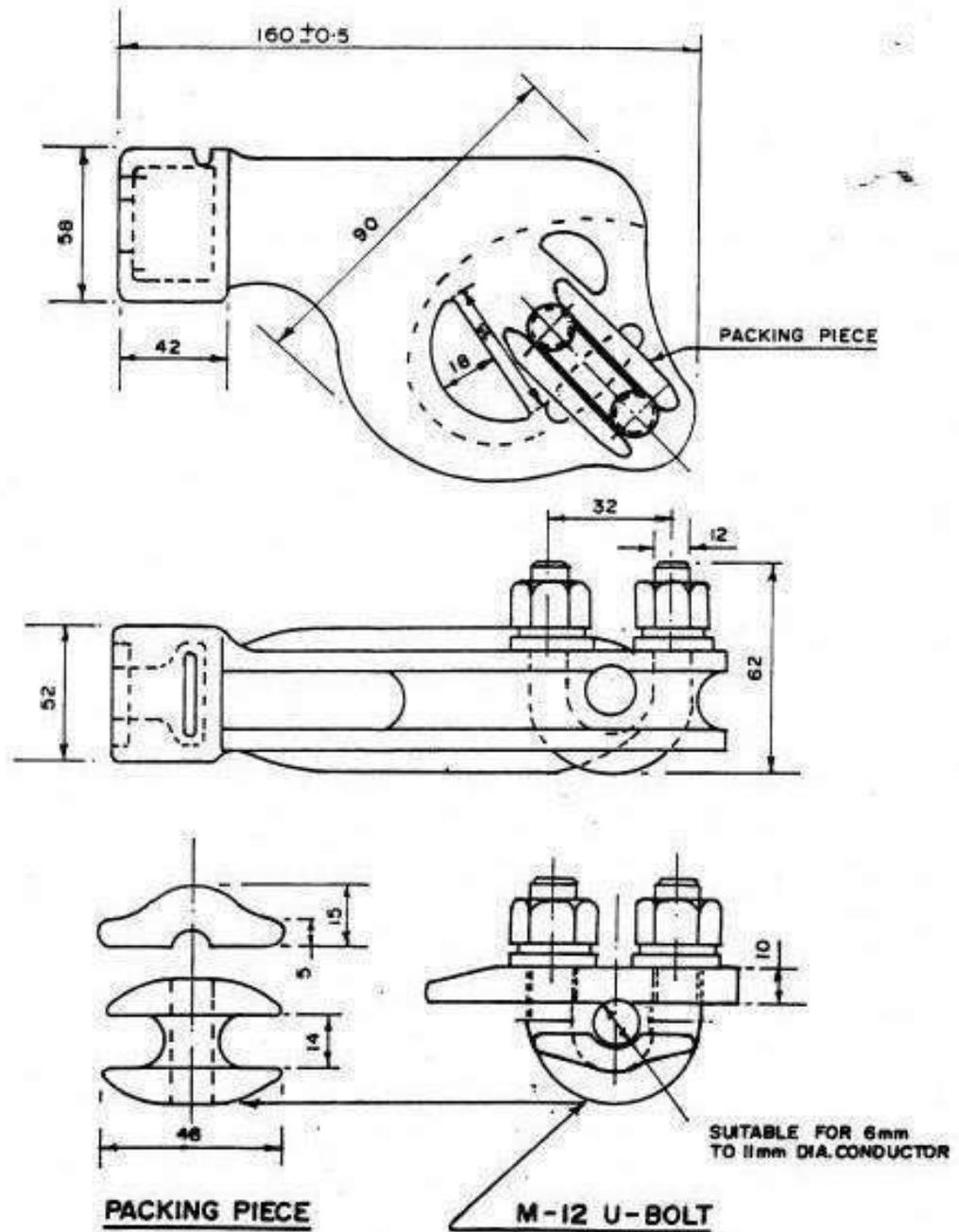
विद्युत रोधक पिन
 INSULATOR PIN
 (TYPE S 165P)
 AS PER IS: 2486 Pt.II.

FIG-3.



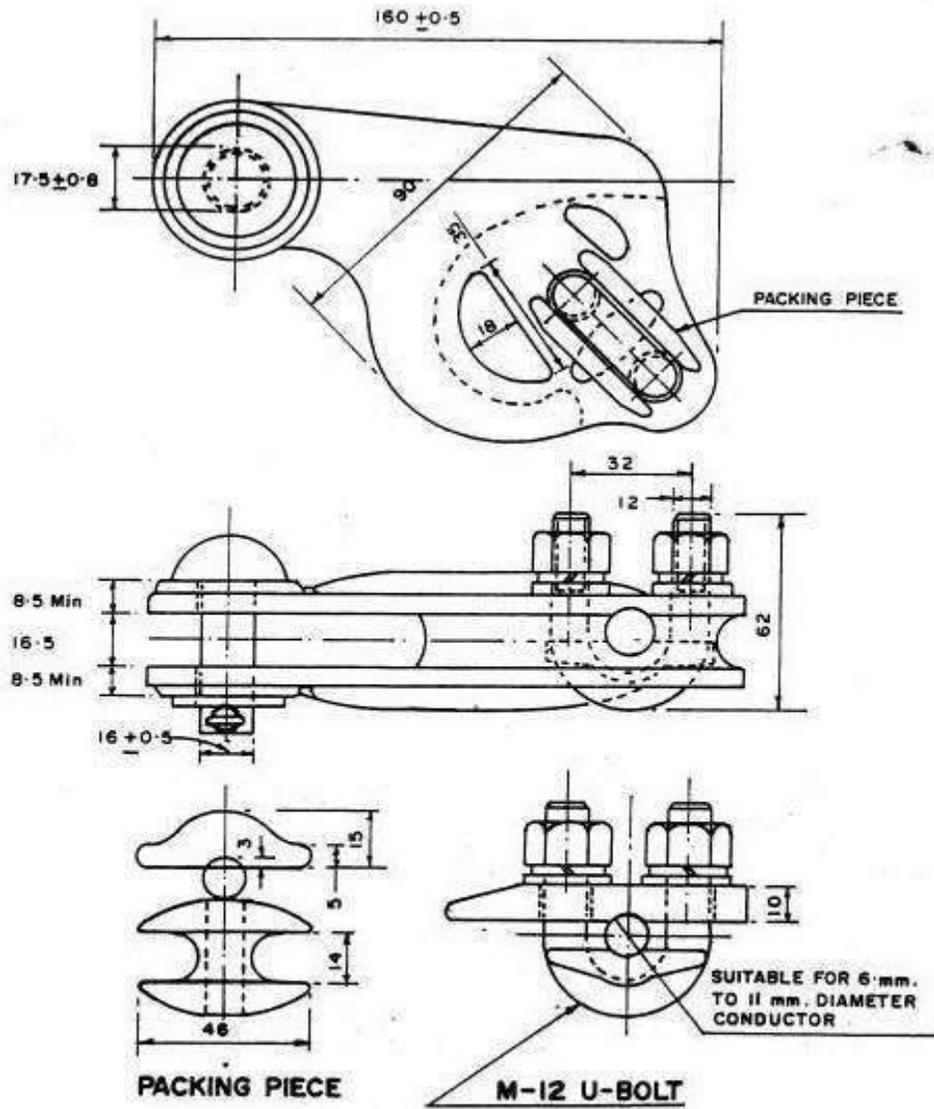
चित्र.४. ११ के.वी. पिन इन्सुलेटर टाई
(सीधी और १०° तक कोणीय स्थिति के लिए उपयुक्त)

FIG:- 4 - 11 KV PIN INSULATOR TIE
(SUITABLE FOR STRAIGHT RUNS AND ANGLE LOCATIONS UPTO 10°)



चित्र- 10. बॉल और सॉकेट प्रकार के विद्युत्तरोधक के लिए 11 के. वी. विकृति (स्ट्रेन) क्लैम्प
 FIG. 10 - 11KV. STRAIN CLAMP FOR BALL AND SOCKET TYPE INSULATOR.

ALL DIMENSIONS ARE IN mm.



चित्र: ८. टंग और क्लेविस् टाइप विद्युतरोधक के लिए ११ के. वी. विकृति क्लैम्प

FIG: 8. 11 KV. STRAIN CLAMP FOR TONGUE AND CLÉVIS TYPE INSULATOR.

ALL DIMENSIONS ARE IN mm.

21. Porcelain Insulators and Insulator Fittings for 33 kV Overhead Power Lines

1. SCOPE

This specification covers the details of the porcelain insulators and insulator fittings for use on 33 KV lines in rural electric sub-transmission systems.

2. APPLICABLE STANDARDS

Unless otherwise stipulated in this Specification, the insulators shall comply with the Indian Standard Specification **IS:731-1971** and the insulator fittings with **IS:2486 (Pt.I)-1971** and **IS:2486 (Pt.II)-1974** or the latest version thereof.

3. INSULATORS

3.1 General Requirements

3.1.1 The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

3.1.2 Unless otherwise specified, the glaze shall be brown in color. The glaze shall cover all the porcelain parts of the insulator except those areas which serve as supports during firing or are left unglazed for the purpose of assembly.

3.1.3 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.

3.1.4 Cement used in the construction of the insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings, and its thickness shall be as uniform as possible.

3.2 Classification

3.2.1 Only Type 'B' insulators as defined in Indian Standards shall be used.

3.2.2 The string insulators shall only be of ball and socket type.

3.3 Basic Insulation Levels

3.3.1 The test voltages of the insulators shall be as under :

Table (Clause 3.3.1)

Highest System Voltage	Visible Discharge Test	Wet Power Frequency Withstand Test	Power Frequency Withstand Test		Puncture	Impulse Voltage Withstand Test
			Pin	String Insulator Units		
kV (rms)	kV (rms)	kV (rms)	kV (rms)	kV(rms)		kV (Peak)
36	27	75	180	1.3 times the actual dry fl over voltage of the Unit.		170

3.3.2 In this specification, power frequency voltages are expressed as peak values divided by 2 and impulse voltages are expressed as peak values.

3.3.3 The withstand and flashover voltages are referred to the ‘Reference Atmospheric Conditions’ as per Indian Standard.

3.4 Mechanical Load

The insulators shall be suitable for the minimum failing loads specified as under:

Pin Insulator Failing loads	String Insulator Units	
	Failing Loads	Commended Pin Ball Shank Diameter
10 KN	45 KN	16 mm

2.5 Creepage Distance

The minimum creepage distance shall be as under:

Highest System Voltage	Normal and Moderately Polluted Atmosphere (Total)	Heavily polluted Atmosphere (Total)
1	2	3
36KV	580mm	840mm

Note: For insulator used in an approximately vertical position the values given in Col. (2) or (3) shall apply. For insulators used in an approximately horizontal position, the value given in Col. (2) shall apply but the value in Col. (3) may be reduced by as much as 20%.

3.6 Tests :

The insulators shall comply with the following tests as per **IS:731-1971** and latest version thereof.

3.6.1 Type Tests

- a) Visual examination,
- b) Verification of dimensions,
- c) Visible discharge test,
- d) Impulse voltage withstand test,
- e) Wet power-frequency voltage withstand test,
- f) Temperature cycle test,
- g) Electro-mechanical failing load test
- h) Mechanical failing load test (for those of Type B string insulator units to which electromechanical failing load test (g) is not applicable).
- i) Twenty-four hours mechanical strength test (for string insulators only when specified by the purchaser.
- j) Puncture Test
- k) Porosity test and
- l) Galvanizing test

3.6.2 Acceptance Tests

The test samples after having withstood the routine tests shall be subjected to the following acceptance test in the order indicated below:

- a) Verification of dimensions.
- b) Temperature cycle test
- c) Twenty four hours mechanical strength test (for string insulator units only when specified by the purchaser)

- d) Electro-mechanical failing load test.
- e) Puncture test.
- f) Porosity test and
- g) Galvanizing test

3.6.3 Routine Test

- a) Visual examination.
- b) Mechanical routine test (for string insulator units only) and
- c) Electrical routine test (for string insulator units only)

3.7 Marking

3.7.1 Each insulator shall be legibly and indelibly marked to show the following:

- a) Name or trademark of the manufacturer
- b) Month and year of manufacture
- c) Minimum failing load in Newtons
- d) Country of the manufacture and
- e) ISI Certification mark, if any.

3.7.2 Marking on porcelain shall be printed and shall be applied before firing.

3.8 Packing

All insulators (without fittings) shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail transport. Where more than one insulator is packed in a crate, wooden separators shall be fixed between the insulators to keep individual insulators in position without movement within the crate. Disc insulators, however, may be assembled in string and packed inside a crate to prevent movement.

4. INSULATOR FITTINGS

4.1 Pins for Pin Insulators

4.1.1 General Requirements

4.1.1.1 The pin shall be a single piece obtained preferably by the process of forging. It shall not be made by joining, welding, shrink-fitting or any other process from more than one piece of material. It shall be of good finish, free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided.

4.1.1.2 All ferrous pins, nuts and washer except those made of stainless steel shall be galvanized. The threads of nuts shall be cut after galvanizing and shall be well oiled and greased.

4.1.2 Type & Dimensions

4.1.2.1 Pins with large steel head Type L300N as per **IS:2486 (Pt.II)** having stalk length of 300 mm and shank length of 150 mm with minimum failing load of 10 KN shall be used.

4.1.2.2 The complete details of the pin are given in Fig.1.

4.1.3 Tests

Insulator pins shall comply with the following tests as per **IS:2486 (pt.I)**.

4.1.3.1 Type Tests

- a) Visual examination test
- b) Checking of threads on heads
- c) Galvanising test and
- d) Mechanical test

4.1.3.2 Acceptance Tests

- a) Checking of threads on heads
- b) Galvanising test and
- c) Mechanical test

4.1.3.3 Routine Test

Visual examination

4.2 String Insulator Fittings

4.2.1 General Requirements

4.2.1.1 All forgings and castings shall be of good finish and free of flaws and other defects. The edges on the outside of fittings, such as at the ball socket and holes, shall be rounded.

4.2.1.2 All parts of different fittings which provide for interconnection shall be made such that sufficient clearance is provided at the connection point to ensure free movement and suspension of the insulator string assembly. All ball and socket connections shall be free in this manner, but care shall be taken that too much clearance between ball and socket is avoided.

4.2.1.3 All ferrous fittings and the parts other than those of stainless steel, shall be galvanized. Small fittings like spring washers, nuts, etc. may be electro-galvanized.

4.2.2. Type and Dimensions

4.2.2.1 Only ball and socket type insulator sets shall be used. The nominal dimensions of the ball and sockets, ball eye and cross-arm straps are given in Fig. 2. An assembly drawing of the complete insulator string is given in Fig. 3.

4.2.2.2 Strain clamps shall be suitable for ACSR conductors $7/3.35 \text{ mm}^2$ (50 mm^2 Al. area), $7/4.09\text{mm}$ (80 mm^2 Al. area) and $6/4.72\text{mm} + 7/1.57 \text{ mm}$ (100 mm^2 Al. area). The ultimate strength of clamps shall not be less than 41 KN.

4.2.3 Tests

String insulator fittings shall comply with the following tests as per **IS:2486 (Pt.I)**.

4.2.3.1 Type Tests

- a) Slip strength test
- b) Mechanical test
- c) Electrical resistance test

- d) Heating cycle test
- e) Verification of dimensions
- f) Galvanising/Electroplating test, and
- g) Visual examination test

4.2.3.2 Acceptance Tests

- a) Verification of dimensions
- b) Galvanising/Electroplating test, and
- c) Mechanical tests

4.2.3.3 Routine Tests

- a) Visual examination test and
- b) Routine mechanical test

4.2.4 Marking

4.2.4.1 The caps and clamps shall have marked on them the following :

- a) Name or trade mark of the manufacturer and
- b) Year of manufacture

4.3 Packing

4.3.1 For packing of GI pins, strain clamps and related hardware, double gunny bags (or wooden cases, if deemed necessary) shall be employed. The heads and threaded portions of pins and the fittings shall be properly protected against damage. The gross weight of each packing shall not normally exceed 50 Kg. Different fittings shall be packed in different bags or cases and shall be complete with their minor accessories fitted in place. All nuts shall be hand-tightened over the bolts and screwed upto the farthest point.

4.3.2 The packages containing fittings may also be marked with the ISI certification mark.

22. 33 kV and 11 kV Post Insulator

1 GENERAL REQUIREMENTS

- I. The porcelain shall be sound and free from defects, thoroughly vitrified and smoothly glazed.
- II. Unless otherwise specified the glaze shall be brown in colour. The glaze shall cover all the exposed porcelain part of the insulator except those areas which serve as support or required to be left un-glazed.
- III. Precaution shall be taken during design and manufacture to avoid the following:
 - a) Stress due to expansion and contraction which may lead to deterioration.
 - b) Stress concentration due to direct engagement of the porcelain with the metal fittings.
 - c) Retention of water in the recesses of metal fitting and
 - d) Shapes which do not facilitate easy cleaning by normal methods.
- IV. Cement used in the construction of the post insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. Further, the cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.
- V. All ferrous metal parts except those of stainless steel, shall be hot dip galvanized and the uniformity of zinc coating shall satisfy the requirements of IS : 2633. The parts shall be galvanized after mechanising. The finished galvanized surface shall be smooth.
- VI. The threads of the tapped holes in the post insulators metal fittings shall be cut after giving anti-corrosion protection and shall be protected against rust by greasing or by other similar means. All other threads shall be cut before giving anti-corrosion protection. The tapped holes shall be suitable for bolts with threads having anti-corrosion protection and shall conform to IS : 4218(Part-I to VI). The effective length of thread shall not be less than the nominal diameter of the bolt.
- VII. The post insulator unit shall be assembled in a suitable jig to ensure the correct positioning of the top and bottom metal fitting relative to one another. The faces of the metal fittings shall be parallel and at right angles to the axis of the insulator and the

corresponding holes in the top and bottom metal fittings shall be in a vertical plan containing the axis of insulator.

2 CLASSIFICATION

The post insulators shall be of type 'B' according to their construction, which is defined here under:

A post insulator or a post insulator unit in which the length of the shortest puncture path through solid insulating material is less than half the length of the shortest flash over path through air outside the insulator.

3 Standard insulation levels:

I. The standard insulator levels of the post insulator or post insulator unit shall be as under:

Highest system voltage	Visible discharge test	Dry one minute power frequency withstand test.	Wet one minute power frequency withstand test.	Power frequency puncture withstand test.	Impulse voltage withstand test.
12 kV (rms)	9 kV(rms)	35 kV(rms)	35 kV(rms)	1.3 times the actual dry flash over voltage of the unit (kVrms)	75 kV peak
36 kV (rms)	27 kV(rms)	75 kV(rms)	75 kV(rms)	1.3 times the actual dry flash over voltage of the unit (kVrms)	170 kV peak

II. In this standard, power frequency voltage is expressed as peak values divided by $\sqrt{2}$. The impulse voltages are expressed as peak values.

III. The withstand and flashover voltage are referred to the atmospheric condition.

4 TESTS

I. The insulators shall comply with the following constitute the type tests:

- a) Visual examination.
- b) Verification of dimensions.
- c) Visible discharge test.
- d) Impulse voltage withstand test.
- e) Dry power frequency voltage withstand test.
- f) Wet power frequency voltage withstand test.
- g) Temperature cycle tests.
- h) Mechanical strength tests.
- i) Puncture test.
- j) Porosity test.
- k) Galvanizing test.

Type test certificates for the tests carried out on prototype of same specifications shall be enclosed with the tender and shall be subjected to the following acceptance test in the order indicated below.\

II. Acceptance test:

The test samples after having withstood routine test shall be subjected to the at least following acceptance test in the order indicated below:

- a) Verification of dimensions.
- b) Temperature cycle tests.
- c) Mechanical strength tests.
- d) Puncture test.
- e) Porosity test.
- f) Galvanizing test.

III. Routine tests:

The following shall be covered under routine tests on each post insulator or post insulator unit.

- a) Visual examination as per Cl. No.- 9.12 of IS: 2544/1973
- b) Mechanical routine test as per Cl. No.- 9.14 of IS: 2544/1973
- c) Electrical routine test as per Cl. No.- 9.13 of IS: 2544/1973

5 MARKING

I. Each post insulator shall be legibly and indelibly marked to show the following.

- a) Name or trademark of the manufacturer.
- b) Month & year of manufacture.

c) Country of manufacture.

II. Marking on porcelain shall be printed and shall be applied before firing.

III. Post insulator or post insulator units may also be mark with I.S.I. certification mark.

6 PACKING

All post insulators shall be pack in wooden crates suitable for easy but rough handling and acceptable for rail, transport. Where more than one insulator is packed in a crate wooden separator shall be fixed between the insulators to keep individual insulator in position without movement within the crate.

Table-I

Highest System Voltage in kV	Minimum Creepage distance in mm
12	Post insulator 320
36	900

ANNEXURE – A

1 Hydraulic Internal Pressure Test on Shells (if applicable)

The test shall be carried out on 100%-disc strain insulator shells before assembly. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

2 Thermal Mechanical Performance Test

Thermal Mechanical Performance Test shall be performed in accordance with IEC-383-1-1993 Clause 20 with the following modifications:

(1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.

(2) The acceptance criteria shall be

(a) X greater than or equal to $R + 3S$.

Where,

X Mean value of the individual mechanical failing load.

R Rated electro-mechanical / mechanical failing load.

S Standard deviation.

- (b) The minimum sample size shall be taken as 20 for disc insulator units.
- (c) The individual electromechanical failing load shall be at least equal to the rated value. Also, puncture shall not occur before the ultimate fracture.

3 Electromechanical/Mechanical Failing Load Test.

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance

- (i) X greater than or equal to $R + 3S$

Where,

X Mean value of the electro-mechanical/mechanical/ failing load.

R Rated electro-mechanical / mechanical failing load.

S Standard deviation.

- (ii) The minimum sample size shall be taken as 20 for disc insulators units. However, for larger lot size, IEC 591 shall be applicable.
- (iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also, electrical puncture shall not occur before the ultimate fracture.

4 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analysed as per IS:209. The purity of zinc shall not be less than 99.95%.

5 Tests for Forgings

The chemical analysis, hardness tests and magnetic particle inclusion test for forgings, will be as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

6 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inclusion for castings will be as per the internationally recognised procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

23. 11 kV/22 kV/33 kV Composite Insulators

1) SCOPE :

This specification covers the design, manufacture, testing and supply of 11KV / 22KV / 33 KV Composite Insulators. The composite insulators shall be of the following type:

- i) Long rod insulators for conductors in tension application at angle / cut points the insulators shall be of tongue & clevis type.
- ii) Line post insulators or pin insulators for straight line locations

2) SERVICE CONDITIONS :

The insulators to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

Maximum ambient temperature (Degree C)	...	50
Minimum ambient temperature (Degree C)	...	3.5
Relative Humidity (%)	...	10 to 100
Maximum Annual Rainfall (mm)	...	1450
Maximum Wind pressure (kg/m.sq.)	...	150
Maximum wind velocity (km/hour)	...	45
Maximum altitude above mean sea level (meter)	...	1000
Isoceraunic level (days/year)	...	50
Seismic level (Horizontal acceleration)	...	0.3 g
Moderately hot and humid tropical climate Conductive to rust and fungus growth		

3) SYSTEM PARTICULARS:

a) Nominal System Voltage	11 kV	22 kV	33 kV
b) Corresponding highest system Voltage	12 kV	24kV	36kV
c) Frequency	50 Hz with 3% tolerance		
d) Number of phase	3	3	3
e) Neutral earthing	effectively grounded.		

4) STANDARDS :

Unless otherwise specified elsewhere in the specifications insulators shall conform to the latest revisions of all relevant standards available at the time of placement of the order. The standards are listed in Annexure ‘A’.

5) **GENERAL REQUIREMENTS**

- i) The composite insulators shall generally conform to latest Standards as listed in Annexure ‘A’
- ii) The Composite Insulators will be used on lines on which the conductors will be A.A.A. Conductor of size up to 200 sq. mm. and ACSR of any size up to Panther (0.2 sq. inch copper equivalent). The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.
- iii) Supplier must be an indigenous manufacturer and manufacturer of composite insulators of rating 33 kV or above OR must have developed proven in house technology and manufacturing process for composite insulators of above rating OR possess technical collaboration /association with a manufacturer of composite insulators of rating 33kV or above. The Manufacturer shall furnish necessary evidence in support of the above, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the Employer.
- iv) Insulator shall be suitable for both the suspension and strain type of load & shall be of tongue & clevis type. The diameter of Composite Insulator shall be less than 200 mm. The center-to-center distance between tongue & clevis shall be max. 300 mm for 11 kV, 450 mm for 22 kV & 550 mm for 33 kV composite Insulator.
- v) Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134.
- vi) The size of Composite insulator, minimum creepage distance and mechanical strength along with hardware fittings shall be as follows:

Sr. No.	Type of Composite insulator	Nominal System Voltage	Highest System Voltage kV(rms)	Visible Discharge Test Voltage	Wet Power Frequency	Impulse Withstand voltage kV(rms)	Minimum Creepage Distance	Center to Center Distance	Min. Failing load	Shed Diameter (mm) (
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	s	e kV (rms)		kV(rms)	Withstand Voltage kV(rms)		(mm) (Heavily Polluted 25mm/k V)	Between Tongue & Clevis (mm)	kN	min)
i.	Long Rod insulator	11	12	9	35	75	320	300	45	75-
		22	24	18	55	125	600	450	70	100
		33	36	27	75	170	900	550	70	100
ii.	Post/Pin Insulator	11	12	9	35	75	320		5	
		22	24	18	55	125	560		10	
		33	36	27	75	170	900		10	

* Amendment issued vide letter No.REC/DDUGJY/SBD/749 Dated 27-07-2016

vii) Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with-IEC 61109:

(0.04d+1.5) mm when $d \leq 300$ mm.

(0.025d+6) mm when $d > 300$ mm.

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be. However no negative tolerance shall be applicable to creepage distance.

viii) Interchangeability:

The composite insulator together with the tongue & clevis fittings shall be of standard design suitable for use with the hardware of any other indigenous make conforming to relevant standards referred above.

ix) Corona and RI Performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall

be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

6) **TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS**

Polymeric Insulators shall be designed to meet the high quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.

Polymeric Insulators shall consist of THREE parts, at least two of which are insulating parts:-

- (a) Core- the internal insulating part
- (b) Housing- the external insulating part
- (c) Metal end fittings.

i) **CORE**

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free.

ii) **HOUSING:**

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy compound of a thickness of 3mm minimum. It shall be one-piece housing using Injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences. Housing shall conform to the requirements of IEC 61109/92-93 with latest amendments

iii) **WEATHERSHEDS**

The composite polymer weather sheds made of a silicone elastometric compound or silicone alloy compound shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections It should protect the FRP rod against environmental influences, external pollution and humidity. The weather sheds should have silicon content of minimum 30% by weight. The strength of

the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

iv) **METAL END FITTINGS:**

End fitting transmit the mechanical load to the core. They shall be made of spheroidal graphite cast iron, malleable cast iron or forged steel or aluminum alloy. They shall be connected to the rod by means of a controlled compression technique. Metal end fittings shall be suitable for tongue & clevis hard wares of respective specified mechanical load and shall be hot dip galvanized after, all fittings have been completed. The material used in fittings shall be corrosion resistant. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process & should not damage the individual fibers or crack the core. The gap between fitting and sheath shall be sealed by a flexible silicone elastomeric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof. The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC: 60120/ IS: 2486 - Part-II /1989.

7) **WORKMANSHIP**

- 7.1 All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Manufacturers shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.
- 7.2 The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.
- 7.3 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- 7.4 The core shall be sound and free of cracks and voids that may adversely affect the insulators.
- 7.5 Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and

shall be free from defects and excessive flashing at parting lines.

- 7.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress; effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with out projecting points or irregularities, which may cause corona.

All load bearing surfaces shall be sooth and uniform so as to distribute the loading stresses uniformly.

- 7.7 All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. or 87 microm thickness and shall be in accordance with the requirement of IS:4759. the zinc used for galvanizing shall be of purity 99.5% as per IS:4699. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

8) **TESTS AND STANDARDS**

Insulators offered shall be manufactured with the same configuration & raw materials as used in the insulators for which design & type test reports are submitted. The manufacturer shall submit a certificate for the same. The design & type test reports submitted shall not be more than five years old.

8.1 **DESIGN TESTS :**

For polymeric insulators it is essential to carry out design test as per clause 4.1 of IEC 61109 / 92-93 with latest amendments. The design tests are intended to verify the suitability of the design, materials and method of manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which are represented by the one tested and having the following characteristics:

- Same materials for the core, and sheds and same manufacturing method;
- Same material of the fittings, the same design, the same method of attachment;

Same or greater layer thickness of the shed material over the core (including a sheath where used);

- Same or smaller ratio of the highest system voltage to insulation length;
- Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings
- Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances.

Manufacturer should submit test reports for Design Tests as per IEC – 61109 (clause – 5). Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract:

UV test: the test shall be carried out in line with clause 7.2 of ANSI C29.13.

8.2 TYPE TESTS :

The type tests are intended to verify the main characteristics of a composite insulator. The type tests shall be applied to composite insulators, the class of which has passed the design tests.

8.2.1 Following Type test shall be conducted on a suitable number of individual insulator units, components, materials or complete strings:

Sl. No	Description of type test	Test procedure / standard
1	Dry lightning impulse withstand voltage test	As per IEC 61109(Clause 6.1)
2	Wet power frequency test	As per IEC 61109(Clause 6.2)
3	Mechanical load-time test	As per IEC 61109(Clause 6.4)
4	Radio interference test	As per IEC 61109(Clause 6.5) revised
5	Recovery of Hydrophobicity test	Annexure – B This test may be repeated every 3yrs by the manufacturer
6	Chemical composition test for silicon content	Annexure – B Or any other test

		method acceptable to the Employer
7	Brittle fracture resistance test	Annexure – B

The Manufacturer shall submit type test reports as per IEC 61109. Additional type tests required if any shall be carried out by the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

8.3 ACCEPTANCE TESTS :

The test samples after having withstood the routine test shall be subject to the following acceptance tests in order indicated below:

(a)	Verification of dimensions	: Clause 7.2 IEC: 61109,
(b)	Verification of the locking system (if applicable)	: Clause 7.3 IEC: 61109,
(c)	Verification of tightness of the interface Between end fittings & Insulator housing	: Clause 7.4 IEC: 61109 amendment 1 of 1995
(d)	Verification of the specified mechanical load	: Clause 7.4 IEC: 61109, amendment 1 of 1995
(e)	Galvanizing test	: IS:2633/IS:6745

8.4 ROUTINE TESTS:

Sr.No.	Description	Standard
1	Identification of marking	As per IEC: 61109 Clause 8.1
2	Visual Inspection	As per IEC: 61109 Clause 8.2
3	Mechanical routine test	As per IEC: 61109 Clause 8.3

Every polymeric insulator shall withstand mechanical routine test at ambient temperature tensile load at RTL corresponding to at least 50 % of the SML for at least 10 sec.

8.5 TESTS DURING MANUFACTURE:

Following tests shall also be carried out on all components as applicable

- (a) Chemical analysis of zinc used for galvanizing

- (b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
- (c) Chemical analysis, hardness tests and magnetic particle inspection for forgings.

8.6 SAMPLE BATCH FOR TYPE TESTING :

The Manufacturer shall offer material for sample selection for type testing only after getting Quality Assurance Plan approved by Employer. The sample for type testing will be manufactured strictly in accordance with the approved Quality Assurance Plan.

9) **QUALITY ASSURANCE PLAN :**

9.1 The Manufacturer shall submit following information:

- i) Test certificates of the raw materials and bought out accessories.
- ii) Statement giving list of important raw material, their grades along with names of sub-Manufacturers for raw materials, list of standards according to which the raw materials are tested. List of tests normally carried out on raw materials in presence of Manufacturer's representative.
- iii) List of manufacturing facilities available.
- iv) Level of automation achieved and lists of areas where manual processing exists.
- v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- vi) List of testing equipments available with the Manufacturer for final testing of equipment along with valid calibration reports.
- vii) The manufacturer shall submit Manufacturing Quality Assurance Plan (QAP) for approval

& the same shall be followed during manufacture and testing.

9.2 The Manufacturer shall submit the routine test certificates of bought out raw materials/accessories and central excise passes for raw material at the time of inspection.

- 9.3 The Employer's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Manufacturer's and sub-Manufacturer's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.
- 9.4 The material for final inspection shall be offered by the Manufacturer only under packed condition. The Employer shall select samples at random from the packed lot for carrying out acceptance tests. The lot offered for inspection shall be homogeneous and shall contain insulators manufactured in 3-4 consecutive weeks.
- 9.5 The Manufacturer shall keep the Employer informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.
- 9.6 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the Employer in writing waives off the inspection. In the later case also the material shall be dispatched only after satisfactory testing specified herein has been completed.
- 9.7 The acceptance of any quantity of material shall in no way relieve the Manufacturer of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective

10) **TEST CERTIFICATE :**

The manufacturerer shall furnish detailed type test reports of the offered composite Insulators as per clause 8.2 of the Technical Specifications at the NABL approved laboratories to prove that the composite Insulators offered meet the requirements of the specification. These Type Tests should have been carried out within five years prior to the date of opening of this manufacturer

The Employer reserves right to demand repetition of some or all the Type Test in presence of Employer's representative. For this purpose, the manufacturerer shall quote unit rates for carrying out each Type Test. However, such unit rates will not be considered for evaluation of the offer. In case the unit fails in the Type Tests, the complete supply shall be rejected.

11) **TESTING FACILITIES :**

The manufacturer must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine & acceptance Tests. These facilities should be available to Employer's Engineers if deputed or carry out or witness the tests in the manufacturer works. The insulators shall be tested in accordance with the procedure detailed in IEC 61109 / 92-93 with latest amendments.

12) **DRAWINGS :**

- (i) The Manufacturer shall furnish full description and illustration of the material offered.
- (ii) The Manufacturer shall furnish the outline drawing (3 copies) of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not be limited to the following information:

- Long rod diameter with manufacturing tolerances
- Minimum Creepage distance with positive tolerance

- Protected creepage distance
- Eccentricity of the long rod unit

- Axial run out

- Radial run out

- Unit mechanical and electrical characteristics
- Size and weight of ball and socket/tongue & clevis
- Weight of composite long rod units
- Materials

- Identification mark
- Manufacturer's catalogue number

- (iii) After placement of award the Manufacturer shall submit fully dimensioned insulator crate drawing for different type of insulators for approval of the Employer.

13) **RETEST AND REJECTION:**

- 13.1 Sample Procedure for testing of insulators shall be as per clause 7.1 to 7.6 of IEC

61109 for Acceptance & Routine Tests.

For the sampling tests, two samples are used, E1 and E2. The sizes of these samples are indicated in the table below.

Lot Size (N)	Sample Size	
	E1	E2
N < 300	Subject to agreement	
300 < N < 2000	4	3
2000 < N < 5000	8	4
5000 < N < 10000	12	6

If more than 10000 insulators are concerned, they shall be divided into an optimum number of lots comprising between 2000 and 10000 insulators. The results of the tests shall be evaluated separately for each lot.

The insulators shall be selected by the Employer's representative from the lot at random.

The samples shall be subjected to the applicable sampling tests.

The sampling tests are:

- Verification of dimensions - (E1 + E2)
- Verification of the locking system - (E2)
- Verification of tightness of the interface between end fittings & Insulator housing - (E2)
- Verification of the specified mechanical load SML - (E1)
- Galvanizing test - (E2)

In the event of a failure of the sample to satisfy a test, the retesting procedure shall be as follows :

If only one insulator or metal part fails to comply with the sampling tests, a new sample equal to twice the quantity originally submitted to the tests shall be subjected to retesting. The retesting shall comprise the test in which failure occurs. If two or more insulator or metal parts fail to comply with any of the sampling tests or if any failure occurs during the retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with these defects. The sorted lot then be

resubmitted for testing. The number then selected shall be three times the first chosen quantity for tests. If any insulators fail during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

13.2 Verification of dimensions (E1 + E2)

The dimensions given in the drawings shall be verified. The tolerances given in the drawing are valid. If no tolerances are given in the drawings the values mentioned in this specification shall hold good.

13.3 Verification of the locking system (E2)

This test applies only to the insulators equipped with socket coupling as specified by IEC 120 and is performed according to IEC 383.

13.4 Verification of tightness of the interface between end fittings & Insulator housing (E2)

One insulator selected randomly from the sample E2, shall be subjected to crack indication by dye penetration, in accordance with ISO 3452, on the housing in the zone embracing the complete length of the interface between the housing and metal fitting and including an additional area, sufficiently extended beyond the end of the metal part.

The indication shall be performed in the following way.

- (i) the surface shall be properly pre-cleaned with the cleaner ;
- (ii) the penetrant, which shall act during 20 minutes, shall be applied on the cleaned surface;
- (iii) with in 5 minutes after the application of the penetrant, the insulator shall be subjected, at the ambient temperature, to a tensile load of 70 % of the SML, applied between the metal fittings; the tensile load shall be increased rapidly but smoothly from zero up to 70 % of the SML, and then maintained at this value for 1 minute;
- (iv) the surface shall be cleaned with the excess penetrant removed, and dried;
- (v) the developer shall be applied if necessary;

(vi) the surface shall be inspected.

Some housing materials may be penetrated by the penetrant. In such cases evidence shall be provided to validate the interpretation of the results.

After the 1 min. test at 70 % of the SML, if any cracks occur, the housing and, if necessary, the metal fittings and the core shall be cut, perpendicularly to the crack in the middle of the widest of the indicated cracks, into two halves. The surface of the two halves shall then be investigated for the depth of the cracks.

13.5 Verification of the specified mechanical load SML

The insulators of the sample E1 shall be subjected at ambient temperature to a tensile load, applied between the couplings. The tensile load shall be increased rapidly but smoothly from zero to approximately 75 % of the SML, and then be gradually increased to the SML in a time between 30 sec. to 90 sec.

If 100 % of the SML is reached in less than 90 s, the load (100 % of the SML) shall be maintained for the remainder of the 90 s. (This test is considered to be equivalent to a 1min withstand test at the SML.)

The insulators have passed the test at 13.4 & 13.5 above if:

No failure (breakage or complete pull out of the core, or fracture of the metal fitting) occurs either during the 1 min. 70 % withstand test (a) or during the 1 min.100 % withstand test (b).

No cracks are indicated after the dye penetration method described in 13.4 above.

The investigation of the halves described in 13.4 above shows clearly that the cracks do not reach the core.

13.6 Galvanizing test

This test shall be performed according to IS: 2633/IS: 6745 on galvanized parts.

14) **MARKINGS :**

14.1 Each insulator shall be legibly and indelibly marked with the following details as per IEC- 61109:

- a) Name or trademark of the manufacturer.
- b) Voltage & Type
- c) Month and year of manufacturing.
- d) Min. failing load/guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.
- e) RDSS 'Employer Name'. Marking

14.2 One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the end fitting of each composite long rod of particular strength for easy identification. The paint shall not have any deteriorating effect on the insulator performance.

Following codes shall be used as identification mark:

For 45 KN long rod units	: Blue
For 70 KN long rod units	: Red

15) **PACKING :**

- 15.1 All insulators shall be packed in strong corrugated box of min. 7 ply duly palletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 Kg to avoid hackling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.
- 15.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 15.3 Suitable cushioning, protective padding, or Dunn age or spacers shall be provided to prevent damage or deformation during transit and handling.
- 15.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case /crate /corrugated box shall have all the markings stenciled on it in indelible ink.
- 15.5 The Manufacturer shall provide instructions regarding handling and storage

precautions to be taken at site.

16) **GUARANTEE**

The Manufacturer of insulators shall guarantee overall satisfactory performance of the insulators. The manufacturerer shall furnish in the form attached (Schedule 'A') all the guaranteed technical particulars.

SCHEDULE – A1**GUARANTEED TECHNICAL PARTICULARS.****COMPOSITE INSULATOR UNIT****11KV(45KN) / 11KV(70KN).****(to be filled separately for each type mentioned above)**

Sr.No	Parameter Name	Parameter type	
1.	Type of insulator	Text	
2.	Standard according to which the insulators manufactured and tested	Text	
3.	Name of material used in manufacture of the insulator with class/grade	Text	
3.1	Material of core (FRP rod) i) E-glass or ECR-glass ii) Boron content		
3.2	Material of housing & weather sheds (Silicon content by weight)		
3.3	Material of end fittings	Text	
3.4	Sealing compound for end fitting	Text	
4.0	Colour	Text	
5.	Electrical characteristics		
5.1.	Nominal system voltage	KV (rms)	Numeric
5.2	Highest system voltage	KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage	KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage	KV (rms)	Numeric
5.5	Dry flashover voltage	KV (rms)	Numeric
5.6	Wet flash over voltage	KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage a) Positive b) Negative	KV (peak) KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage a) Positive b) Negative	KV (peak) KV (peak)	
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition	Micro volts	Numeric
6.0	Creepage distance (Min.) (320mm)	(mm)	Numeric

Sr.No	Parameter Name	Parameter type
6.1	Center to center distance between tongue & clevis) (300mm) (mm)	Numeric
6.2	Shed diameter (100mm) (mm)	Numeric
7.0	Mechanical characteristics: Minimum failing load	Numeric KN
8.0	Dimensions of insulator	
8.1	Weight	Numeric Kg
8.2	Dia. of FRP rod:	Numeric mm
8.3	Length of FRP rod	Numeric mm
8.4	Dia. of weather sheds (100mm)	Numeric mm
8.5	Thickness of housing	Numeric mm
8.6	Dry arc distance	Numeric mm
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	Type of sheds	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	Packing details	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the Manufacturer may like to give	File

SCHEDULE – A2**GUARANTEED TECHNICAL PARTICULARS.****COMPOSITE INSULATOR UNIT****22KV (70KN)**

Sr.No	Parameter Name	Parameter type
1.	Type of insulator	Text
2.	Standard according to which the insulators manufactured and tested	Text
3.	Name of material used in manufacture of the insulator with class/grade	
3.1	Material of core (FRP rod) i) E-glass or ECR-glass ii) Boron content	Text
3.2	Material of housing & weather sheds (silicon content by weight)	Text
3.3	Material of end fittings	Text
3.4	Sealing compound for end fitting	Text
4.0	Colour	Text
5.	Electrical characteristics	
5.1.	Nominal system voltage KV (rms)	Numeric
5.2	Highest system voltage KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage KV (rms)	Numeric
5.5	Dry flashover voltage KV (rms)	Numeric
5.6	Wet flash over voltage KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	Numeric
6.0	Creepage distance (Min.) mm	Numeric
6.1	Center to center distance between tongue & clevis (mm)	Numeric

Sr.No	Parameter Name	Parameter type
6.2	Shed diameter (mm)	Numeric
7.0	Mechanical characteristics: KN	Numeric
	Minimum failing load	
8.0	Dimensions of insulator	
8.1	Weight Kg	Numeric
8.2	Dia. of FRP rod: mm	Numeric
8.3	Length of FRP rod mm	Numeric
8.4	Dia. of weather sheds mm	Numeric
8.5	Thickness of housing mm	Numeric
8.6	Dry arc distance mm	Numeric
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	Type of sheds	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	Packing details	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the Manufacturer may like to give	File

SCHEDULE – A3**GUARANTEED TECHNICAL PARTICULARS.****COMPOSITE INSULATOR UNIT****33KV (70KN)**

Sr.No	Parameter Name	Parameter type
1.	Type of insulator	Text
2.	Standard according to which the insulators manufactured and tested	Text
3.	Name of material used in manufacture of the insulator with class/grade	
3.1	Material of core (FRP rod) i) E-glass or ECR-glass ii) Boron content	Text
3.2	Material of housing & weather sheds (silicon content by weight)	Text
3.3	Material of end fittings	Text
3.4	Sealing compound for end fitting	Text
4.0	Colour	Text
5.	Electrical characteristics	
5.1.	Nominal system voltage KV (rms)	Numeric
5.2	Highest system voltage KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage KV (rms)	Numeric
5.5	Dry flashover voltage KV (rms)	Numeric
5.6	Wet flash over voltage KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	Numeric
6.0	Creepage distance (Min.) mm	Numeric
6.1	Center to center distance between tongue & clevis (mm)	Numeric

Sr.No	Parameter Name	Parameter type
6.2	Shed diameter (mm)	Numeric
7.0	Mechanical characteristics: Minimum failing load	KN Numeric
8.0	Dimensions of insulator	
8.1	Weight	Kg Numeric
8.2	Dia. of FRP rod:	mm Numeric
8.3	Length of FRP rod	mm Numeric
8.4	Dia. of weather sheds	mm Numeric
8.5	Thickness of housing	mm Numeric
8.6	Dry arc distance	mm Numeric
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	Type of sheds	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	Packing details	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the Manufacturer may like to give	File

ANNEXURE 'A'

Sr.	Indian Standard	Title	International Standard
1	-	Definition, test methods and acceptance criteria for composite insulators for A.C. overhead lines above 1000V	IEC: 61109
2	IS: 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V	IEC: 60383
3	IS: 2071	Methods of High Voltage Testing	IEC: 60060-1
4	IS: 2486	Specification for Insulator fittings for Overhead power Line with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	IEC: 60120 IEC: 60372
5.	-	Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
6.	IS: 13134	Guide for the selection of insulators in respect of polluted condition	IEC: 60815
7.	-	Characteristics of string insulator units of the long rod type	IEC: 60433
8.	-	Hydrophobicity Classification Guide	STRI guide 1.92/1
9.	-	Radio interference characteristics of overhead power lines and high-voltage equipment.	CISPR: 18-2 Part 2
10.	IS: 8263	Methods of RI Test of HV insulators	IEC: 60437
11.		Standard for Insulators- Composite-Distribution Dead-end Type	ANSI C29.13-2000
12.	IS: 4759	Hot dip zinc coatings on structural steel & other allied products	ISO: 1459 ISO: 1461
13.	IS: 2629	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO: 1461 (E)
14.	IS: 6745	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	ISO: 1460
15.	IS: 3203	Methods of testing of local thickness of electroplated coatings	ISO: 2173
16.	IS: 2633	Testing of Uniformity of Coating of zinc coated articles	
17.	-	Standard specification for glass fiber strands	ASTM D 578-05
18.	-	Standard test method for compositional analysis by Thermogravimetry	ASTM E 1131-03

19.	IS:4699	Specification for refined secondary Zinc	
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STANDARDS TO BE ADOPTED FOR COMPOSITE INSULATORS

Annexure-B

Tests on Insulator units

1 RIV Test (Dry)

The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10kV & 30 kV for 11 kV & 33 kV class insulators respectively under dry condition. The test procedure shall be in accordance with IS:8263 /IEC:437/CISPR 18-2.

2 Brittle Fracture Resistance Test

Brittle fracture test shall be carried out on naked rod along with end fitting by applying “1n HNO₃ acid” (63 g conc. HNO₃ added to 937 g water) to the rod. The rod should be held 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

3 Recovery of Hydrophobicity & Corona test

The test shall be carried out on 4mm thick samples of 5cm X 7cm.

- i. The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRI guide for Hydrophobicity classification. Dry the sample surface.
- ii. The sample shall be subjected to mechanical stress by bending the sample over a ground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. The test shall be done for 100 hrs.
- iii. Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 2 above. Note HC classification. Repeat the cycle for 1000 hrs. or until an HC of 6 or 7 is obtained. Dry the sample surface.
- iv. Allow the sample to recover and repeat hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2

within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

4 Chemical composition test for Silicon content

The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X- ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI or any other NABL accredited laboratory.

24. Guy Strain Insulators

1. SCOPE

This Specification covers porcelain guy strain insulators for use in rural electrification system.

2. APPLICABLE STANDARDS

Unless otherwise modified in this specification, the insulators shall comply with IS: 5300-1969 or the latest version thereof.

3. GENERAL REQUIREMENTS

- 3.1** The porcelain insulator shall be sound, free from defects, thoroughly vitrified and smoothly glazed.
- 3.2** The design of the insulator shall be such that the stresses due to expansion and contraction in any part of the insulator shall not lead to its deterioration.
- 3.3** The glaze, unless otherwise specified, shall be brown in colour. The glaze shall cover the entire porcelain surface parts except those areas that serve as supports during firing.

4. TYPE OF INSULATORS

- 4.1** The standard guy strain insulators shall be of designations 'A' and 'C' as per IS:5300.
- 4.2** The recommended type of guy strain insulators for use on guy wires of overhead lines of different voltage levels are as follows :

Power Line Voltage	Designation of Insulators
415/240V	A
11000V	C
33000V	C (2 Insulators to be used in series)

5. DIMENSIONS

The dimensions of guy strain insulators shall be in accordance with Figs. 1 and 2.

6. BASIC INSULATION LEVELS

The test voltage of the insulators shall be as under :

Designation of Insulator	Dry one minute power Frequency withstand voltageKV (rms)	Wet one minute power Frequency withstand voltage KV (rms)
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A	18	8
C	27	13

7. MECHANICAL STRENGTH

The insulators shall be suitable for the minimum failing loads specified as under:

Designation of Insulator	Minimum failing load (KN)
A	44
	88

8. TESTS

The insulators shall comply with the following routine, type and acceptance tests as per IS:5300.

8.1 Routine Test

Visual examination

8.2 Type Tests

- a) Visual examination
- b) Verification of dimensions
- c) Temperature cycle test
- d) Dry one-minute power-frequency voltage withstand test
- e) Wet one-minute power frequency voltage withstand test
- f) Mechanical strength test
- g) Porosity test

8.3 Acceptance Tests: (to be conducted in the following order)

- a) Verification of dimensions
- b) Temperature cycle test
- c) Mechanical strength test
- d) Porosity test

9. MARKING

9.1 Each insulator shall be legibly and indelibly marked to show the following :

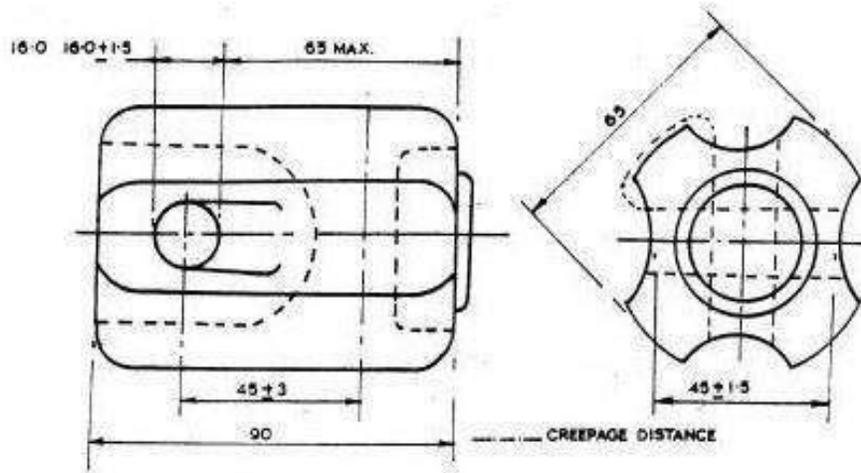
- a) Name or trade mark of the manufacturer
- b) Year of manufacture

c) ISI certification mark, if any.

9.2 Marking on porcelain shall be applied before firing.

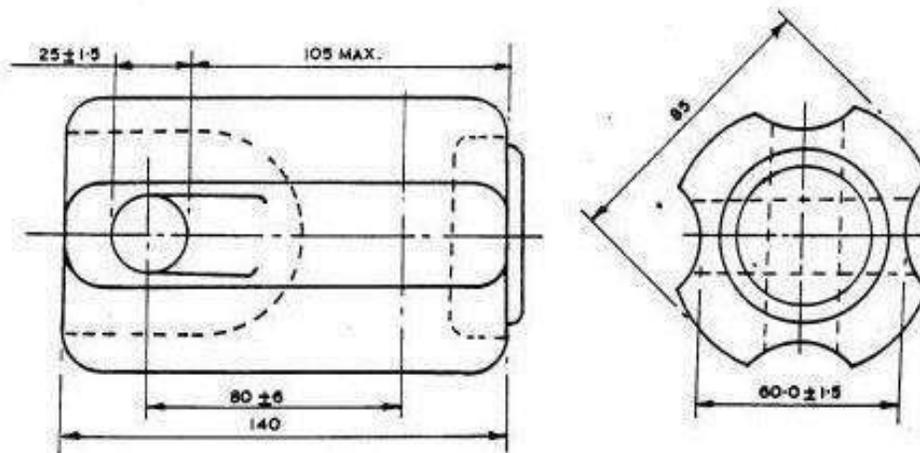
10. PACKING

All insulators shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail transport. Wooden separators shall be fixed between the insulators to keep individual insulators in position without movement within the crate.



चित्र-१. तान रस्सी विकृतिसह विद्युतरोधक - संज्ञा ए.

FIG. 1. GUY STRAIN INSULATOR (DESIGNATION - A)



चित्र-२ तान रस्सी विकृतिसह विद्युतरोधक - संज्ञा सी.

FIG. 2. GUY STRAIN INSULATOR (DESIGNATION - C)

ALL DIMENSIONS ARE IN MM

25. Helically Formed Fittings for 11 kV and LT Lines

1. SCOPE

This Standard specifies the requirements and tests for helically formed fittings for use on 11 KV and LT overhead lines.

The following types of fittings are covered:-

- a) Conductor dead end fittings
- b) Distribution ties, side ties and double ties
- c) Conductor splices
- d) Guy grip dead-ends
- e) Tap connectors
- f) Service grip dead-ends
- g) Lashing rods

2. GENERAL REQUIREMENTS

- 2.1** Aluminium alloy, aluminium-clad steel and galvanised steel wires having required mechanical strength, corrosion resistance and formability, depending on the type of application shall be employed in the manufacture of the fittings. The material of the formed fittings shall be compatible with the conductors with which it is used.
- 2.2** In case of formed wires, no joints shall be permitted except those in the base rod or wire before final drawing.
- 2.3** Each formed set shall be marked with indelible and distinct colour to indicate starting/cross-over point of application to facilitate its application on the conductor.
- 2.4** The ends of the individual wires of the formed fittings shall be suitably debarred to provide a smooth finish so as to avoid any damage to the conductor due to sharp edges.
- 2.5** Suitable grit shall be applied to the gripping section of the formed fitting (except lashing rods) in order to enhance its gripping strength.

3. PROPERTIES OF WIRES

- 3.1** Materials of the wires used in the manufacture of the fittings covered by this

specification shall have the mechanical and electrical properties as specified in

Tables 1,2 and 3. Materials used for chloroprene pad shall have the properties specified in Table 4.

Table 1

Aluminium Alloy Wires

Test	Requirements
1. Visual	a) No scratches
	b) No peeling off
	c) No speed crack
	d) No cut mark
2. Dimensions after forming	a) Diameter Tolerance (+) .000 mm (-) .025 mm
	b) Flattening (+) .000 mm (-) .076 mm
3. Tensile strength of formed wires	35 Kg/mm ²
4. Elongation of finished wire	Min. 2% in a gauge length of 50 mm
5. Conductivity of finished wire	Min. 39% as per IACS
6. <u>Wrap test</u> Wire diameter mm Upto 3.07 From 3.08 to 3.45 From 3.46 to 3.71 From 3.72 to 4.24 From 4.25 and above	Min. number of twists on a mandrel of its own dia without fracture at a rate of 15 turn per minute 18 16 14 12 10

Table 2

Aluminium Clad Steel Wires

S.No.	Test	Requirements
1.	Visual	Free from splints, scale, inequalities, flaws and other irregularities :
2.	Dimentional	Roundness to (±) 0.013mm
3.	Tensile strength	As per table 2a below
4.	Weight of coating	As per table 2b below

5.	Wrap test (on a mandrel 2 times the dia of the sample and at the rate of 15 turns/minute)	After close helix, the sample should not fracture
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6.	Adherence of coating (in a close helix not exceeding 15 turns/minute) around a cylindrical mandrel having a diameter prescribed in table 2c.	No cracking or flacking to such an extent that the aluminium coating can be removed by rabbing with the bare fingers
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Table 2a

Wire diameter (mm)	Ultimate tensile strength (minimum) MPa	Ultimate elongation (Min.) percent in 254 mm
1.270 to 2.283 including	1280	3.0
2.286 to 3.045 including	1240	3.5
3.048 to 3.515 including	1210	4.0
3.518 to 3.782 including	1170	4.0
3.785 to 4.826 including	1140	4.0

Table 2b

Wire diameter (mm)	Min. weight of aluminium coating on uncoated wire surface (gms/m ²)
1.270 to 1.521 including	70
1.524 to 1.902 including	76
1.905 to 2.283 including	79
2.286 to 2.639 including	85
2.642 to 3.045 including	92
3.048 to 3.553 including	98
3.556 to 4.569 including	104
4.572 to 4.826 including	116

Table 2c

Wire diameter	Min. ratio of mandrel diameter to wire diameter
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1.270 to 2.283 including	3
2.286 to 3.553 including	4
3.556 to 4.826 including	5

Table 3**Zinc coated steel wire**

	Test	Requirements
1.	Visual	Free from splints, scale, inequalities and other irregularities :
2.	Dimentional	Roundness to (\pm) 0.013mm
3.	Tensile strength of finished wire	As per table 3a below
4.	Weight of zinc coating	As per table 3b below
5.	Wrap test (on a mandrel 2 times the dia of the sample and at the rate of 15 turns/minute)	After close helix of minimum 8 turns, the sample should not fracture.
6.	Adherence of coating (in a close helix not exceeding 15 turns/minute) around a cylindrical mandrel having a diameter prescribed in table 3c.	No cracking or flacking to such an extent that zinc coating can be removed by rabbing with the bare fingers

Table 3 a

Wire diameter mm	Ultimate tensile strength (Minimum) MPa	Elongation in 200 mm gauge length minimum (%) mm
1.270 to 2.283 including	1450	3.0
2.286 to 3.045 including	1410	3.5
3.048 to 3.053 including	1410	4.0

3.556 to 4.022 including	1380	4.0
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Table 3b

Wire diameter (mm)	Minimum weight of zinc coating on uncoated wire surface (gms/m ²)
1.270 to 1.521 including	183
1.524 to 1.902 including	198
1.905 to 2.283 including	214
2.286 to 2.639 including	229
2.642 to 3.045 including	244
3.048 to 3.553 including	259
3.556 to 4.69 including	274
4.572 to 4.822 including	305

Table 3c

Wire diameter (mm)	Ratio of mandrel diameter to wire diameter
1.270 to 2.283 including	3
2.286 to 3.553 including	4
3.556 to 4.822 including	5

Table 4**Properties for Chloroprene pad**

Chloroprene cushion shall have following properties :

1a)	Tensile Strength	Minimum 100Kg/cm ²
b)	Tensile strength (after ageing)	Loss of maximum 25% of the test value obtained in 1(a)
2a)	Elongation	250% minimum
b)	Elongation (after ageing)	Loss of maximum 25% of the test value obtained in 2(a)
3a)	Shore hardness 'A'	65 (±)5
b)	Shore hardness (after ageing)	(±)15% of test values obtained in 3(a)

Note : Ageing should be carried out for 70 hours at 100°C.

4. REQUIREMENTS OF FORMED FITTINGS FOR VARIOUS APPLICATIONS

4.1 Conductor Dead-end fittings

4.1.1 Formed conductor dead-end fitting for 11 KV lines consists of the following parts for use with disc insulators of clevis and tongue type:

a) Cross arms strap for attaching the fittings to the pole on one side and the disc insulator on the other. These fittings shall conform to the REC Specifications of 11 KV Porcelain Insulators and Fitting.

b) Aluminium alloy die cast thimble clevis for attaching the fitting to the tongue of disc insulator on one end and for accomodating loop of the helically formed fitting at the other end in its smooth internal contour. The thimble clevis is attached to the insulator through a steel cotter pin used with a non-ferrous split pin of brass or stainless steel. The thimble clevis shall have clevis dimensions as per IS : 2486 (Part II) - 1989 and shall have the minimum failing load strength of 3000 kg.

c) Helically formed fitting acting as the dead-end grip.

4.1.2 The die-cast aluminium alloy thimble clevis shall be manufactured with alloy A6 Designation of IS : 617 - 1975.

4.1.3 Nuts and bolts used shall be of galvanised steel conforming to IS : 1364 - 1967 and cotter pins conforming to IS : 2004 -1978. Spring washers used shall beelectro-galvanised.

4.1.4 The fitting for LT lines shall comprise of the helically formed fitting to suit the LT shackle insulator as per REC Specification of Porcelain Insulators and Insulator Fittings For 415/240V Overhead Power Lines

4.1.5 The fittings shall be made to suit the following conductor sizes for 11 KV/LT Lines conforming to REC Specification 1/1971(R-1993) and each fitting shall have a clear identification mark on PVC/metallic/plastic tag, indicating size of the conductor and voltage. The following colour code shall be used for the tag as also for the starting/cross-over marks for quick identification:

20 mm ² ACSR(Squirrel)	Blue
30 mm ² ACSR(Weasel)	Red
50 mm ² ACSR (Rabbit)	Yellow
50 mm ² ACSR (Rabbit)	Brown
50 mm ² AAC (Ant)	Grey

4.2 Distribution ties side ties and double ties

4.2.1 Helically formed ties are used to hold the conductor to pin insulators or shackle insulators.]

4.2.2 Chloroprene pad shall be provided with the formed ties for use on 11 KV lines to avoid abrasion of the conductor

4.2.3 The conductor sizes and voltage class shall be clearly marked on each fitting and the fittings shall also be identified by color code as per clause 4.1.5.

4.2.4 To ensure proper fitting of 11 KV pin insulator ties, the purchaser shall furnish full-dimensions of the insulator top particularly the crown diameter, neck diameter etc. See REC specification 11KV porcelain insulators and fittings.

4.3 Conductor Splices

4.3.1 Conductor splices for ACSR conductors shall consist of (i) galvanised steel formed splice for steel core (ii) aluminium alloy formed filler rod (iii) aluminium alloy formed splice for the aluminium strands of the conductor. For AAC conductor, splice is formed with aluminium alloy only.

4.3.2 Repair Splice: Repair splices are non-tension splices and are used where some of the outer strands of the conductor are damaged.

4.4 Guy Grip Dead-End

4.4.1 Guy grip dead ends have one leg shorter than the other and are suitable for gripping the guy wire. These grips are applied on one side into the thimble eye of the stay rod and on the other side to the guy wire. These can also be used directly with guy insulators.

4.4.2 The fittings shall be made of two sizes to suit stay wires of 7/3.15mm(7/10SWG) and 7/2.5 mm(7/12SWG) having UTS values 3625 kg and 2300 kg respectively.

4.4.3 The fittings shall be clearly identified on a PVC/mettalic/plastic tag for the size of stay wire with which these are to be used and, in addition, the following colour codes for the tag as well as the corss-over marks shall be adopted for proper identification:

Guy grip for 7/3.15 mm stay wire - Green

Guy grip for 7/2.5 mm stay wire - Black

4.4.4 The guy grip shall be supplied complete with thimble to suit the fitting. Thimble shall be made of hot-dipped galvanized steel.

Note: The guy grips to be used with guy insulators shall take into account the standard sizes of insulators as per REC specification and the type and size of the guy insulator shall be clearly specified by the purchaser.

4.5 Tap Connectors: Tap connectors consist of helically formed aluminium alloy wires for non-tension tapping of conductors and cables from the main line. The

sizes of conductors/cables for which these tap connectors are to be used have to be clearly specified by the purchaser.

- 4.6 Service Grip Dead End: Service grip dead-ends are used with metallic knob to hold one or more service bearer wires.
- 4.7 Lashing Rods: Lashing rods are helically formed wires to secure the bearer wire to the service cable. The number of lashing rods will depend on the length of service.

5. DIMENSIONAL REQUIREMENTS OF THE FINISHED FORMED FITTINGS

- 5.1 The lay of the helix shall be right hand.
- 5.2 The diameter and number of formed rods used per set of fittings to be used on various sizes of conductors shall be as per the approved drawings.
- 5.3 Tolerances of formed fittings: The various requirements of the helically formed fitting shall be within the following tolerances:

	Item	Tolerances
	Pitch length	+ 0.6 mm (-)0.12 mm
	Internal diameter	+ 1% (-) 3%
	Length of individual rod	(±) 1%
	Difference in length	(±) 1% between the longest and the shortest rod in an individual set

6. TESTS

- 6.1 **Type Tests:** The following tests shall constitute the type tests on the finished fittings:

Test	Applicable to
Visual examination	All fittings
Verification of dimension	All fittings
Tensile strength test	All fittings
Electrical resistance test	All aluminium alloy fittings
Wrapping test	All fittings
Slip strength test	Conductor dead-end, guy grip and splices

Resilience test	Conductor dead-end, guy grip and conductor splices
-----------------	---

Unbalanced holding Strength Test	Ties only
Fatigue test	Conductor dead-end, ties and splices
Galvanising test	Hardwares and fittings using GI wire
Pull-off strength test	Ties only
Electrical & Mechanical Test	Tap Connectors

Acceptance Test: The following shall constitute the acceptance test:

1. Visual examination
2. Verification of dimension
3. Tensile Strength test
4. Electrical resistance test
5. Wrapping test
6. Slip Strength test
7. Resilience test
8. Unbalanced load
9. Galvanisation test
10. Pull-off strength
11. Electrical & Mechanical tests on tap connectors
12. The tests for other requirements as per Tables 1,2,3 & 4 on the individual wires used in making the helically formed fittings and chloroprene pad (where used).

6.2 Routine Tests: The following shall constitute the routine tests:

- a) Visual examination
- b) Verification of dimensions

7. TEST PROCEDURE

7.1 Visual Examination: All fittings and individual wires shall be checked visually for good workmanship, smooth finish and other requirements indicated in Table 1, 2 and 3.

7.2 Verification of dimensions: The dimensions shall be checked as specified in the tables 1, 2, 3 and clause 5.

7.3 Tensile Strength Test:

7.3.1 Individual wire of the helically formed wires shall be straightened by light hammering and tested for tensile strength and elongation in accordance within the

IS:398(Part II)-1976. The tensile strength and the elongation of the formed wires shall not be less than the values specified in tables 1, 2 and 3.

7.3.2 For thimbles and hardwares other than formed fittings:

The dead-end clevis thimble and straps shall be tested for tensile strength in accordance with the requirements of mechanical failing load as per IS:2486(Part I)-1993.

7.4 Electrical Resistance Test: This test shall be done on straightened aluminium alloy formed wires only. The conductivity of the wires should not be less than 39% IACS.**7.5** Wrapping Test: The individual wires of the formed fittings shall be tested as specified in tables 1, 2 and 3. The wires should not break or show fracture when tested as above.**7.6** Slip Strength Test: For the conductor dead-end and guy grip dead-end, the test shall be made in accordance with IS:2486(Part I)-1993 and the value of slip/breaking strength shall not be less than 85% of the breaking strength of the conductor for conductor dead-end fitting and 100% for guy wires dead end fittings. In case of tension splices, the test shall be carried out as per IS:2121. No slippage or damage to the fitting shall occur at a value less than 100% of breaking load of the conductor. This test should be repeated after the resilience test.**7.7** Resilience Test: A set of helically formed fitting is wrapped and un-wrapped on a piece of conductor 3 times successively. The helical fitting should not lose its resilience even after three applications and should be able to pass the slip strength test requirements mentioned in 7.6 thereafter.**7.8** Unbalanced Holding test: Unbalanced holding strength is the ability of the formed ties to maintain a constant and uniform grip on the conductor when intermittent and repeated unbalanced loads impose a tension imbalance in the span. These imbalances occur due to wind induced motion, impacts, ice conditions and more so when the conductor is broken.

The test is intended to simulate the broken wire condition. A span of minimum 20 meters tensioned for 40% of UTS of the conductor shall be erected in the laboratory and a pin insulator alongwith the insulator tie under test shall be applied in the middle of span. The conductor used for this purpose shall be of the specific size with which the insulator tie is to be used. The test set up shall be such

that it should be possible to apply a pull on one of the two dead ends of the conductor. For the purpose of this test, a steel replica of the insulator will be used. During the test, tension on one side of the pin insulator shall be suddenly

released and effect observed. No slippage or damage to the fitting shall occur. After releasing tension from the other end, the fitting should retain the original form. This test will not only check the holding strength of the fitting but will also prove the resilience of the fitting in the event of broken wire.

The test shall be repeated. After releasing the conductor tension on one side, pulling force shall be slowly applied on the other dead-end to pull the conductor till slippage/damage occurs. This force shall not be less than 320 kg.

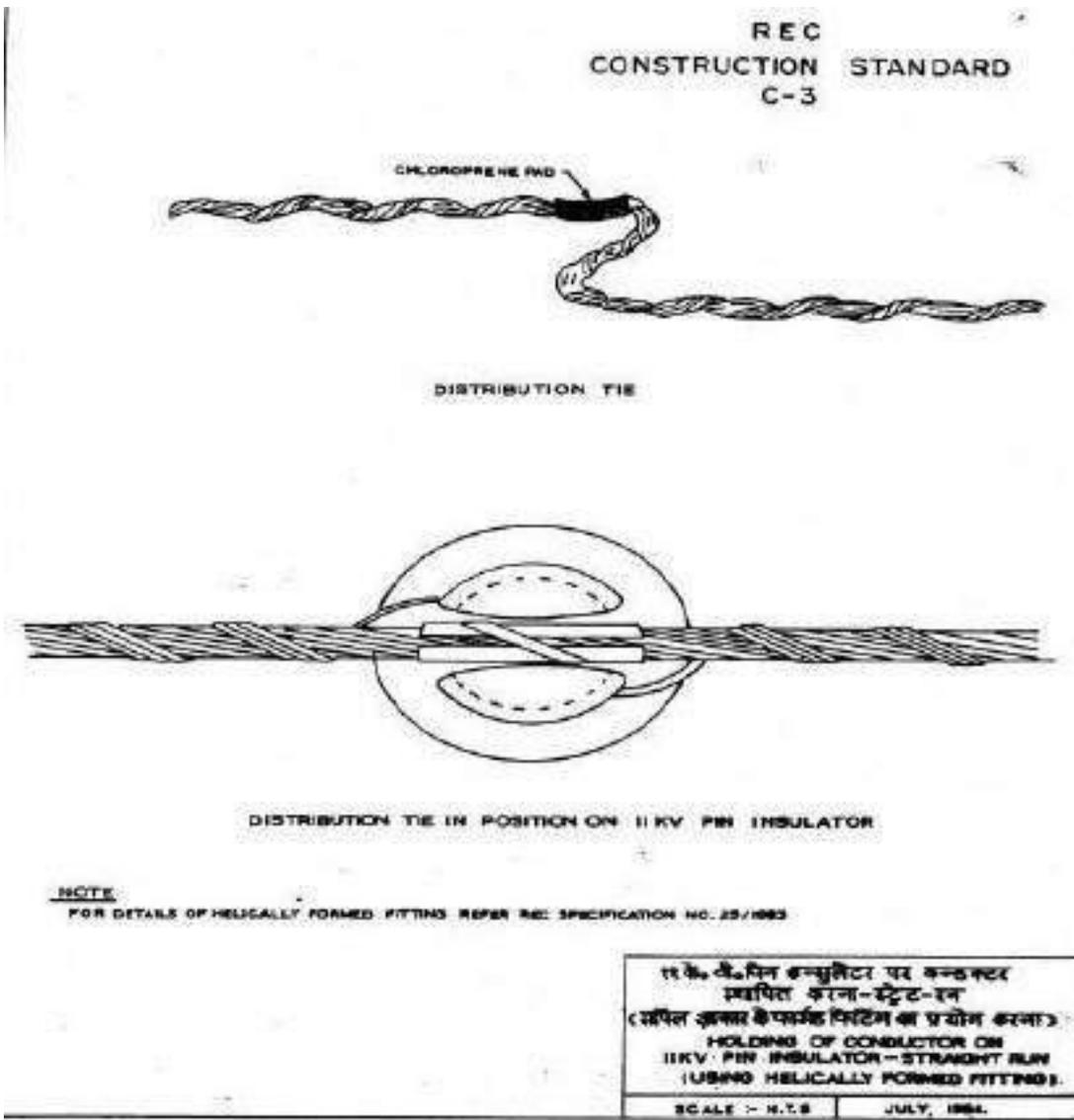
- 7.9 Fatigue Test:** The fittings should be subjected to fatigue test alongwith the conductor by imparting 10 million cycles of peak to peak amplitude at a frequency above 30 cycles for minimum span length of 20 meters, at 40% of UTS of conductor. The amplitude of the vibrations at the antinodal points should be atleast 50% of the diameter of the conductor. The test should be carried out for 10 million cycles as continuously as possible after which the conductor fitting and insulator should be examined. There should be no damage to the conductor or the insulator where the fitting is attached. The fitting should also be able to withstand the test without any damage.
- 7.10 Galvanising Test:** Galvanising test should be carried out in accordance with IS:4826-1979 for uniformity and IS:6745-1972 for weight of zinc coating and the fittings will meet the requirements of Table 3.
- 7.11 Pull-Off Strength Test:** This test is intended to simulate the conductor pull-off conditions created by various factors including elevation difference of the supporting structures on the two sides of the tie. A span of minimum 20 metres tensioned for 40% of UTS of the conductor shall be erected in the laboratory with a conductor of the specified size with which the fitting is intended to be used. A steel replica of pin insulator alongwith the insulator tie under test shall be applied in the middle of span so that a suitable pull-off force can be applied on the pin by means of a machine. The pull-off strength of the tie shall not be less than 200 Kg. for all the three sizes of ACSR.
- 7.12 Electrical & Mechanical Test on Tap Connectors:** The tap Connectors shall conform to all the electrical and mechanical properties as per IS:5561.

8. PACKING AND MARKING

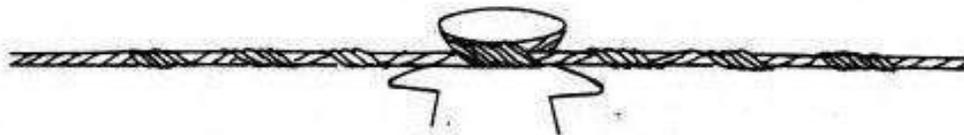
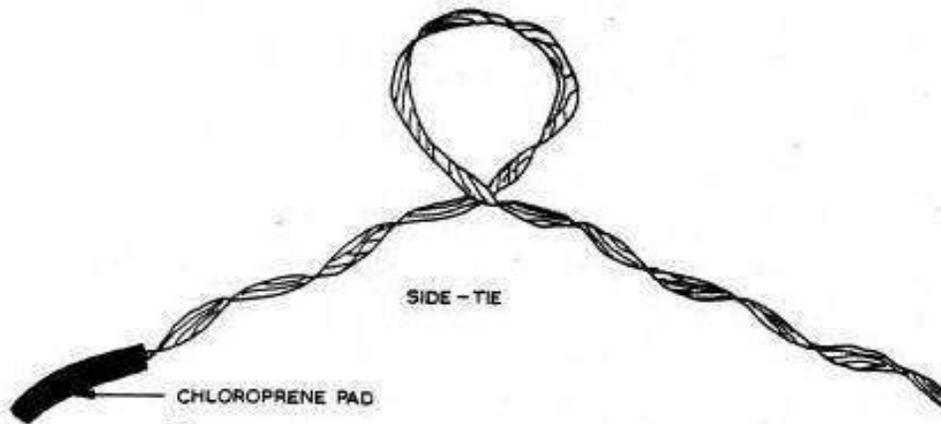
- 8.1** All helically formed items covered under this specification shall be carefully handled to prevent distortion and damage. These items shall be packed and stored

in suitable cartons.

- 8.2 Different colour codes shall be adopted for different conductor sizes and catalogue number and range of outside diameter of the conductor shall be indicated on the packing.
- 8.3 Clevis thimbles and other hardware for conductor dead-ends shall be packed in wooden crates with all necessary markings.
- 8.4 The packings of the fittings should carry the following informations.
 - a) Purchaser's name
 - b) Manufacturer's name and trade mark
 - c) Size of conductor, line voltage (when required) and numbers
 - d) Batch number, date, month and year of manufacture
 - e) Any other marking agreed to between manufacturer and user.



REC
CONSTRUCTION STANDARD
C-4

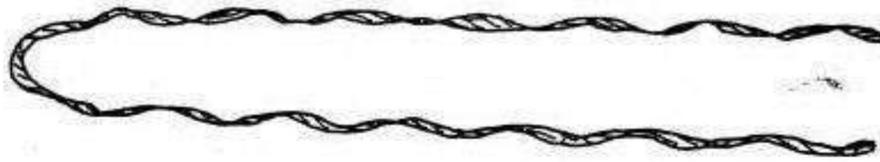


SIDE TIE IN POSITION ON 11KV. PIN INSULATOR

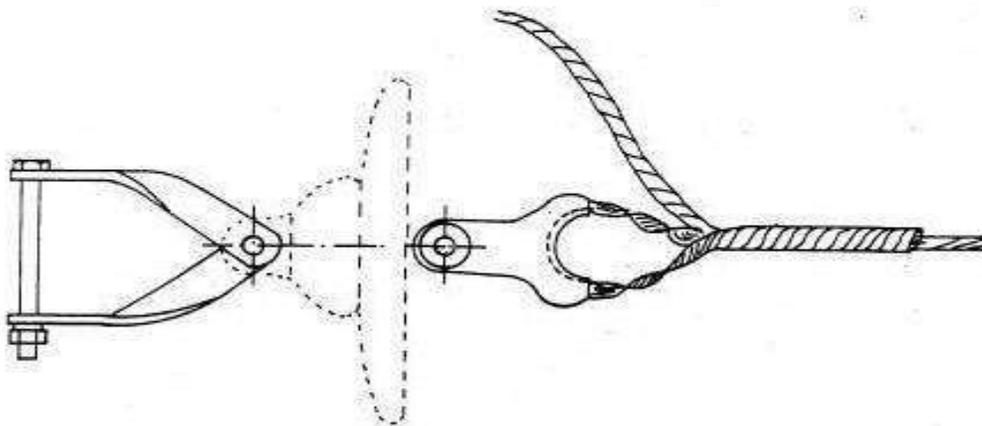
NOTE :- FOR DETAILS OF HELICALLY FORMED FITTINGS
REFER REC SPECIFICATION NO. 25/1983.

११ के. वी. पिन इन्सुलेटर पर कन्डक्टर स्थापित करना - एकल कोणस्थान (सोपल प्रकार के हेलिकल फिटिंग का प्रयोग करना)	
HOLDING OF CONDUCTOR ON 11KV PIN INSULATOR - ANGLE LOCATION (USING HELICALLY FORMED FITTING)	
SCALE:-N.T.S	JULY, 1984

REC
CONSTRUCTION STANDARD
C-5



CONDUCTOR DEAD-END FITTING



11KV CONDUCTOR DEAD-END FITTING IN POSITION

11 KV STRAIN INSULATOR HARDWARE CONSIST OF:

1. HELICALLY FORMED DEAD-END FITTING
2. CLEVES THIMBLE AND
3. CROSS-ARM STRAP WITH BOLT.

NOTE:-

FOR DETAILS OF HELICALLY FORMED FITTING REFER
REC SPECIFICATION NO. 23/1983

११ के. वी. कन्डक्टर अन्तिम होर का फिनिशिंग
(सर्पिल आकार के फॉर्मड फिटिंग का प्रयोग
करना)

11KV CONDUCTOR DEAD-END ARRANGEMENTS
(USING HELICALLY FORMED FITTINGS)

SCALE :- N.T.S

JULY, 1984

REC
CONSTRUCTION STANDARD
E-31

USE OF LASHING RODS TO SECURE THE OVERHEAD BEARER WIRE AND
THE PVC SERVICE CABLE



FIGURE-1

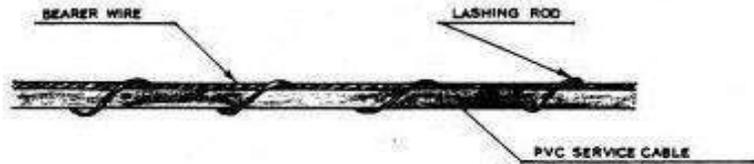


FIGURE-2

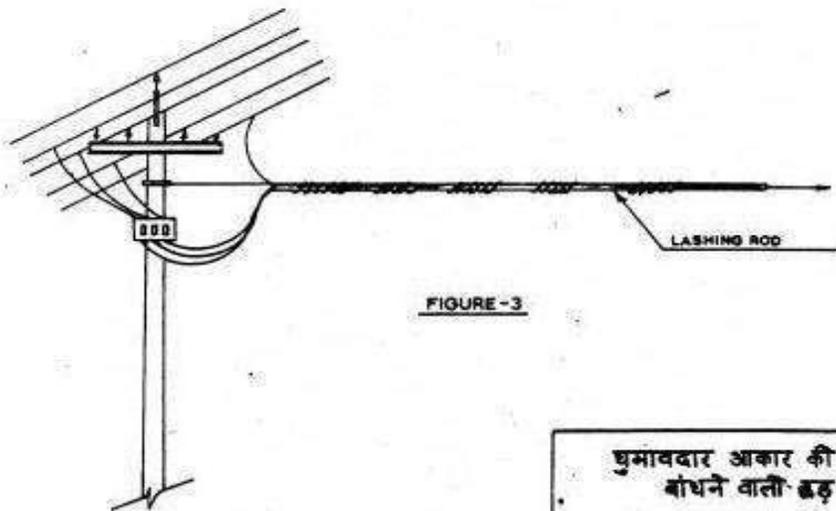


FIGURE-3

FIG-1 SHOWS THE LASHING ROD.
FIG.2&3 SHOW THE LASHING RODS IN POSITION.

घुमावदार आकार की फिटिंग
बांधने वाली छड़
HELICALLY FORMED FITTINGS
LASHING RODS
SCALE :- N.T.S JULY - 1984

REC
CONSTRUCTION STANDARD
E-32

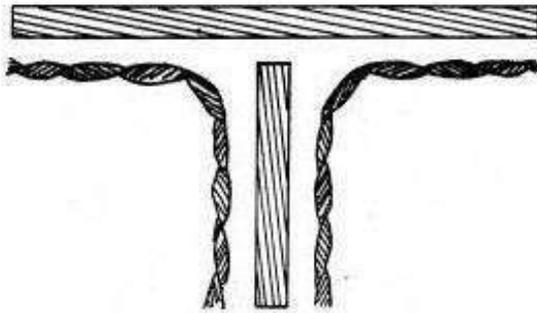


FIGURE -1

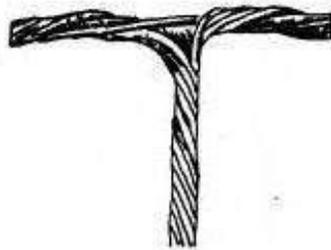


FIGURE -2

NOTE:-

T-CONNECTORS CAN BE USED TO TAP SERVICE CONNECTIONS FROM THE LINE OR FOR TAPPING A BRANCH LINE FROM THE MAIN LINE.

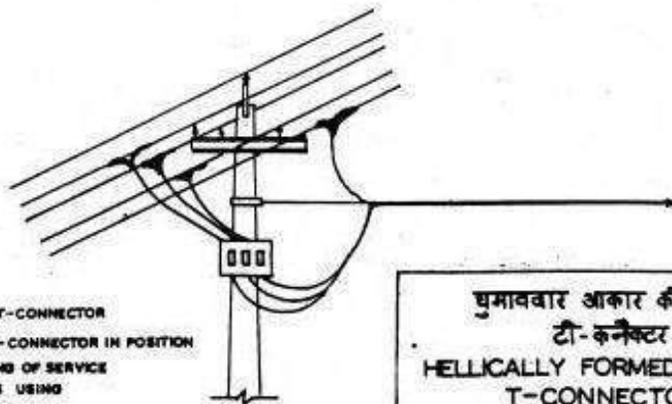


FIG.1 SHOWS THE T-CONNECTOR
FIG.2 SHOWS THE T-CONNECTOR IN POSITION
FIG.3 SHOWS TAPPING OF SERVICE CONNECTIONS USING T-CONNECTORS.

FIGURE -3

घुमावदार आकार की फिटिंग टी-कनेक्टर HELICALLY FORMED FITTINGS T-CONNECTOR	
SCALE:- N.T.S	JULY - 1984

R E C
CONSTRUCTION STANDARD
E - 33

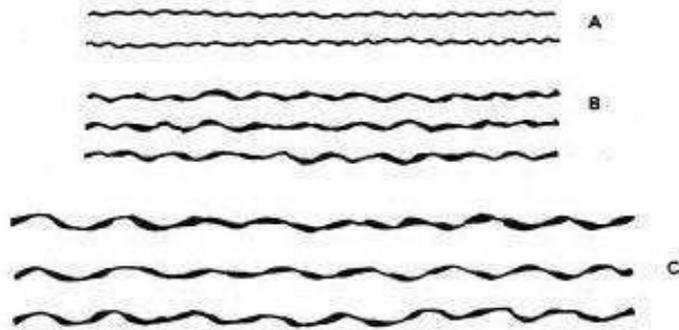


FIGURE-1

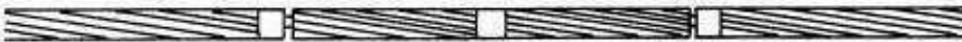


FIGURE-2

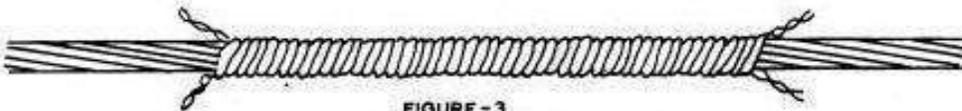


FIGURE-3

- A SHOWS THE CORE SPLICE
- B SHOWS THE FILLER RODS.
- C SHOWS THE OUTER SPLICE
- FIG. 1. SHOWS THE CORE SPLICE IN POSITION
- FIG. 2. SHOWS THE CORE SPLICE AND FILLER RODS IN POSITION
- FIG. 3. SHOWS THE COMPLETE JOINT AND THE OUTER SPLICE IN POSITION.

घुमावदार आकार की फिटिंग ए.सी.एस.आर. के लिए स्पलाईस HELLICALLY FORMED FITTINGS SPLICE FOR ACSR JOINT	
SCALE :- N.T.S	

26. Insulation Piercing Connectors, Anchor (Dead End) & Suspension Accessories & Other Accessories for Aerial Bunched Cables for Working Voltage upto and including 1100 Volts

1.0 SCOPE

This specification covers the design, manufacture, assembly, testing and supply of Accessories for anchoring, suspending & making connections to Aerial Bunched Cables rated 1100 volts and insulated with cross-linked polyethylene.

2.0 STANDARD

The design, performance and test requirements shall confirm to this specification and the following standards. However in case of any conflict, the requirements of this specification shall prevail.

- NFC 33-020 Insulation Piercing Connectors
- NFC 33-209 LV Aerial Bunched Cables
- NFC 20-540 Environment Testing for Outdoor
- NFC 33-004 Electrical Ageing Test
- NFC 33-040 Suspension Equipments
- NFC 33-041 Anchoring Devices
- IS 14255 LV Aerial Bunched Cables

The Devices shall also be compatible with the cables of sizes & dimensions as defined in the Cable Specifications for the cables with which they are intended to be used.

3.0 CLIMATIC CONDITIONS

For the purpose of designing the climatic conditions as specified in annexure-1 shall be considered.

4.0 CABLE DATA

The standard sizes and characteristics of the phase and street lighting conductors, messenger wires shall be as specified in IS: 14255-1995.

The Accessories of LT XLPE Insulated Aerial Bunched Cables (ABC) with ~~insulated~~ bare messenger cum neutral are specified below:

- a) The ABC accessories should be of proven design with minimum 2 years record of satisfactory operation with a major utility. Order copies and Performance Certificates should be enclosed with the offer.

- b) Since ABC accessories are to be used with ~~insulated~~ bare neutral-cum-messenger, their design should incorporate specific features to prevent damage to the insulation which meeting the required electrical, mechanical & thermal requirements.
- c) All mechanical, electrical & thermal ratings should meet or exceed 90% of the corresponding ratings of the cable, or the values specified herein, whichever are more stringent.
- d) The accessories should provide “Double Insulation” so that a single point failure of insulation will not result in the system tripping.

5.0 THE ABC ACCESSORIES

The ABC Accessories shall consist of the following:

a)	Insulation Piercing Connectors (IPC)	:	For making tap-off/branch connectors/service connector to an ABC line.
b)	Anchoring Assembly (AA)	:	For fitting onto a pole for anchoring the end of a length of ABC, or for a major change in direction.
c)	Suspension Assembly (SA)	:	For supporting a length of ABC at an intermediate pole in a length, with small angle of deviation.
d)	Service clamp (sc)	:	For anchor Insulated service lines (armoured or unarmour)
e)	Transformer Connections	:	For connection to the transformer bushing.
f)	Junction Sleeves	:	For Phases, neutral messengers & Street lighting conductor.
g)	ABC Service Main Distribution Box	:	For Distribution of multiple no. of Service Connections from Main AB cable.

5.1 Insulation Piercing Connectors (IPC)

- 5.1.1 Insulation Piercing Connectors (IPC) are used for making Tee/Tap-off/Service connectors to an ABC/Bare Overhead Line.
- 5.1.2 Insulation Piercing Connectors are designed to make a connection between the uncut main conductor and a branch cable conductor without having to strip either cable to expose the conductor instead the tightening action of the IPC will first pierce the Insulation, then make good electrical contact between the main end and branch conductor while simultaneously insulating and sealing the connection.
- 5.1.3. Constructional Features of IPC
 - 5.1.3.1 The housing shall be made entirely of mechanical and weather resistant plastic insulation material and no metallic part outside the housing is acceptable except for the tightening bolt.
 - 5.1.3.2 Any metallic part that is exposed must not be capable of carrying a potential during or after connector installation.
 - 5.1.3.3 Screws or nuts assigned for fitting with IPC (Insulating Piercing connector), must be fitted with torque limiting shear heads to prevent over tightening or under tightening (min & max torque values to be specified by Manufacturer).
 - 5.1.3.4 The IPC must perform piercing and connection on Main and Branch cable simultaneously.
 - 5.1.3.5 The IPCs shall be water proof and the water tightness shall be ensured by appropriate elastomer materials and not by grease, gel or paste alone.
 - 5.1.3.6 Design of IPC should be such as to not cause damage to insulation of adjacent conductors due to vibration and relative movement during service.
 - 5.1.3.7 The connector shall have a rigid removable end cap which can be slide fitted onto the main connector body on either right or left by the installer (depending on site requirement) for sealing the cut end of the branch cable. Once the connector is fitted, it should not be possible to remove the cap without removing the connector.

5.1.3.8 All the metallic parts of the connector should be corrosion resistant and there should not be any appreciable change in contact resistance & temperature after overloads & load cycling.

- The contact plates should be made of tinned copper/aluminium alloy.
- Connector teeth should be factory greased & sealed to retard water or moisture ingress & corrosion.
- The Insulation material should be made of weather & UV resistant reinforced polymer.
- The outer metallic part should have potential free tightening bolts to allow safe installation on live lines.

5.1.4 Mechanical Tightening and Electrical Continuity

5.1.4.1 Connectors shall be tightened upto 70% of the minimum torque indicated by the Manufacturer. At this torque electrical contact should have occurred between conductors to be joined. Then connectors shall be tightened up to the breakdown of the shear heads and lastly, upto 1.5 times the maximum torque indicated by the manufacturer.

For the connector fitted with two screws on the same core, after the breakdown of the shear heads tightening may be carried out manually and alternatively using a torque meter. The test conditions shall be as close as possible to those defined for the use of the test machine as per NF-C standard.

5.1.4.2 At 1.5 times the maximum torque indicated by the manufacturer, there shall be no breakdown of any part of the connector or the core conductor.

5.1.4.3 Maximum rated torque shall not exceed 20 N.m for conductor <95 sq.mm and 30 for >95 but <150 sq.mm.

5.1.4.4 Tightening screws shall have hex. Heads of 10 mm, 13 mm or 17 mm only.

5.1.5 Effect of Tightening on Main Core of IPC

5.1.5.1 The connector shall be fitted approx. at the centre of the main core, which is secure between two anchoring points 0.5 mtr. To 1.5 mtr.apart. At the time of fitting the connectors, the main core shall be under longitudinal tension at 20% of the load indicated in Table-1:

Table-1

Nominal Cross – section (sq.mm.)	Tensile Strength (Newton)
16	1200
25	1800
35	2500
50	3500
70	5000
150	10000

5.1.5.2 Tensile strain shall be increased to the full value indicated in the Table 1 and held minute. There should be no breakdown of the core conductor.

5.1.6 Effect of Tightening on Branch Core of IPC

5.1.6.1 Test specimen shall be made up as in clause 5.1.5.1 except that this shall be do the smallest cross sections of main and branch conductors within its range.

5.1.6.2 An increasing tensile load shall be applied to the Branch Conductor along the axis of the recess for the Branch cable. Load shall increase at 100 – 500 N/minute until it reaches the value specified in the Table 2 and maintained for 1 minute.

Table-2

Nominal Cross – section (sq.mm.)	Tensile Strength (Newton)
16 (Alu)	290
25	450
35 & above	500

5.1.6.3 No slippage or breaking of conductor shall occur.

5.1.7 Dielectric & Water Tightness Test of IPC

5.1.7.1 The connector is tightened up to the minimum torque indicated by the manufacturer.

5.1.7.2 Connectors are mounted on

- Minimum cross section of main core.
- Maximum cross section of main core.

5.1.7.3 In each case Branch is of minimum cross section.

- 5.1.7.4 Protection caps for the branch cable are to be used in accordance with the requirements of clause 5.1.3.7. An additional water tight cap of any design may be used to seal one end of the main cable if it is immersed under water. No additional gel or any protection is to be provided while installing connector.
- 5.1.7.5 The entire assembly shall be immersed at a depth of approx. 30cms. For 30 minutes with the free ends of main and branch cable out of the water.
- 5.1.7.6 An AC voltage of 6 kV shall be applied between the water bath and each of the cores in turn for 1 minute. There shall be no flashover or electrical tripping with a trip setting of 10 mA + 0.5mA.

5.1.8 Electrical & Ageing Test of IPC

- 5.1.8.1 Two test configurations are used according to Table 3 with the connections tightened to the minimum torque specified by their manufacturers and resistance recorded.

Table - 3

Configuration	Main core cross section	Branch core cross section
1st Configuration	Maximum	Maximum
2nd Configuration	Maximum	Maximum

- 5.1.8.2 The configurations are subjected to 200 heat cycles by injecting suitable current into them. In each cycle the temperature of the conductor shall be raised from ambient to 120 + 5°C as, measured by a thermocouple.
- 5.1.8.3 The duration of each heating cycle is chosen to maintain a sufficiently steady temperature of 120 + 5°C for 15 minutes. The duration of each cooling cycle is chosen to bring the conductor temperature to within 2°C of ambient.
- 5.1.8.4 Nominal heating current is indicated in the Table-4. It shall be permissible to accelerate the temperature rise by using a current up to 1.5 times the nominal current and to accelerate the cooling period by use of a fan or air blower.

Table-4

Nominal Cross – section (sq.mm.)	Nominal Heating Current (A)
----------------------------------	-----------------------------

16	102
25	139
35	175
50	225
70	283
95	350
120	412
150	480
185	545
240	670

5.1.8.5 The over current test of Clause 5.1.9 shall be done after 50 cycles if the connector is a safety connector designed to ground a phase connector while the line is being worked on.

5.1.8.6 At the end of the 200 cycles the resistance shall again be measured. It shall not differ from the initial value by more than 12%.

5.1.9 Over Current Test of IPC

5.1.9.1 Over current test is required to establish the performance of Safety Connectors that are intended to provide a safe path to ground for the phases while the line is de-energised for working. It establishes the performance of the connector under short term over load conditions.

5.1.9.2 After the first 50 cycles of clause 5.1.8, the connectors are subjected to 4 over currents of 1 sec duration each.

5.1.9.3 The conductor temperature at the start of the over current test should be not more than 35°C.

5.1.9.4 Current density during over current shall be 100 A/sq.mm for Aluminium and 95 A/sq.mm for Aluminium – Alloy Conductor.

5.1.9.5 Variation in time of over current is permissible between 0.85 sec & 1.15 sec., provided if maintains the relationship $I^2t = K$

$t = K$ where,

I = rms value of over current in Amps.

t = time in seconds

K = Constant

5.1.9.6 After the over current test the electrical ageing test of clause 5.1.8 shall be resumed.

5.1.10 Type Test of IPC

- 5.1.10.1 Type Test Reports should be submitted from an Independent Laboratory of Repute or the Works Laboratory in case of a foreign manufacturer covering the following (on any convenient size of fitting of same design made from the same materials).
- 5.1.10.2 The installation of the connectors shall be done by the laboratory following instructions provided by the manufacturer.
- 5.1.10.3 The Test report shall record the embossing and marking on the connector.
- 5.1.10.4 The following shall constitute Type Tests for IPC :
- Electrical Ageing Test
 - Dielectric and Water Tightness Test.
 - Mechanical Tightening Test
 - Effect of Tightening on main Core
 - Effect of Tightening on Branch core
 - Over-current Test (Applicable as per relevant clause of latest version of NFC 33020)*

The following shall be Type Test for Suspension Assembly (SA)

- Mechanical Test
- Voltage Test
- Climatic Aging Test
- Corrosion Test
- Endurance Test under Thermal & Mechanical Stresses (optional till testing facilities are available in India)*

The following shall be Type Tests for Anchoring Assemblies (AA)

- Mechanical Test
- Voltage Test
- Dynamic Test (Applicable for areas having subzero minimum temperature)
*
- Climatic Aging Test
- Corrosion Test
- Endurance Test under Thermal & Mechanical Stresses

5.2 Anchoring Clamp for Insulated Messenger:

The clamps should be designed to Anchor LT-AB cable with insulated messenger. The clamp should consists of an Aluminium alloy corrosion resistant castled body,

bail of stainless steel and self adjusting plastic wedges which shall anchor/hold the neutral messenger without damaging the insulation.

*Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/609 dated 05.10.2018

- No losable part in the process of clamping arrangement
- The clamp should conform to the standard NFC 33041 and 33042 or equivalent I.S. if any.
- The clamp body should be made of corrosion resistant Alluminium alloy, bail should be of stainless steel and wedges should be weather and UV resistant polymer.
- ~~Ultimate tensile strength of the clamp should not be less than 15 kN for 50/70sq.mm insulated messenger wire / 10 KN for 25/35 sq.mm insulated messenger wire.~~
- ~~Slip load of the clamp should not be less than 3 KN for 50/70 sq.mm. messenger wire / 2 KN for 25/35 sq.mm. messenger wire.~~ Ultimate tensile strength of the clamp should be as per Table-6 of Technical Specification. *

5.2.1 Anchoring assemblies are used to firmly attach the messenger of ABC to a support and transmit the mechanical tension.

- at the end of a run or to the supporting structures
- at a major change in direction.

5.2.2 Each Anchoring Assembly shall include.

- One number tension bracket.
- One number wedge type tension clamp
- Flexible Rope for fixing tension clamp to bracket.

5.2.3 Anchoring assemblies shall be supplied in sets to ensure compatibility of the materials against corrosion or wear of moving parts.

5.2.1 Tension Bracket of AA

5.2.4.1 The tension bracket shall be made out of a single piece of Aluminium alloy suitable for attachment to a pole either by

- a) 16mm galvanized steel bolt (s) or
- b) two stainless Steel straps of 20 x 0.7 mm.

5.2.4.2 The tension bracket should be designed to ensure the Flexible rope cannot slip out at any angle.

5.2.4.3 The tension bracket should be rated and tested for the loads specified in Table-5. The load shall be applied at an angle of 45° from the normal to the surface of mounting of the bracket.

Table - 5

Conductor Size (Sq.mm.)	Rating	Load for deformation <10mm (Newtons)	Load for deformation <30mm & no-break (Newtons)
25-35	500 Kg.	12,000	15,000
50-95	000Kg	15,600	19,500

5.2.5 Flexible Rope of AA

5.2.5.1 The Anchoring assembly shall be supplied with a stainless steel flexible Rope to connect the Tension Clamp to the Tension Bracket.

5.2.5.2 The rope should have sufficient flexibility to ease the torsional movement of the ABC System.

5.2.5.3 The Rope should be pre-fitted with compression type end fittings to secure the tension clamp.

*Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/609 dated 05.10.2018

5.2.5.4 A wear resistant moveable saddle should be un-loosably fitted on the Rope to prevent abrasion at the point of fitting into the tension bracket.

5.2.5.5. The Rope should have sufficient mechanical strength to withstand the mechanical test for the complete assembly tests in this specification.

5.2.6 Wedge Type Tension Clamp of AA

5.2.6.1 Wedge type clamps shall be used for clamping the messenger without damaging the insulation.

5.2.6.2 The clamp shall be capable of clamping an uncut messenger so that it can continue without break to the connecting point or next span.

5.2.6.3 The clamp shall be fully insulating type of mechanical and weather resisting thermoplastic.

5.2.6.4 No bolts or loose parts are allowed as part of the Clamping system.

- 5.2.6.5 No tools shall be needed for fitting the messenger into the clamp.
- 5.2.6.6 The clamp shall be self tightening and capable of holding without slippage the load specified in the Table-6.

Table - 6

Conductor Size		Rating (Kg.)	T start (I final minute) (I final minute)	
Sq. mm.	Dia. (mm)		(Newtons)	(Newtons)
25-35	8-11	1000 Kg.	8,000	10,000
50-54	8-11	1500 Kg.	12,000	15,000
70-95	13.5-16	2000 Kg.	12,000	15,000

- 5.2.6.7 After fitting the insulated messenger in the clamp, load T start will be held for 1 minute & then load increased to T final at rate between 5000 – 7,500 N/mtr. In each case there shall be no breakdown of any part of clamp and slippage of messenger in relation to the clamp.

5.2.7 Voltage Test on Clamp of AA

- 5.2.7.1 Voltage test is carried out on anchor clamps to ensure no damage is caused to the insulated messenger.
- 5.2.7.2 A conductive rod of dia. corresponding to the average dia. that can be accommodated in the clamp is fitted into the clamp, protruding by approx. 50mm at each end of the tightening piece.
- 5.2.7.3 The rod and clamp is subjected to tensile load as stated in Table 7 below when fixed to a support in its normal manner.

Table - 7

Conductor Size		Normal rating (kg)	Load Applied (N)
Sq. mm.	Dia. (mm)		
25-35	8-11	1000	2000
50-54	8-11	1500	4000
70-95	13.5-16	2000	4000

5.2.7.4 A power frequency voltage of 6 kV is applied for 1 minute between the rod and conductive part of the clamp, or fixation point in absence of conductive part.

5.2.7.5 No breakdown or flashover shall occur. There shall be no tripping due to leakage with a setting of $10 + 0.5 \text{ mA}$.

5.2.8 Endurance under Mechanical & Thermal Stress of AA

5.2.8.1 This test is done on clamp rated 1500 Kg. or 2000 Kg. using insulated messenger 50 to 70 sq. mm.

5.2.8.2 A neutral messenger is fitted between two anchor clamps, with clamp spacing approx. 5 mtr. & 1 mtr. Of messenger protruding from the end. Marks are made to enable measurement of slippage.

5.2.8.3 The sample is subjected to 500 cycles of 90 minutes each as described below:

5.2.8.3.1 Messenger temperature is raised by passing an AC current to $60 + 30 \text{ C}$ within 15 minutes. This temperature is maintained for at least 30 minutes to give a total heating period of 45 mts.per cycle.

5.2.8.3.2 Messenger is allowed to cool naturally to ambient for further 45 minutes to complete 90mts. Cycle time.

5.2.8.3.3 Mechanical load is applied during the cycle as per table 8 below. Load F1 is applied throughout the cycle, except for a short period of 5 sec. to 60 sec. when it is gradually increased from F1 to F2 at any time during the last 15 minutes of the 90 minute cycle.

Table - 8

Conductor Size		Rating (Kg.)	F1 (Newtons)	F2 (Newtons)
Sq. mm.	a. (mm)			
25-35	8-11	1000 Kg.	2,200	5,000
50-54	8-11	1500 Kg.	4,000	7,500
70-95	13.5-16	2000 Kg.	4,500	10,000

5.2.8.3.4 There should be no slippage greater than 4 mm after 2 cycles or greater than 8 mm after 500 cycles.

5.2.8.3.5 Voltage test is done at the end of the 500 cycles by immersing the test specimen of neutral messenger and clamps in water of resistivity not less than 200 Ohm mtr. For 30 minutes.

5.2.8.3.6 A voltage of 10 kV ac is applied for 1 minute between messenger and water bath

using a trip setting of $10 + 0.5$ am. There should be no breakdown or tripping.

5.3 Suspension clamp for insulated neutral messenger:

The clamp should be designed to hang L.T – AB cable with insulated neutral messengers. The neutral messengers should be fixed by an adjustable grip device. A movable link should allow longitudinal and transversal movement of the clamp body.

- No losable part in the process of clamping arrangement.
- The clamp should conform to the standard NFC 33040 or equivalent I.S, if any.
- The clamp and the link made of Polymer should provide an additional insulation between the cable and the pole.
- The clamps and movable links should be made of weather and UV resistant glass fibre reinforced polymer.
- Clamps should be fixed with pole by eye hook / bracket. Bracket should be made of corrosion resistant aluminium alloy.
- ~~Ultimate tensile strength of the clamp should not be less than 15 KN for 50/70 sq.mm. Insulated messenger wire 4.3 KN for 25/35 sq.mm. Insulated messenger wire.~~
- ~~Maximum allowable load of the clamp should not be less than 20 KN for 50/70 sq.mm. insulated messenger wire/15 KN for 25/30 sq.mm insulated messenger wire.~~ Ultimate tensile strength of the clamp should be as per Table-10 of Technical Specification.

*Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/609 dated 05.10.2018

5.3.1 Suspension Assembly is used for supporting an ABC by installation on the messenger at an intermediate point of support such as a pole. It can accommodate small angles of deviation upto 30°.

5.3.2 Each Suspension Assembly shall consist of:

- One number Suspension Bracket.
- One number moveable (articulated) connecting link.
- One number Suspension Clamp.

5.3.3 Suspension Assemblies shall be supplied in sets to ensure compatibility of the materials against corrosion or wear of rotating/moving parts.

5.3.4 Suspension Bracket of SA

5.3.4.1 The Suspension Bracket shall be made from single piece aluminium alloy

suitable for attachment to a pole by either.

- a) 16 mm galvanized steel bolt or
- b) Two stainless steel straps.

5.3.4.2 The Suspension Bracket shall be provided with an upper bulge to prevent the clamp from turning over on the Bracket for more than 45° from the horizontal or to within less than 60 mm from the pole / fixing structure.

5.3.4.3 The Suspension Bracket should be so designed to ensure that the articulated link cannot slip out of it.

5.3.4.4 Suspension Brackets shall be designed to withstand a load applied at the anchoring point of the movable link as per Table – 9 below without deformation of more than 10mm or breakdown at 330° below horizontal (there should be no longitudinal component of load parallel to the plane of fixing).

Table - 9

Conductor Size		Normal	Load
Sq. mm.	Dia. (mm)	rating	(N)
25-35	8-11	(kg) 1500Kg.	12500
70-95	13-17	2000Kg.	14000

5.3.5 Movable (Articulated) Link of SA

5.3.5.1 Movable Links are used between the Suspension Bracket and Suspension Clamp to allow a degree of movement and flexibility between the two.

5.3.5.2 Moveable Links should be made fully of insulating type of mechanical and weather resistant thermoplastic. A metallic wear resistant ring should however be fitted at point of contact between the Suspension Bracket and the movable link.

5.3.5.3 The Movable link should be unloosably fitted to the Bracket and the Clamp.

5.3.6 Suspension Clamp of SA

5.3.6.1 Suspension Clamps are used for locking the messenger of the ABC bundle without damaging the insulation or allowing the messenger to become dismounted from the fitting.

5.3.6.2 The Suspension Clamp shall accommodate messenger wires from 25 to 95

sq.m.

- 5.3.6.3 The Suspension Clamp shall be made fully of insulating type of mechanically strong and weather resistant plastic.
- 5.3.6.4 Bolts should not be used for clamping / locking the messenger in the Clamp.
- 5.3.6.5 There shall be no losable parts in the Suspension clamp.
- 5.3.6.6 The Suspension Clamp should be unloosably fitted to the rest of the Suspension Assembly.
- 5.3.7 Mechanical Test on Clamp of SA
 - 5.3.7.1 The Sub Assembly shall be subjected to a vertical load applied as per drawing in accordance with Table-10. There shall be no breakdown or permanent deformation at load T initial for 1 minute or when the load is increased to T final and released.

Table - 10

Conductor Size		Rating (Kg.)	T start (I minute) (Newtons)	T final (I minute) (Newtons)
Sq. mm.	Dia. (mm)			
25-54	8-15	1500 Kg.	9,600	12,000
70-95	13-17	2000 Kg.	12,800	16,000

- 5.3.7.2 A sample messenger shall be fitted into a fixed suspension clamp and subjected to a gradually applied longitudinal load of 300 N. There shall be no permanent slip page.
- 5.3.8 Voltage Test of SA
A copper foil is wrapped at the clamping point around the maximum size of messenger allowed in that clamp. An ac voltage of 6 KV is applied between the copper foil and nearest conductive point of the clamp or into its absence to the point of fixation. The voltage should be withstood for 1 minute without breakdown or flashover.
- 5.3.9 Test Under Mechanical & Thermal Stress
- 5.3.9.1 The test specimen is made up of approx. 10mts. Of messenger wire strung between two anchor clamps with a Suspension Clamp fixed in the middle. Masses of 40 Kg. are suspended at a distance of 1-2mtr. On either side of the Suspension Clamp with a fixing mechanism of mass 2 + 1 Kg.

5.3.9.2 The specimen is subjected to 500 cycles of 90 minutes each. Each cycle consists of the following:

- a) For first 75 minutes a constant longitudinal tension of 4000 N is applied to the messenger for rating of 1500 Kg. and of 4500 N rating of 2000 Kg. while 64cycles right and left oscillation are produced on the clamp 32°on either side of the vertical.
- b) During the first 45 minutes an intermittent current of 4-5 A/sq.mm is applied to maintain the conductor temp at $60 + 3^{\circ}$ C.
- c) During the next 45 minutes of the cycle the conductor is allowed to cool down naturally to the ambient.
- d) At the 75th minute, after having completed 64 oscillations, the oscillations are stopped and the longitudinal tension is increased to 7500 N for 1500 kg. Rating and 10000 N for 2000 Kg. Rating.

3.9.3 No messenger slippage should occur within the Suspension Clamp during the 500cycles.

5.3.9.4 At the end of the 500 cycles, the messenger is immersed in water for 30 minutes. It is then tested to withstand 10 kV ac for 1 minute with a trip setting of $10 + 0.5$ mA. There should be no breakdown or flashover.

5.4 Acceptance Tests

5.4.1 The following shall constitute Acceptance Tests for Insulation Piercing Connectors(IPC) :

- Visual *
- Dimensional (as per SCD and overall dimensions submitted with Tender Offer)*
- ~~Electrical Ageing Test ***~~
- Dielectric and Water Tightness Test. **
- Mechanical Tightening Test **
- Effect of Tightening on Main Core **
- Effect of Tightening on Branch Core **

The above tests are to be carried out as per sampling plan below. ~~However electrical ageing test on IPC (market***) is to be done on only one connector of each type and size.~~

In case of random failure/defect, double the sample lot is to be drawn and there

should be no failure/defect exceeding half the permissible defects (rounded down) shown in the chart.

Lot Size	For tests Marked*		For tests Marked**	
	Sample Size	Max. permissible Defects	Sample Size	Max. permissible Defects
Upto 100	2	nil	2	nil
101 to 1000	6	nil	4	nil
>1001	0.01% subject to min. 6 pieces	0.1% of pieces checked	4	nil

5.4.2 The following shall constitute acceptance tests for Anchor Assemblies:

- Visual *
- Dimensional (as per SCD and overall dimensions submitted with Tender Offer)*
- Mechanical Test on Bracket**
- Mechanical Test on Clamp **
- Voltage Test *

5.4.3 The following shall constitute acceptance tests for Suspension Assemblies:

- Visual *
- Dimensional (as per SCD and overall dimensions submitted with Tender Offer)*
- Mechanical Test on Bracket**
- Mechanical Test on Clamp **
- Voltage Test *

The above tests (for AA & SA) are to be carried out as per sampling plan below. In case of random failure/defect, double the sample lot is to be drawn and there should be no failure/defect exceeding half the permissible defects (rounded down) shown in the chart.

For tests Marked*

For tests Marked**

Lot Size	Sample Size	Max. permissible Defects	Sample Size	Max. permissible Defects
Upto 100	2	nil	1	nil
101 - 500	5	1	2	nil
501 - 2500	10	2	2	nil
2501 & above	10 + 0.2 %	2 + 10% pf addl. Sample quantity	4	1

6.0 SERVICE CLAMP

The clamps should be designed to anchor insulated service lines (armoured or unarmoured) with 2/4 conductors.

- The clamps should be made of weather and UV resistant polymer.
- No losable part in the process of clamping arrangement
- The clamp should conform to the standard NFC 33042 or equivalent I.S., if any. No losable
- Breaking Load of the clamp should not be less than 3 KN.

7.0 TRANSFORMER CONNECTION

- The connection to the transformer should be made with Pre-Insulated lugs for phase and street lighting conductors and with an Aluminum Lug for neutral Messenger. If the Bus-bars-bars are of copper, the Lugs should be preferably Bi-metallic type.
- The Barrel of the lug normally insulated with an Anti-UV black Thermoplastic tube sealed with a flexible ring. Die reference, size and strip length are to be indicated on the plastic.
- Sizes covered 16-70 & upto 150 m2 Aluminium XLPE insulated cable.
- Reference standard NFC 33021 or equivalent I.S. if any.

8.0 JUNCTION SLEEVES

- The sleeves should be Pre-Insulated for phases, neutral messengers and street lighting conductors.
- Sleeve should be made of Aluminum, insulated with an Anti-UV black thermoplastic tube hermetically sealed two ends with 2 flexible rings.

- Die reference, size and strip length are indicated on the sleeve itself.
- Sizes needed : 16-70 & upto 150 mm² for Aluminum XLPE insulated cable.
- Reference standard : NFC 33021 or equivalent I.S. if any.
- Design as per furnished drawing.

9.0 EYE HOOKS

- Eye looks should be designed as to hold suspension clamps and Dead end clamps and to be installed with the pole clamp.
- Eye-hooks should be made of forged Galvanized steel.
- The clamps corrosion resistance should conform the standards I.S. 2629 & I.S.2633.
- Bolts and nuts should be made of hot dip Galvanized steel according to VDE 0210 and VDE 0212.
- Ultimate Tensile strength (UTs) of the clamp should 20 KN.
- Design as per furnished drawing.

10.0 SERVICE MAIN DISTRIBUTION BOXES

10.1 Scope

This Distribution Box should be Weather & Moisture Proof with Spring loaded/Bolt& Nut type Bus Bar system & should be able to carry a current according to specified capacity. It can have 1/3-phase input & provision of 4 to 6 nos. of 3-phase or 1-phase outputs. The box should have the provision for special key for locking & Proper arrangement of sealing. The boxes should be assembled on the pole using Metal Tapes & Buckles or Bolts. No. of Boxes per pole may vary with supporting arrangement for more no. of service connections. The Spring used should be of stainless steel having required capacity to provide suitable pressure in the connector.

10.2 Construction

Distribution Boxes should be designed with Bus Bars with spring action contact, or screw-bolt technique. For spring action contact only insertion of the conductor into the specified groove of the Busbar is sufficient for proper connection whereas for Nut Bolt type proper washers & other accessories are to be provided for connections. It should be used for multiple connections (3-phase or 1-phase) in low voltage Distribution Network. The boxes should be suitable for 1/3-phase (4 crores) inputs & provision for 4 to 6 nos. of 3-phase or 1-phase outputs. Bus bars should be with a continuous pair of contact bars with colour code to facilitate the identification of the correct energy phase.

The box should be able to incorporate the input or output cable dia. Of maximum 16mm. (Equivalent to 120Sq.mm.).

The Boxes should consist of special type Lock & key system as well as provision for sealing for complete protection of the service connection contacts.

10.3 Current Ratings

The maximum current rating should be 140A/200A/250A & concerned authority should have the liberty to choose among the above ratings as per their requirement.

10.4 Voltage Ratings:

The maximum voltage withstand capacity should be 600V.

10.5 Working Temp

Safe working temperature should be around 80 C for Outer Box & 100OC for metallic Bus bars.

10.6 Materials

Material used in the manufacturing process of the components of this product should be specified in the respective product drawings & can be summarized as follows :

- Outer Box (Base & Cap) : With UV protection & Flame retardant characteristics(HB, as per UL 94-Tests for Flammability of Plastic materials) & preferably made up of ASA (Achylonitrile Styrene Acrylate).
- Cable Grommets : Ethyelene-Propylene Rubber :
- Safety Key : PA 6.6 (Nylon).
- Safety Screw : Stainless Steel or Plating Finished steel.
- Insulation protection as per IP 44.
- Bus bars or Terminal Blocks : PA 6.6 (Nylon), Stainless Steel & Copper.
- Button & Cable Holder : PA 6.6 (Nylon) with 50% Glass Fibre.
- Busbar Insulation :Polymide.

10.7 Locking System

The boxes should consist of Special type Lock & Key arrangement as well as provision for sealing for complete protection of the service connection contacts.

11.0 G.A. DRAWINGS ETC.

11.1 A drawing / picture clearly showing principal parts & dimensions for all products should be submitted along with the offer.

11.2 The principal outer dimensions of each item, l x b x w in mm and weight in gms should be submitted along with the offer.

11.3 The Employer may call for samples for verification & evaluation purposes.

12.0 GENERAL CONDITIONS OF MANUFACTURE

13.0 GTP

The Guaranteed Technical Particulars should be filled up in the given format of GTP.

14.0 TESTING STANDARD – Given in Annexure 2 & 3.

Note : 1) Any specific meteorological data other than those listed above applicable for a particular equipment/item will be available in the technical specification for that equipment/item.

2) When values specified above contradicts with respective equipment TS, the later will prevail for that equipment.

3) The atmosphere in the area is laden with industrial and town gases and smoke with dust in suspension during the dry months and subject to tough colder months.

4) Heavy lightning is usual in the area during the months from May to November.

ANNEXURE-1**GENERAL CONDITIONS FOR MANUFACTURE**

The products shall be in accordance recognized standards used in L.T. ABC or equivalent I.S., if any.

- Marking : Each product shall be clearly identified with manufacturer name or trade mark, reference and capacity of the item and batch no.
- Packaging : Manufacturer shall mention the packaging of each item. Installation instruction should be included in packaging.
- Type test : Each supplier should provide type test reports with the offer, carried out in accordance with one of the reference standards in NABL Accredited Laboratory.
- Routine test : Supplier shall provide a control plan, which will be implemented on each item. Routine test reports should be submitted by the manufacturer with inspection call.
- Quality : All suppliers should preferably be ISO-9000 certified.

Anchoring and suspension clamps should be installable on existing poles using appropriate devices (hooks, pigtails, brackets etc.).

All crimped connectors should be installed with mechanical or hydraulic hand crimping tools.

ANNEXURE – 2**TESTING STANDARDS :**

The Insulating Piercing Connector should conform to following std. :

Tests	Tests Standard / Test Procedure
Corrosion Qualification Test	<p>As per NF C 33-020 (Jun '98), or equivalent I.S., if any.</p> <p>Exposure in Saline Environment : The exposure should be carried out as per NF en 60068-2-11 (Aug. '99) std. requirement. The concentration of Saline solution must be of 5% \pm 1% in mass, & the temperature of the test chamber must be maintained at 35°C \pm 2°C.</p> <p>Exposure in Sulphur environment saturated of humidity – The exposure should be carried out as per NF T 30-055 (Mar. '74) std. requirement. SO₂ concentration in the chamber should be 0.067% in volume. The temperature of the test chamber should be increased to 40°C \pm 3°C.</p> <p>The total test should include four identical periods of 14 days, in which 7 days of exposure in Saline environment & in other 7 days – 8 hrs. cycles in SO₂ environment & 16 hrs. in laboratory environment.</p>
Electrical Ageing Test	<p>As per NF C 33-020 & NF C 33-004 (Jun '98) or equivalent I.S., if any.</p> <p>Total no. of cycles 200, Heating time -60 mins., Cooling time - 45 mins., Pause time – 2 mins.</p>

<p>Dielectric Investigation Test in water</p>	<p>As per NF C 33-020 (Jun '98) or equivalent I.S., if any. 15°C & 30°C & relative humidity between 25% & 75%. The tightening of the connectors should be at minimal value of the torque indicated by the manufacturer. The sample should be placed in tank full of water on 30 cm height, after an immersion length of 30 mins. The set is subjected to a dielectric test under a voltage of 6 KV at industrial frequency during 1 min. No flashover breakdown should occur at 6 KV during 1 min.</p>
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Tests	Tests Standard / Test Procedure
Tests	Tests Standard / Test Procedure
Mechanical Tests	As per NF C 33-020 (Jun '98) or equivalent I.S., if any. For checking electrical continuity, shear heads & mechanical behaviour of the connector's suitable tests as per the above specification have to conduct.

Capacity needed :

For ABC 16 to 95 mm²

Model 1 for customer service

Main 16 to 95 mm²

Tap 2.5 to 10 mm² (For Street lighting/service connection)

Design as per furnished drawing

Model 2 for customer service

Main 16 to 95 mm²

Tap 04 to 35 mm² (for distribution box charging)

Design as per furnished drawing

Model 3 for customer service

Main 25 to 95 mm²

Tap 25 to 95 mm² (For ABC to ABC Tee Joint)

Design as per furnished drawing.

ANNEXURE – 3

TESTING STANDARDS

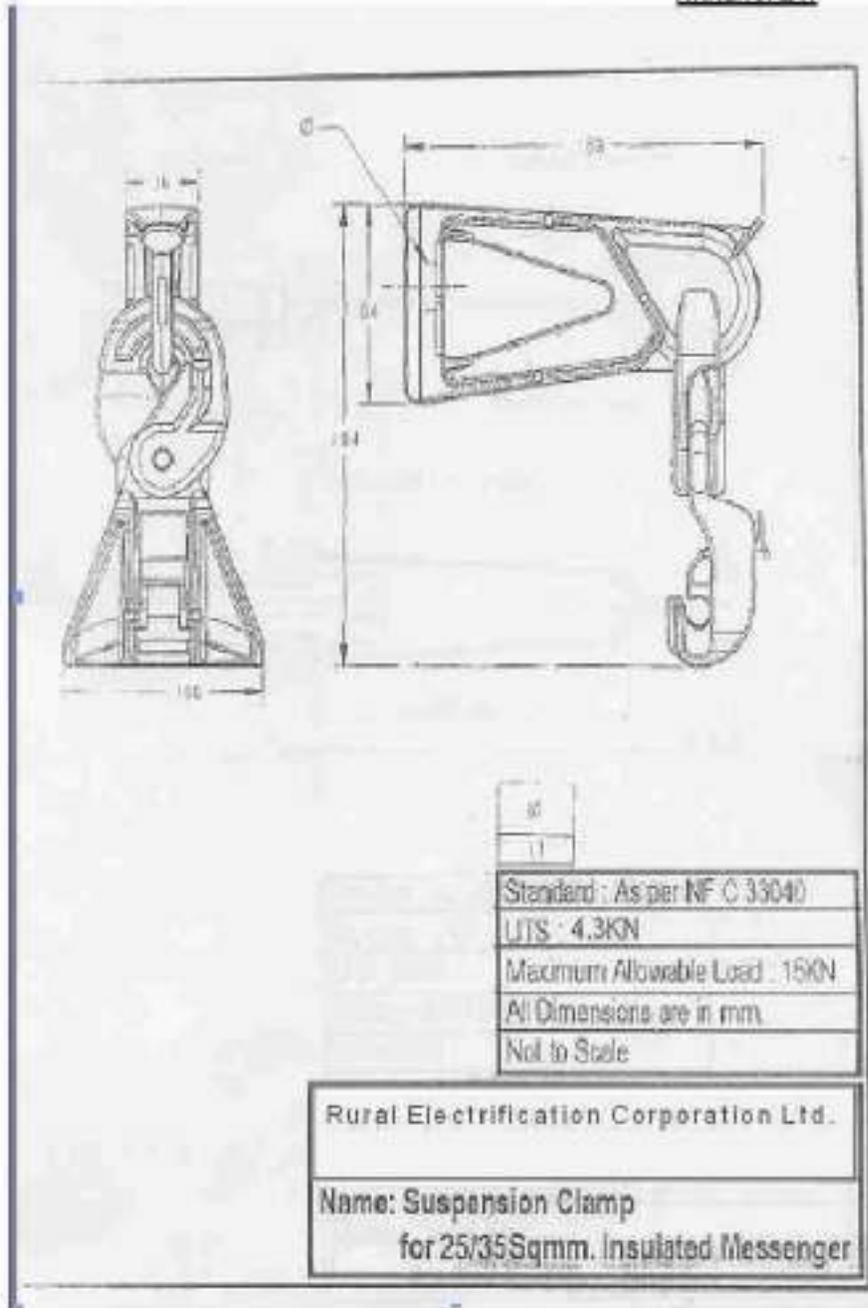
Impact Resistance should be according to UL 746C. Insulation Protection should be as per IP 44. The Outer Plastic box should conform to following std. –

Test / Standard	Requirements	Test Procedures
Degree of Protection IEC 60529	IP 44 – Protected against the penetration of solid objects exceeding 1.0mm in diameter and against penetration of water jets that may affect the product operation.	<p>First Digit : A 1.0mm diameter test wire should not penetrate in any apparent opening (force = $1 N \pm 10\%$)</p> <p>Second Digit : A spray nozzle is used to spread a water jet in all possible directions.</p>
Impact Resistance UL 746-C	<p>After the test the product should not show any evidence of :</p> <ul style="list-style-type: none"> - Live electrical parts accessible to the test probe, as described in this test specification. - Any results, which may affect the mechanical performance of the product. - Any results, which may increase the probability of electrical shocks. 	<p>The impact should be generated by dropping a steel ball – with a diameter of 50.8 mm and a mass of 0.535 kg – from a specified height sufficient to produce an impact energy of 6.8 J (0.69 13 kg.m.)</p>
UV Resistance	The sample physical properties	According to ASTM G26,

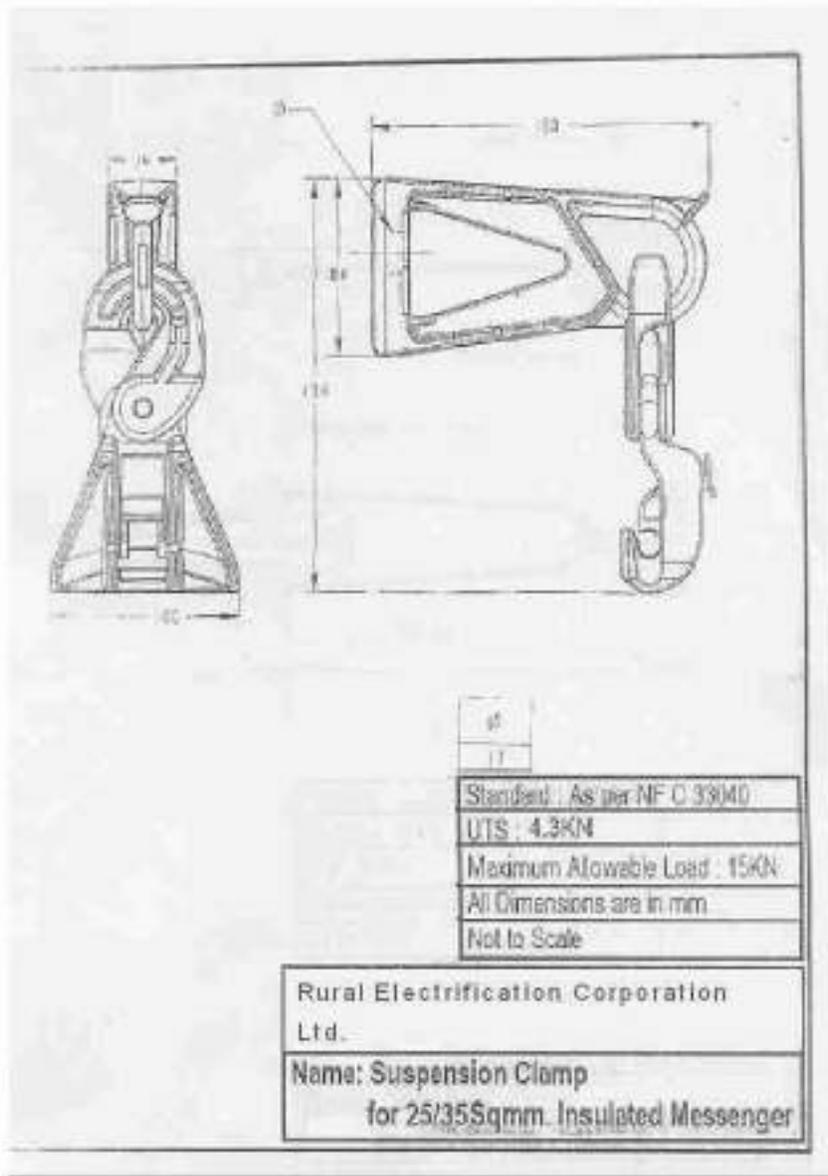
UL 746-C	average value after an accelerated aging with UV	Exposure Method 1, Xenon Arc Lamp Type B or
Test / Standard	Requirements	Test Procedures
	radiation – should not be lower than 70% of its initial value, without aging, that is, a variation of + 30% is allowed.	ASTM G 155, Exposure Cycle I, with continuous exposure to light and intermittent exposure to water jets, with programmed cycles of 120 minutes, consisting of a 102 minutes light-only exposure and a 18 minutes exposure to light and water jets.
Withstanding Voltage UL 746-C	Product should withstand the specified voltage	A 5 kV voltage should be applied to the samples after the 40 hours conditioning cycle at $23 \pm 2^{\circ}\text{C}$ and $50 \pm 5\%$ relative humidity plus 96 hours at $35 \pm 2^{\circ}\text{C}$ and $90 \pm 5\%$ relative humidity.
Flammability UL 94	After the UV radiation accelerated aging, the material should maintain the same original flammability level (HB).	The test can be applied to test samples molded with the same material used for the base and the cap of the box or taking a piece of these components.
Flexural Strength ASTM D790 UL 746-C	After UV radiation accelerated aging, the average value for this test should not be lower than 70% of the original value, that is, a maximum variation of 30% is allowed.	A group of test samples without aging should be tested and the average values calculated. Another group should be aged under UV radiation then it should be tested and the new

		average should be calculated and compared to the initial average value.
Tensile Strength ASTM D638	After aging with UV Radiation, the average value	One of the test bodies must be tested without being
Test / Standard UL 746-C	Requirements should not be lower than 70% of the initial values, that is, a maximum variation of 30% is allowed.	Test Procedures submitted to accelerated aging and is computed over mean values. Another group is submitted to the radiation induced aging and then tested and the new mean value is computed and compared to the first computed mean value.

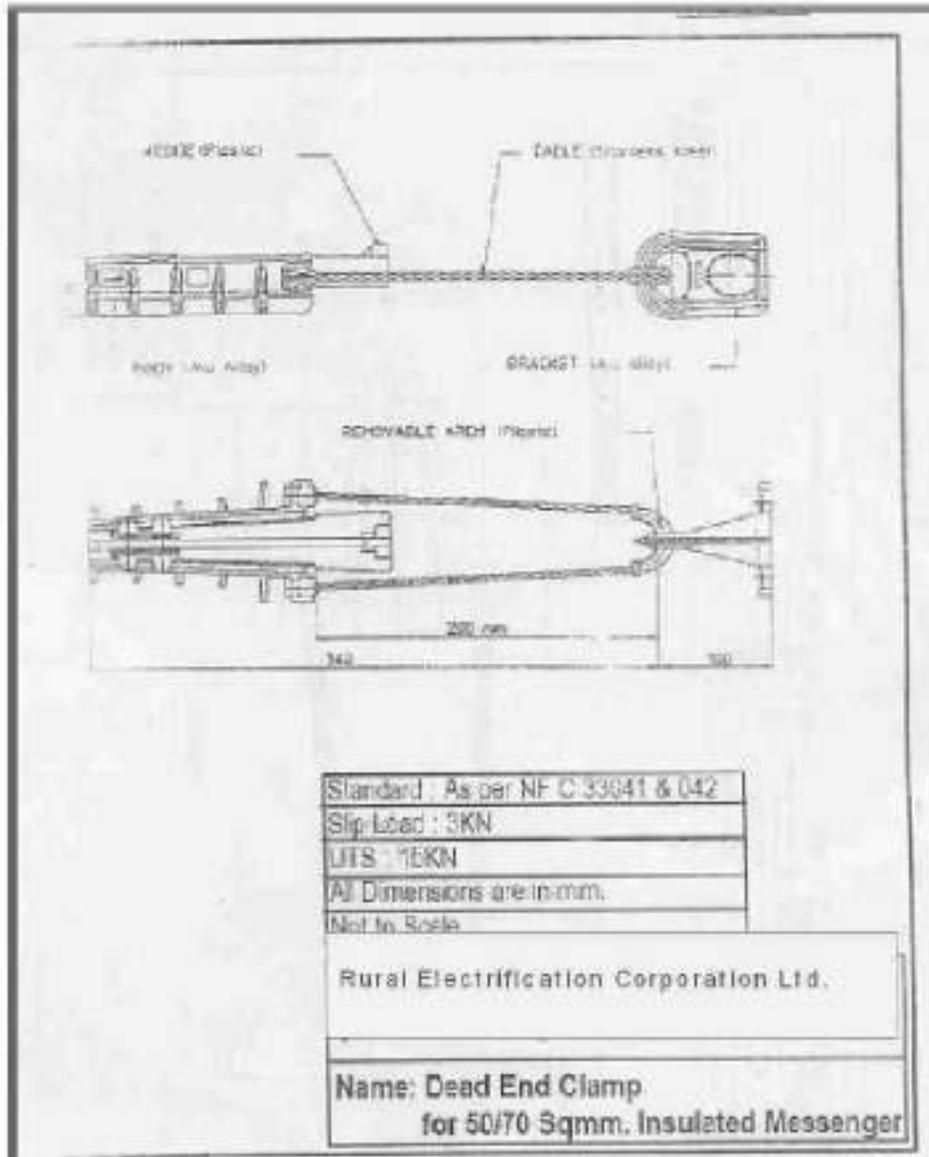
ANNEXURE-A



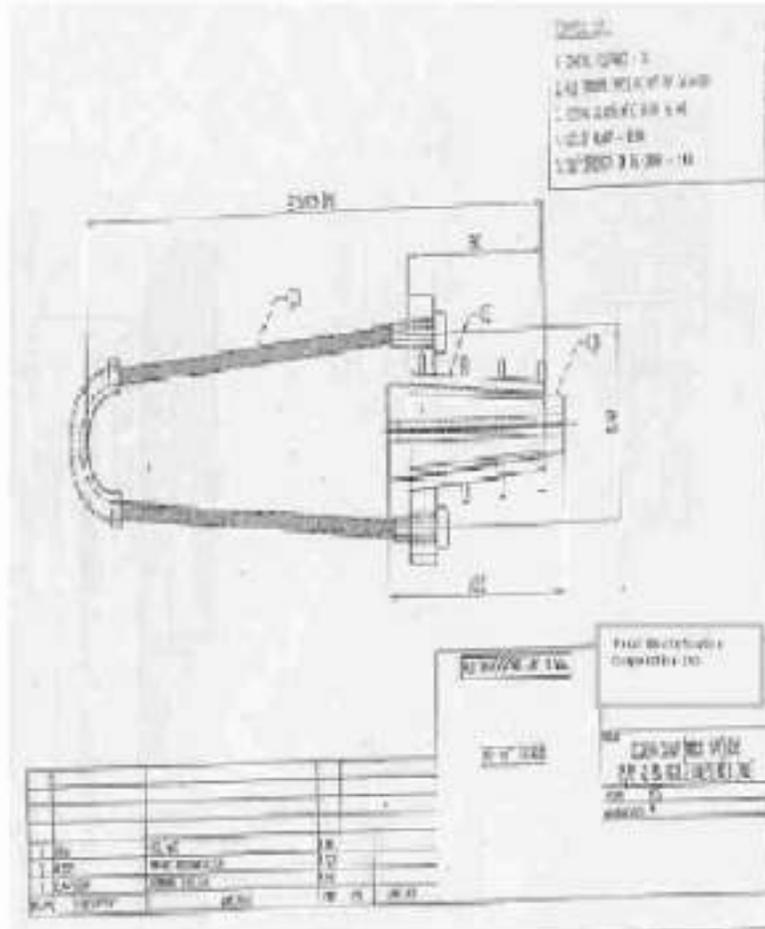
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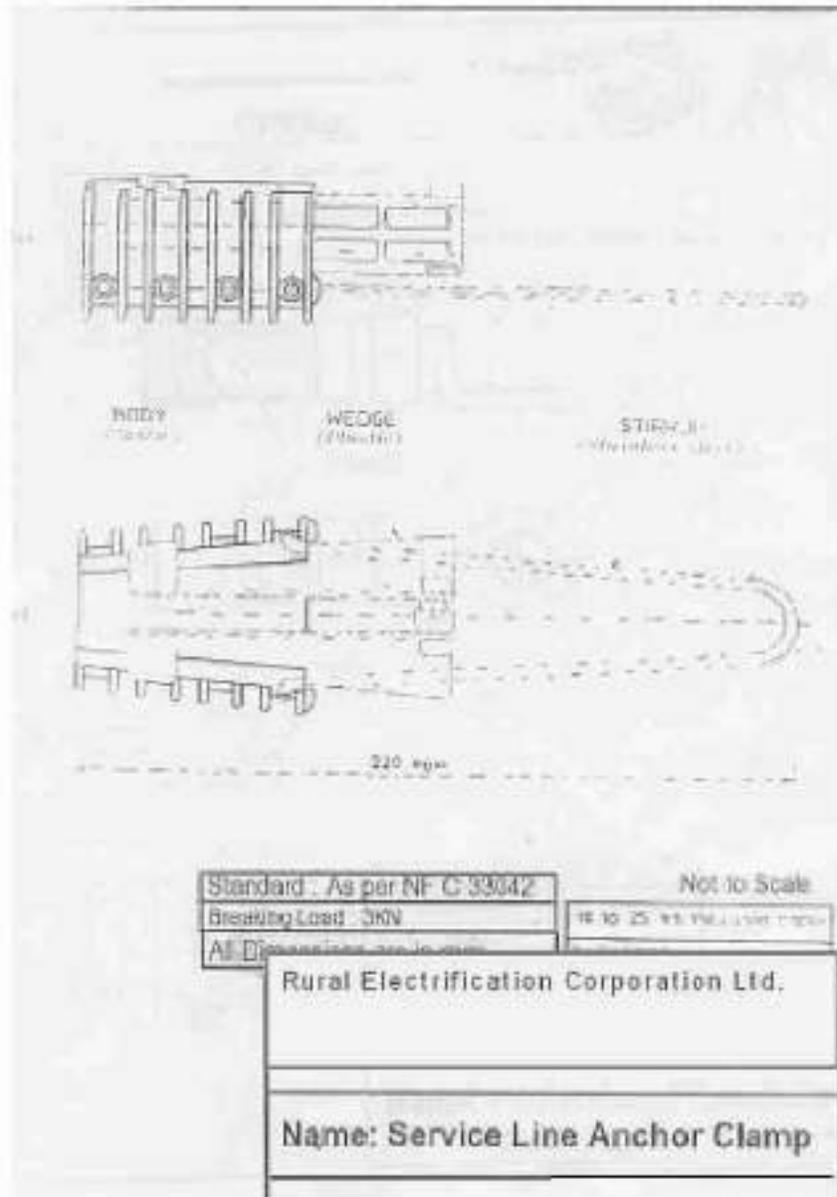
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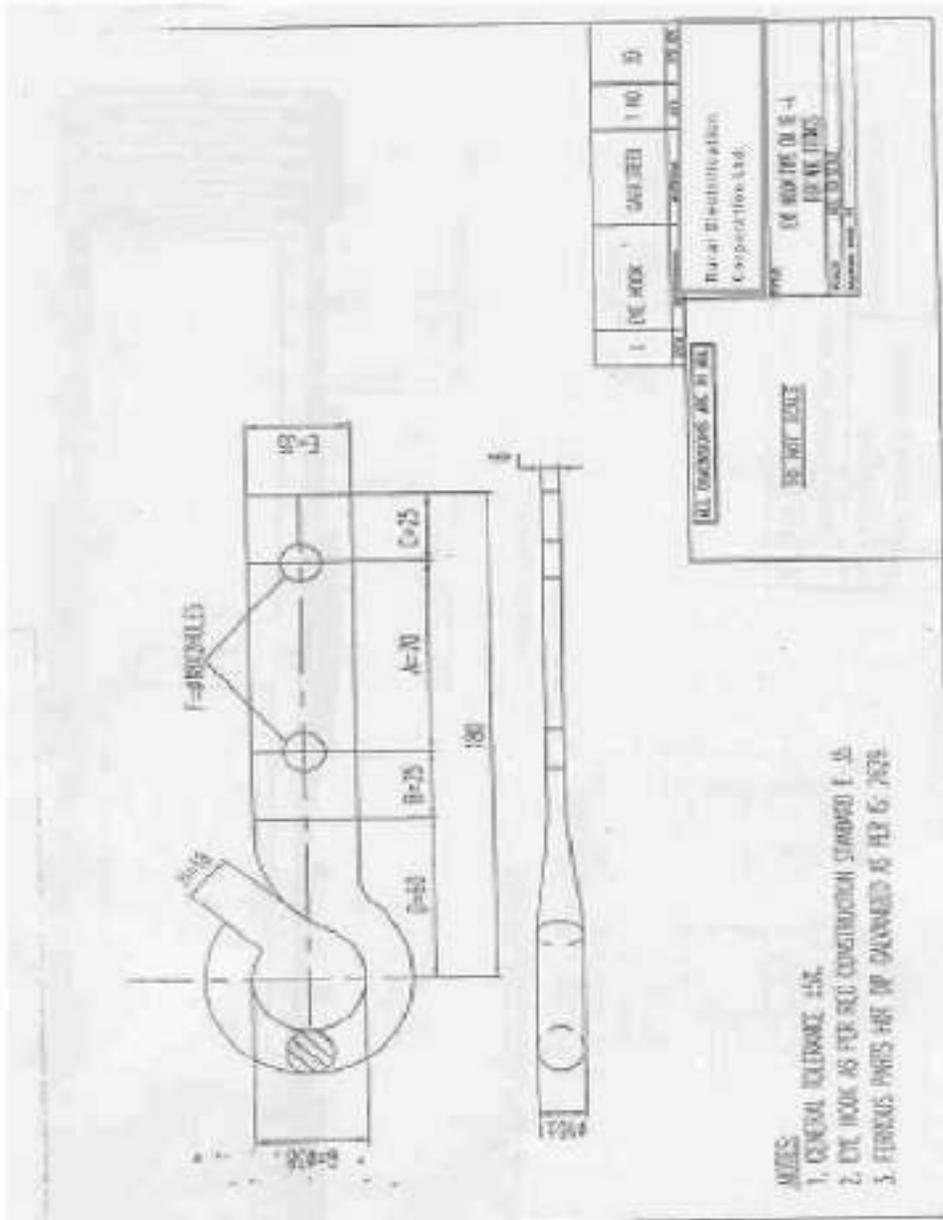
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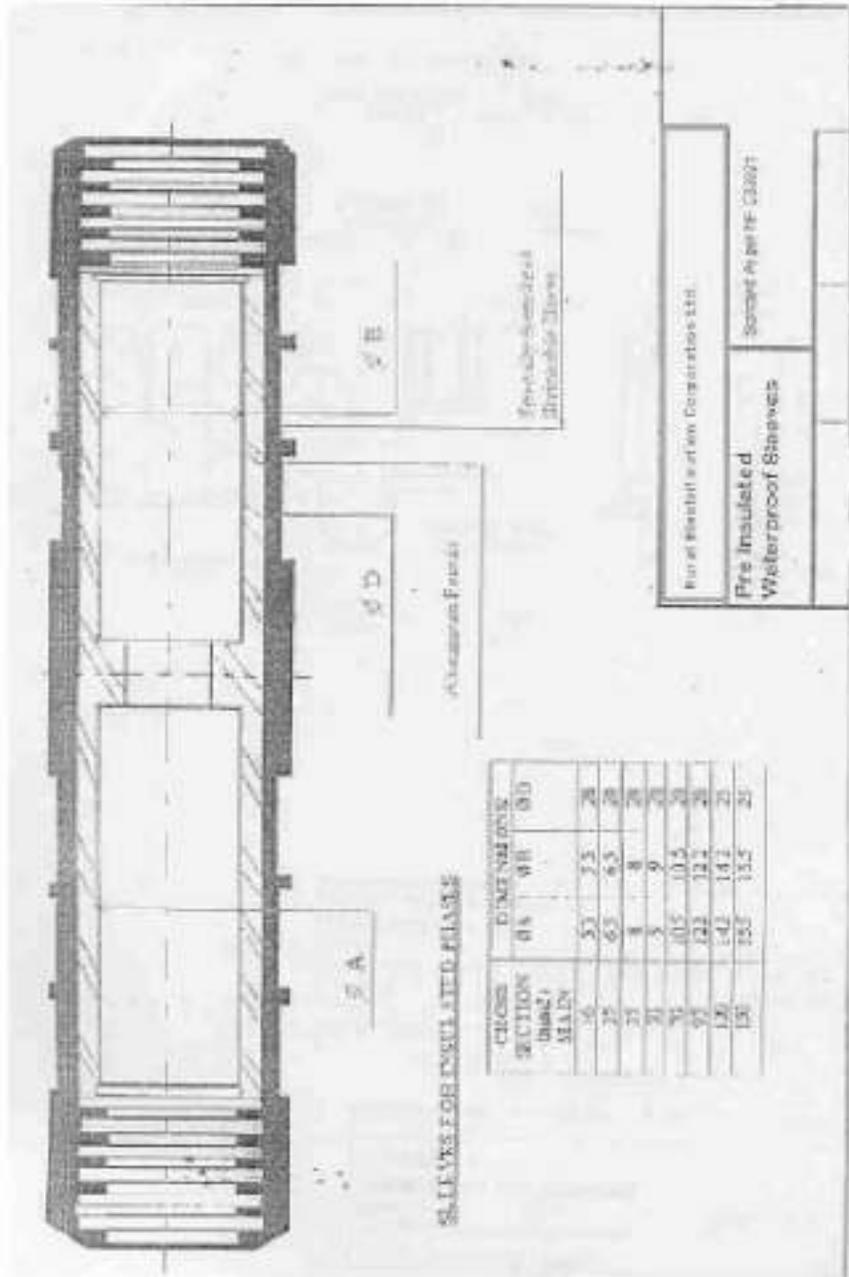
ANNEXURE E



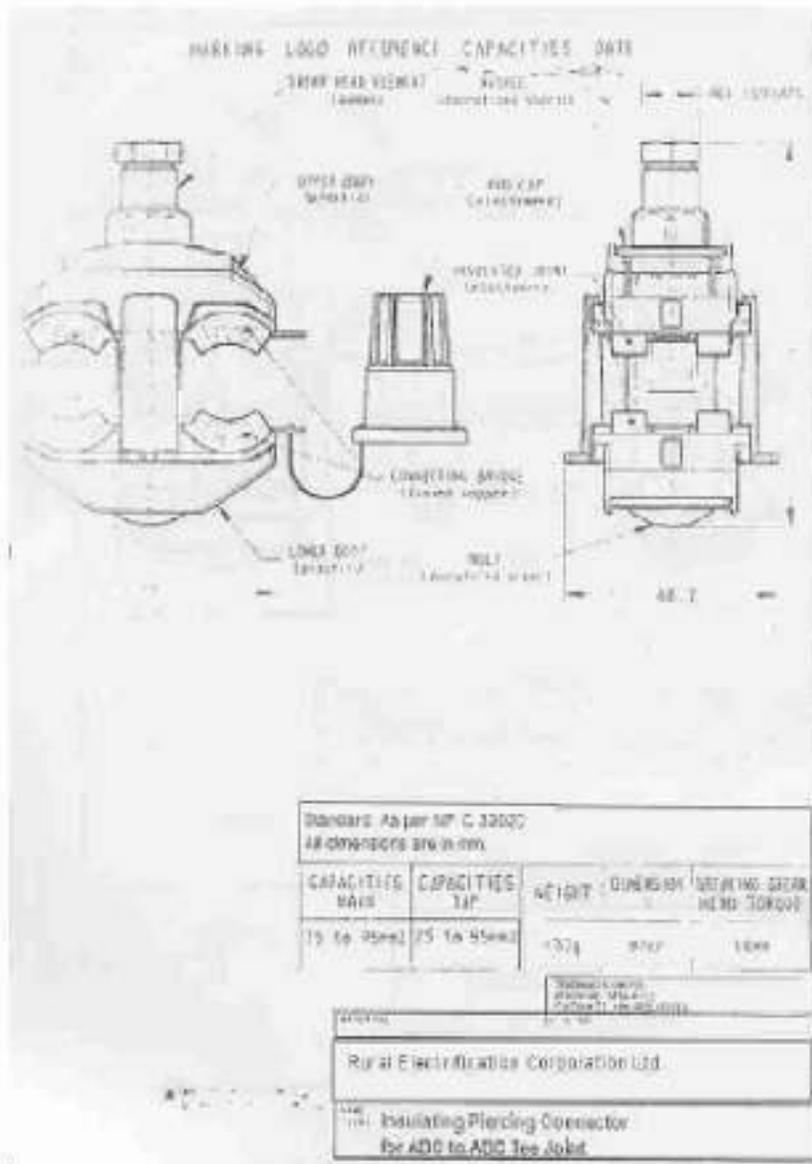
ANNEXURE-G



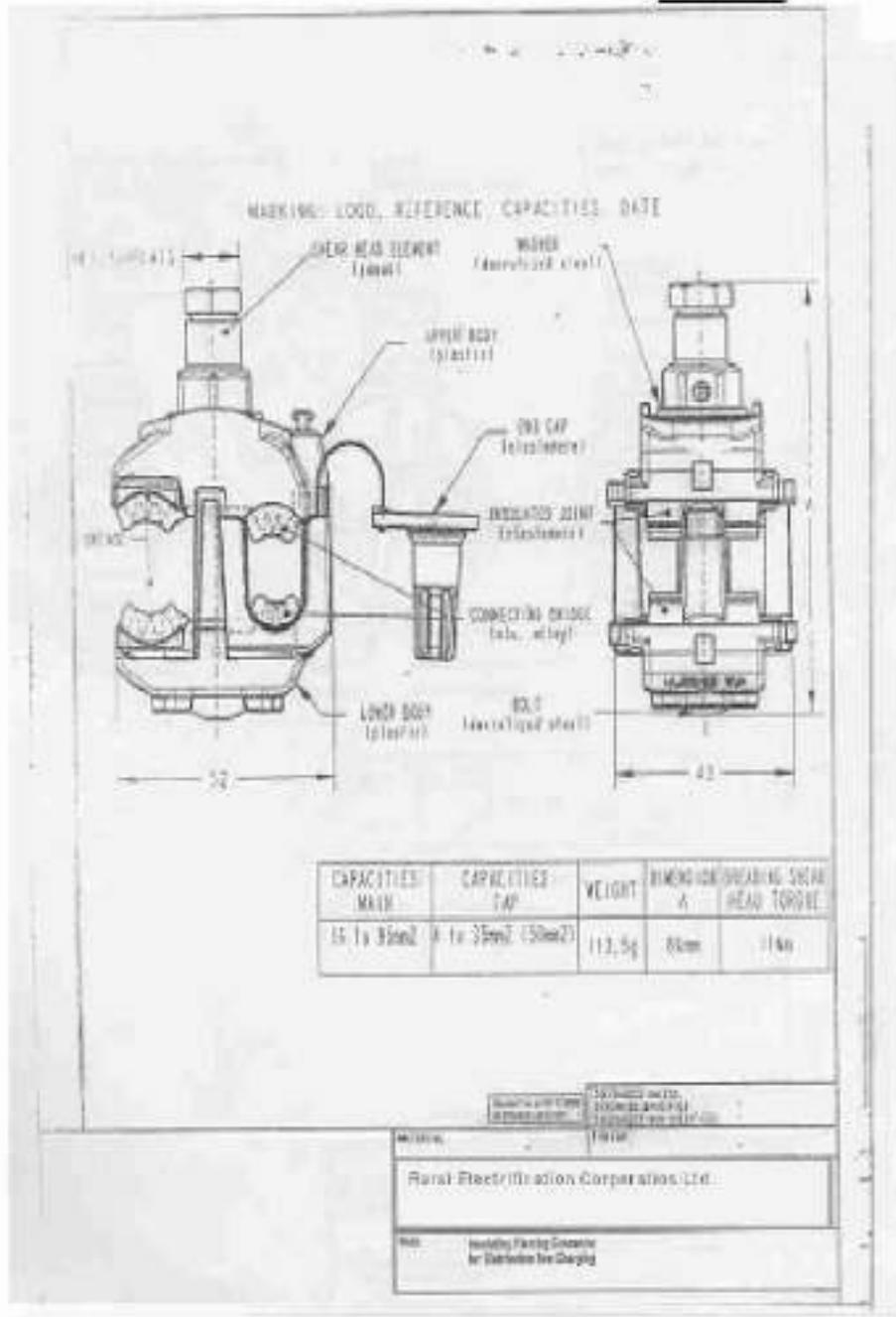
ANNEXURE II



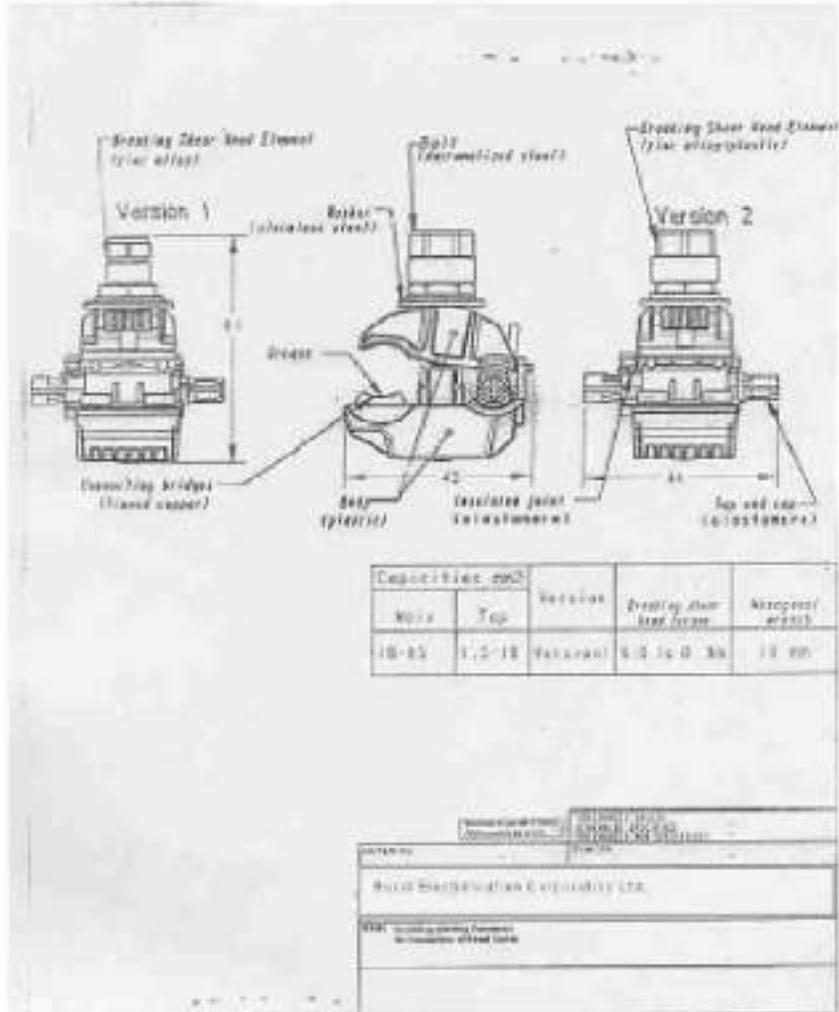
ANNEXURE I



ANNEXURE-I



ANNEXURE-K



27. 11 kV and 33 kV Isolators

1) SCOPE

This specification provides for design, manufacture, testing at manufactures works, delivery of outdoor station type 11KV and 33KV (Local) manual operating mechanism isolating without/ with earthing blades and complete in all respect with bi-metallic connectors. Operating mechanism, fixing details etc. shall be as described herein.

2) PARTICULARS OF THE SYSTEM

The isolators to be provided under this specification are intended to be used on 3 phase A.C. 50 cycles, effectively grounded system. The nominal system voltages are 11 kV & 33 kV respectively.

3) STANDARD

The Isolator shall comply in all respects with IS: 9921 or IEC Publication No.: 129. Equipment meeting any other authoritative standard which ensures an equal or better quality than the standard mentioned above will also be accepted.

4) TYPE & RATING

Isolators shall have three posts per phase, triple pole single throw, gang operated out-door type silver plated contacts with horizontal operating blade and isolators posts arranged vertically. The isolators will be double break type. Rotating blade feature with pressure relieving contacts is necessary i.e. the isolator shall be described in detail along-with the offer. However, the design of turn & twist arrangement shall be subject to owner's approval. (Banging type feature is not acceptable). All isolators shall operate through 90 degree from their fully closed position to fully open position, so that the break is distinct and clearly visible from the ground level.

The equipment offered by the tenderer shall be designed for a normal current rating of 400 A for 11 KV & 630 A for 33 KV suitable for continuous service at the system voltage specified herein. The isolators are not required to operate under load but they must be called upon to handle magnetization currents of the power transformers and capacitive currents of bushings, bus-bars connections, very short lengths of cables and current of voltage transformers.

The rated insulation strength of the equipment shall not be lower than the levels specified in IS 9921 JEC publication No. 129, which are reproduced below

Standard declared voltage	Rated voltage of the Isolator	Standard withstand positive kV (peak)	Impulse Voltage polarity	One minute power frequency withstand voltage KV (RMS)
---------------------------------	-------------------------------------	--	--------------------------------	--

kv/rms		Across the isolating distance	To earth and between poles	Across the isolating distance	To earth and between poles
11 KV	12	85	75	45	35
33 KV	36	195	170	100	75

The 11 KV and 33 KV isolators are required with post insulators but with mounting structures. The isolators should be suitable for mounting on the Boards standard structures. The isolators shall be supplied with base channels along with fixing nuts, bolts and washers for mounting on the structured.

5) **TEMPRATURE RISE**

The maximum temperature attained by any part of the equipment when in service at site under continues full load conditions and exposed to the direct rays of Sun shall not exceed 45 degree centigrade above ambient temperature.

6) **ISOLATOR INSULATION**

Isolation to ground, insulation between open contacts and the insulation between phases of the completely assembled isolating switches shall be capable of withstanding the dielectric test voltage specified above.

7) **MAIN CONTACTS**

All isolators shall have heavy duty self aligning and high pressure line type fixed contacts of modern design and made of hard drawn electrolytic copper. The fixed contact should be of reverse loop type. The various parts shall be accordingly finished to ensure inter- changeability of similar components.

The fingers of fixed contacts shall be preferably in two pieces and each shall form the reverse loops to hold fixed contacts. The fixed contacts would be placed in ‘c’ clamp. The thickness of ‘C’ clamp shall be adequate. This channel shall be placed on a channel of adequate thickness. This channel shall be welded on an insulator mounting plate of 8mm thickness. The spring of fixed contact shall have housing to hold in place. This spring shall be made of stainless steel with adequate thickness. The pad for connection of terminal connector shall be of aluminum with thickness not less than 12 mm.

The switch blades forming the moving contacts shall be made from tubular section of hard drawn electrolytic copper having outer dia not less then 38 mm and thickness 3 mm. These contacts shall be liberally dimensioned so as to withstand safely the highest short circuit and over voltage that may be encountered during service. The surfaces of the contacts shall be rendered smooth and silver plated. The thickness of silver plating shall not be less than 15 microns for 11 KV and 25

microns for 33 KV. In nut shell, the male and female contact assemblies shall be of robust construction and design of these assemblies shall ensure the same.

1. Electro-dynamic withstands ability during short circuit without any risk of repulsion of contacts.
2. The current density in the copper parts shall not be less than 2 Amp/sq.mm and aluminium parts shall be less than 1 Amp/sq.mm.
3. Thermal withstand ability during short circuit.
4. Constant contact pressure even when the live parts of the insulator stacks are subjected to tensile stresses due to linear expansion of connected bus bar of flexible conductors either because of temperature verification or strong winds.
5. Wiping action during closing and opening.
6. Self alignment assuring closing of the switch without minute adjustment.

The earthing switch should be provided with three sets of suitable type of fixed contacts below the fixed contacts assemblies of the main switch on the incoming supply side and the sets of moving contacts having ganged operation. These contacts shall be fabricated out of electrolytic copper for 33 KV isolators with earth switch and designed to withstand current on the line.

Arcing contacts / Horn: Arcing contacts are not required.

Auxiliary switches : Auxiliary switches are not required.

8) **CONNECTORS**

The connectors for 11KV isolator shall be made of Aluminium alloy LM-9 or LM-25 and shall be suitable for Squirrel, Weasel and Rabbit ACSR Conductors for 11KV and Raccoon/Dog conductors for 33 KV with horizontal and vertical takeoff arrangement. The details in regard to dimensions, the number of bolts to be provided, material and manufacture shall be furnished by the bidder for owner approval before manufacturing. The groove provided in the connection should be able to accommodate conductor size mentioned above smoothly.

The clamps to be offered should be manufactured by gravity die-casting method only and not by sand casting process. It is necessary that suitable clamps are offered along with the isolator and also it is obligatory to give complete technical particular of clamps along with the drawing, as per details given above and also as per following detail.

1. The terminal connector shall be manufactured and tested as per IS: 5561.
2. All castings shall be free from blow holes, surface blisters, cracks and cavities.
3. All the sharp edges shall be blurred and rounded off.
4. No part of the clamp shall be less than 12 mm thick.
5. All current carrying parts shall be designed and manufactured to have minimum contact resistance.
6. Connectors shall be designed to be corona free in accordance with the requirement of IS: 5561.
7. All nuts and bolts shall be made of stainless steel only. Bimetallic sleeve/liner

shall be 2 mm thick

Wherever necessary, bi-metallic strip of standard quality and adequate dimension shall be used.

9) **POST INSULATOR**

11KV / 33KV insulators shall be of reputed make subject to owner approval. The post insulators for the above 11 KV isolators shall comprise of three numbers 11 KV insulators per stack and 9 such stack shall be supplied with each isolator.* Similarly, for 33 KV isolators, two numbers 33 KV insulators per stack and 9 stacks shall be supplied with each isolator*. The insulator stack shall conform to the latest applicable Indian or IEC standard and in particulars to the IS; 2544 specification for porcelain post insulators. The porcelain used for manufactures of insulators shall be homogeneous, free from flaws or imperfections that might affect the mechanical or dielectric quality, and they shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be uniform brown colour, free from glisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

The porcelain and metal parts should be assembled in such a manner that any thermal expansion differential between the metal and the porcelain parts throughout the range of temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high-grade cast steel or malleable steel casting and they shall be machine faced and smoothly galvanised. The cap and base of the insulators shall be interchangeable with each other.

The tenders shall in variably enclose with the offer, the type test certificate and other relevant technical guaranteed particulars of insulators offered by them. Please note that isolators without type test certificates will not be accepted.

Each 11KV / 33KV Post Insulators used in the isolators should have technical particulars as detailed below:-

* Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091 Dated 25.08.2017.

	11KV	33KV
1. Nominal system voltage KV (rms)	11	33
2. Highest system voltage KV (rms)	12	36
3. Dry P.F. One minute with stand KV (rms)	35	75
4. Wet PF one minute withstand KV (rms)	35	75
5. P.F. Puncture withstand test voltage KV	1.3 time the actual dry flash over voltage of the unit	
6. Impulse voltage withstand test KV (peak)	75	170
7. Visible discharge test KV voltage	9	27

8.	Creepage distance mm (min)	320	580
9.	Tensile strength in KN	10KN	16KN
10.	Short time current rating for 3 Secs	25KA	25KA

For 33 KV Isolators: In place of 33 KV Post Insulator the composition of 2 units of 22KV Post Insulators per stack complying the following parameters are acceptable:-

(a) Norminal system voltage	:	33 KV
(b) Highest system voltage	:	36 KV
(c) Impulse voltage withstand	:	170 KV
(d) Power frequency wet withstand voltage	:	75 KV
(e) Height of stack	:	500 mm
(f) Creepage distance (Minimum)	:	840 mm
(g) Tensile Strength	:	30KN
(h) Bending strength	:	4.5KN

Operating Mechanism for 11KV / 33KV Isolators:-

All Isolators and earthing switches shall have separate dependent manual operation. The Isolator should be provided with padlocking arrangements for locking in both end position to avoid unintentional operation. For this purpose Godrej make 5 lever brass padlocks having high neck with three keys shall be provided. The isolating distances should be visible for isolators.

The Isolators and Isolators with earth switch inclusive of their operating mechanism should be such that they cannot come out of their open or close position by gravity wind pressure, vibrations reasonable shocks or accidental touching of connecting rods of the operating mechanism. Isolators should be capable of resisting in closed position, the dynamic and thermal effects of maximum possible short circuit current at the installation point. They shall be so constructed that they do not open under the influence of the short circuit current. The operating mechanism should be of robust construction and easy to operate by a single person and conveniently located for local operation in the switchyard. Provision for earthing of operating handle by means of 8 SWG GS wire must be made.

10) PIPES

Tandem pipes operating handle shall be class B ISI marked type having atleast 24mm internal diameter for 11KV/33KV isolator. The operating pipe shall also be class B ISI marked with internal diameter of atleast 32 mm and 38 mm for 11 KV and 33KV isolators respectively.

The pipe shall be terminated in to suitable universal type joints between the insulator bottom bearing and operating mechanism.

11) BASE CHANNEL

The Isolator shall be mounted on base fabricated from steel channel section of adequate size not less than 75x40x6 mm for 11KV and 100x50x6 mm for 33KV.

To withstand total weight of isolator and insulator and also all the forces that may encounter by the isolator during services, suitable holes shall be provided on this base channel to facilitates it's mounting on our standard structures. The steel channel in each phase shall be mounted in vertical position and over it two mounting plates atleast 8mm thick with suitable nuts and bolts shall be provided for minor adjustment at site.

12) CLEARANCES

We have adopted the following minimum clearance for isolators in our system .The bidder should therefore keep the same in view while submitting their offers: -

Description	Center distance between Poles (Center to Center) i.e. Phase to Phase clearance	Distance between center lines of outer posts on same pole
11 KV Isolator	75 Cm	60 Cm
33 KV Isolator	120 Cm	96 Cm

28. 11 kV and 33 kV Air Break Switches

1) SCOPE

This specification provides for manufacture, testing at works and supply of 11KV & 33KV AB switches. The 11KV and 33 KV AB switches shall conform to IS: 9920 (Part-I to IV)

2) AB SWITCHES

The 11KV & 33KV Air Break Switches are required with two poles in each phase. The AB Switches shall be supplied complete with phase coupling shaft, operating rod and operating handle. It shall be manually gang operated and vertically break and horizontal mounting type.

The equipment offered by the bidder shall be designed for a normal current rating of 200 Amps and for continuous service at the system voltage specified as under:

i) 11 KV AB Switch : 11KV + 10% continuous 50 C/s solidly grounded earthed neutral system

ii) 33KV AB Switch : 33 kV + 10% -do-

The length of break in the air shall not be less than 400 mm for 11KV AB Switches and 500 mm for 33 KV AB Switches.

The 11KV & 33KV AB Switches are required with post insulators. The AB switches should be suitable for mounting on the structure. The mounting structure will be arranged by the bidder. However, the AB Switches shall be supplied with base channel for mounting on the structure which will be provided by the owner. The phase to phase spacing shall be 750mm in case of 11KV AB Switches & 1200mm in case of 33KV AB Switches.

3) POST INSULATORS

The complete set of three phase AB Switches shall have stacks of post insulators.

11KV AB Switches : 3 No. 11KV Post Insulator per stack* (1 No. 11kV post insulator per stack shall be permitted)

33KV AB Switches : 3 No. 33KV Post Insulator per stack* (2 No. 22kV or 3 No. 11kV post insulator shall be permitted in each stack).

The post insulators should conform to the latest applicable Indian standards IS: 2544 Specification for Porcelain Post insulator of compact solid core or long rod insulators are also acceptable. Creepage distance should be adequate for highly polluted outdoor atmosphere in open atmosphere. The porcelain used for

manufacture of AB Switches should be homogeneous free from flaws or imperfections that might affect the mechanical dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain

shall be of uniform brown in colour, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

* Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091 Dated 25.08.2017.

The porcelain and metal parts shall be assembled in such a manner that any thermal expansion differential between the metal and porcelain parts through the range of temperature variation shall not loose the parts or create undue internal stresses which may affect the electrical or mechanical strength. Cap and base of the insulators shall be interchangeable with each other. The cap and base shall be properly cemented with insulators to give perfect grip. Excess cementing must be avoided.

Each 11KV & 33KV Post Insulators should have technical particulars as detailed below:

		11 kV	33 kV
i	Nominal system voltage kV (rms)	11	33
ii	Highest system voltage kV (rms.)	12	36
iii	Dry Power Frequency one kV minute withstand voltage (rms) in KV	35	75
iv	Wet Power frequency one minute withstand voltage (rms) in KV	35	75
v	Power Frequency puncture kV (rms) voltage	1.3 times the actual dry flashover voltage	
vi	Impulse withstand voltage kV (Peak)	75	170
vi	Visible discharge voltage kV (rms)	9	27
vi	Creepage distance in mm (minimum)	320	580

The rated insulation level of the AB Switches shall not be lower than the values specified below:-

Sl. No	Standard declared voltage KV/R MS	Rated Voltage of the AB Switches	Standard impulse withstand voltage (positive & negative polarity kV (Peak)	One Minute power frequency withstand voltage kV (rms)

			Across the Isolating distance	To earth & between poles	Across the Isolating distance	To earth & between poles
i	11KV	12KV	85KV	75KV	32KV	28KV
ii	33KV	36KV	195KV	170KV	80KV	70KV

4) TEMPERATURE RISE

~~The maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed to the direct rays of Sun shall not exceed 45 degree above ambient.~~ Maximum permitted temperature rise over ambient temperature will be as per Table-4 of IS 9921 (Part-2). *

Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091 Dated 25.08.2017.

5) MAIN CONTACTS

AB Switches shall have heavy duty self-aligning type contacts made of hard drawn electrolytic copper/brass. The various parts should be accordingly finished to ensure interchangeability of similar components. The moving contacts of the switch shall be made from hard drawn electrolytic copper brass. This contact shall have dimensions as per drawing attached so as to withstand safely the highest short-circuit currents and over voltage that may be encountered during service. The surface of the contact shall be rounded smooth and silver-plated. In nut shell the male and female contact assemblies shall ensure.

1. Electro-dynamic withstands ability during short circuits without any risk of repulsion of contacts.
2. Thermal withstands ability during short circuits.
3. Constant contact pressure even when the lower parts of the insulator stacks are subjected to tensile stresses due to linear expansion of connected bus bar of flexible conductors either because of temperature variations or strong winds.
4. Wiping action during closing and opening.
5. Fault alignment assuring closing of the switch without minute adjustments.

6) CONNECTORS

The connectors shall be made of hard drawn electrolytic copper or brass suitable for Raccoon/Dog ACSR conductor for both 11KV & 33KV AB Switches. The connector should be 4 -bolt type.

7) OPERATING MECHANISM

All AB Switches shall have separate independent manual operation. They should be provided with ON/OFF indicators and padlocking arrangements for locking in both the end positions to avoid unintentional operation. The isolating distances should also be visible for the AB Switches.

The AB Switch will be supplied with following accessories:

Sl	Item	Size of 11KV AB Switch	Size of 33KV AB Switch
i	Operating Rod (GI dia) ISI mark	Length 5.50 meter dia: 25MM	Length 5.50 mtrs dia: 40MM
ii	Phase coupling square rod (GI) ISI mark	Length 1800 mm Size 25x25 mm	Length 2700 mm Size 40 x 40 mm
iii	Hot dip galvanized Operating handle (GI)	1 No.	1 No.

The AB Switches shall be capable to resist any chance of opening out when in closed position. The operating Mechanism should be of robust constructions, easy to operate by single person and to be located conveniently for local operation in the switchyard. The GI pipe shall conform to ('B' class or Medium class Blue strip) ISS: 1239-68 and ISI marked by embossing. The vertical down rod should be provided with adequate joint in the mid section to avoid bending or buckling. Additional leverage should be provided to maintain mechanical force with minimum efforts.

All iron parts should be hot dip galvanized as per IS 4759-1979 and zinc coating shall not be less than 610 gm/sq. meter. All brass parts should be silver plated and all nuts and bolts should be hot dip galvanized.

8) ARCING HORNS

It shall be simple and replaceable type. They should be capable of interrupting line-charging current. They shall be of first make and after break type.

9) BUSH

The design and construction of bush shall embody all the features required to withstand climatic conditions specified so as to ensure dependable and effective operations specified even after long periods of inaction of these Air Break Switches. They shall be made from highly polished Bronze metal with adequate provision for periodic lubrication through nipples and vent.

10) DESIGN, MATERIALS AND WORKMANSHIP

All materials used in the construction of the equipment shall be of the appropriate class, well finished and of approved design and material. All similar parts should be accurately finished and interchangeable.

Special attention shall be paid to tropical treatment to all the equipment, as it will be subjected during service to extremely severe exposure to atmospheric moisture and to long period of high ambient temperature. All current carrying parts shall be of non-ferrous metal or alloys and shall be designed to limit sharp points/edges and similar sharp faces.

The firm should have the following type test certificate. The type test should be from CPRI or equivalent lab:-

1. Test to prove capability of rated peak short circuit current and the rated short time current. The rated short time current should correspond to minimum of 10K Amp and the peak short circuit current should correspond to minimum of 25K Amps.
2. Lightning impulse voltage test with positive & negative polarity.
3. Power Frequency voltage dry test and wet test
4. Temperature rise test
5. Mill volt drop tests

The above tests should be performed on the AB Switches, manufactured as per owner approved drawing with the specification. Along with the type test certificate, the certified copy of the drawing (from the testing lab) should also be kept for inspection of our officer. Also the test certificates should not be older than 5 years from the date of opening of tender.

Dimension of 11 & 33KV AB Switches in (Max.)Tolerance 5%.

Sl.	Particulars	11KV AB Switch	33KV AB Switch
i	MS Channel	450x75x40	675x100x50
ii	Creepage distance of Post Insulator	320mm (Min)	580mm (Min)
iii	Highest of Port shell	254 mm	368 mm
iv	Fixed contact assembly		
	i) Base	165x36x8	165x36x8
	ii) Contact	70x30x6	70x30x6
	iii) GI cover	110x44	140x44
	v) Spring	6 Nos.	6 Nos.

11) Moving Contact Assembly

i	Base Assembly	135x25x8	170x40x8
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ii	Moving	180x25x9	290x25x14
iii	Bush	Bronze Metal	Bronze Metal
iv	Thickness of Grooves	7	11

12) Connectors

i	Connector	60x50x8 (Moving & fix both)	60x50x8 (Moving & fix both)
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The bidder should provide AB Switches with terminal connectors, set of insulators, mechanical inter works and arcing horns sets. The base channel for the mounting of AB Switches shall also be included in the scope of AB Switches. The operating mechanisms together with down pipe operating handle etc. are also included in the scope of supply.

29. 11 kV Drop Out Fuse Cut Outs

1. SCOPE

This specification covers outdoor, open, drop-out expulsion type Fuse Cutouts suitable for installation in 50 Hz, 11 KV distribution system.

2. APPLICATION

The distribution fuse cutouts are intended for use in distribution transformers and have no inherent load break capacity.

3. APPLICABLE STANDARD

Unless otherwise modified in this specification, the cutout shall conform to IS:9385 (Part-I to III) as amended from time to time.

4. RATED VOLTAGE

The rated voltage shall be 12 KV.

5. RATED CURRENT

The rated current shall be 100 A.

6. RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE VALUES FOR THE FUSE BASE

The rated lightning impulse withstand voltages both for positive and negative polarities shall be as given below:

- | | |
|---|--------------|
| a) To earth and between poles | 75 KV (Peak) |
| b) Across the isolating distance of fuse base | 85 KV (Peak) |

7. RATED ONE MINUTE POWER FREQUENCY WITHSTAND VOLTAGE (DRY & WET) VALUES FOR THE FUSE BASE

- | | |
|----------------------------------|-------------|
| a) To earth and between poles | 28 KV (rms) |
| b) Across the isolating distance | 32 KV (rms) |

8. TEMPERATURE RISE LIMIT (In Air)

- | | |
|---------------------------------|------|
| a) Copper contacts silver faced | 65°C |
| b) Terminals | 50°C |

c) Metal parts acting as springs. - The temp. shall not reach such a value that elasticity of metal is changed

9. RATED BREAKING CAPACITY

The rated breaking capacity shall be 8 KA (Asymmetrical).

10. GENERAL REQUIREMENTS/CONSTRUCTIONAL DETAILS

- 10.1** The cutouts shall be of single vent type (downward) having a front connected fuse carrier suitable for angle mounting.
- 10.2** All ferrous parts shall be hot dip galvanised in accordance with the latest version of IS:2633. Nuts and bolts shall conform to IS:1364. Spring washers shall be electro-galvanised.
- 10.3** Typical constructional details of the fuse cutout are shown in Fig. 1

11. FUSE BASE TOP ASSEMBLY

- 11.1** The top current carrying parts shall be made of a highly conductive copper alloy and the contact portion shall be silver plated for corrosion resistance and efficient current flow. The contact shall have a socket cavity for latching and holding firmly the fuse carrier until the fault interruption is completed within the fuse.
- 11.2** The top contact shall be actuated by a strong steel spring which keeps it under sufficient pressure to maintain a firm contact with the fuse carrier during all operating conditions. The spring shall also provide flexibility and absorbs most of the stresses when the fuse carrier is pushed into the closing position.
- 11.3** The current carrying parts of the assembly shall be protected from water and dust formation by a stainless steel top cover.
- 11.4** The top contact assembly shall have a robust galvanised steel hook to align and guide the fuse carrier into the socket latch even when the fuse carrier is closed at an off-centre angle.
- 11.5** The top assembly shall have an aluminum alloy terminal connector (refer clause 19).
- 11.6** The top assembly shall be robust enough to absorb bulk of the forces during the fuse carrier closing and opening operations and shall not over-stress the spring contact. It shall also prohibit accidental opening of the fuse carrier due to vibrations or impact.

12. FUSE BASE BOTTOM ASSEMBLY

- 12.1** The conducting parts shall be made of high strength highly conductive copper

alloy and the contact portion shall be silver plated for corrosion resistance and

shall provide a low resistance current path from the bottom fuse carrier contacts to the bottom terminal connector.

12.2 The bottom assembly shall have hinge contacts made from highly conductive, anti-corrosive copper alloy and shall accommodate and make a firm contact with the fuse carrier bottom assembly. The fuse carrier shall be placed easily in or lifted from The hinges without any maneuvering. In addition, the bottom assembly shall perform the following functions :-

- i) When opened manually or after fault interruption the fuse carrier shall swing through 180° to the vertical and its further travel shall be prevented by the fuse base bottom assembly.
- ii) The fuse carrier shall be prevented from slipping out of the self locking hinges during all operating conditions and only when the fuse carrier has reached its fully open position can it be removed from the hinge support.

12.3 The assembly shall have an aluminium alloy terminal connector (refer clause 19).

13. FUSE CARRIER TOP ASSEMBLY

13.1 The fuse carrier top contact shall have a solid replaceable cap made from highly conductive, anti-corrosive copper alloy and the contact portion shall be silver plated to provide a low resistance current path from the Fuse Base Top Contact to the Fuse Link. It shall make a firm contact with the button head of the fuse link and shall provide a protective enclosure to the fuse link to check spreading of arc during fault interruptions.

13.2 The fuse carrier shall be provided with a cast bronze opening eye (pull ring) suitable for operation with a hook stick from the ground level to pull-out or close-in the fuse carrier by manual operation.

14. FUSE CARRIER BOTTOM ASSEMBLY

14.1 The fuse carrier bottom assembly shall be made of bronze castings with silver plating at the contact points to efficiently transfer current to fuse base. It shall make smooth contact with the fuse base bottom assembly during closing operation.

14.2 The bottom assembly shall have a lifting eye for the hook stick for removing or replacing the fuse carrier.

14.3 The bottom assembly shall have a suitable ejector which shall perform the following functions :

- i) It shall keep the fuse link in the centre of fuse tube and keep it tensioned under all operating conditions.

ii) It shall be capable of absorbing the shock when the fuse carrier is pushed into the closed position and shall not allow the fuse link to be damaged. This is specially important when the fuse link is of low-ampere rating.

iii) The ejector at the instant of interruption shall retain the fuse carrier in the closed position long enough to ensure that the arc is extinguished within the fuse tube thereby excluding the possibility of arcing and subsequent damage at the contact surfaces.

iv) The ejector shall help the fuse link separation after fault interruption, allowing the fuse carrier to drop out and clearing the pigtail of the blown fuse link through the bore of fuse tube.

15. FUSE BASE (PORCELAIN)

The fuse base shall be a bird-proof, single unit porcelain insulator with a creepage distance (to earth) not less than 320mm. The top and bottom assemblies as also the middle clamping hardware shall be either embedded in the porcelain insulator with sulphur cement or suitably clamped in position. For embedded components, the pull out strength should be such as to result in breaking of the porcelain before pull out occurs in a test. For porcelain insulators, the beam strength shall not be less than 1000 Kg.

16. FUSE TUBE

The fuse tube shall be made of fibre glass coated with ultraviolet inhibitor on the outer surface and having arc quenching bone fibre liner inside. The tube shall have high bursting strength to sustain high pressure of the gases during fault interruption. The inside diameter of the fuse tube shall be 17.5mm. The

solid cap of the fuse carrier shall clamp the button head of the fuse link, closing the top end of the fuse tube and allowing only the downward venting during fault interruption.

17. TYPE TESTS

The cutout shall be subjected to the following type tests :

i) Dielectric tests (rated impulse withstands and rated one minute power frequency with stand test voltages)

ii) Temperature rise test

The above tests shall be carried out in accordance with IS:9385 Part I & II.

For Porcelain Fuse Base only.

- iii) Pull out test for embedded components of the fuse base
- iv) Beam strength of porcelain base

18. MOUNTING ARRANGEMENT

- 18.1** The cutouts shall be provided with a suitable arrangement for mounting these on 75x40mm or 100x50mm channel cross arm in such a way that the centre line of the fuse base is at an angle of 15° to 20° from the vertical and shall provide the necessary clearances from the support. Mounting arrangement shall be made of high strength galvanised steel flat and shall be robust enough to sustain the various stresses encountered during all operating conditions of the cutout. For more details see enclosed figure 2.
- 18.2** Strength of the component marked 1 (see figure) shall be determined by clamping the member with the shorter leg at the top to a rigid support by M-10 carriage bolts. A downward force shall be applied along the axis of M-14 carriage bolt parallel to the longer leg and in the direction of longer leg of the member under test. A load of 50 Kg. shall be applied and then removed to take up any slack in the mounting arrangement before the measurement of position is taken, the permanent set measured at the axis of the M-14 carriage bolt shall not exceed 1.6mm when a load of 425 Kg. is applied and removed.
- 18.3** The strength of the M-14 bolt shall in no case be less than 1900 Kg. and the strength of M-10 bolts not less than 3500 Kg.

19. TERMINAL CONNECTIONS

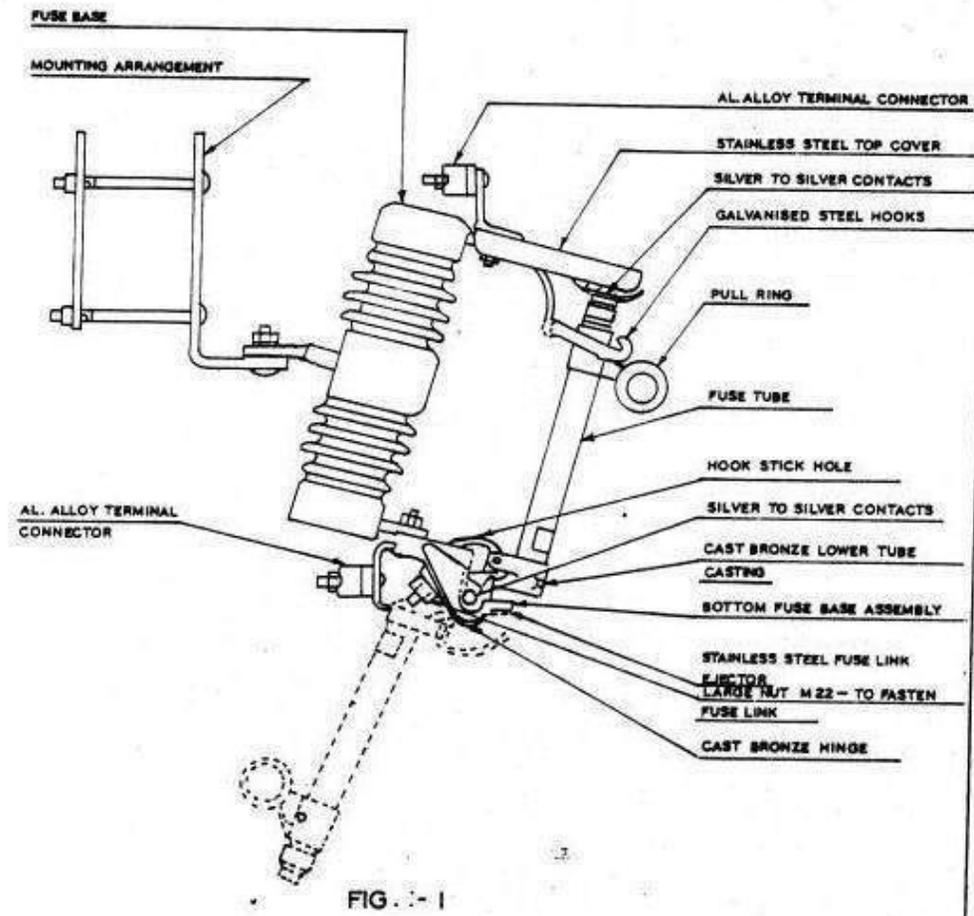
The cut-out shall be provided with two aluminium alloy (alloy designation 2280 (A-11) as per IS:617-1975) terminal connectors at top and bottom of fuse base assemblies to receive aluminium conductors of diameters between 6.3mm to 10.05mm. These terminals shall be easily accessible irrespective of the cut-out location with respect to the pole. The terminals shall meet the test requirements of REC Construction Standard.

20. INSPECTION

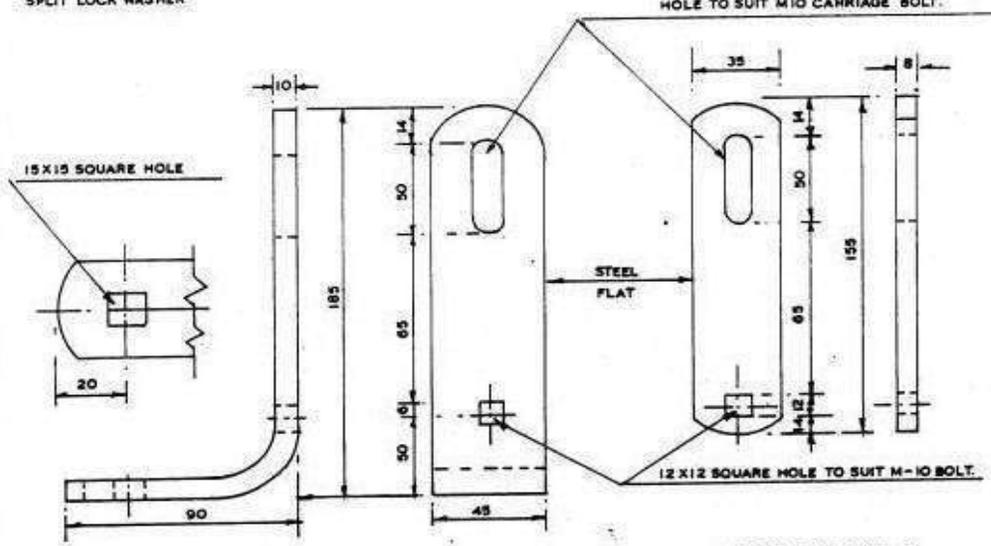
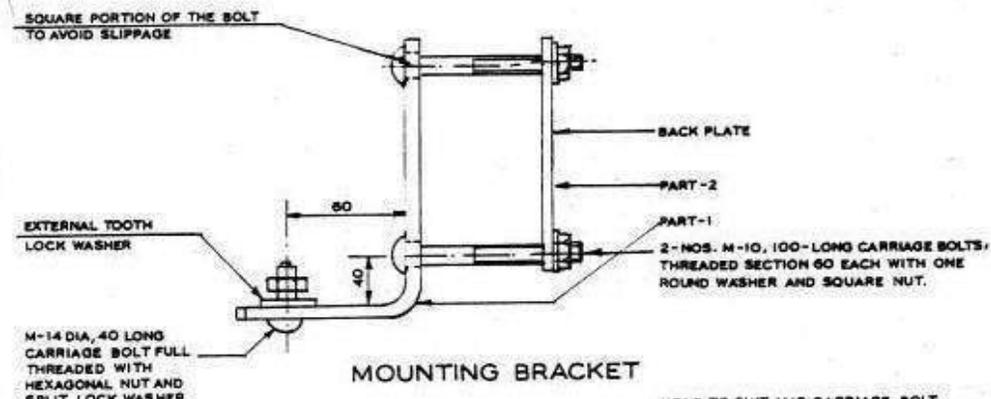
All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and the purchaser at the time to purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities without charge, to satisfy him that the material is being furnished in accordance with this specification.

The purchaser has the right to have the tests carried out at his own cost by an

independent agency whenever there is dispute regarding the quality of supply.



११ के. वी. फ्यूज कट-आउट का प्रारंभिक निर्माण विवरण
 TYPICAL CONSTRUCTION DETAILS OF 11KV
 FUSE CUT-OUT



DETAIL OF PART - 1

DETAIL OF PART - 2

FIG.2:- MOUNTING DETAILS OF 11KV FUSE CUTOUT

ALL DIMENSIONS ARE IN MM.

११ के.वी. ड्रॉप-आउट फ्यूज कटआउट 11 KV DROP-OUT FUSE CUTOUT	
SCALE :- N.T.S	JULY, 1987

30. 33 & 11 kV Station Class Lightning Arrestor & 11 kV Distribution Class Surge Arrestors

1. 33kV VOLTAGE CLASS SURGE ARRESTORS

Lightning Arrestors at Grid Substation shall be of Station class only in 33 & 11 KV System.

1.1. INTRODUCTION

The section covers the specification of 33kV voltage level, 10 kA, and Station class heavy duty, gapless metal (zinc) oxide Surge Arrestors complete with insulating base, terminal clamps, complete fittings & accessories for installation on outdoor type 33kV switchgear/transmission lines / transformers.

1.2. STANDARDS

The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material and processes shall conform to the latest applicable Indian/International Standards as listed hereunder:

IS:2071-1993 (Part-1)	Methods of High Voltage Testing General Definitions & Test Requirements.
IS:2071-1974(Part-2)	Test Procedures
IS:2629-1985	Recommended Practice for hot dip galvanizing on Iron & Steel
IS:2633-1986	Method for Testing uniformity of coating of zinc coated Articles.
IS:3070-1993 (Part – 3)	Specification for surge arrestor for alternating current systems. Metal-Oxide lightning Arrestors without gaps
IS:4759-1996	Specification for hot dip zinc coating on Structural Steel and Other allied products.
IS:5621-1980	Hollow Insulators for use in Electrical Equipment.
IS:6209-1982	Methods of Partial discharge measurement.
IS:6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles
ANSI/IEEE-C.62.11	Metal oxide, Surge Arrestor for AC Power Circuits.
IEC –60099-4	Surge Arrestors

The equipment complying with any other internationally accepted standards

shall also be considered if it ensures performance equivalent to or superior to the Indian Standards.

1.3. GENERAL REQUIREMENT

- 1.3.1. The metal oxide gap less Surge Arrestor without any series or shunt gap shall be suitable for protection of 33kV switchgear, transformers, associated equipment and 33 kV lines from voltage surges resulting from natural disturbance like lightning as well as system disturbances.
- 1.3.2. The surge arrester shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
- 1.3.3. The surge arrester shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified creepage distance.
- 1.3.4. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.
- 1.3.5. The surge arrester shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrester shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrester and second end to a separate ground electrode. The bidder shall also recommend the procedure which shall be followed in providing the earthing system to the Surge Arrester.
- 1.3.6. The surge arrester shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrester shall change over to the conducting mode.
- 1.3.7. The surge arrester shall be suitable for circuit breaker performing 0-0.3sec.-CO-3 min-CO- duty in the system.
- 1.3.8. Surge arrestors shall have a suitable pressure relief system to avoid damage to the porcelain/silicon polymeric housing and providing path for flow of rated fault currents in the event of arrester failure.
- 1.3.9. The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- 1.3.10. The arrestors for 33 kV system shall be suitable for mounting on transformers, Bus, Line & structure as per scheme. The supplier shall furnish the drawing indicating the dimensions, weights etc. of the surge arrestors for the design of mounting Structure.

- 1.3.11. The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

1.4. **ARRESTOR HOUSING**

- 1.4.1. The arrester housing shall be made up of porcelain/**silicon polymeric** housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform brown (**for porcelain**)/Grey (**for silicon polymeric**) colour, free from blisters, burrs and other similar defects.

Arrestors shall be complete with fasteners for stacking units together and terminal connectors.

- 1.4.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrester. The arrestors shall not fail due to contamination. The 33 kV arrestors housing shall be designed for pressure relief class as given in Technical Parameters of the specification.
- 1.4.3. Sealed housings shall exhibit no measurable leakage.

1.5. **FITTINGS & ACCESSORIES**

- 1.5.1. The surge arrester shall be complete with fasteners for stacking units together and terminal connectors.
- 1.5.2. The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrester shall be galvanized. The line terminal shall have a built in clamping device which can be adjusted for both horizontal and vertical take off.

1.6. **TESTS**

1.6.1. **Test on Surge Arrestors**

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS : 3070 (Part-3)/IEC-60099-4. In addition, the suitability of the surge arresters shall also be established for the followings

i) **Acceptance tests**

- a) Measurement of power frequency reference voltage of arrester units.
- b) Lightning impulse residual voltage on arrester units (IEC clause 6.3.2)

- c) Internal ionization or partial discharge test
- ii) **Special Acceptance tests**

- a) Thermal stability test (IEC 99-4 clause 7.2.2)
- b) Watt loss test.

- iii) **Routine tests**
 - a) Measurement of reference voltage
 - b) Residual voltage test of arrester unit
 - c) Internal ionization or partial discharge test
 - d) Sealing test
 - e) Verticality check on completely assembled surge arresters as a sample test on each lot if applicable.

- iv) **Type Tests**

Following shall be type test as per IS 3070 (Part 3): 1993 or its latest amendment.

1.	Insulation Withstand test a) Lightning Impulse b) Power Frequency (Dry/Wet)
2.	Residual Voltage Test a) Steep current impulse residual voltage test b) Lightning impulse residual voltage test c) Switching Impulse Residual voltage test
3.	Long duration current impulse withstand test
4.	Switching surge operating duty test
5.	Power frequency voltage Vs. Time characteristics
6.	Accelerated Ageing test
7.	Pressure relief test a) High Current b) Low Current
8.	Artificial pollution test (for porcelain housing)
9.	Seismic Test
10.	Partial Discharge test
11.	Bending test
12.	a) Temperature cycle test (for porcelain housing) b) Porosity test (for porcelain housing)
13.	Galvanising test on metal parts
14.	Seal Leakage test (for porcelain housing)

15.	Seal leak test and operation tests (for surge monitor)
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16.	Weather ageing test (for polymer housing)
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- 1.6.2. The maximum residual voltages corresponding to nominal discharge current of 10 kA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to **Annex-K of IEC-99-4**.
- 1.6.3. The contractor shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrester and power frequency voltage v/s time characteristic of the surge arrester subsequent to impulse energy consumption as per clause 6.6.7 of IS:3070 (Part-3) offered along with the GTP/Drawing.
- 1.6.4. The surge arrester housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 5621.

1.6.5. **Galvanization Test**

All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS:2633 & IS 6745.

1.7. **NAME PLATE**

- 1.7.1. The name plate attached to the arrester shall carry the following information:
- Rated Voltage
 - Continuous Operation Voltage
 - Normal discharge current
 - Pressure relief rated current
 - Manufacturers Trade Mark
 - Name of Sub-station
 - Year of Manufacturer

- Name of the manufacture
- Name of Client-“ “

- Purchase Order Number along with date

1.8. DRAWINGS AND INSTRUCTION MANUALS

Within 15 days of receipt of the order, the successful tenderer shall furnish to the purchaser the following drawings and literature for approval:

- (i) Outline dimensional drawings of Surge Arrestor and all accessories.
- (ii) Assembly drawings and weights of main component parts.
- (iii) Drawings of terminal clamps.
- (iv) Arrangement of earthing lead.
- (v) Minimum air clearance to be maintained of line components to ground.
- (vi) Name plate
- (vii) Instructions manual
- (viii) Drawing showing details of pressure relief valve
- (ix) Volt-time characteristics of surge arrestors
- (x) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height, profile, creepage distance, dry arcing distance etc.

1.9. TECHNICAL PARTICULARS

- 1.9.1. The surge arrestors shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

System Parameters:

Nominal system voltage	:	33 kV
Highest system voltage	:	36 kV
System earthing	:	Solidly earthed system
Frequency (Hz)	:	50
Lightning Impulse withstand Voltage (kVP)	:	170
Power frequency withstand Voltage (kV rms)	:	70
Connection to system	:	Phase to earth

1.9.2. Surge Arrestors

Type of Surge Arrestor	:	Gapless Metal oxide outdoor
Arrestor rating (kV rms)	:	30
Continuous Operating voltage (kV rms)	:	25
Standard Nominal Discharge Current Rating (kA) (8x20 micro impulse shape)	:	10
Line discharge class	:	2
Degree of protection	:	IP-67
Lightning Impulse at 10 kA	:	85
Partial discharge at 1.05 COV not greater than	:	50 (PC)
Energy capability corresponding to		
a) Arrestor rating (kJ/kV)	:	4.5
b) COV (kJ/kV)	:	4.9
Peak current for high current impulse operating duty of arrestor classification 10 kA	:	100

1.9.3. Insulator Housing

Power frequency withstand test voltage (wet) (kV rms)	:	70
Lightning impulse withstand/tests voltage (kVP)	:	170
Pressure Relief Class	:	40
Creepage distance not less than	:	900 mm

1.9.4. Galvanisation

<u>Fabricated Steel Aticles</u>		
-- 5 mm thick cover	:	610 g/m ²
-- Under 5 mm but not less than 2 mm thickness	:	460 g/m ²

-- Under 2 mm but not less than 1.2 mm thickness	:	340 g/m ²
<u>Castings</u>		

-- Grey Iron, malleable iron	:	610 g/m ²
<u>Threaded works other than tubes & tube fittings</u>		
-- Under 10 mm dia		270 g/m ²
-- 10 mm dia & above		300m ²

2. 11kV VOLTAGE CLASS SURGE ARRESTORS

2.1. INTRODUCTION

This section covers the specification of 11kV voltage station Surge Arrestors for installation on outdoor type 11kV switchgear, transmission lines, transformers etc. 11kV side of which is not enclosed in a cable box. Station class surge arrestors shall be complete with fasteners for stacking units.

2.2. STANDARDS

The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material & processes shall conform to the latest amendments of the following:

IS:2071-1993 (Part-1)	Methods of High Voltage Testing General Definitions & Test Requirements.
IS:2071-1974 (Part-2)	Test Procedures.
IS: 2629-1985	Recommended Practice for hot dip galvanizing on Iron & Steel.
IS: 2633-1986	Method for Testing uniformity of coating of zinc coated Articles.
IS:3070-1993 (Part – 3)	Specification for surge arrester for alternating current systems. Metal-Oxide lightning Arrestors without gaps.
IS: 4759-1996	Specification for hot dip zinc coating on structural steel and other allied products.
IS: 5621-1980	Hollow Insulators for use in Electrical Equipment.
IS: 6209-1982	Methods of Partial discharge measurement.
IS: 6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles.

ANSI/IEEE-C.62.11	Metal oxide, Surge Arrestor for AC Power Circuits.
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IEC –60099-4	Surge Arrestors.
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The equipment complying with any other internationally accepted standards shall also be considered if it ensures performance equivalent to or superior to the Indian Standards.

2.3. GENERAL REQUIREMENT

- 2.3.1. The metal oxide gap less Surge Arrestor without any series or shunt gap shall be suitable for protection of 11 kV side of power transformers, associated equipment and 11kV lines from voltage surges resulting from natural disturbance like lightning as well as system disturbances.
- 2.3.2. The surge arrester shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
- 2.3.3. The surge arrester shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified Creepage distance.
- 2.3.4. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.
- 2.3.5. The surge arrester shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrester shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrester and second end to a separate ground electrode. The bidder shall also recommend the procedure which shall be followed in providing the earthing system to the Surge Arrestor.
- 2.3.6. The surge arrester shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrester shall change over to the conducting mode.
- 2.3.7. The surge arrester shall be suitable for circuit breaker performing 0-0.3 min-CO-3 min-CO- duty in the system.
- 2.3.8. Surge arrestors shall have a suitable pressure relief system to avoid damage to the porcelain/ silicon polymeric housing and providing path for flow of rated fault currents in the event of arrester failure.
- 2.3.9. The reference current of the arrester shall be high enough to eliminate the influence

of grading and stray capacitance on the measured reference voltage.

- 2.3.10. The Surge Arrestor shall be thermally stable and the bidder shall furnish a copy of thermal stability test with the bid.
- 2.3.11. The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.
- 2.3.12. The surge arrestor shall be provided with line and earth terminals of suitable size.

2.4. **ARRESTOR HOUSING**

- 2.4.1. The arrestor housing shall be made up of porcelain/**silicon polymeric** housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform **brown (for porcelain)/Grey (for silicon polymeric)** colour, free from blisters, burrs and other similar defects.

Arrestors shall be complete with fasteners for stacking units together and terminal connectors.

- 2.4.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrestor. The arrestors shall not fail due to contamination. The 11kV arrestors housing shall be designed for pressure relief class as given in Technical Parameters of the specification.
- 2.4.3. Sealed housings shall exhibit no measurable leakage.

2.5. **ARRESTOR MOUNTING**

The arrestors shall be suitable for mounting on 4 pole/2 pole structure used for pole/plinth mounted transformer and for incoming and outgoing lines. Arrestor may also be required to be mounted on a bracket provided in the Transformers.

2.6. **FITTINGS & ACCESSORIES**

- 2.6.1. The surge arrestor shall be complete with fasteners and terminal connectors.
- 2.6.2. The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built in clamping device which can be

adjusted for both horizontal and vertical take off.

2.7. TESTS

2.7.1. Test on Surge Arrestors

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS : 3070 (Part-3)-/IEC:600994. In addition, the suitability of the surge arresters shall also be established for the followings.

i) Acceptance tests

- a) Measurement of power frequency reference voltage of arrester units.
- b) Lightning impulse residual voltage on arrester units (IEC clause 6.3.2)
- c) Internal ionization or partial discharge test

ii) Special Acceptance tests:

- a) Thermal stability test (IEC clause 7.2.2)
- b) Watt loss test.

iii) Routine tests

- a) Measurement of reference voltage
- b) Residual voltage test of arrester unit
- c) Internal ionization or partial discharge test
- d) Sealing test
- e) Verticality check on completely assembled surge arresters as a sample test on each lot if applicable.

iv) Type Tests

Following shall be type test as per IS 3070 (Part 3): 1993 or its latest amendment

1.	Insulation Withstand test a) Lightning Impulse b) Power Frequency (Dry/Wet)
2.	Residual Voltage Test a) Steep current impulse residual voltage test b) Lightning impulse residual voltage test c) Switching Impulse Residual voltage test
3.	Long duration current impulse withstand test
4.	Switching surge operating duty test
5.	Power frequency voltage Vs. Time characteristics

6.	Accelerated Ageing test
7.	Pressure relief test

	c) High Current d) Low Current
8.	Artificial pollution test (for porcelain housing)
9.	Seismic Test
10.	Partial Discharge test
11.	Bending test
12.	a) Temperature cycle test (for porcelain housing) b) Porosity test (for porcelain housing)
13.	Galvanising test on metal parts
14.	Seal Leakage test (for porcelain housing)
15.	Seal leak test and operation tests (for surge monitor)
16.	Weather ageing test (for polymer housing)

- 2.7.2. The maximum residual voltages corresponding to nominal discharge current of 10 kA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to Annex-K of IEC-99-4.
- 2.7.3. The contractor shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrestor and power frequency voltage v/s time characteristic of the surge arrestor subsequent to impulse energy consumption as per clause 6.6 of IS:3070 (Part-3) offered alongwith the bid.
- 2.7.4. The surge arrestor housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS :5621.
- 2.7.5. **Galvanization Test**
All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS:2633 & IS 6745.
- 2.8. **NAME PLATE**
- 2.8.1. The name plate attached to the arrestor shall carry the following information:
- Rated Voltage
 - Continuous Operation Voltage

- Normal discharge current

- Pressure relief rated current
- Manufacturers Trade Mark
- Name of Sub-station
- Year of Manufacturer
- Name of the manufacture
- Name of Client-
- Purchase Order Number along with date

2.9. DRAWINGS AND INSTRUCTION MANUALS

Within 15 days of receipt of the order, the successful tenderer shall furnish to the purchaser, the following drawings and literature for approval:

- (i) Outline dimensional drawings of Surge Arrestor and all accessories.
- (ii) Assembly drawings and weights of main component parts.
- (iii) Drawings of terminal clamps.
- (iv) Arrangement of earthing lead.
- (v) Minimum air clearance to be maintained of line components to ground.
- (vi) Name plate
- (vii) Surge monitor, if applicable.
- (viii) Instructions manual
- (ix) Drawing showing details of pressure relief valve
- (x) Volt-time characteristics of surge arrestors
- (xi) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height, profile, creepage distance, dry arcing distance etc.

2.10. TECHNICAL PARTICULARS

- 2.10.1.** The surge arrestors shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

System Parameters

- i) Nominal system voltage 11kV
- ii) Highest system voltage 12 kV

iii)	System earthing	Effectively earthed system
iv)	Frequency (Hz)	50
v)	Lightning Impulse withstand	75 Voltage (kVP)
vi)	Power frequency withstand	28 Voltage (kV rms)
vii)	Arrestor duty	
	-- Connection to system	Phase to earth
	-- Type of equipment to be protected	transformers & switchgear

2.10.2. Surge Arrestors

i)	Type	Gapless Metal oxide outdoor
ii)	Arrestor rating (kV rms)	9
iii)	Continuous Operating voltage	7.65 (kV rms)
iv)	Standard Nominal Discharge Current impulse shape)	10 Rating (kA) (8x20 micro
v)	Degree of protection	IP 67
vi)	Line discharge Class	2
vii)	Steep current at 10 kA	45
viii)	Lightning Impulse at 10 kA	40
ix)	Energy capability corresponding to	
	a) Arrestor rating (kj/kV)	4.5
	b) COV (kj/kV)	4.9
x)	Peak current for high current impulse operating duty of Standard TS fo arrestor classification10 kA	100

2.10.3. Insulator Housing

i)	Power frequency withstand test voltage (Wet) (kV rms)	28
ii)	Lightning impulse withstand/tests voltage (kVP)	75

2.10.4. Galvanisation

- i) Fabricated Steel Articles
 - a) 5 mm thick cover 610 g/m²
 - b) Under 5 mm but not less than 2 mm thickness 460 g/m²
 - c) Under 2 mm but not less than 1.2 mm thickness 340 g/m²
- ii) Castings
 - Grey Iron, malleable iron 610 g/m²
- iii) Threaded works other than tubes & tube fittings
 - a) Under 10 mm dia 270 g/m²
 - b) 10 mm dia & above 300 g/m²

NOTE- Surge Monitor shall have to be provided if covered in BPS.

3. DISTRIBUTION CLASS SURGE ARRESTORS

To be used in distribution Transformer Substations only.

3.1. INTRODUCTION

This section covers the specification of Distribution class Surge Arrestor for 11kV transmission lines, transformers etc.

3.2. STANDARDS

The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material and processes shall conform to the latest applicable Indian/International Standards as listed hereunder:

IS:2071- 1993 (Part-1)	:	Methods of High Voltage Testing General Definitions & Test
IS:2071-1974 (part-2)	:	Test Procedures
IS:2629-1985	:	Recommended Practice for hot dip galvanizing on Iron & Steel
IS:2633-1986	:	Method for Testing uniformity of coating of zinc coated Articles.
IS3070-1993 (Part-3)	:	Specification for surge arrestor for alternating current systems. Metal-Oxide lightning Arrestors without gaps
IS:4759-1996	:	Specification for hot dip zinc coating on Structural Steel and Other allied products.
IS:5621-1980	:	Hollow Insulators for use in Electrical Equipment.

IS:6209-1982		Methods of Partial discharge measurement.
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IS:6745		Method for determination of mass of zinc coating on zinc coated iron and steel articles
ANSI/IEEE-C.62.11 :		Metal oxide, Surge Arrestor for AC Power (1982) Circuits.
IEC –60099-4		Surge Arrestors

3.2.1. The equipment complying with any other internationally accepted standards shall also be considered if it ensures performance equivalent to or superior to the Indian Standards.

3.3. GENERAL REQUIREMENT

3.3.1. The metal oxide gap less Surge Arrestor without any series or shunt gap shall be suitable for protection of 11 kV side of Distribution Transformers, associated equipment and 11 kV lines from voltage surges resulting from natural disturbance like lightning as well as system disturbances.

3.3.2. The surge arrester shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.

3.3.3. The surge arrester shall consist of non-linear metal oxide resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified Creepage distance.

3.3.4. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.

3.3.5. The surge arrester shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrester shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrester and second end to a separate ground electrode. The contractor shall also recommend the procedure which shall be followed in providing the earthing/system to the Surge Arrester.

3.3.6. The surge arrester shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrester shall change over to the conducting mode.

3.3.7. The surge arrester shall be suitable for circuit breaker performing 0-0.3 min-CO-3 min-CO- duty in the system.

3.3.8. The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

- 3.3.9. The Surge Arrestor shall be thermally stable and the contractor shall furnish a copy of thermal stability test with the bid.
- 3.3.10. The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

3.4. **ARRESTOR HOUSING**

- 3.4.1. The arrestor housing shall be made up of porcelain/*silicon polymeric* housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform **brown (for porcelain)/ Grey (for silicon polymeric)** colour, free from blisters, burrs and other similar defects.
- 3.4.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrestor. The arrestors shall not fail due to contamination.
- 3.4.3. Sealed housings shall exhibit no measurable leakage.

3.5. **ARRESTOR MOUNTING**

The arrestors shall be suitable for mounting on 4 pole/2 pole structure used for pole mounted transformer and for incoming and outgoing lines.

3.6. **FITTINGS & ACCESSORIES**

- 3.6.1. The surge arrestor shall be complete with disconnecter and terminal connectors and all other accessories.
- 3.6.2. The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built in clamping device which can be adjusted for both horizontal and vertical take off.

3.7. **TESTS**

3.7.1. **Test on Surge Arrestors**

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS : 3070 (Part-3)-1993. In

addition, the suitability of the surge arresters shall also be established for the followings

a) **Acceptance tests:**

- i) Measurement of power frequency reference voltage of arrester units.
- ii) Lightning impulse residual voltage on arrester units (IEC clause 6.3.2)
- iii) Internal ionization or partial discharge test

- b) Special Acceptance tests:**
 - i) Thermal stability test (IEC clause 7.2.2)

- c) Routine tests:**
 Measurement of reference voltage
 - i) Residual voltage test of arrester unit
 - ii) Internal ionization or partial discharge test
 - iii) Sealing test
 - iv) Verticality check on completely assembled surge arresters as a sample test on each lot if applicable.

- d) Type tests:** Following shall be type test As per IS 3070 (Part 3)-/IEC;60094 or its latest amendment

1.	Insulation Withstand test a) Lightning Impulse voltage test b) Power Frequency (Dry & Wet)
2.	Residual Voltage Test a) Steep current impulse residual voltage test b) Lightning Impulse Residual Voltage Test
3.	Long duration current impulse withstand test
4.	High current impulse operating duty test
5.	Power frequency voltage Vs. Time characteristics
6.	Accelerated Ageing test
7.	Artificial pollution test (for porcelain housing)
8.	Partial discharge test
9.	Visual Examination (for porcelain housing)
10.	a) Temperature cycle test (for porcelain housing)

11.	Mechanical Failing Load test (Bending Strength test)
12.	Uniformity of Zinc coating, Mass of zinc coating

13.	Time versus current curve (for disconnecter)
14.	Weather ageing test (for polymer housing)

3.7.2. The maximum residual voltages corresponding to nominal discharge current of 5 kA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to Annex-K of IEC-99-4.

3.7.3. The contractor shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrester and power frequency voltage v/s time characteristic of the surge arrester subsequent to impulse energy consumption as per clause 6.6.7 of IS:3070 (Part-3) offered alongwith the GTP.

3.7.4. The surge arrester housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 5621

3.7.5. GALVANIZATION TEST

All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS:2633 & IS 6745.

3.7.6. TEST ON SURGE ARRESTOR DISCONNECTORS

The test shall be performed on surge arrestors which are fitted with arrester disconnecter or on the disconnecter assembly alone if its design is such as to be unaffected by the heating of adjacent parts of the arrester in its normally installed portion in accordance with IS:3070 (Part-3)

3.8. NAME PLATE

3.8.1. The name plate attached to the arrester shall carry the following information:

- Rated Voltage
- Continuous Operation Voltage
- Normal discharge current
- Manufacturers Trade Mark

- Year of Manufacturer

- Name of the manufacture
- Name of Client-
- Purchase Order Number along with date

3.9. **DRAWINGS AND INSTRUCTION MANUALS**

The successful bidder shall furnish to the purchaser the following drawings and literature for approval:

- (i) Outline dimensional drawings of Surge Arrestor and all accessories.
- (ii) Assembly drawings and weights of main component parts.
- (iii) Drawings of terminal clamps.
- (iv) Arrangement of earthing lead.
- (v) Minimum air clearance to be maintained of line components to ground.
- (vi) Name plate
- (vii) Instructions manual
- (viii) Drawing showing details of pressure relief valve
- (ix) Volt-time characteristics of surge arrestors
- (x) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height, profile, creepage distance, dry arcing distance etc.

3.10. **TECHNICAL PARTICULARS**

- 3.10.1. The surge arrestors shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

System Parameters

- i) Nominal system voltage 11kV
- ii) Highest system voltage 12 kV

iii)	System earthing	Solidly earthed system
iv)	Frequency (Hz)	50
vii)	Lightning Impulse withstand	75 Voltage (kVP)
viii)	Power frequency withstand	28 Voltage (kV rms)
vii)	Arrestor duty	
	-- Connection to system	Phase to earth
	-- Type of equipment to be protected	11 kV transformers & switchgear
3.10.2. Surge Arrestors		
i)	Type	Gapless Metal oxide outdoor
ii)	Arrestor rating (kV rms)	9
iii)	Continuous Operating voltage (kV rms)	7.65
v)	Nominal Discharge Current (micro impulse shape)	5 Rating (kA) (8x20)
v)	Long Duration discharge class	Distribution class
vi)	Maximum residual voltage (kV peak)	
	a) at 5 kA	27
vii)	Partial discharge at 1.05 COV not greater than	50 (PC)
viii)	High current impulse withstand voltage at 5 kA (kVp)	65
3.11. INSULATOR HOUSING		
i)	Power frequency withstand test voltage (Wet) (kV rms)	28
ii)	Lightning impulse withstand/tests voltage (kVP)	75
iii)	Creepage distance not less than (mm)	300
3.12. GALVANISATION		
i)	Fabricated Steel Aticles	

a) 5 mm thick cover	610 g/m ²
b) Under 5 mm but not less than 2 mm thickness	460 g/m ²
c) Under 2 mm but not less than 1.2 mm thickness	340 g/m ²

- ii) Castings
Grey Iron, malleable iron 610 g/m²

- iii) Threaded works other than tubes & tube fittings
 - a) Under 10 mm dia 270 g/m²
 - b) 10 mm dia & above 300 g/m²

31. LED Self Ballasted Lamps (Retrofit LED Lamp)

1. Lamp Terminology: Self Ballasted LED Lamp retrofits for GLS lamp, cap size E27.
2. Technical Requirement: The lamps shall conform to 16102 (Part 1) for safety requirements. The test method for performance requirement shall be as per IS 16102(Part 2). The performance of lamps shall be as specified in the following table.
3. LED Chip conformity should mandatory be as per LM80.
4. Lamp Specifications:

Sl. No.	Test Parameters	Requirements	Referred Standard IS/IEC
1	Rated Wattage	Upto 9 W	IS 16102 (Part 2)
2	Cap Type	E27	IS 16102 (Part 1)
3	Efficacy (lm/w)	Minimum 80 lumen/watt	IS 16102 (Part 2)
4	Minimum operating input voltage	AC 144 V to 288 V	Shall be able to operate satisfactorily
5	Rated Voltage	Up to and including 250 V AC; in case of voltage range - 220 V to 240 V, AC	
6	Rated frequency	50 Hz	IS 16102(Part 1)
7	Light Source (LED chips/Die)	COB/SMD LED	LM 80 Compliant (Certified by the supplier)
8	CCT	Cool White (Cool daylight) 5700K (5665 ± 270) to 6500K(6432±340) Colour variation category, initial and maintained-B	IS 16102 (Part 2)
9	Beam angle	Minimum 140°	IS 16102 (Part 2)
10	Power factor	Minimum 0.9°	IS 16102 (Part 2)
11	Life	Average life 25,000 hrs	IS 16102 (Part 2)
12	CRI	Minimum 70	IS 16102 (Part 2)
13	Lumen Maintenance	Maximum 10% at 25% of rated lamp life(with a maximum duration of 6000hrs).	IS 16102 (Part 2)
14	Rated Luminous flux	Minimum 710 lm	IS 16102 (Part 2)

15	Safety requirement	Lamp shall meet all the safety requirements	IS 16102 (Part 1)
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16	Guarantee	Minimum 3 years	
Making		<p>On the product of packaging</p> <ol style="list-style-type: none"> 1. This lamp is specially made for distribution under RDSS scheme 2. Year of Mfr/Batch No./Serial no. 3. Name/ Address of Manufacturer 4. "Not for SALE or retail market" 	<p>Marking shall be on the carton and the product as specified in IS 16102 (Part 1) and (Part 2)</p>
Certification endurance and switching immediately		<p>For life, immediately self-certification to deter from sub-standard supply. Later final life test after 9 months</p>	

5. Testing: LED lamps are tested for acceptance test as per clause 19.2, Page No.8 of IS 16102 (Part-II). The sampling of testing shall be as per clause 15, 16 & 17 of IS 16102 (Part-I).

Note- The rating of LED lamp shall be upto 9W and the lamp shall be capable to produce 710 Lumen conforming to IS 16102 (Part-II)

32. Earthing Coil

Earthing Coils shall be fabricated from soft GI Wire Hot Dip Galvanized. The Hot Dip galvanized wire shall have clean surface and shall be free from paint enamel or any other poor conducting material. The coil shall be made as per REC constructions standard (Refer tender drawing No. REC-XI Plan-Gen-005). The Hot Dip galvanizing shall conform to IS:2629/1966, 2633/1972 and 4826/1969 with latest amendments. Galvanizing should be heavily coated and should stand for the following tests.

Galvanizing Tests

- i) Minimum Mass of Zinc
 - a) ON GI Wire used 280 gm/m²
 - b) After Coiling – 266 gm/m². The certificate from recognized laboratory shall be submitted towards mass of zinc.
- ii) Dip Test Shall stand 3 dips of 1 minute and one dip of ½ minute before coiling and 43 dips of 1 minute after coiling as per IS : 4826/1979.

THE DIMENSIONAL REQUIREMENT SHALL BE AS FOLLOWS

- a) Nominal dia of GI Wire 4 mm (Tolerance $\pm 2.5\%$)
- b) Minimum no. of turns – 115 Nos.
- c) External dia of Coil (Min) – 50 mm
- d) Length of Coil (Min) – 460 mm
- e) Free length of GI Wire at one end coil (Min.) – 2500 mm

The turns should be closely bound. Weight of one finished Earthing Coils (min.) – 1.850 Kg.

Adhesion test – As per ISS 4826 – 1979.

33. Earthing Conductors

All conductors buried in earth and concrete and above ground level shall be galvanised steel. Galvanised steel shall be subject to four one minute dips in copper sulphate solution as per IS:2633.

34. Three Phase 4 Wire L.T. Distribution Box for Aerial Bunched Conductor

1 SCOPE:

- 1.1 The L.T. Distribution Box shall be used for connection through overhead conductors or ABC line and for giving connections to the consumers. This specification covers the design, manufacture, inspection, testing and supply of L.T. Distribution Box. The L.T. Distribution Box will be installed at the Poles and it shall withstand solar radiations, rain, wind pressure and pollution.

2 CONSTRUCTIONAL AND TECHNICAL PARTICULARS:

- 2.1 The Distribution Box shall be made from 20 SWG CRCA MS sheet by **Deep Drawn/Sheet Bending process*Method with Powder Coating**. Size of the box shall be 418mm x 300mm x 120mm as shown in drawing. There shall not be any welding joint to make base and cover of the Distribution box. Roof of the box shall be tapered on both sides to drain the rain water.
- * Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017.
- 2.2 Distribution box shall have Insulated Multiple Outgoing Connectors for R, Y, B Phases and Neutral. Distribution box shall have arrangement for one incoming cable of three phase of size up to 4core 35mm². Arrangement for four outgoing cables of size up to 4core 16mm² for three phase connection shall be provided in the distribution box. Each Incoming & outgoing cable shall be fixed inside the connection terminals by two screws of size not less than M8. The connection terminals shall be such that the outgoing cables can be fixed or removed easily without disconnecting the power supply. No current carrying part shall be approachable by hand or finger. Any current carrying part should be at a minimum distance of 5mm from the outer edge of the insulation. Insulation shall be Fire retardant.
- 2.3 Connection terminals for R, Y, and B Phases shall be mounted horizontally in a single line and Neutral shall be mounted parallel to R, Y, and B Phases in stepped pattern. Mounting arrangement shall be such that minimum clearance of 40mm is maintained between each phase and neutral. Fixing of connection terminals with the distribution box shall be preferably non-removable type to avoid theft of connection terminals.
- 2.4 Box shall be provided with U-latch sealing arrangement. A hole of 8mm & 2.5mm shall be provided in the U-latch to provide a padlock & sealing of the box respectively. U-latch shall be joined with stainless steel rivet. Box should be duly powder coated after 7-tank Phosphating process. Box should be of Light Admiralty Grey color (IS-5:1993, COLOUR NO-697). The L.T. Distribution box shall be powder coated only. The facility for 7-Tank Phosphating and powder coating shall be in-house of the tenderer to ensure proper quality, since these boxes are for outdoor

applications.

- 2.5 4 Holes for incoming cables and 4 Nos. holes for outgoing cables shall be provided on the lower wall of the box. Cable holes shall be provided with rubber / plastic glands duly pasted with the box. Incoming and outgoing cable gland shall have internal diameter of 20mm. Cable Glands shall be made such that internal diameter of glands provided for cables should be closed with the film of minimum 1mm thickness. Cable will go through the cable glands by piercing the film of the glands. Gap of minimum 100mm shall be maintained between the lower wall and neutral mounted inside the distribution box for easy handling of incoming and outgoing cables.
- 2.6 **MARKING:** Following shall be provided on the cover of box.
- a) Manufacturers name duly embossed
 - b) Utility name duly embossed
 - c) Name of scheme duly embossed
 - d) Danger marking in red color.
- 2.7 M.S. Earthing Screw of diameter 6mm with washer shall be provided in the threads of the earth clamp welded to the main body of the box.
- 2.8 The box shall comply with the requirement of IP54. The box shall be fully type tested along with dimensional details as per the requirement of relevant Indian Standard (latest edition) IS13947: Part-I and latest amendments. Tests shall be carried out from laboratories which are accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India to prove that the complete box meet the requirement of IP54. The tests report shall be submitted along with the tender failing which the tender of the firm shall not be opened. Government approved laboratories should be accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India. The type test reports shall not be older than 5 years.
- 2.9 Distribution Box shall be duly packed in 3Ply corrugated box. The tolerance permissible on the overall dimensions of the MMB shall be (\pm) 3%.

3.0 TESTS:

Following tests shall be performed on the box during inspection:

3.1 Visual Examination:

The L.T. Distribution box will be inspected visually, externally and internally for proper Powder Coating layer, fitting of all the components in accordance with technical Specification.

3.2 Verification of dimensions:

Verification of dimensions, external / internal clearances will be carried out as per

technical specifications.

- 3.3 Verification of fittings:** Components like insulated connection terminals, screws etc will be verified as per technical specification.

3.4 High voltage withstand test at 2.5KV:

The A.C. voltage of 2.5KV, 50HZ shall be applied for one minute as follows:

- a) Between each Phase
- b) Between each Phase and earth screw
- c) On the insulation of connection terminals

There shall not be any puncture or flash over during this test.

3.5 Current Carrying Capacity: The Current of 200 AMP shall be applied for 30 minutes through high current source on the each Phase. There shall not be overheating of the terminals during this test.

35. Single Phase L.T. Distribution Box for Aerial Bunched Conductor

1 SCOPE:

The LT Distribution box for ABC single phase is used for Connection through overhead conductors or ABC line and for giving connections to the consumers. This specification covers the design, manufacture, inspection, testing and supply of the LT Distribution box. The LT Distribution box suited for ABC single phase cable will be installed at the Poles and it shall withstand solar radiations, rain, wind pressure and pollution.

2 CONSTRUCTIONAL AND TECHNICAL PARTICULARS:

- 2.1 The Distribution Box shall be made from 20 SWG CRCA MS sheet **with Powder Coating**. Internal size of the box shall be 225mm x 285mm x 120mm as shown in drawing. There shall not be any welding joint to make base and cover of the Distribution Box. Roof of the box shall be tapered on both sides to drain the rain water.
- 2.2 Distribution Box shall have insulated Multiple Outgoing Connector for Phase and Neutral. Each Multiple Outgoing Connector shall have arrangement for one incoming cable of Single phase of size up to 25mm² and 8 outgoing cables of single phase of size up to 2core 10mm². Each Incoming & outgoing cable shall be fixed inside the Multiple Outgoing Connector by two screws of size not less than M6. The Multiple Outgoing connector shall be such that the outgoing cables can be fixed or removed easily without disconnecting the power supply. No current carrying part shall be approachable by hand or finger. Any current carrying part should be at a minimum distance of 5mm from the outer edge of the insulation. Insulation shall be Fire retardant.
- 2.3 Multiple Outgoing Connectors shall be mounted horizontally. Mounting arrangement shall be such that minimum clearance of 40mm is maintained between phase and neutral. Fixing of Multiple Outgoing Connectors preferably shall be non-removable type to avoid theft of connectors.
- 2.4 Box shall be provided with U-latch sealing arrangement. A hole of 8mm & 2.5mm shall be provided in the U-latch to provide a padlock & sealing of the box respectively. U-latch shall be joined with stainless steel rivet. Box should be duly powder coated after 7-tank Phosphating process. Box should be of Light Admiralty Grey color (IS-5:1993, COLOUR NO-697). The LT Distribution box for ABC single phase shall be powder coated only. The facility for 7-Tank Phosphating and

powder coating shall be in-house of the tenderer / manufacturer to ensure proper quality, since these boxes are for outdoor applications.

2.5 One Hole for incoming cable and 8 Nos. holes for outgoing cables shall be provided on the lower wall of the box. Cable holes shall be provided with rubber / plastic

glands duly pasted with the box. Incoming and outgoing cable gland shall have internal diameter of 30mm & 15mm respectively. Cable Glands shall be made such that internal diameter of glands provided for cables should be closed with the film of minimum 1mm thickness. Cable will go through the cable glands by piercing the film of the glands. Gap of minimum 100mm shall be maintained between the lower wall and neutral mounted inside the Distribution Box for easy handling of incoming and outgoing cables.

2.6 **MARKING:** Following shall be provided on the cover of box.

- a) Manufacturers name duly embossed
- b) Utility name duly embossed
- c) Name of the scheme
- d) Danger marking in red color.

2.7 M.S. Earthing screw of diameter 6mm with washer shall be provided in the threads of the earth clamp welded to the main body of the box.

* Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017.

The box shall comply with the requirement of IP54. The box shall be fully type tested along with dimensional drawings as per the requirement of relevant Indian Standard (latest edition) IS13947: Part-I and latest amendments. Tests shall be carried out from laboratories which are accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India to prove that the complete box meet the requirement of IP54. The tests report shall be submitted along with the tender failing which the tender of the firm shall not be opened. Government approved laboratories should be accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India. The type test reports shall not be older than 5 years. In case order is placed on a firm, no change in design / manufacturer of LT Distribution box shall be allowed in supplies.

2.8 Box shall be duly packed in 3Ply corrugated box. The tolerance permissible on the overall dimensions shall be (\pm) 3%.

3 TESTS:

Following tests shall be performed on the box during inspection:

3.1 **Visual Examination:** -

The LT Distribution box for ABC single phase will be inspected visually, externally and internally for proper Powder Coating layer, fitting of all the components in accordance with technical Specification.

3.2 **Verification of dimensions:** -

Verification of dimensions, external / internal clearances will be carried out as per

technical specifications.

3.3 **Verification of fittings:** -

Components like insulated Multiple Outgoing Connectors, screws etc will be verified as per technical specification.

3.4 **High voltage withstand test at 2.5KV: -**

The A.C. voltage of 2.5KV, 50HZ shall be applied for one minute as follows:

- a) Between Phase & Neutral
- b) Between Phase and earth screw
- c) On the insulation of Multiple Outgoing Connectors.

There shall not be any puncture or flash over during this test.

3.5 **Current Carrying Capacity: -**

The Current of 200 AMP shall be applied for 30 minutes through high current source on each Multiple Outgoing Connector. There shall not be overheating of the terminals during this test.

36. Earthing

(AS PER IS 3043-1987)

Earthing shall generally be carried out in accordance with the requirements of Indian Electricity Rules 2003 amended from time to time and relevant regulations under Electricity Supply Authority concerned.

In case of high and extra high voltages, the neutral points shall be earthed by not less than two separate distinct connections with earth, each having its own electrodes sub-station and will be earthed at any other point provided no interference is caused by such earthing. If necessary, the neutral may be earthed through suitable impedance.

As far as possible, all earth connections should be visible for inspection. Each earthing system shall be so designed, that, the testing of individual earth electrodes is possible. It is recommended that the value of any earth system resistance shall be such as to conform to the degree of shock protection desired.

It is recommended, that a drawing showing the main earth connections and earth electrodes be prepared for each installation and submitted to Employer.

No addition to the current carrying system, either temporary or permanent, shall be made which will increase the maximum available fault current on its duration until it has been ascertained that the existing arrangement of earth electrodes, earth bus-bar etc., are capable of carrying the new value of earth fault current which may be obtained by this addition.

All materials, fittings etc., used in earthing shall conform to Indian Standard Specifications, wherever they exist.

GENERAL REQUIREMENTS AND PROCEDURES FOR EARTHING AT SUB-STATIONS.

The ground resistance for sub-stations should not exceed a value 2(two) ohms. The joints/connections in the earthing, system shall be welded only, except the connections, which require opening for testing/maintenance. Such connections should be bolted tightly, using spring and ring washers for proper contact pressure. The G.S. flats to be provided for the horizontally laid earth grid should have overlap welded joints, with length of welding at least twice the width of the flat, e.g., 100 MM for 50x6 MM G.S. flats. There should not be any dirt, grease, oil, enamel, paint or any such non-conductive coatings on the surfaces being joined/connected. Only the finished joints/connections above ground may be provided with red-oxide or any other protective coating. Underground earth electrodes and earth grid elements, when laid, should have a clean metallic surface, free from paint, enamel, grease or any such non-conductive coatings.

As far as possible, all earth connections should be accessible for visual inspection. No cut-outs, links or switches, other than linked switches arranged to operate simultaneously on the earthed or earthed neutral conductor and the live wire shall

be inserted in the supply system. Earth electrodes or mate should not be installed in close proximity to metal fence to avoid possibility of fence becoming live. Separate

earth electrodes, isolated from the earth grid, are to be provided for grounding the fence wires.

Pipes or rods used as electrodes should be in one piece, as far as possible, with a minimum allowable length of 3 mtrs. Except where rock or hard stratum is encountered, the pipe/rod electrodes should be driven into the ground to a minimum depth of 3 mtrs. The strip electrodes, forming the horizontal grid, should be buried underground to a minimum depth of 0.5 mtrs. The path of earth wire should be out of normal reach of any person, as far as possible.

For high resistivity soils, above 100 Ohm-mtrs., attempts should be made to bring the soil resistivity in the range of 50 to 60 Ohm-mtrs. By digging and treating the soil mass around the earth grid/electrodes with a mixture of salt and charcoal.

In case of rocky top soil and sub-stratum, having very high resistivity, with no scope of improvement by other means, the procedure given below should be followed:

1. At least two bores of diameter little less than 40 mm, with a minimum distance of 10 mtrs. between them, should be made in the ground at suitable locations inside the S/S yard. The boring should be done until soil sub-stratum rich in moisture and low in resistivity is encountered. G.I. pipes of 40 MM dia. should be descended in each bore, such that, the soil mass around the pipes grips them tightly, Back – filling of bores, if required, with wet soil/clay may be done to ensure this condition. The G.I. pipes in these deep bores should be interconnected with the main earthing grid of the S/S through 50x6 mm G.S. flat, with all the joints/connections and terminations being either fully welded, or clamped/bolted and welded simultaneously. The G.I. pipes in the bores should also be interconnected with each other. In extreme cases, the bores may have to be made at remote locations i.e. outside the S/S yard, with inter-connections, through 50x6 MM flats, as explained before.
2. The procedures to be observed stringently for making connections and joints between various elements of the earthing system are as follows:
 - a. G.S. flat to Structure/flat - The G.S. flat should be welded to the metallic portion (leg) of the structure after thoroughly cleaning the surfaces to be welded. The length of the welding should be at least twice the width of the G.S. flat, e.g.-minimum 100 mm for 50x6 mm G.S. flat. Exactly similar procedure is to be adopted for joints between two G.S. flats.
 - b. G.I. wire to structure. The G.I. wire should be bolted to the structure after
 - c. making an eye formation and kept tight with the help of spring and ring washer. Then, the entire arrangement should be welded.
 - d. G.I. wire to G.S. flat- The G.I. wire should be bolted and then welded to G.S. flat, as explained above.

- e. G.I. rod to G.S. flat- The G.I. rod should be securely clamped to the G.S. flat with the help of bolts and washers and the entire arrangement should then be welded.

- f. G.I. wire to G.I. pipe – GI wire should be bolted to the G.I. pipe and then welded, keeping in view the relevant precautions, mentioned before.
- g. G.I. flat to G.I pipe – The GI flat should be bolted tightly to the G.I. pipe and then the connection should be welded.

Before making connections and joints, it should be ensured that, the elements to be joined have a clean metallic contact surface without any non-conductive coating.

EARTH GRID SYSTEM

Grid system of interconnected conductors forming a closed loop mesh is to be installed using 75x8 mm MS flat for peripheral and branch conductors. Interconnections are made by welding them. This earth grid will be laid at a depth of about 0.5 mtr. bonded to general mass of the earth by 3 mtrs. long earth electrode of solid MS rod (or pipe) of dia 25mm. The G.I. pipe 40 mm. dia 3 mtrs. long in the earthing pits, driven vertically.

It is to this earth grid that the transformer neutral, apparatus, frame work and other non-current carrying metal work associated like transformer tank, switchgear frame etc. are to be connected. All these connections should be made in such a way that reliable and good electrical connection is ensured. Aluminum/ other paint, enamel, grease and scale should be removed from the point of contact before connections are made. No part of the ground connection leads should be embedded in concrete. Arrangement of connection of earth connection shall be as follow:

1. STRUCTURES:

Structures including frames, metal supports within the substation grid at least two legs, preferably diagonally opposite (where more than two legs are provided) on each metal structure shall be connected to earth grid with GI wire of 4mm dia or 6 mm dia.

2. ISOLATORS/ SWITCHES:

The operating handle shall be connected to earth grid independent of the structure earthing or through the steel mounting structure, through 4 mm dia G.I. wire.

3. LIGHTNING ARRESTOR:

The bases of lightning arrestors shall be directly connected to the earth electrodes by 4 or 6 SWG G.I. wires as short and as straight as practicable, to ensure minimum impedance. Separate earth leads should be used for L.A. in each phase. In addition there shall be as direct connections as practicable from the earthed side of the lightning arrestors to the frame of the apparatus

being protected. Surge counters, could also be inserted in the circuit where lightning incidences are high, but in such cases, the lightning arrestor should be mounted on insulated base. Invariably, earth connections for lightning

arrestors should be separate, and in no case should they be joined looped or meshed with other conductors. For lightning arrestors mounted near transformers, earthing connections shall be done with the earthing pits and earthing leads shall be laid clear of the tank and collars in order to avoid possible oil leakage caused by arcing. The earth connection should not pass through iron pipes, as it would increase the reactive impedance of the connection.

4. POWER TRANSFORMER:

- The tank of the transformer shall be directly connected to the main earth grid. In addition there shall be a separate and as direct a connection as practicable from the tank to the earth side of protecting LA using 4 or 6 SWG GI wire.
- The earthing of the neutral shall be by two separate, distinct and direct connections of 50x6 mm GS flat to earth pits, which form a part of the earth grid, and shall be run clear of the tank and collars.
- The transformer track rails shall be connected to earth

5. OUT DOOR VCB:

At least two legs, preferably diagonally opposite of the supporting structure frame work of each circuit breaker unit shall be connected to the earth grid, through 50x6 mm G.S. flats.

6. FENCING:

Fencing and gate should be earthed separately.

7. CURRENT TRANSFORMERS / POTENTIAL TRANSFORMERS:

The bases of the current transformers should be directly connected to the earth grid through 4 or 6 SWG G.I. wires. The base (neural side) of the P.Ts. should be directly connected to the earth grid through 4 or 6 SWG G.I. wires. Separate earth leads should be used for P.Ts. in each phase. The termination of leads on the P.T. neutral should be bolted/clamped and not welded, to facilitate opening of the earth connection for testing purposes. In addition, all bolted cover plates to which bushings are attached, should be connected to the earth grid, both in case of C.Ts. and P.Ts.

- 8.** Armoring of armored metal-sheathed cables within the station grid area shall be connected to the earth grid.

9. Substation L.T. Supply Transformer: Same as above except that the neutral earthing conductor used shall be 4 or 6 SWG G.I. wire.

37. GI Earthing Pipe

Earthing pipe should be made of 40 mm diameter ISI marked B class GI Pipe. 12 mm dia suitable holes on its circumference shall be made as per approved drawing. The pipe should be in one piece. No joints or welding would be allowed on its length. Clamps made of 50x6mm GI flat duly drilled with 12 mm size holes should be welded at the top end for connection of earth conductor.

Pipe used shall be 40mm NB diameter, ISI marked Galvanized Mild Steel Tubes continuously welded Electric Resistance Welded ERW/High Frequency Induction welded (HFIW)/Hot finished welded (HFW) type, conforming to IS-554-1985 with latest amendment of MEDIUM quality (Class B).

1. MANUFACTURE:

GI earth pipe (40 mm diameter & 3 metre long) shall be made of tubes which shall be made from tested quality steel manufactured by any approved process as follows:

- a) Electric Resistance Welded (ERW).
- b) High Frequency Induction Welded (HFIW) and
- c) Hot finished Welded (HFW).

Tubes made by manual welding are not acceptable.

2. DIMENSIONS:

The dimensions and weights of tubes shall be in accordance with Table-I and Table-II of IS: 1239 (Part-I)/1990 with latest amendments, subject to tolerance permitted therein. Necessary 12 mm diameter holes across the circumference shall be provided as per approved drawing. Drawings shall be approved by the owner before start of the manufacturing work. The tube, earthing pipe shall be provided with 50x6mm GS clamps on one end, one clamp is to be welded with the pipe and another is removable to enable measurement of earth resistance of the pit. Other end of the earth pipe should be cut half in slop to make it a sharp.

3. GALVANIZING:

Tubes shall be galvanized in accordance with IS-4736-1986 with latest amendment for not dip zinc coating of Mild Steel Tubes. The minimum mass of zinc coating on the tubes shall be in accordance with clause 5.1 of IS-4736-1986 (specification for hot dip zinc) and when determined on a 100mm long test piece in accordance with IS: 6745:1972 shall be 400 g/m². The zinc coating shall be uniform adherent reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rust, stains, bulky white deposits and blisters.

4. HYDRAULIC TEST:

(Before applying holes) Each tube shall withstand a test pressure of 5 M Pa maintained for at least 3 seconds without showing defects of any kind. The pressure shall be applied by approved means and maintained sufficiently long for proof and inspection. The testing apparatus shall be fitted with an accurate pressure indicator

5. TEST ON FINISHED TUBES AND SOCKETS:

The following tests shall be conducted by the manufacturer of finished tubes and sockets.

- a) The tensile strength of length of strip cut from selected tubes when tested in accordance with IS-1894-1972, (Method for tensile testing of steel tubes), shall be at least 320N/mm^2 .
- b) The elongation percentage on a gauge length of $5.65/s_0$ (where s_0 is the original cross-sectional area of test specimen) shall not be less than 20%.
- c) When tested in accordance with IS-2329-1985 (Method for Bend test on Metallic tubes) the finished tube shall be capable of with standing the bend test without showing any sign of fracture or failure. Welded tubes shall be bent with the weld at 90 degree to the plane of bending. The tubes shall not be filled for this test.
- d) Galvanized tubes shall be capable of being bent cold without cracking of the steel, through 90 degree round a former having a radius at the bottom of the groove equal to 8 times the outside diameter of tube.
- e) Flattening Test on Tubes above 50 mm Nominal Bore: Rings not less than 40 mm in length cut from the ends of selected tubes shall be flattered between parallel plates with the weld, if any, at 90 degree (point of maximum bending) in accordance with IS-2328-1983. No opening should occur by fracture in the weld unless the distance between the plate is less than 75 percent of the original outside diameter of the pipe and no cracks or breaks in the metal elsewhere than in the weld shall occur, unless the distance between the plates is less than 60% of the original outside diameter. The test rings may have the inner and outer edges rounded.
- f) GALVANISHING TEST:
 - Weight of zinc Coating: For tubes thickness upto 6 mm the minimum weight of zinc coating, when determined on a 100 mm long test piece in accordance

with IS-4736-1986 shall be 400 grm/m².

- The weight of the coating expressed in gram/m² shall be calculated by dividing the total weight of the zinc (inside plus outside) by the total area (inside plus outside) of the coated surface.
 - Test specimen for this test shall be cut approximately 100 mm in length from opposite ends of the length of tubes selected for testing. Before cutting the test specimen, 50 mm from both ends of the samples shall be discarded.
- g) Free Bore Test: A rod 230mm long and of appropriate diameter shall be passed through relevant nominal bore of the sample tubes to ensure a free bore.
- h) Uniformity of Galvanized Coating: The galvanized coating when determined on a 100 mm long test piece [see V (a) (iii)] in accordance with IS-2633-1986 (Method for testing uniformity of coating on zinc coated articles) shall with stand 4 one minute dips.

6. WORKMANSHIP:

The tubes shall be cleanly finished and reasonably free from injurious defects. They shall be reasonably straight, free from cracks, surface flaws, laminations, and other defects, both internally and externally. The screw tubes and sockets shall be clean and well-cut. The ends shall be cut cleanly and square with the axis of tube.

7. MARKING:

The medium class of tubes shall be distinguished by Blue colour bands which shall be applied before the tubes leaves the manufacturers' works. Tubes shall be marked with the standard mark.

38. GS Stay Sets (16 mm AND 20 mm)

1. 16MM DIA STAY SETS (GALVANIZED)

The stay sets (Line Guy set) will consist of the following components:-

- a) **ANCHOR ROD WITH ONE WASHER AND NUT:** Overall length of rod should be 1800 mm to be made out of 16 mm dia GS Rod, one end threaded upto 40mm length with a pitch of 5 threads per cm and provided with one square GS washer of size 40x40x1.6mm and one GS hexagonal nut conforming to IS:1367:1967 & IS:1363:1967. Both washer and nut to suit threaded rod of 16mm dia. The other end of the rod to be made into a round eye having an inner dia of 40mm with best quality welding.
- b) **ANCHOR PLATE SIZE 200x200x6MM:** To be made out of GS plate of 6mm thickness. The anchor plate should have at its centre 18mm dia hole.
- c) **TURN BUCKLE & EYE BOLT WITH 2 NUTS:** To be made of 16mm dia GS Rod having an overall length of 450 mm, one end of the rod to be threaded upto 300 mm length with a pitch of 5 threads per cm and provided with two GS Hexagonal nuts of suitable size conforming to IS:1363:1967 & IS:1367:1967. The other end of rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality welding.
- d) **BOW WITH WELDED ANGLE:** To be made out of 16mm dia GS rod. The finished bow shall have an overall length of 995mm and height of 450 mm, the apex or top of the bow shall be bent at an angle of 10 R. The other end shall be welded with proper and good quality welding to a GS angle 180mm long having a dimension of 50x50x6mm. The angle shall have 3 holes of 18mm dia each.
- e) **THIMBLE:** To be made on 1.5 mm thick GS sheet into a size of 75x22x40mm and shape as per standard shall be supplied.
- f) **Galvanizing:** The complete assembly shall be hot dip galvanized.
- g) **WELDING:** The minimum strength of welding provided on various components of 16mm dia stay sets shall be 3100 kg. Minimum 6 mm fillet weld or its equivalent weld area should be deposited in all positions of the job i.e. at any point of the weld length. The welding shall be conforming to relevant IS: 823/1964 or its latest amendment. Minimum length of weld to be provided at various places in the stay sets shall be indicated by the bidder. Welding if,

found short in lengths as per final approved drawings shall be rejected.

- h) **THREADING:** The threads on the Anchor Rod, Eye Bolt & Nuts shall be as per specification IS: 4218:1967 (ISO Metric Screw Threads). The nuts shall be conforming to the requirement of IS: 1367:1967 & have dimensions as per IS: 163:1967. The mechanical property requirement of fasteners shall conform to property clause 4.6 each for anchor rod & Eye bolt and property clause 4 for nuts as per IS: 1367:1967.

AVERAGE WEIGHT OF FINISHED 16MM STAY SETS 7.702 KG.
(MINIMUM) (EXCLUDING NUTS THIMBLES AND WASHERS) 8.445 KG.
(MAXIMUM)

2. 20 MM DIA STAYS SETS FOR 33KV LINES (GALVANIZED)

THE STAY SET (LINE GUY SET) WILL CONSIST OF THE FOLLOWING COMPONENTS:

- a) **ANCHOR ROD WITH ONE WASHER AND NUT:** Overall length of Rod should be 1800mm to be made out of 20mm dia GS Rod, one end threaded upto 40mm length with a pitch of a threads per cm. And provided with one square G.S. Washer of Size 50x50x1.6mm and one GS Hexagonal nut conforming to IS:1367:1967 & IS:1363:1967. Both washer & nut to suit the threaded rod of 20mm. The other end of the rod to be made into a round eye having an inner dia of 40mm with best quality welding. Dimensional and other details are indicated and submitted by bidders for owner's approval before start of manufacturing.
- b) **ANCHOR PLATE:** Size 300x300x8mm: To be made out of G.S. Plate of 8mm thickness. The anchor plate to have at its centre 22mm dia hole.
- c) **TURN BUCKLE, EYE BOLT WITH 2 NUTS:** To be made of 20mm dia G.S. Rod having an overall length of 450 mm. One end of the rod to be threaded upto 300mm length with a pitch of 4 threads per cm. The 20mm dia bolt so made shall be provided with two G.S. Hexagonal nuts of suitable size conforming to IS:1637/1967 & IS:1363/1967.

The other end of the rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality of welding. Welding details are to be indicated by the bidder separately for approval.

- d) **BOW WITH WELDED CHANNEL:** To be made out of 16mm dia G.S. Rod. The finished bow shall have an overall length of 995 mm and height of 450 mm. The apex or top of the bow shall be bent at an angle of 10°. The other end shall be welded with proper and good quality welding to a G.S. Channel

200mm long having a dimension of 100x50x4.7 mm. The Channel shall have 2 holes of 18 mm dia and 22 dia hole at its centre.

- e) **THIMBLE 2 Nos.:** To be made of 1.5mm thick G.S. sheet into a size of 75x22x40mm and shape as per standard.
- f) **GALVANISING:** The complete assembly shall be hot dip galvanised.
- g) **WELDING:** The minimum strength of welding provided on various components of 20mm dia stay sets shall be 4900 kg. Minimum 6mm fillet weld or its equivalent weld area should be deposited in all positions of the job i.e. at any point of the weld length. The welding shall be conforming to relevant IS: 823/1964 or its latest amendment.
- h) **THREADING:** The threads on the Anchor Rods, Eye Bolts and Nuts shall be as per specification IS: 4218:1967 (ISO Metric Screw Threads). The Nuts shall be conforming to the requirements of IS: 1367:1967 and have dimension as per IS 1363:1967. The mechanical property requirement of fasteners shall conform to the properly clause 4.6 each for anchor rods and Eye bolt and property clause 4 for nuts as per IS: 1367:1967.

AVERAGE WEIGHT OF FINISHED 20MM STAYS SET: 14.523 KG. (MIN.)
(EXCLUDING NUTS THIMBLE & WASHER): 15.569 KG. (MAX.)

- 3. **TEST CERTIFICATE:** The contractor shall be required to conduct testing of materials at Govt./Recognized testing laboratory during pre – dispatch inspection for Tensile Load of 3100 Kg/4900 Kg. applied for one minute on the welding & maintained for one minute for 16 mm and 20 mm dia stay sets respectively.
- 4. **IDENTIFICATION MARK:** All stay sets should carry the identification mark of word RDSS and size of the stay set. This should be engraved on the stay plate and on stay rods to ensure proper identification of the materials.

The nuts should be of a size compatible with threaded portion of rods and there should be no play or slippage of nuts.

Welding wherever required should be perfect and should not give way after erection.

- 5. **TOLERANCES:** The tolerances for various components of the stay sets are indicated below subject to the condition that the average weight of finished stay sets of 16mm dia excluding nuts, thimbles and washers shall not be less than the weight specified above :-

No. Item	Section	Fabrication Tolerances	Material
	Tolerances		
1 Anchor Plate	6mm thick + 12.5% - 5%	200x200mm + 1%	GS plate 6mm thick
	8mm thick + 12.5% - 5%	300x300mm + 1%	GS plate 8mm thick
2 Anchor Rod	16mm dia + 5% - 3%	Length 1800mm + 0.5%	GS Round 16mm dia
		Rounded Eye 40 mm inside dia + 3%. Threading 40mm+11% - 5	GS Round 16mm dia
	20mm dia + 3% - 2%	Length 1800mm + 0.5%	GS Round 20mm dia
		Round Eye 40mm inside dia + 3%. Threading 40mm +11% -5%	GS Found 20mm dia
3 Turn Buckle Bow	16 mm dia + 5% - 3%	Length 995mm + 1% 16mm dia	GS Round 16mm dia
		Length 180mm + 1% 50x50x6mm	GS Angle
		Channel length 200mm + 1%	GS Channel 100x50x4.7m m
4 Eye Bolt Rod	16mm dia + 5% - 3%	Length 450mm + 1% Threading 300mm + 1% Round Eye 40mm inside dia + 3%	GS Round 16mm dia
	20mm dia + 3% - 2%	Length 450mm + 1% Threading 300mm + 1% Round Eye 40mm inside dia + 3%	GS Round 20mm dia

39. GI Stay Wires

1. SCOPE

This Specification covers details of G.I. stranded stay wires for use in rural distribution system.

2. APPLICABLE STANDARDS

Except when they conflict with the specific requirements of this specification, the G.I. Stranded Wires shall comply with the specific requirements of IS:2141-1979, IS:4826-1979 & IS:6594-1974 or the latest versions thereof.

3. APPLICATION AND SIZES

3.1 The G.I. stranded wires covered in this Specification are intended for use on the overhead power line poles, distribution transformer structures etc.

3.2 The G.I. stranded wires shall be of 7/2.5mm, 7/3.15mm and 7/4.0mm standard sizes.

4. MATERIAL

The wires shall be drawn from steel made by the open hearth basic oxygen or electric furnace process and of such quality that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall be of uniform quality and have the properties and characteristics as specified in this specification. The wires shall not contain sulphur and phosphorus exceeding 0.060% each.

5. TENSILE GRADE

The wires shall be of tensile grade 4, having minimum tensile strength of 700 N/mm² conforming to IS:2141.

6. GENERAL REQUIREMENTS

- 6.1** The outer wire of strands shall have a right-hand lay.
- 6.2** The lay length of wire strands shall be 12 to 18 times the strand diameter.

7. MINIMUM BREAKING LOAD

The minimum breaking load of the wires before and after stranding shall be as follows :

No. of wires & const.	Wire dia (mm)	Min. breaking load of Single wire before stranding (KN)	Min. breaking load of the standard wire (KN)
7(6/1)	2.5	3.44	22.86
7(6/1)	3.15	5.45	36.26
7(6/1)	4.0	8.79	58.45

8. CONSTRUCTION

- 8.1** The galvanised stay wire shall be of 7-wire construction. The wires shall be so stranded together that when an evenly distributed pull is applied at the ends of completed strand, each wire shall take an equal share of the pull.
- 8.2** Joints are permitted in the individual wires during stranding but such joints shall not be less than 15 metres apart in the finished strands.
- 8.3** The wire shall be circular and free from scale, irregularities, imperfection, flaws, splits and other defects.

9. TOLERANCES

A tolerance of (\pm)2.5% on the diameter of wires before stranding shall be permitted.

10. SAMPLING CRITERIA

The sampling criteria shall be in accordance with IS:2141.

11. TESTS ON WIRES BEFORE MANUFACTURE

The wires shall be subjected to the following tests in accordance with

IS:2141.

i) Ductility Test

- ii) Tolerance on Wire Diameter

12. TESTS ON COMPLETED STRAND

The completed strand shall be tested for the following tests in accordance with IS:2141.

- a) Tensile and Elongation Test :

The percentage elongation of the stranded wire shall not be less than 6%.

- b) Chemical analysis

- c) Galvanising Test :

The Zinc Coating shall conform to “Heavy Coating” as laid down in IS:4826

13. MARKING

Each coil shall carry a metallic tag, securely attached to the inner part of the coil, bearing the following information:

- a) Manufacturers’ name or trade mark
- b) Lot number and coil number
- c) Size
- d) Construction
- e) Tensile Designation
- f) Lay
- g) Coating
- h) Length
- i) Mass
- j) ISI certification mark, if any

14. PACKING

The wires shall be supplied in 75-100 Kg. coils. The packing should be done in accordance with the provisions of IS:6594.

40. MCCB

The MCCBs provided in these boxes shall conform in all respects to the relevant IS: 2516 (Pt-I&II)/1977 or its latest revision as applicable.

REQUIREMENT OF MCCBs:

The moulded case circuit breakers should comprise of a switching mechanism, an effective extinguishing device and a tripping unit contained in a compact moulded case cover made of high strength, heat resistance and flame retardant thermo-insulating materials. They should comprise of a spring assisted quick make/quick break type independent manual trip free mechanism rendering it easy to manually operate the MCCBs and capable of clearly indicating “TRIPPED”, “ON” AND “OFF” positions from the position of the operating handle. The contact tips should be made of a suitable alloy having high arc resistance and a long electrical and mechanical life needing no replacement. The breakers should be designed with a common trip bar to break and make all the three phase together even when fault occurs on any of the phases. The breakers should provide protection against sustained overloads and short circuits through thermal-magnetic/fully magnetic releases. These MCCBs along with terminal blocks are intended to be housed in the distribution boxes made out of sheet steel of 2mm gauge. The assembly of the MCCBs and the terminal blocks should be compact, reliable from operation point of view and safe to the operating personnel. As already mentioned earlier, the MCCBs should be fully maintenance free.

TECHNICAL PARTICULARS OF MCCBs:

The LT MCCBs should have inverse current/time characteristics suitable for protection of 63KVA, 100KVA, 200KVA & 315KVA 11.0.4KV Distribution Transformers against sustained over-loads and short circuits for following operating conditions:-

i	Rated Operating Voltage	3 Phase 415 Volts AC 50 cycles with neutral solidly grounded system
ii	Standard rated current ratings for MCCBs to be used with different sizes of transformers will be as follows:-	
a)	For 63KVA 11/0.4KV Dist. Transformer	90 Amps
b)	For 100KVA 11/0.4KV Dist. Transformer	140 Amps

c)	For 200KVA 11/0.4KV Dist. Transformer	300 Amps
d)	For 315KVA 11/0.4KV Dist.	450 Amps

	Transformer	
iii	No. of Poles	3
iv	Duty	Un-interrupted
v	Maximum ambient temperature	47°C in shade
vi	Minimum ambient temperature	4°C in shade
vii	Average altitude	A maximum of 1000 meter
viii	Maximum humidity	Frequently approaches saturation point

TIME/CURRENT CHARACTERISTICS:

The circuit breakers shall have time/current characteristics suitable for following operating conditions :-

Multiple of normal current rating	Tripping time
1.1 times	After 4 hours
1.2 times	Less than 50 minutes
1.3 times	Less than 30 minutes
1.4 times	Less than 10 minutes
2.5 times	Less than 1 minute
6 times	Less than 40 mili-seconds
12 times	Less than 40 mili-seconds

Time/Current characteristic of the Circuit Breaker (MCCB) shall be tested in accordance with Clause-7.7.2.3 (b) (2) of IS:2516-(Pt-I&II) Sec.I/1977 and the test shall be made with all the three phases loaded.

For time/current characteristic, the reference calibration temperature of the MCCBs shall be 40°C and durance, if any, upto 50°C operating temperature in the enclosure shall not exceed 10% of the value indicated above in Clause (I) above.

The MCCBs shall be calibrated and adjusted in the factory itself for the desired time/current characteristic.

The MCCB should have the following maximum resetting time under overload & short circuit conditions :-

- Overload conditions - 3 minutes
- Short Circuit conditions - Instantaneous

RATED SHORT CIRCUIT BREAKING CAPACITY:

The rated short circuit breaking capacity of the MCCBs shall be as follows: -

Transformer rating(KVA)	Rated short circuit breaking capacity of the breaker in Kilo-Amps
63 KVA	A minimum of 3 Kilo-Amps
100 KVA	A minimum of 5 Kilo-Amps
200KVA	A minimum of 10 Kilo-Amps
315KVA	A minimum of 15 Kilo-Amps

The short circuit breaking capacity test as specified above shall be based on short circuit tests carried out at 0.4 Power Factor (lagging). For the purpose of these tests, the following operating sequence shall be followed: -

Break-3 minutes interval-Make-Break-3 minutes interval-Make-Break.

41. H.R.C. Fuse

The H.R.C. fuse links of 100 Amp, 200 Amp, 300 Amp ratings, should be ISI marked & conforming to ISS: 9224-1979 with latest amendment and to be supplied with suitable base of bakelite on DMC. The knife contact should be made of tinned/silver plated copper complete with extension strips. The extension strips should be made of copper. The thickness of the copper strips should be 2mm for 100 Amp and 200 Amp, 3.0mm for 300 Amp. The strips should be in one piece. The HRC Fuse units should also be supplied with suitable lugs for 3 core 95 sq.mm, 120 sqmm and 300 sq.mm. cables for 100, 200 and 300 Amps ratings respectively. The dimension of the lugs should be as under

S.No	Ratings of HRC Fuse unit	Cable sizes	Minimum thickness of lugs Flat (mm) / Rounded (mm)	Minimum total length of lugs (mm)
1	100 Amp	95 sq.mm	4.2 / 2.1	64
2	200 Amp	120 sq.mm	4.6 / 2.3	73
3	300 Amp	300 sq.mm	7.0 / 3.5	15

The knife contact should have pressure springs to hold the fuse links. The extension strips shall be provided with GI nut & bolts and plain and spring washer to both the end. The DMC or bakelite base should be provided with suitable fixing alignment.

The following test certificates should invariably to be performed on the HRC Fuse Units.

1. Test for temperature rise at rated current
2. Current time characteristics
3. Determination of minimum fusing current and minimum non-fusing current
4. Test for duty

The breaking capacity of HRC Fuse Units should not be less than 80 KA.

The following tests shall be performed during pre-despatch inspection at manufacturer's works: -

1. Insulation resistance test
2. Temperature rise test
3. High Voltage test

Marking on the fuse base and on the fuse links :

1. Name of the manufacturer
2. Rated current
3. Rated voltage
4. ISI marking and reference of 185 No. (only on fuse links)
5. Rated Power loss
6. Name of the Employer

42. Triple Pole Switch Fuse Units with Neutral Links (200A, 320A & 400A/415 VOLTS RATINGS)

This specification covers manufacture, testing before dispatch and delivery of Triple Pole Switch Fuse Units with neutral Link and HRC cartridge type fuses suitable for AC 3 Phase 4 wire 415 V with neutral solidly grounded system. The working conditions and technical requirements are as under:-

TECHNICAL REQUIREMENTS

- a) Rated Current : 200 Amps, 320 Amps & 400 Amps
- b) I) Rated Operational Voltage : 3 Phase 4 Wire, 415 Volts AC 50 Hz
with solidly earthed neutral
- II) Highest System Voltage : 415V + 10%
- c) Type of Fuse to be used : Non-deteriorating quick arcing type
ISI marked

HRC Cartridge fuse Links suitable for Class-1 category of duty of IS:13703(Part-I). The temperature rise shall be in accordance with IS:13703 (Part-I) (with latest amendments) over and above the ambient temperature of 45°C. It shall be used for protecting the distribution circuits and distribution transformers and shall be capable of carrying continuously the above stated rated current safely.

- d) Number of Poles : Three
- e) Neutral Link : One
- f) Duty : Un-interrupted duty
- g) Rated fused short circuit current capacity at 415V : 40KA for 1 second. withstands
- h) Utilization category as : AC-23 (B) as defined in IS: 13947 (Pt-III)/ 1993

GENERAL

1. CONTACTS AND BLADES & OPERATING MECHANISM

The switch shall be a combination of double break per pole AB switch with HRC fuses in all the three phases. The switch shall be spring assisted, quick make and quick break type having operating mechanism independent of the speed of the operator to minimize the arcing. If required, additional contact springs shall be provided to maintain correct contact pressures throughout operating life of the switches. The switch shall be so constructed that the alignment of its contacts & blades, which will be made of silver plated electrolytic copper/tinned copper, is maintained under asymmetrical fault conditions also. The tenders should furnish in their offers about the details of switching mechanism and the contacts. The switch shall have positive break feature such that it is possible to make it OFF even if the quick action spring fails due to ageing or other causes. The switch fuse unit shall be provided with double break per pole to ensure complete isolation of HRC Fuses from both incoming and outgoing circuits when the switch is in OFF position, in order to minimize the damage to the maintenance personnel. Ample flash over distances shall be provided so as to make the unit suitable for controlling highly inductive loads.

2. ENCLOSURES

The Triple Pole Switch fuse units shall be totally enclosed in robust enclosures made out of 16 gauge/1.5 mm pressed steel sheet (conforming to relevant ISS for M.S. sheet) designed to withstand humid and hot weather conditions. The enclosures should have adequate strength and rigidity to withstand rough usage without fracture or permanent distortion. Suitable mounting arrangement shall be provided on the enclosures for mounting the units on a supporting structure.

3. INTER LOCK

It should not be possible to open the switch cover when the switch is in 'ON' position and also it should not be possible to operate the switch 'ON' when the switch cover is open.

4. PAINTING

The inside and outside of the enclosure should be painted with a grey paint. Before painting the surface, the same should be chemically cleaned for removing rust, grease etc. Then it should be given phosphate coating, followed by two coats of anti-rust primer (i.e. Red zinc Chrome Primer), after which two coats of synthetic paint of light grey colour shall be applied on internal and external surfaces of the

enclosures with a spray gun. The enclosures shall then be baked in oven so as to give an elegant and durable finish.

5. EARTHING

The enclosure shall be provided with earthing arrangements at two places.

6. TERMINAL CONNECTIONS

The switch shall be provided with aluminium lugs for termination of PVC coated aluminium cables of following sizes: -

S.No.	Capacity of TPN Switches	Size of Cable	No. of cable sockets required
1	200 Amps	150 sq.mm. 3.5 Core stranded aluminium cable	8 Nos. (3 Nos. phase leads and 1 natural lead for incoming and also 3 Nos. phase leads and 1 neutral for outgoing connections)
2	320 Amps	300 sq.mm. 3.5 Core stranded aluminium cable	-do-
3	400 Amps	300 sq.mm. 3.5 Core stranded aluminium cable	-do-

7. All the surface contacts (e.g. lugs, connectors, fixed contacts, moving contacts etc.) should be fitted with GI nuts & bolts having yellowish OR whitish passivation with good finish.

8. TESTING & TEST CERTIFICATES FOR SWITCHES

The performance of the switch should conform to IS:10027/1981 with latest amendments. Accordingly, certificates from reputed laboratories such as CPRI, ERDA, IITs, for the type tests in accordance with IS:10027/1981 with latest amendment would necessarily be furnished by the tenderers along with offer.

9. USE OF ISI MARK HRC FUSES

The HRC Fuses with ISI mark only should be used. These HRC fuses should conform to IS:13703 (Part-I)/1993 or as per its latest revision. The rated current of HRC fuses must be 200 Amps for 200 Amps Switches, 315 Amps for 320 Amps Switches and 400 Amps for 400 Amps Switches.

10. IMPORTANT NOTE

The firms must consider supply of 'ISI' certificate (valid on date) products on their offer in the tender, Other certification such as ISO:9001 & 9002 shall be given due weightage while considering their offer, however, the attested photo copies of such certification must be enclosed with the offer.

11. INSULATION FOR LIVE PARTS

All live parts shall be fully shielded with bakelite shrouds.

43. Clamps & Connectors

CLAMPS & CONNECTORS: Clamps & connectors shall conform to IS: 5561. The clamps and connectors shall be made of materials listed below:

For connecting ACSR conductors	Aluminium alloy casting, conforming to designation A6 of IS: 617 and shall be tested for all tests as per IS: 617
For connecting equipment terminals made of copper with ACSR conductor	Bimetallic connectors made from aluminium alloy casting conforming to designation A6 of IS:617 with 2mm thick Bimetallic liner and shall be tested as per IS:617
For connecting GS shield wire	Galvanised mild steel
Bolts, Nuts & plain washers	Hot dip galvanised mild steel for sizes M12 and above, and electro-galvanised for sizes below M12
Spring washers for items 'a' to 'c'	Electro-galvanised mild steel suitable for at least service condition 4 as per IS:1573

All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

No current carrying part of a clamp or connector shall be less than 10 mm thick. They shall be designed and manufactured to have minimum contact resistance.

For Bimetallic clamps or connectors, copper alloy liner of minimum 2 mm thickness shall be provided.

Flexible connectors, braids or laminated strips made up of copper/ aluminium for the terminal clamps for equipment shall be suitable for both expansion or through (fixed/ sliding) type connection of IPS Aluminium tube as required. In both the cases the clamp height (top of the mounting pad to center line of the tube) should be same.

Size of the terminal/conductor for which the clamp/connector is suitable shall be embossed/punched (i.e. indelibly marked) on each components of the clamp/connector, except on the hardware.

Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/ connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

Clamps and connector shall be designed corona controlled.

Clamps & connectors shall conform to type tests and shall be subjected to routine and acceptance tests on minimum 3 samples per lot as per IS: 5561. Type tests report for

all clamps and connectors for temperature rise test, tensile test, shall be furnished by the Contractor.

44. Epoxy Based Protective Paint

1. SCOPE

This specification covers the requirement of self-priming epoxy-based protective paint both for new and old steel structures such as poles, sub-station structures etc.

2. COMPOSITION

The paint shall be epoxy-based with metallic zinc as an essential component. The paint shall be supplied in two components and shall be suitable for a single coat application. It shall have such composition as to satisfy the requirements of this standard. The mixing ratio (base-to-accelerator) shall be specified by the manufacturer.

3. REQUIREMENTS

3.1	Volume Solids	85% (\pm)3%
3.2	Theoretical covering Capacity	6.5 sq. mtrs. per litre at 125 microns dry film thickness
3.3	Weight per 10 litres of mixed paint	14 to 15 Kg. (\pm) 0.3 kg
3.4	Drying time (at 30 OC) dry	Surface : Not more than 4 hours Hard Dry : 16-18 hours Recoating Time: 16-18 hours Curing time : 7 days
3.5	Scratch hardness (with 1.5 kg.load)	No such scratch as to show the base metal
3.6	Finish	Smooth and semi-glossy
3.7	Colour	Ash Grey or Aluminium (as required)
3.8	Dry Film Thickness	The paint shall develop a dry film of minimum 100-125 microns in a single coat(measured by Elcometer)
3.9	Flash point	Not below 40 OC
3.10	Flexibility and adhesion	The paint shall not show damage, detachment or cracking.
3.11	Resistance to humidity	Shall pass 1000 hours (minimum) at 125 microns D.F.T

3.12	Resistance to lubricating oil petroleum, hydrocarbon solvent, petrol and heat	Shall show no sign of permanent injury
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4. STORAGE LIFE & POT LIFE

4.1	Storage life	Minimum 6 months from the date of manufacture in original sealed container under normal covered storage conditions
4.2	Pot life (at 30OC)	Not less than 4 hours

5. DURABILITY

Under severe surface conditions, paint shall protect the substrate at least for 5 years, if it is wire-brushed/power tool cleaned and 7 years for commercially grit-blasted steel sub-strate.

6. SURFACE PREPARATION

If possible, the surface on which the paint has to be applied shall be cleaned by grit blasting, otherwise manual wire brushing or power tool cleaning process may be used as convenient.

7. METHOD OF APPLICATION

Brushing, rollers or spraying.

8. TESTS

The following tests shall be carried out in accordance with the procedure given in the Indian Standard quoted against each, except requirements stipulated in clauses 3.1 and 3.2 which shall be tested in accordance with the procedure indicated in Annexure-II; preparation of painted panels for conducting different tests shall be done as given in Annexure-I.

- 8.1 Requirement stipulated in clauses 3.3 to 3.12 - **IS:101**
- 8.2 **Resistance to Salt Spray**
Shall pass 1000 hours (minimum with 200 microns D.F.T.) - **IS:2074**
- 8.3 **Chemical Resistance**
Shall be resistant to acid/alkaline chemicals or solvents - **IS:8662**

9. PACKAGE

Unless otherwise specified by the purchaser, the paint shall be normally supplied in 2 litre packs.

Annexure – I

DETAILS OF PREPARATION OF PAINTED PANELS FOR TESTING EPOXY BASED PROTECTIVE PAINT (TWO PACKS)

S. N.	Test	Type of Metal	Size in mm	Painting Details	Dry Film Thickness	Method of Application	Duration of air drying before commencement of test	Special Instructions
1	2	3	4	5	6	7	8	9

1	Drying Time	Mild Steel	150x100x1.25	One coat of Epoxy based protective paint	100	Brush /Spray	-	-
2	Finish		-do-		-do -		48 hours	
3	Colour	-do -	-do -	-do -	-do-		24 hours	
4	Dry Film Thickness	-do -	-do -	-do -	-do -		24 hours	-
5	Flexibility and adhesion	-do -	150x150x0.315	-do-	-do-		7 days	-
6	Scratch Hardness	Tinned	-do -		-do -		-do -	
7	Resistance to Salt Spray	-do -	150x150x1.25	-do-	200		7 days	Apply a load of 1.5 Kgs. Instead of 1 kg.

8	Protection against corrosion under conditions of condensation	Mild Steel - do -	- do -	-do-	125	- do -	- do -	As specified in Col.15.1 of IS: 101 – 64
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ANNEXURE-II

Procedure for determining volume solids

1. Scope :

This method is applicable to the determination of the volume non-volatile matter of paint coatings.

2. Significance :

This method is intended to provide a measure of the volume of dry coating obtainable from a given volume of liquid coating. This volume is considered to be the most equitable means of comparing the coverage (square metre of surface covered at a specific film thickness per unit volume) and also for calculating the wet film thickness of the given paint.

3. Apparatus

- i) Analytical Balance
- ii) Steel disc : Preferably stainless steel, 60mm dia, and 0.70mm thickness with a small hole 2 to 3mm from the edge. A fine wire such as chromel is attached through the hole and made of the appropriate length for suspending the disc in a liquid.
- iii) Weight Box
- iv) Beaker : 1 litre for weighing the disc in liquid.
- v) Weight per litre cup for determining the specific gravity of the paint material and of the suspending liquid if not known.
- vi) Oven

4. Procedure

- i) Dry the disk in an oven at 105^{0C} for 10 minutes and cool.
- ii) Weigh the disk in air, let it be W1 grams.

iii) Suspend the disk in water and weigh again. Let it be W_2 grams.

iv) Calculate the volume of disk 'V' as follows:

$V = \frac{W_1 - W_2}{d}$ where 'd' is the density of the water at room temperature

v) Determine the weight of non-volatile content per gram of the liquid coating material by drying a known amount of paint at 105°C for 3 hours. Let it be 'W' grams.

vi) Determine the specific gravity of the paint to the nearest 0.001 g/ml. by using weight per liter cup. Let it be 'p'.

vii) Dip the disk in the paint sample for 10 minutes, and take out the disc and allow the excess coating material to drain off. Blot the coating material off the bottom edge of the disc so that beads or drops do not dry on the bottom edge of the disc.

viii) Dry the disc in oven for 3 hours at 105°C and cool.

ix) Weigh the coated disc in air. Let it be W3 grams.

x) Suspend the coated disc in water and weigh it. Let it be W4 grams.

xi) Calculate the volume of the coated disc as follows:

$V_1 = \frac{W_3 - W_4}{d}$, where 'd' is the density of the water at room temperature.

xii) Calculate the volume of the dried coating as follows:

Volume of dried coating (Vd) = $V_1 - V$

xiii) Calculate the volume of the wet coating as follows:

$V_w = \frac{W_3 - W_1}{W \times P}$, where W = grams of non volatile matter in one gram of wet coating

P = Specific gravity of the paint.

xiv) Calculate the percentage volume solids of the paints as follows:

$$= \frac{V_1 - V \times 100}{V_w} \quad \text{or} \quad \frac{V_d \times 100}{V_w}$$

The volume of non volatile matter or the percentage volume solids of a paint is related to the covering capacity and film thickness in the following manner:

- a) Theoretical Coverage (m^2/l) = $\frac{\% \text{ volume solids} \times 10}{\text{Dry film thickness (in microns)}}$
- b) Wet film thickness (in microns) = $\frac{\text{Dry Film thickness} \times 100}{\text{(in microns)}}$

% volume solids.

45. Mid Span Compression Joint and Repair Sleeve

1.0 Mid Span Compression Joint

1.1 Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistivity less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

1.2 In ACSR conductors, the joint shall be made of steel and Aluminium for jointing the steel core and Aluminium respectively. The steel sleeve should not crack or fail during compression. The Brinell Hardness of steel sleeve shall not exceed 200. The steel sleeve shall be hot dip galvanised. The Aluminium shall have Aluminium/alloy. Aluminium plugs shall also be provided on the line of demarcation between compression and non compression zone.

2.0 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from Aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during **installation**.

3.0 Material and Workmanship

3.1 All the equipment shall be of the latest proven design and conform to the best modern practices adopted in the power line field. The Supplier shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 11/33 kV transmission line application and will give continued good performance.

3.2 The design, manufacturing process and quality control of all the materials shall be such as to achieve requisite factor of safety for maximum working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.

3.3 All ferrous parts shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanized as per grade 4 of IS-1573-1970. The bolt threads shall be undercut to take care of increase in diameter due to galvanising. Galvanising shall be done in accordance with IS:2629-1985 / IS-1367 (Part-13) and satisfy the tests mentioned in IS-2633-1986. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall have a minimum over range coating of Zinc equivalent to 600 gm/sq.m and shall be guaranteed to withstand at least six dips each lasting one

minute under the standard Peerce test for galvanising unless otherwise specified.

- 3.4** The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn.99.95 as per IS:209.
- 3.5** In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blow holes. cracks etc.
- 3.6** All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum and localised heating phenomenon is averted.
- 3.7** No equipment shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under all service conditions.
- 3.8** Particular care shall be taken during manufacture and subsequent handling to ensure smooth surface free from abrasion or cuts.
- 3.9** The fasteners shall conform to the requirements of IS:6639-1972. All fasteners and clamps shall have corona free locking arrangement to guard against vibration loosening.

4.0 Compression Markings

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' 'suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible.

5.0 Drawings

- 5.1** The Supplier shall furnish detailed dimensioned drawings of the equipments and all component parts. Each drawing shall be identified by a drawing number and Contract number. All drawings shall be neatly arranged. All drafting and lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions and dimensional tolerances shall be mentioned in mm.
- 5.2** The drawings shall include
- (i) Dimensions and dimensional tolerances
 - (ii) Material. Fabrication details including any weld details and any specified

finishes and coatings. Regarding material, designations and reference of standards are to be indicated.

- (iii) Catalogue No.
- (iv) Marking
- (v) Weight of assembly
- (vi) Installation instructions
- (vii) Design installation torque for the bolt or cap screw
- (viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts
- (ix) The compression die number with recommended compression pressure.
- (x) All other relevant technical details

5.3 The above drawings shall be submitted in 3 copies with all the details as stated above along with the bid document. After the placement of award. The Contractor shall again submit the drawings in four copies to the Owner for approval. After Owner's approval and successful completion of all type tests, 10 more sets of drawings shall be submitted to Owner for further distribution and field use at Owner's end.

6.0 Tests

6.1 Type Tests

6.1.1 Mid Span Compression Joint for Conductor

- (a) Chemical analysis of materials (as per Annexure – A)
- (b) Electrical resistance test
- (c) Heating cycle test
- (d) Slip strength test

6.1.2 Repair Sleeve for Conductor

- (a) Chemical analysis of materials

6.1.3 Flexible Copper Bond

- (a) Slip Strength Test (as per Annexure – A)

6.2 Acceptance Tests

6.2.1 Mid Span Compression Joint for Conductor and Earthwire

- (a) Visual examination and dimensional verification
- (b) Galvanising test
- (c) Hardness test

6.2.2 Repair Sleeve for Conductor

- (a) Visual examination and dimensional verification

6.2.3 Flexible Copper Bond

- (a) Visual examination and dimensional verification
- (b) Slip strength test

6.3 Routine Tests

- (a) Visual examination and dimensional verification

6.4 Tests During Manufacture

On all components as applicable

- (a) Chemical analysis of Zinc used for galvanising))
- (b) Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings) As per Annexure-A)
- (c) Chemical analysis, hardness tests and magnetic particle inspection for forgings))

7.0 Tests and Standards

7.1 Testing Expenses

7.1.1 Supplier shall indicate the laboratories in which they proposes to conduct the type tests. They shall ensure that adequate facilities for conducting the tests are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

7.1.2 The Contractor shall intimate the Owner about carrying out of the type tests alongwith detailed testing programme at least 3 weeks in advance of the scheduled date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

8.0 Sample Batch For Type Testing

8.1 The Contractor shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Owner. The Contractor shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme

approved by the Owner.

8.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Owner's representative.

9.0 Schedule of Testing and Additional Tests

9.1 The Supplier has to indicate the schedule of following activities

- (a) Submission of drawing for approval.
- (b) Submission of Quality Assurance programme for approval.
- (c) Offering of material for sample selection for type tests.
- (d) Type testing.

9.2 The Owner reserves the right of having at his own expense any other test(s) of reasonable nature carried out at Contractor's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications.

9.3 The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items, all without any extra cost to the Owner.

10 Test Reports

10.1 Copies of type test reports shall be furnished in atleast six copies alongwith one original. One copy shall be returned duly certified by the Owner, only after which the commercial production of the concerned material shall start.

10.2 Copies of acceptance test report shall be furnished in atleast six copies. One copy shall be returned, duly certified by the Owner, only after which the materials will be despatched.

10.3 Record of routine test report shall be maintained by the Contractor at his works for periodic inspection by the Owner's representative.

10.4 Test certificates of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Owner.

11.0 Inspection

11.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub-Contractor's works raw materials. manufacturer's of all the material and for conducting necessary tests as detailed herein.

- 11.2 The material for final inspection shall be offered by the Contractor only under packed condition. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.
- 11.3 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.
- 11.4 Material shall not be despatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be despatched only after all tests specified herein have been satisfactorily completed.
- 11.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such material are later found to be defective.

12.0 Packing and Marking

- 12.1 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 50 Kg to avoid handling problems.
- 12.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 12.3 Suitable cushioning, protective padding, dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
- 12.4 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.
- 12.5 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture.
- 12.6 All the packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly despatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stencilled on it in indelible ink.

13.0 Standards

- 13.1 The Hardware fittings, conductor and earthwire accessories shall conform Indian/International Standards which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

ANNEXURE – A

1.0 TESTS ON HARDWARE FITTINGS

1.1 Galvanising/Electroplating Test

The test shall be carried out as per Clause no. 5.9 of IS:2486-(Part-1) - 1972 except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

1.2 Mechanical Strength Test of Each Component

Each component shall be subjected to a load equal to the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. The component shall then again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The applied load shall then be increased until the failing load is reached and the value recorded.

1.3 Mechanical Strength Test of Welded Joint

The welded portion of the component shall be subjected to a Load of 2000 kgs for one minute. Thereafter, it shall be subjected to die-penetration/ ultrasonic test. There shall not be any crack at the welded portion.

1.4 Clamp Slip Strength Vs Torque Test for Suspension Clamp

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of Conductor shall be fixed in the clamp. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs torque curve shall be drawn. The clamp slip strength at the recommended tightening torque shall be more than 12.5% but less than 20% of conductor rated strength.

2.0 TESTS ON CONDUCTOR AND EARTHWIRE ACCESSORIES

2.1 Mid Span Compression Joint for Conductor and Earthwire

(a) Slip Strength Test

The fitting compressed on conductor/earthwire shall not be less than one metre in length. The test shall be carried out as per IS:2121 (Part-II)- clause 6.4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of

conductor/earthwire and retained for one minute at this load. There shall be no

movement of the conductor/ earthwire relative to the fittings and no failure of the fittings during this one minute period.

(b) Hardness Test

The Brinnel hardness at various points on the steel sleeve of conductor core and of the earthwire compression joint and tension clamp shall be measured.

2.2 Flexible Copper Bond

a) Slip Strength Test

On applying a load of 3 kN between the two ends, stranded flexible copper cable shall not come out of the connecting lugs and none of its strands shall be damaged. After the test, the lugs shall be cut open to ascertain that the gripping of cable has not been affected.

2.3 Chemical Analysis Test

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

3.0 TESTS ON ALL COMPONENTS (AS APPLICABLE)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analysed as per IS-209. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognised procedures for these tests. The, sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognised procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Pro

46. Terminal Block

All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of cabinet, junction box, terminal box and marshalling box.

The terminal blocks shall be made of moulded, non-inflammable thermosetting plastic. The material of terminal block moulding shall not deteriorate because of varied conditions of heat, cold humidity, dryness etc. that would be anticipated at the location where the equipment is proposed to be installed.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally. The terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CAT-M4.

The conducting part in contact with cable shall be tinned or silver plated. The terminal blocks shall be of extensible design. The terminal blocks shall be of 1100 V grade and shall be rated to carry continuously the maximum current that is expected to be carried by the terminals.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deterioration type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

The terminals shall be provided with the marking tags for wiring identification.

The blocks shall be provided with 20% spare terminals unless otherwise specified. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT/VT Minimum of two 2.5 sq.mm copper flexible

All CT/VT circuits Minimum of 4 nos. of 2.5 sq.mm copper flexible

AC/DC Power supply circuit One of 16 sq. mm. Aluminium.

There shall be a minimum clearance of 250 mm between the first row of terminal block and the cable gland plate or side of the box. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. Cabinet wiring should be suitable for 60°C as the space heaters will keep the temperature 10°C higher than the ambient.

For the Control and Relay Panels the terminal blocks for current transformer and voltage transformer secondary lead shall be provided with test links and isolating facilities. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

47. Wiring

All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:

1. All circuits except CT circuits 2.5 sq.mm
2. CT circuits 2.5 sq. mm (minimum number of strands shall be 3 per conductor).

All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.

All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.

All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Inter-pole cabling for all equipment's shall be carried out by the Contractor.

48. Equipment Erection Notes

All support insulators, circuit breaker and other fragile equipment shall preferably be handled with cranes with suitable booms and handling capacity.

The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

For cleaning the inside and outside of Hollow insulators only muslin or leather cloth shall be used.

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

Bending of compressed air piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

Cutting of the pipes wherever required shall be such as to avoid flaring of the ends, and only a proper pipe cutting tool shall be used. Hack-saw shall not be used.

The Contractor shall arrange at site all the equipments, instruments and auxiliaries required for testing and commissioning of equipment.

STORAGE OF EQUIPMENTS

The Contractor shall provide and construct adequate storage shed for proper storage of equipments. Weather sensitive equipment shall be stored indoor. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instruction of the equipment manufacturer/Owner shall be strictly adhered to.

49. Danger Notice Plates

1. SCOPE

This Specification covers Danger Notice Plates to be displayed in accordance with rule No. 35 of Indian Electricity Rules, 2003.

2. APPLICABLE STANDARDS

Unless otherwise modified in this specification, the Danger Notice Plates shall comply with IS:2551-1982 or the latest version thereof.

3. DIMENSIONS

3.1 Two sizes of Danger Notice Plates as follows are recommended:

- a) For display at 415 V installations - 200x150mm
- b) For display at 11 KV (or higher voltages) installations - 250x200mm

3.2 The corners of the plate shall be rounded off.

3.3 The location of fixing holes as shown in Figs. 1 to 4 is provisional and can be modified to suit the requirements of the purchaser.

4. LETTERINGS

All letterings shall be centrally spaced. The dimensions of the letters, figures and their respective position shall be as shown in figs. 1 to 4. The size of letters in the words in each language and spacing between them shall be so chosen that these are uniformly written in the space earmarked for them.

5. LANGUAGES

5.1 Under Rule No. 35 of Indian Electricity Rules, 2003, the owner of every medium, high and extra high voltage installation is required to affix permanently in a conspicuous position a danger notice in Hindi or English and, in addition, in the local language, with the sign of skull and bones. The type and size of lettering to be done in Hindi is indicated in the specimen danger notice plates shown in Fig. 2 and 4 and those in English are shown in Figs. 1 and 3.

5.2 Adequate space has been provided in the specimen danger notice plates for having the letterings in local language for the equivalent of 'Danger', '415' '11000' and 'Volts'.

6. MATERIAL AND FINISH

The plate shall be made from mild steel sheet of at least 1.6mm thick and vitreous enameled white, with letters, figures and the conventional skull and cross-bones in signal red colour (refer IS:5-1978) on the front side. The rear side of the plate shall also be enamelled.

7. TESTS

The following tests shall be carried out :

- i) Visual examination as per IS:2551-1982
- ii) Dimensional check as per IS:2551-1982
- iii) Test for weather proofness as per IS:8709-1977 (or its latest version)

8. MARKING

Maker's name and trade mark and the purchaser's name shall be marked in such a manner and position on the plates that it does not interfere with the other information.

9. PACKING

The plates shall be packed in wooden crates suitable for rough handling and acceptable for rail/road transport.

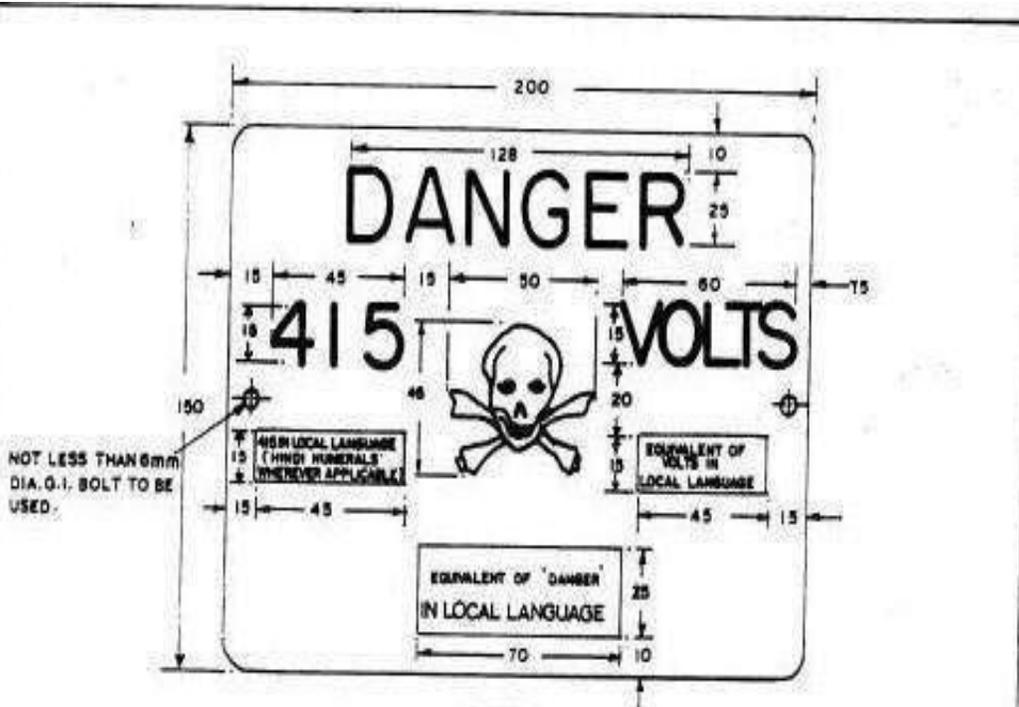


FIG.-1

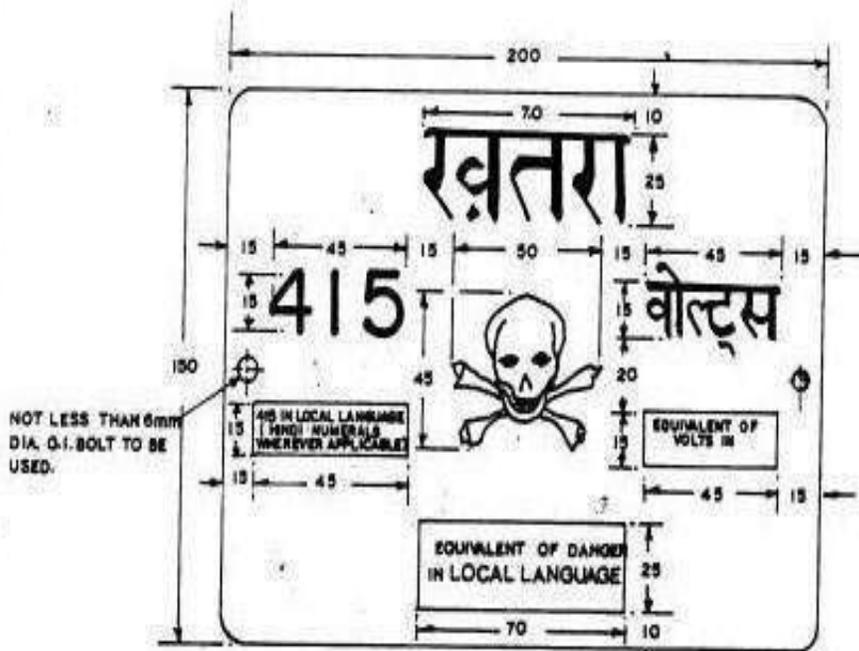


FIG.-2

ALL DIMENSIONS ARE IN MM.

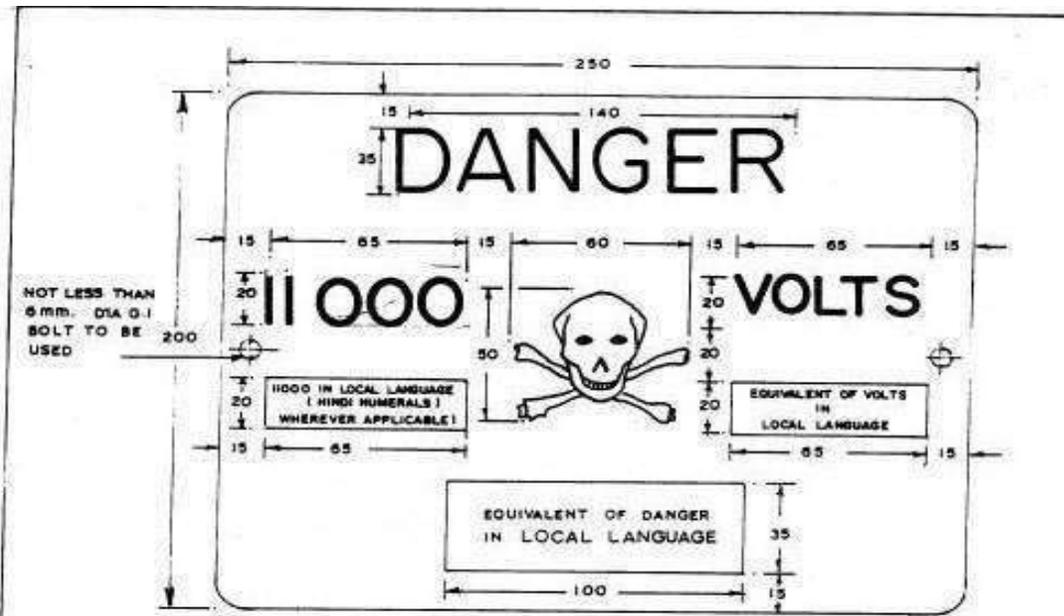


FIG:-3

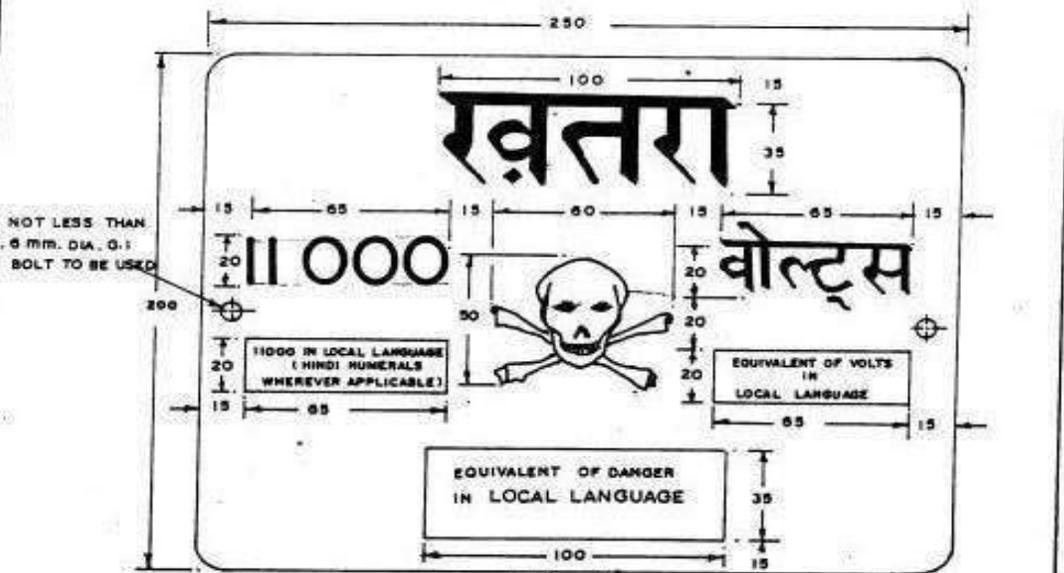


FIG:-4

NOTE: 11000 SHALL BE REPLACED BY 33000, 66000 ETC. AS REQUIRED.

ALL DIMENSIONS ARE IN MM.

50. Number Plate (Support)

Weather proof number plate shall have unique name are to be installed on the pole support. The plate shall be made from mild steel sheet of at least 1.6mm thick and vitreous enameled white, with letters in signal red color (refer IS: 5-1978) on the front side. The rear side of the plate shall also be enameled. The digits shall be as under:

110121

000001

226

Digits shall be displayed as detailed above having at-least 25mm height. The over all size of the plate shall be 200x250mmx1.6mm. The corners of the plate shall be rounded off. All lettering shall be centrally spaced. The dimensions of the letters, figures and their respective position shall be as shown above. The size of digits and spacing between them shall be so chosen that these are uniformly written in the space earmarked for them. The type and size of digits to be written in English as indicated above. The plate should be provided with 6mm dia holes in horizontal alignment for fixing to the pole by means of Galvanized MS flat clamp of 25x3 mm size. The nut & bolts used for fixing of plate should be of galvanized and washers of electro-plated. The bolt should be used of at-least 6mm diameter.

TESTS: The following tests shall be carried out:

- i) Visual examination as per IS:2551-1982
- ii) Dimensional check as per IS:2551-1982
- iii) Test for weather proof-ness as per IS 8709-1977 (or its latest version).

Numbering Transformer/ Feeders/ Equipments (in Grid Sub-Station):

All augmented/ new power transformer, Breakers, Outgoing feeders, respective control panels, Kiosks are to be named. Base should be painted with yellow paint and black digits should be displayed of at-least 25mm height. Experienced painter should be used to provide this work. LT and HT bushing should be colour coded, CT and PT panels are to be named. The Yellow base plate should be encircled by a black strip. Naming shall be in the local as well as English language.

Numbering of control panel:

Name of Feeder should be displayed on front end and at rear end along with serial number of the panel. Yellow base paint and 25mm high black digits are to be used for this purpose. The base paint should be encircled by a black strip. Naming shall be in the local as well as English language.

Strip
25mm Height



51. Cable Glands and Lugs

Cable glands shall be Double compression type, tinned/Nickel plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.

The cable glands shall be tested as per BS: 6121. The cable glands shall also be duly tested for dust proof and weather proof termination.

Cables lugs shall be tinned copper solder less crimping type conforming to IS: 8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

52. Cables Tags and Markers

Each cable and conduit run shall be tagged with numbers that appear in the cables and conduit schedule.

The tag shall be of aluminum with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS: 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate.

Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint".

The marker shall project 150 mm above ground and shall be spaced at analysis interval 30 meters and at every change in direction. They shall also be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing and on each duct/conduit entry. Cable tags shall be provided inside the switchgear, motor control centers, control and relay panels, etc., wherever required for cable identification, such as where a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/ conduits quoted by the contractor.

Specific requirements for cabling for cabling, wiring, ferrules as covered in respective equipment section shall also be complied with.

CABLE GLANDS

Double compression type cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof termination. Required number of packing glands to close unused openings in gland plates shall also be provided.

CABLE LUGS

Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided. Crimping tool used shall be of approved design and make.

Storage and handling of cable drums

Cable drums shall be unloaded, handled and stored in an approved manner. Rolling of drums shall be avoided as far as practicable. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication the drums may be rolled in the same direction it was rolled during taking up the cables.

CABLE SUPPORTS AND CABLE TRAY MOUNTING ARRANGEMENTS

Cable trenches in the control room are normally provided with embedded steel

inserts on concrete floors/ walls. The Contractor shall secure supports by welding to these inserts or available building steel structures.

Insert plates will be provided at an interval of 600 mm wherever cables are to be supported without the use of cable trays, while at all other places these will be at an interval of 2000 mm.

CABLE TERMINATIONS AND CONNECTIONS

The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/ or as directed by the Owner.

The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

The equipment will be generally provided with un-drilled gland plates for cables/ conduit entry. The Contractor shall be responsible for drilling of gland plates, painting, and touching up. Holes shall not be made by gas cutting.

The Contractor shall tag/ferrule the control cable cores at all terminations, as instructed by the Owner. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well. Spare cores shall be similarly tagged with cable numbers and coiled up.

Control cables shall have stranded copper conductor. Bare portion of the solid conductors shall be tinned after removing the insulation and shall be terminated directly without using cable lugs.

All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor with the approval of the Owner.

DIRECTLY BURIED CABLES

The Contractor shall construct the cable trenches required for directly buried cables. The scope of work and unit rates for construction of cable trenches for cables shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective cover, back filling and reaming, supply and installation of route markers and joint markers. The Contractor/Supplier shall ascertain the soil conditions prevailing at site, before quoting the unit rates. Laying the cable and providing protective covering shall be as per approved drawing.

Installation of cables

Power and control cables shall be laid in separate tiers. The order of laying of various cables shall be as follows:

- Power cables on top tiers.

- Control, instrumentation and other service cables in bottom tiers.

Single core cable in trefoil formation shall be laid with a distance of three times the diameter of cables between trefoil center lines. All power cables shall be laid with a minimum center to center distance equal to twice the diameter of the cable.

Power and control cables shall be securely fixed to the trays/ supports. Trefoil clamps for single core cables shall be pressure die-cast aluminum (LM-6). Nylon-6 or fiber glass and shall include necessary fixing nuts, bolts, washer, etc. These are required at every 2 meter of cable run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminum strip clamps at every 2 m. Horizontal runs in cable trays and trenches shall be secured using 4 mm nylon cord at every 2 m.

Cables shall not be bent below the minimum permissible limit. The minimum bending radius of power cables shall be 12D and that of control cables shall be 10D, where D is overall diameter of cable.

Where cables cross roads, drains and rail tracks, the cables shall be laid in reinforced spun concrete or steel pipes, buried at not less than one meter depth.

In each cable run some extra length shall be kept at a suitable point to enable one (for LT Cables) or two (for H.T. cables) straight through joints to be made, should the cable develop fault at a later date.

Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the Owner.

Control cable terminations inside equipment enclosures shall have sufficient lengths so that switching of termination in terminal blocks can be done without requiring any splicing.

Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required.

Rollers shall be used at intervals of about 2.0 meters, while pulling cables.

All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kink, sharp bends, etc.

Cable ends shall be kept sealed to prevent damage.

Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard codes or practices.

Wherever cables pass through floor or through wall openings or other partitions, wall sleeves with bushes having a smooth curved internal surface so as not to damage the cables shall be supplied, installed and properly sealed at no extra charges.

The erection work shall be carried out in a neat workmanlike manner and the areas of work shall be cleaned of all scrap materials after the completion of work in each area every day. Contractor shall remove the RCC/steel trench covers before taking

up the work and shall replace all the trench covers after the erection work in that particular area is completed or when further work is not likely to be taken up for some time.

Contractor shall furnish three copies of the report on work carried out in a particular week, such as cable numbers and a date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever the modifications are made.

In case the outer sheath of a cable is damaged during handling/ installation, the Contractor shall repair it at his own cost, and to the satisfaction of the Engineer-in-Charge. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable, at no extra cost i.e. the Contractor shall not be paid for supply, installation and removal of the damaged cable.

All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating type, sleeve or paint.

53. Earth Knobs for LT Lines

1. SCOPE

This standard covers the requirements of knobs for supporting the neutral-cum-earth wire used for earthing of metal parts of supporting structures of overhead power lines with a nominal voltage upto 1000V (refer Construction Standard B-3 & B-4).

2. APPLICABLE STANDARDS

Except when they conflict with the specific requirements of this specification, the earth knobs shall conform to the latest version of IS:9511-1980.

3. MATERIALS

Earth knobs shall be made of cast iron.

4. GENERAL REQUIREMENTS

Earth knobs shall not have blow holes, shrinkage and other casting defects. The top and bottom flat portion of earth knob shall be smooth and plain.

5. SHAPE AND DIMENSIONS

The shape and dimensions of earth knob shall conform to Fig. 1.

6. ACCEPTANCE TESTS

The following acceptance tests shall be carried out atleast on one knob for every 1000 nos.

6.1 Electrical Resistance

6.1.1 The electrical resistance of the earth knob shall be measured using a Kelvin bridge. Adequate electrical contact shall be ensured against the two surfaces of the knob preferably by using brass washers, soldered to the leads going to the bridge circuit. The washers shall be of adequate size to ensure sufficient area of contact.

6.1.2 The electrical resistance of the earth knob, measured as given in 6.1.1 between the two flat portions, shall not exceed 200 m ohms.

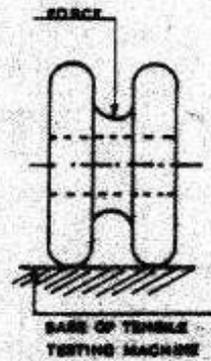
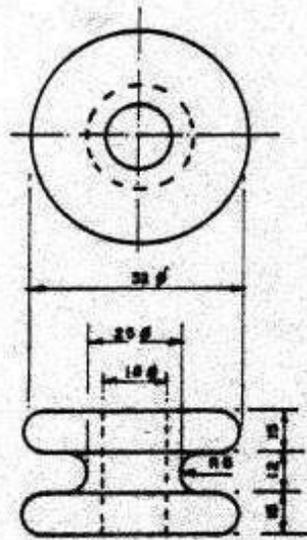
6.2 Mechanical Strength

The breaking strength at the neck of the earth knob shall not be less than 11,500

kg. when force is applied in the direction shown in Fig. 2.

7. MARKING

Each earth knob shall be marked with the name of the manufacturer or his trade mark.



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EARTH KNOB FOR LT. LINES

54. GI Wires

1. SCOPE

This specification covers details of solid G.I. Wires for use in rural distribution system.

2. APPLICABLE STANDARDS

Except when they conflict with the specific requirements of this specification, the G.I. wires shall comply with the provisions of IS:280-1978 and IS:7887-1975 or the latest version thereof.

3. APPLICATION & SIZES

G.I. wires covered in this Specification are intended for the following applications :

Application	Sizes (nominal dia)
Bearer wire for service	3.15mm (for single phase cables services) 4 mm (for three phase services)
Earthing of Transformers, poles & Fittings.	4 mm
Continuous Earthwire for. 11 KV lines	4 mm
Protective guarding at the crossing of over-head power lines with roads, railway tracts and telecommunication lines	3.15, 4 and 5 mm

4. MATERIAL

4.1 The wires shall be drawn from the wire rods conforming to IS:7887-1975 or the latest version thereof.

4.2 The requirements for chemical composition for the wires shall conform to IS:7887.

- 4.3** The wires shall be sound, free from split surface flaws, rough jagged and imperfect edges and other detrimental defects on the surface of the wires.

5. GALVANISING

The wires shall be galvanised with ‘Heavy Coating’ as per IS:4826-1979 or the latest version thereof.

6. GRADES

GI wires shall be classified into two grades based on their tensile strength :

Grade	Tensile Strength (MPa)
Annealed	300-550
Hard	550-900

7. TOLERANCE IN DIAMETER

The tolerance on nominal diameter at any section of wire shall not exceed (±)2.5%. Further, the maximum difference between the diameters at any two cross-sections of wires shall not exceed 2.5%.

8. TESTS

The following tests shall be carried out in accordance with IS:280-1978 or the latest version thereof as per sampling criteria stipulated therein :

- i) Dimensional check (dia) - refer clause 7 above.
- ii) Visual inspection regarding freedom from defects refer clause 4.3 above.
- iii) Tensile test
- iv) Wrapping test (for wire diameters smaller than 5mm)
- v) Bend test (for wire diameters 5mm only)
- vi) Coating test - refer clause 5 above
- vii) Chemical composition

9. PACKING

The wires shall be supplied in 50-70 kg. coils, each coil

having single continuous length. Each coil of wire shall be suitably bound and fastened compactly and shall be protected by suitable wrapping.

10. MARKING

Each coil shall be provided with a label fixed firmly on the inner part of the coil bearing the following information :

- a) Manufacturer's name or trade mark
- b) Lot number and coil number
- c) Size
- d) Grade (Annealed or Hard)
- e) Mass
- f) Length
- g) ISI Certification mark, if any

55. Hot Dip Galvanised GS Solid Wire

The hot dip galvanized MS Solid wire of sizes 5 mm, 4 mm and 3.15 mm diameters shall conform to the relevant ISS specification, briefed here below: -

1) MATERIAL

The Mild Steel wire shall have the chemical composition maximum sulfur - .055%, Phosphorus – 0.055%, Carbon 0.25%. Zinc shall conform to grade Zen 98 specified in IS 209-1966 & IS: 4826-1979 with up to date amendments.

2) ZINC COATING

Zinc coating shall be in accordance with IS: 4826-1979 (Col.4.2.1) for heavily coated hard quality.

3) GALVANISING

Galvanizing shall be as per IS 2629-1966, IS: 4826-1979 with up to date amendments.

4) UNIFORMITY OF ZINC COATING

Uniformity of Zinc coating shall be as per IS 2633-1972 (Col.4.2.1 to 4.2.3) with up to date amendments.

5) TENSILE PROPERTIES

The tensile strength of the wire after, galvanizing shall be between 55-95 Kg/Sq.mm (heavily coated Hard as per IS: 4826-1979 Tables-1) ensuring MS wire Mechanical properties as per IS-28-1972 8.1 to 8.3.

6) FREEDOM FROM DEFECTS

As per IS 2629-1966 (Cl.6.1) & 4826-1979 (Col.4.3) & with up to date amendments, be ensured.

7) TESTS

During the process of manufacture/ fabrication and finish all tests for chemical, mechanical, galvanizing as per IS-280-1979, IS: 1521-1972, IS1755-1961, IS: 6745-1972 & 4826-1979 be carried out. Test certificate towards, chemical composition (as per above) shall be submitted for each lot offered for inspection.

The following tests shall be conducted in presence of owner's representative.

1. Visual Physical inspection and measurement of specified dimensions.
2. Coating test as per IS-1755-1961, IS: 2629-1966, IS: 2633-1972, IS: 4826-1969 & 1979 – IS: 6745-1972.
3. Adhesion test as per IS: 1755-1961, IS: 2629-1966, IS: 2633-1972, IS: 4826-1969 & 1979 – IS: 6745-1972.
4. Tensile strength and breaking load and elongation determined as per IS 1521-

1972 with up to date amendments.

8) PACKING

Packing shall be as per IS 280-1979 (Col.3.1) and each coil shall be between 50-100 Kg.

9) **MARKING**

As per IS: 280-1972 (Col.14.1 & 14.1.1) is required.

56. Material Properties and Other Technical Requirements for Heat Shrinkable Cable Terminations and Joints Suitable for XLPE Cables.

- 1) **GENERAL:** The term heat shrink refers to extruded or moulded polymeric materials which are cross linked to develop elastic memory and supplied in expanded or deformed size or shape.
- 2) **QUALIFYING EXPERIENCE:** The kits should have satisfactory performance record in India in excess of 5 years supported with proof of customers having had satisfactory use of these kits in excess of 5 years.
- 3) **TYPE TEST REPORTS:** The Joints and terminations should have been type tested and type test reports made available.
- 4) **KITS CONTENTS :** The Kits should generally consist of:
 - (a) Heat shrinkable clear insulating tubes
 - (b) stress control tubing where necessary,
 - (c) Ferrule insulating tubing for joints,
 - (d) Conductive cable break outs for terminations, non tracking, erosion and weather resistant tubing both outer / inner
 - (e) non tracking erosions and weather resistant outdoor sheds in case of terminations
 - (f) high permittivity mastic wedge
 - (g) Insulating mastic.
 - (h) Aluminium crimping lugs of ISI specification.
 - (i) Tinned copper braids
 - (j) Wrap around mechanical protection for joints.
 - (k) Cleaning solvents, abrasive strips.
 - (l) Plumbing metal.
 - (m) Binding wire etc. adequate in quantity and dimensions to meet the service and test conditions.

The kit shall have installation instructions and shall be properly packed with shelf life of over 3 years.

57. Technical Specification of 66/11 KV Sub-station

1. General

This specification covers the design, manufacture, assembly; shop testing, supply, delivery, installation works and field test of the Power Transformers complete with all accessories, fittings and auxiliary equipment for trouble free operation. The transformers shall be oil immersed and suitable for outdoor installation and shall comply with IEC 76/IS 2026.

2. Design requirements

The transformers shall be connected to three phase 50 Hz system of 66 kV systems.

The transformer shall be installed outdoor. The transformer shall be oil immersed and designed for the cooling system as specified in Appendix-A.

The transformers shall be capable of operating continuously at its rated output without exceeding the temperature rise limits as specified in Appendix-A.

The transformer windings shall be designed to withstand short circuit stresses at its terminal with full voltage maintained behind it for a period as per IEC-76.

The transformer shall be capable of continuous operation at the rated output under the following conditions:

- a) The voltage varying $\pm 10\%$ of rated voltage.
- b) Frequency varying $\pm 5\%$ of the rated frequency.

The transformer shall be capable of delivering its rated output at any tap position.

The transformer shall be free from annoying hum and vibration when in operation even at 10% higher voltage over the rated voltage. The noise level shall be in accordance with respective IEC standards.

The transformer shall be designed and constructed so as not to cause any undesirable interference in radio or communication circuits.

The Transformer Secondary terminal shall be adequately designed for terminating two runs of 1CX800 sqmm cable (to be customized by utility) to it, with the help of appropriate size Outdoor Termination Kit. The cable shall be supported on a structure.

3. Construction features

3.1 Tank

The tank shall be of all welded construction and fabricated from sheet steel of adequate thickness. All seams shall be properly welded to withstand requisite impact during short circuit without distortion. All welding shall be stress relieved.

Stiffener of structural steel for general rigidity shall reinforce the tank wall. The tank shall have sufficient strength to withstand without any deformation by mechanical shock during transportation and vacuum filling in the field.

The tank cover shall be bolted on the tank with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible metallic stops shall be provided to prevent over compression. Bushings, turrets, cover of access holes and other devices shall be designed to prevent any leakage of water into or oil from the tank. The tank cover shall also be provided with two (2) nos. grounding pads and connected separately to tank grounding pads.

The transformer tank shall be provided with sets suitable transporting arrangement

All heavy removable parts shall be provided with eye bolts for ease of handling and necessary lugs and shackles shall be provided to enable the whole transformer to be lifted by a crane or other means. Manholes of sufficient size shall be provided for access to leads, windings, bottom terminals of bushings and taps.

3.2 Core & Coils

The transformer may be of core or shell type. The core shall be built up with interleaved grade non-ageing, low loss, high permeability, grain-oriented, cold rolled silicon steel lamination properly treated for core material. The coils shall be manufactured from electrolytic copper of suitable grade. They should be properly insulated and stacked.

All insulating material shall be of proven design. Coils shall be so insulated that impulse and power frequency voltage stresses are at a minimum.

Insulating spacers and barriers shall suitably support coil assembly. Bracing and other insulations used in the assembly of the winding shall be arranged to ensure a free circulation of the oil and to reduce the hot spot of

the winding.

All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used where practicable.

The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer of under short circuit stresses.

3.3 Tappings

Off load / on-load taps as specified in Appendices shall be provided on the high voltage winding of the transformers.

The transformer shall be capable of operation at rated output at any tap position provided the primary voltage does not vary by more than $\pm 10\%$ of the rated voltage corresponding to the normal tap.

The winding, including the tapping arrangement, shall be designed to maintain the electromagnetic balance between H.V. and L.V. winding at all voltage ratios.

3.4 On Load Tap Changer (OLTC)

The continuous current rating of the tap changer shall be based on connected winding rating and shall have liberal and ample margin. Lower rated tap changers connected in parallel are not acceptable.

The tap changing mechanism shall be located in an oil filled compartment separated from the main tank by a suitable oil tight barrier. The oil in OLTC compartment shall have its own separate oil preservation system complete with conservator, Buchholz relay/oil surge relay, breather, shut-off valves, oil level gauge, gas vent etc. However, one segregated compartment of the main conservator tank may be utilized for OLTC oil preservation.

3.5 Remote/local Tap Operation

The on-load tap changing equipment shall have the provision for mechanical and electrical control from a local position. For local mechanical operation, the operating handle shall be brought outside the tank for operation from floor level with provision to lock the handle in each tap position.

In driving mechanism cubicle

- "RAISE-LOWER" control switch
- Means for manual operation when power supply is lost

- Tap change operation counter

The OLTC should be designed to be controlled from the remote. The remote OLTC panel with the switching and control devices shall be provided in the switchgear room.

3.6 Insulating Oil

The insulating oil shall conform to the latest revision of IS 335/IEC publication 296, properly inhibited for preventing of sludging.

The necessary first filling of oil shall be supplied for the transformer in non-returnable container suitable for outdoor storing. Ten percent (10%) excess oil shall also be provided to take wastage into account.

3.7 Oil Preservation System

Oil preservation shall be by a means of conservator tank or by a sealed tank system.

a) Conservator Tank System

- 1) The conservator tank shall be mounted on a bracket fixed on the tank.
- 2) The conservator tank shall be provided with two compartments, one for the main transformer tank while the other for the OLTC compartment. The partition barrier shall be provided so that OLTC oil shall not be mixed up with the transformers oil under any circumstances.
- 3) One compartment shall be connected with the main transformer tank by pipes through double float Buchholz Relay (gas operated relay) with valves at both ends.
- 4) The other compartment shall be connected with the OLTC compartment by pipes through single float Buchholz Relay/Oil Surge Relay with valves at both ends.
- 5) Contact of the oil in the compartment for the main tank with atmosphere shall be prohibited by using a flexible urethane air cell. The cell shall be vented in to the atmosphere through a silica gel breather and shall inflate or deflate as oil volume changes.
- 6) Both compartments shall be provided with their own breather, filler cap and drain plug.
- 7) Each compartment of the conservator shall be provided with a dial type level indicator visible from the ground level and fitted with a low oil level alarm contact. Plain oil level gauge shall also be provided to each compartment.

3.8 Temperature Indicators

One set of winding temperature indicators shall be supplied and fitted locally so as to be readable at a standing height from ground level. Necessary current transformer and heating coil for obtaining thermal images of winding temperatures and a detector element shall be furnished and wired.

The above winding temperature indicator shall be provided with necessary contact to take care of the following:

- (a) Starting of cooling units with rise of temperature
- (b) Alarm on high temperature
- (c) Trip on higher temperature

One set of oil temperature indicator with maximum reading pointer and electrically separate sets of contacts for alarm and trip shall be mounted locally so as to be readable at a standing height from ground level

3.9 Buchholz relay (Gas operated relay) – (For conservator type of oil preservation)

The Buchholz relay shall be provided with two floats and two pairs of electrically separate contacts – one pair for alarm and the other pair for tripping.

3.10 Transformer Bushings

Transformer bushing at 11 kV side should be so designed to accommodate two no. 800 sq.mm. aluminium (1C) cable (utility to customize based on actual requirement and rating of transformer) with secondary inter phase clearance. All bushings shall conform to the requirements of the latest revisions of IEC publication 137.

The bushings shall be located so as to provide minimum electrical clearances between phase and ground as per relevant IS/IEC standards.

All bushings shall be porcelain type and shall be furnished complete with terminal connectors of adequate capacity. The porcelain used in bushings shall be homogeneous, nonporous, uniformly glazed to brown color and free blisters, burns and other defects.

Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.

Bushings rated 66 kV and above shall be of the oil-filled condenser type with a central tube and draw-in-conductor which shall be connected to the connector housed in the helmet of the bushings.

Liquid/oil-filled bushings shall be equipped with liquid level indicators and means for sampling and draining the liquid. The angle of inclination to

vertical shall not exceed 30 deg. Oil in oil-filled bushings shall meet the requirements of the transformer oil standards specified.

3.11 Marshalling Box

A sheet, steel weatherproof marshalling box of IP-55 construction shall be provided. The box shall contain all auxiliary devices except those which must be located directly on the transformer. All terminal blocks for external cable connections shall be located in this box.

The marshalling box shall have the following but not limited to them:

- a) Load disconnect switch for incoming power supply for auxiliaries.
- b) AUTO-MANUAL selector switch and Local/Remote switch for OLTC
- c) Wiring and termination individually of the following alarm contacts for remote trip and alarm.
 - Buchholz relay alarm for main tank (For conservator type).
 - Buchholz/oil surge relay alarm for OLTC.
 - Winding temperature high alarm.
 - Oil temperature high alarm.
 - Tank oil level low alarm.
 - OLTC oil level low alarm.
 - Tap change incomplete alarm.
- d) Wiring and termination individually of the following trip contact for remote trip and trip alarm.
 - Winding temperature high trip.
 - Oil temperature high trip.
 - Buchholz relay trip or sudden gas and sudden oil pressure relay trip.
 - Pressure relief device.

Cubicle illumination lamp with door switch and space heater with thermostat and ON-OFF switch shall be provided.

3.12 11 kV Cable Termination

Adequate support structure with necessary cable support system shall be provided for termination of two (2) 800 sq.mm. XLPE cable/phase on the 11 kV bushings (utility may customize based on actual requirement and rating of transformer). Adequate interphase barrier to be provided between the bushings. Suitable arrangement shall be provided for installation of 11kv surge arrestor near the bushing termination.

3.13 Auxiliary Supply

All indications alarms and trip contacts provided shall be suitable for operation on a nominal 220V DC system for 66 kV Class Transformers.

Tap changing gear shall be suitable for operation of 430V, 3 phase, 4 wire, 50 Hz systems.

Cooling fans shall be rated at 430 V, 3 phase, 50 Hz.

The tap changing and cooler control supply voltage shall be 230V, Single phase 50 Hz.

3.14 Current Transformers

The scope includes the supply and installation of neutral current transformers and all necessary wiring to terminal blocks at the transformer-marshalling kiosk. The specification of requirements for current transformers shall be established and co-coordinated with the 66 kV bay CT and 11 kV switchgear CT.

Neutral current transformers are to be mounted inside the transformer and shall be easily accessible for testing.

3.15 Cooler Control Scheme

The bidder shall design and supply the required cooler control scheme with necessary fans and control gear. One no fan shall be provided as stand by.

4. Tests

The following tests shall be performed

- i) Insulation resistance tests on bushings.
- ii) Insulation resistance test at 500V between core and core clamping structure.
- iii) Voltage withstand tests on insulating oil to BS:148.
- iv) Voltage ratio.
- v) Phase relationship/Vector Group.
- vi) Magnetisation characteristics of current transformers of winding temperature devices.
- vii) Calibration of winding temperature devices.
- viii) Tap selector and diverter switch alignment.
- ix) Calibration of automatic voltage control equipment.
- x) Proving tests as necessary on control schemes.
- xi) Proving tests of buchholz device by air injection.
- xii) Impedance voltage at highest rated and lowest voltage tap.
- xiii) Zero sequence impedance at rated voltage tap.

- xiv) DC resistance at all voltage taps.
- xv) Core balance test.
- xvi) Tan delta-capacitance test on bushings (66kV).
- xvii) Tan delta-capacitance test on transformer.

5. Losses at 75 deg Celsius at rated voltage shall be not higher than the values indicated below (IS2026 along with latest amendments if any):

- a) No load losses (Iron losses): 15 MVA- 10 kW, 20 MVA -12 kW
- b) Full load (Copper losses + stray losses) losses: 15 MVA-56 kW, 20 MVA- 69 kW

6. Tender evaluation & capitalization of transformer losses

Conditions of contract at Part - 3 may be referred for this.

The minimum loss indicated by any of the bidder will be taken as a base for computing any Liquidated damages for non-performance of the equipment and LD shall be levied as per GCC clause 24.1, 24.2 and corresponding clause 11 and 12 at SCC.

7. Performance guarantee

The performance figures quoted on Technical Data Sheet shall be guaranteed within the tolerances permitted by standards IS 2026 & IEC 76 and will become a part of the successful Bidder's Contract.

8. Drawings, data & manuals

Submission of Drawings, Data & Manuals by the Bidder along with the tender Document and that after the award of contract for approval shall be as follows:

- a) The following drawings and details shall be furnished along with the Tender.
 - 1) Bidder's proposed typical general arrangement drawing showing constructional features of:
 - Tank including conservator, level gauge, etc.
 - Bushing configuration arrangement
 - Cable termination arrangement
 - Wheel base dimension and detail
 - Head clearance required for detanking of coil assembly.
 - 2) Test certificates of similar transformer as quoted.

- 3) Technical leaflets on accessories such as:
 - Buchholz relay, sudden gas pressure/oil pressure relay
 - Temperature indicators
 - Tap changer
 - High/Low voltage bushings

b) After Award of Contract

After award of contract, the successful Bidder shall submit the required number of copies of following data for approval.

- 1) Outline dimensional drawing showing the general arrangement, indicating the space required for:
 - Cable termination arrangement
 - Wheel base dimension & detail
- 2) Head clearance required for detanking of core and coil assembly.
- 3) Foundation plan and loading.
- 4) Transport/shipping dimension with net weight and weights of various parts.
- 5) Final calculation of impedance for each transformer.
- 6) Schematic flow diagram of cooling system showing the number of cooling units, etc.
- 7) Technical details along with control schematic and wiring diagram for marshalling box, remote tap changer control panel.
- 8) Short circuits withstand capacity design calculation.

Any other relevant data, drawing and information necessary for review of the items whether specifically mentioned or not, shall be furnished along with this information.

The general arrangement drawing, the schematic wiring diagram showing the control scheme, cable termination arrangement, location of terminal blocks, etc., shall be submitted for comment/approval. The Employer/Engineer will return these drawings after their review with their comments and/or approval. The review and comments will generally be made on the schematic diagram drawing and the configuration and the arrangement of the accessories fitted on the transformer. The Bidder on receipt of their returned drawings, with comments from the Employer/Engineer, shall prepare final wiring diagram. The outgoing terminals of the wiring diagram shall be specifically indicated for different

functions, such as closing, tripping, alarm, indication, etc. The responsibility for correctness of the wiring diagram shall lie with the Bidder.

Employer/Engineer will only check the final schematic diagram after submission. If any modification, addition or alternation is considered necessary thereon to comply with the Employer/Engineer approved schematic drawing stated hereinabove, the said modification, addition or alternation shall be carried out by the Bidder either in their works if it is before delivery or at site after delivery at no cost to the Employer.

9. Nameplate

Each transformer shall be provided with a nameplate of weather resistant material fitted in a visible position showing but not limited to the following item:

- a) Kind of transformer
- b) Number of the specification
- c) Manufacturer's name
- d) Year of manufacture
- e) Manufacturer's serial number
- f) Number of phases and frequency
- g) Rated power
- h) Rated voltages and currents
- i) Connection symbol
- j) Impedance voltage at rated current
- k) Type of cooling
- l) Total weight
- m) Weight of insulating oil
- n) Class of insulation
- o) Temperature rise
- p) Connection diagram
- q) Insulation levels
- r) Weight of transportation and untanking
- s) Details regarding tapping's

10. Transportation

The core and coils shall be completely dried before shipment and assembled with tank and with oil or dry nitrogen depending upon the size of the transformers. In order to facilitate handling and shipping, as many

external accessories as practical, including bushings shall be removed and replaced by special shipping covers.

Bushings, radiators and other accessories which may be affected by moisture shall be packed in moisture proof containers.

CODES & STANDARDS (refer Clause 1 of this Part-2, Power Transformer Specification)

APPENDIX-A TECHNICAL PARTICULARS OF 66/11 kV TRANSFORMER

1	Rating ONAN	12.5 MVA, 15 MVA
	ONAF	20 MVA
2	Voltage Ratio	66/11.5 kV
3	Percentage impedance (at nominal Tap) voltage at 20 MVA and 75 deg. C	As per IS
4	Service	Outdoor
5	Type	Oil-immersed
6	Type of cooling	ONAN/ ONAF
7	Temperature rise above 50 deg. C ambient temperature	
	a) In oil by thermometer	45 deg. C
	b) In winding by resistance	55 deg. C
8	Number of phase and frequency	3 phase, 50 Hz
9	Maximum voltage	
	a) Primary	72 kV
	b) Secondary	12 kV

10	Rated voltage (line to line)			
	a)	Primary		66 kV
	b)	Secondary		11 kV
11	Insulation level of winding			
	a)	Basic impulse level as per IEC		
		76		
		-	Primary	325 kV
		-	Secondary	75 kV
	b) Power frequency induced over voltage (1 min.)			
			- Primary	140 kV
			- Secondary	28 kV
12	Connection			
	a) Primary		Delta	
	b) Secondary		Star	
13	Vector group reference			
	Primary – Secondary		Dyn11	
14	Type of tap changer	On-load, full capacity		
15	Taps provided on	HV Winding		
16	Range of taps	-10 To 10%		
17	Number of taps	9		
18	Method of tap change control			
	Mechanical local	Yes		
	Electrical local	Yes		
	Electrical remote with “AUTO-MANUAL” selection	yes		
19	System grounding			
	a) Primary	Solidly grounded		
	b) Secondary	Solidly grounded		

20	System fault level	31.5 kA at 66 kV
21	Neutral terminals a) Primary	Yes
22	Neutral CT a) LV SIDE Neutral CT Details CT TYPE LV 5P20 PS	2- CORE (One-PS, One – 5p20) NEUTRAL CT RATIO:1600/1 RATIO: 1600/1 Vk=800V Rct+2Rl<10

POWER TRANSFORMERS

APPENDIX-B : TRANSFORMER ACCESSORIES

The transformer furnished under this specification shall be equipped with the following:

- *1. Oil conservator with two compartments each with filler caps and drain plugs.
- *2. Two sets of silica gel breathers with connecting pipe and oil seal.
- *3. Air release plug.
- *4. Double float Buchholz Relay with electrically separate trip and alarm contacts for transformer tank.
- *5. Two Nos. of shut-off valves at both sides of each Buchholz Relay.
- **6. Sudden oil pressure relay with trip contact.
- **7. Sudden gas pressure relay with trip contact.
- **8. Pressure vacuum bleeder.
- 9. Mechanically operated self-resetting type pressure relief device with visible operation indicator and trip contact.
- 10. One (1) no. 150 mm Dial Magnetic oil level gauge with low level alarm contact (one for main tank and one for OLTC).
- 11. Direct Reading Plain oil level gauge-two (2) Nos.
- 12. 150 mm Dial oil Temperature indicator with maximum reading pointer and individually adjustable electrically separate sets of contact for alarm and trip.
- 13. 150 mm Dial Winding Temperature Indicator with individually adjustable electrically separate sets of contact for two stage cooler control, alarm and trip with detector element complete with heating coil, CT's etc.
- 14. Single float Buchholz Relay/Oil Surge Relay with alarm contact for OLTC.
- 15. Drain valve with threaded adaptor.
- 16. Sample valve (top and bottom)
- 17. Filter valves with threaded adaptor (top and bottom)
- 18. Manhole of sufficient size for access to the interior of the tank.
- 19. Cover lifting eyes.
- 20. Jacking pads, hauling and lifting lugs.
- 21. Bi-directional flanged wheels.

22. Skids.
23. Clamping device with nuts and bolts for clamping the transformer on foundation rails.
24. Ladder with safety device for access to the transformer to and Buchholz Relay.
25. Two (2) Nos. grounding pads each with two (2) Nos. tapped holes, bolts and washers for transformer tank, radiator bank and cable-end box grounding.
26. Rating plate and terminal marking plate.
27. Marshalling box for housing control equipment and terminal connections.
28. Cooling system complete with isolation valves and all necessary accessories.
29. HV and LV termination arrangement suitable for termination of cables.
30. Neutral bushing complete with connections.
31. One no PRV.
 - * For conservator type of oil preservation system.
 - ** For sealed tank type of oil preservation system.

58. 66 kV CIRCUIT BREAKER (OUTDOOR TYPE)

1. General

66 kV Circuit Breakers shall be outdoor type, comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to IEC-62271-100 or equivalent Indian Standard.

2. Duty requirements

- 2.1 Circuit breaker shall be suitable for 3 phase, 50 Hz, 66 kV System. The circuit breaker shall meet the duty requirement of any type of fault or fault location, when used on 66 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.
- 2.2 The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC:62271-100.
- 2.3 The circuit breakers shall be reasonably quiet in operation. Noise level in excess of 140 dB measured at base of the breaker would be unacceptable. Bidder shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.
- 2.4 The Bidder may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic pressure and arc extinguishing medium pressure, etc.
- 2.5 While furnishing particulars regarding the D.C. component of the circuit breaker, the Bidder shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation.
- 2.6 The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated.
- 2.7 All the duty requirements specified above shall be provided with the support of adequate test reports to be furnished along with the bid.

3. Principle Technical Parameters: - The SF6 gas Circuit Breakers covered in this specification shall meet the technical requirement listed hereunder.

1	Type of circuit breaker	Outdoor SF6 type
2	Rated frequency	50 Hz
3	Number of poles	Three (3)
4	Reclosing duty cycle	O - 0.3 Sec. - CO – 15 Sec.-CO

5	Rated short circuit breaking current at rated voltage	31.5 kA with percentage of DC component as per IEC56 corresponding to minimum opening time under operating conditions specified
6	Symmetrical interrupting Capability	31.5 kA rms
7	Short time current carrying Capability	31.5 kA rms for one (1) second
8	Rated normal current in amps.	800A (utility to customize based on actual requirement)
9	Total break (opening time)	60 m sec. (3 cycles)
10	Reclosing	Three phase high speed auto reclosing (as required)
11	Total closing time	100 ms
12	Trip and closing coil voltage	As per substation D.C. Voltage
13	Auxiliary contacts	As required plus 8NO and 8NC contacts per pole as spare. The contacts shall have continuous rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V DC (Typ.)
14	Temperature rise over Ambient	As per IEC:62271-100
15	Type of operating mechanism	Spring charging
16	Rated ambient temperature	50 deg. Centigrade
17	Seismic acceleration	0.3g horizontal
18	Rated voltage	66 kV (rms)
19	Rated one minute power frequency withstand voltage (Dry and Wet)	170 kV rms
20	Rated lightning impulse withstand voltage (1.2/50 Micro-Sec.)	325 kVp
21	No. of Terminals in common control cabinet	All contacts to be wired to common control cabinet with 24 extra terminal blocks.

4. Constructional features

- 4.1 All making and breaking contacts shall be sealed and free from atmospheric effect. In the event of leakage of extinguishing medium to a value, which cannot withstand the dielectric stresses specified in the open position, the contacts shall preferably self-close. Main contacts shall be first to close and the last to open and shall be easily accessible for inspection and replacement. If

there are no separately mounted arcing contacts, then the main contacts shall be easily accessible for inspection and replacement. Main contacts shall have ample area and contact pressure for carrying the rated current under all conditions. The interrupter sectional drawing showing the following conditions shall be furnished for information with the bid:

- a) Close position
- b) Arc initiation position
- c) Full arcing position
- d) Arc extinction position
- e) Open position.

4.2 All the three poles of the breaker shall be linked together electrically.

4.3 Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.

5. Sulphur hexafluoride (SF₆) gas circuit breaker

5.1 Circuit breakers shall be single pressure type.

5.2 Design and construction of the circuit breaker shall be such that there is minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF₆ gas on insulated surfaces of the circuit breaker.

5.3 In the interrupter assembly, there shall be absorbing product box to eliminate SF₆ decomposition products and moisture. The details and operating experience with such filters shall be brought out in additional information schedule.

5.4 Each pole shall form an enclosure filled with SF₆ gas independent of two other poles. Common monitoring of SF₆ gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF₆ gas from one pole could be removed for maintenance purposes.

5.5 Material used in the construction of circuit breakers shall be such as fully compatible with SF₆.

5.6 The SF₆ gas density monitor shall be adequately temperature compensated to model the density changes due to variations in ambient temperature within the body of circuit breaker as a whole. It shall be possible to dismantle the monitor without removal of gas.

5.7 Sufficient SF₆ gas shall be supplied to fill all the circuit breakers installed plus an additional 10% of the quantity as spare.

6. Operating mechanism

6.1 Circuit breaker shall be operated by electrically spring charged mechanism.

6.2 The operating mechanism shall be anti-pumping and trip free (as per IEC

definition) electrically and either mechanically or pneumatically under every method of closing. The mechanism of the breaker shall be such that the position

of the breaker is maintained even after the leakage of operating media and/or gas.

- 6.3 The operating mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operated closing devices. A mechanical indicator shall be provided to show open and close positions of breaker. It shall be located in a position where it will be visible to a man standing on the ground with the mechanism housing door closed. An operation counter shall also be provided.
- 6.4 Closing coil shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful operation for similar applications of outdoor breaker shall be clearly brought out in the bid.
- 6.5 Working parts of the mechanism shall be of corrosion resisting material. Bearings requiring grease, shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.
- 6.6 Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. 'Local/remote' selector switches and closes & trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided.
- 6.7 Operating mechanism and all accessories shall be in local control cabinet. A central control cabinet for the three poles of the breaker shall be provided along with supply of necessary tubing, cables, etc.
- 6.8 Provisions shall be made on breakers for attaching an operation analyser to perform speed tests after installation at site to record contact travel against time and measure opening time.
- 6.9 The Bidder shall furnish curve supported by test data indicating the opening time under close-open operation with combined variation of trip coil and operating media along with the bid.

6.10 Spring Operated Mechanism

Spring operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. Opening spring shall be supplied with limit switch for automatic charging and other necessary accessories.

As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate

thermal rating for this duty. After failure of power supply to the motor, one

close-open operation shall be possible with the energy contained in the operating mechanism.

Breaker operation shall be independent of the motor, which shall be used solely for compressing the closing spring.

Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring.

Closing action of the circuit breaker shall compress the opening spring ready for tripping.

When closing springs are discharged, after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.

The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

6.11 Fittings and Accessories

6.11.1 Following is list of some of the major fittings and accessories to be furnished as integral part of the breakers. Number and exact location of these parts shall be indicated in the bid.

6.11.2 **Control unit/Central control cabinet** shall be complete with:

- a) Double compression type cable glands, lugs, ferrules, etc.
- b) Local/remote changeover switch
- c) Operation counter
- d) Fuses, as required
- e) Anti-pumping relay/contactors
- g) Rating and diagram plate in accordance with IEC including year of manufacture, etc.
- h) Gauges for SF₆ gas pressure.
- i) Gas density monitor with alarm and lockout contacts

7. Fittings and accessories

7.1 Hollow insulator columns

All routine tests shall be conducted on the insulators as per relevant IEC. In addition the following routine tests shall also be conducted on hollow column insulators:

a. Ultrasonic test

- b. Pressure test
- c. Bending load test in 4 directions at 50% specified bending load.
- d. Bending load test in 4 directions at 100% specified Bending load as a sample test.
- e. Burst pressure test as a sample test.

7.2 Support Structures

The minimum height of equipment supports shall be 3050 mm. The height of center line shall be as given elsewhere in the specification.

7.3 Terminal connectors

Compression joint type terminal connectors suitable for single or twin ACSR panther/zebra/Moose conductor shall be supplied and they shall be suitable for both vertical and horizontal connections of the Transmission line conductor or station bus bar. Suitable terminal earth connectors (two Nos.) for earthing connections shall also be supplied. The drawings for these connectors shall be submitted.

The terminal connectors shall meet the following requirements:

- a) Terminal connectors shall be manufactured and tested as per IS:5561.
- b) All castings shall be free from blow holes, surface blisters, cracks and activities. All sharp edges & corners shall be blurred and rounded off.
- c) No part of a clamp shall be less than 10 mm thick.
- d) All ferrous parts shall be hot dip galvanised conforming to IS:2633.
- e) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.
- f) Flexible connectors shall be made from tinned copper/ aluminium sheets.
- g) All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- h) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS:5561.

8. Tests

8.1 Type Test

Each circuit breaker shall comply with the type test and shall be subjected to

routine tests prescribed in latest edition of IEC-62271/IEC-60694/IS-13118.

Reports of all type tests as stipulated in IEC-62271, IEC-60694 or IS-13118 and line charging current and cable charging current and transformer charging & shunt capacitor switching current tests etc. as given below carried out by internationally recognized test laboratories shall be furnished. Supply from those original equipment manufacturers shall be accepted who are having type test certification for following test in past 5 years and the type and design of the breakers then intend to supply are exactly similar. The type test reports shall be produced in support of sub vender / vender of supply of breaker in quantity more than 25 the supplier shall conduct all following test free of charges in presence of Employer's representative.

In case some type tests are conducted at Manufacturer's own works, instead of at Govt. approved laboratory, the type test reports for same shall be accepted only if tenderer undertakes to conduct this type test free of charges in presence of Utility representative at time of inspection.

- i) Impulse withstand voltage test
- ii) Power frequency voltage withstand dry test on main circuit
- iii) Short circuit withstand capability test
- iv) Mechanical endurance test
- v) Temperature rise test
- vi) Radio interference voltage (RIV)
- vii) Measurement of the resistance of main circuit
- viii) Short time withstand current and peak withstand current test
- ix) Out of phase making & breaking test
- x) Shunt reactor current switching test
- xi) Dielectric test
- xii) IP-55 test on operating mechanism
- xiii) Seismic test
- xiv) Cable charging current switching test
- xv) Line charging current switching test
- xvi) Capacitor current switching test for isolated neutral capacitor banks.
- xviii) Degree of protection test on cubicles

8.2 Routine Tests

Routine tests as per IEC-60056 on the complete breaker/ pole along with its own operating mechanism and pole column shall be performed on all circuit breakers.

8.3 Acceptance tests:

The following acceptance tests as stipulated in the relevant ISS-13118 shall be carried out by the Manufacturer in presence of employer representative, unless

dispensed with in writing by the employer.

- i) Power frequency voltage withstand dry test on main circuit

- ii) Voltage withstand test on control and auxiliary circuits
- iii) Measurement of resistance of the main circuit
- iv) Mechanical operating test
- v) Design and visual test
- vi) Tightness Test

In addition to above, speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-re-closing and trip free operations under normal as well as limiting operating conditions (of control voltage) The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at make-break operation and dynamic contact resistance measurement (DCRM) etc. Also, results obtained in type test analysis as stipulated in clause 8.1 shall be examined for acceptance before release of dispatch clearance for the lot.

9. Completeness of equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

10. Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

59. 66KV ISOLATORS

1. General

The isolators and accessories shall conform in general to IEC-62271-102 except to the extent explicitly modified in specification.

Earth switches shall be provided on isolators wherever called for.

The isolators and earth switches shall be manually operated.

Complete isolator with all the necessary items for successful operation shall be supplied.

Isolators shall be gang-operated, double break or centre break.

2. Duty requirements

Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open under influence of short circuit current and wind pressure together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa.

In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met.

Castel lock type interlock mechanism shall be provided in addition to normal mechanical interlock for-

- (a) Breaker and isolator closing
- (b) Isolator and earth switch closing.

The isolator shall be capable for making/breaking normal currents when no significant change in voltage occurs across the terminals of each pole of the isolator on account of making/breaking operation.

3. Constructional features

The isolators shall be provided with high pressure current carrying contacts on the hinge/jaw ends and all contact surfaces shall be silver plated Copper alloy. The contacts shall be accurately machined and self-aligned. They shall be easily replaceable and shall have minimum movable parts and adjustments.

The isolator shall be provided with a galvanized steel base provided with holes and designed for mounting on a lattice/pipe support structure. The base shall be rigid and self-supporting.

All metal parts shall be of non-rusting and non-corroding metal. Current

carrying parts shall be from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities, if provided on current

carrying parts, shall be made of copper alloy or equivalent. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces.

The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations shocks or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals.

The insulator of the isolator shall conform to the requirements stipulated in relevant IS. Pressure due to the contact shall not be transferred to the insulators after the main blades close. The insulators shall be so arranged that leakage current will pass to earth and not between terminals of the same pole or between phases.

4. Clamps and connectors

The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.

The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.

Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

Current rating and size of terminal/conductor for which connector is suitable shall be embossed/punched on each component.

5. Earthing switches

Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall

form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be suitable for local operation only. The earthing switches shall be constructional interlocked

with the isolator so that the earthing switches can be operated only when isolator is open and vice versa.

6. Operating mechanism and control

The Manufacturer shall offer manual isolators and earth switches having padlock arrangement on both 'ON' and 'OFF' positions.

Limit switches for control shall be fitted on the isolator/earth switch shaft, within the cabinet to sense the open and close positions of the isolators and earth switches.

It shall not be possible, after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed.

Control cabinet/operating mech. Box shall conform to requirements stipulated in IS: 5039/IS 8623/IEC 439.

7. Operation

The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection.

The design of linkages and gears be such so as to allow one man to operate the handle with ease for isolator and earth switch.

8. Tests

In continuation to the requirements stipulated under Part-I the isolator along with operating mechanism shall conform to the type tests and shall be subjected to routine tests and acceptance tests in accordance with IEC-62271-102. Minimum 50 nos. mechanical operations will be carried out on 1 (one) isolator assembled completely with all accessories as acceptance test. During final testing of isolator, closing/ opening of earth switch shall also be checked after isolator is fully open/close. Acceptance test shall be carried out with operating box.

The insulator shall conform to all the type tests as per IEC-60168. In addition to all type, routine and acceptance tests, as per IEC-60168, the following additional routine/ acceptance tests shall also be carried out:

- a) Bending load test in four directions at 50% min. bending load guaranteed in all insulators.
- b) Bending load test in four directions at 100% min. bending load guaranteed on sample insulators in a lot.
- c) Torsional test on sample insulator of a lot.

The type test reports shall not be older than FIVE years and shall be valid up to expiry of validity of offer. The above additional lists if not conducted earlier,

shall be done under the subject project package at no extra cost.

9. Parameters

9.1. General (for General & 11 kV, refer Tech specification Section 6 of Part -2)

9.2. 66 kV Class Isolators (to be customized by utility as per requirements and capacity)

a)	Rated voltage	72 kV (rms)
b)	Rated continuous current	Minimum 800 A at rated ambient temperature
c)	Rated Insulation levels	
i)	Rated one minute power frequency withstand voltage	i) 140 kV (rms) between live terminals and earth. ii) 162 kV rms across isolating distance
ii)	Rated lightning impulse withstand voltage	i) ± 325 kVp between live terminals and earth ii) ± 325 kV rms across isolating distance
d)	Phase to phase spacing	2000 mm

10. Completeness of equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

11. Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

60. 66KV INSTRUMENT TRANSFORMERS (Utility to customize based on actual requirement)

1 Codes and standards

i)	Current Transformers	IEC 60044, BS:3938, IS: 2705
ii)	Voltage Transformers	IEC 60186, IEC 186A, IEC 60358, IS:3156
iii)	Insulating Oil	IS:335

2 General requirements

The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units.

The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.

Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

The insulators shall have cantilever strength of more than 600 kgf.

3 Current Transformers (CTs)

3.1. The CTs shall have single primary of either ring type or hair pin type or bar type.

3.2. In case of "Bar Primary" inverted type CTs, the following requirements shall be met.

3.3. The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.

3.4. The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.

3.5. The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome.

3.6. The insulator shall be one piece without any metallic flange joint.

3.7. The CT shall be provided with oil sight glass.

3.8. The core lamination shall be of cold rolled grain oriented silicon steel or

other equivalent alloys. The cores shall produce undistorted secondary current under transient conditions at all ratios with specified parameters.

3.9. Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.

3.10. The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

3.11. The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box.

3.12. The physical disposition of protection secondary cores shall be in the same order as given under CT requirement table(s) given below.

3.13. The CTs shall be suitable for high speed auto-reclosing.

3.14. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks inside the terminal box of degree of protection IP:55 at the bottom of CT.

3.15. The CTs shall be suitable for horizontal transportation.

4 Voltage Transformers (CVTs)

4.1. Voltage transformers shall be of capacitor voltage divider type with electromagnetic unit.

4.2. The CVTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens.

4.3. The electro-magnetic unit (EMU) shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.

4.4. The secondaries shall be protected by HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP:55. The access to secondary terminals shall be without the danger of access to high voltage circuit.

4.5. The damping device shall be permanently connected to one of the secondary winding and shall be capable of suppressing ferro-resonance oscillations.

4.6. A protective surge arrester/spark gap shall preferably be provided to prevent break down of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor, tuning reactor, RF choke, etc. due to short circuit in transformer secondary. The details of this arrangement (or alternative arrangement) shall be furnished by Bidder for Employer's review.

4.7. The accuracy of metering core shall be maintained through the entire burden range upto 100VA on all three windings without any adjustments during operations.

5 Marshalling box (CT/PT MB)

Marshaling box shall conform to all requirements as given in technical specification for LT Switchgear & DB. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box in such a manner so that it is visible and it does not deteriorate with time. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals.

6 Parameters for current transformers

(Utility to customize based on actual requirement)

a)	Rated primary current	800 A
b)	Rated dynamic current	80 kA (peak)
c)	One minute power frequency withstand voltage between secondary terminal and earth	5 kV
d)	Partial discharge level	10 Pico Coulombs max.
e)	Temperature rise	As per IEC 60044
f)	Type of insulation	Class A
g)	Number of cores	Five (5): Details are given in Table-I below.
h)	Rated frequency	50 Hz
i)	System neutral earthing	Effectively earthed
j)	Installation	Outdoor (up right)
k)	Seismic acceleration	0.3 g horizontal
l)	Rated short time thermal current	31.5 kA for 1 sec.

m)	Number of terminals in marshalling box	All terminals of control circuits wired upto marshalling box plus 10 terminals spare.
n)	Rated extended primary current	120% of rated primary current of 960A
o)	Rated system voltage (Um)	72.5 kV (rms)
p)	Rated insulation levels-	
i	1.2/50 micro-sec. impulse	±325 kVp
ii	One minute power frequency withstand voltage	140 kV rms

7 Parameters for voltage transformers (66 kV CVTs)

a)	Rated frequency	50 Hz
b)	System neutral earthing	Effective earthed
c)	Installation	Outdoor
d)	Seismic acceleration	0.3 g horizontal
e)	System fault level	31.5 kA for 1 sec.
f)	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement.
g)	High frequency capacitance for carrier frequency range	Within 80% to 150% of rated entire capacitance
h)	Equivalent resistance over entire carrier frequency range	Less than 40 ohms
i)	Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:60358
j)	One minute power frequency withstand voltage -	

a)	Between LV (HF) terminal and earth	5 kV rms for exposed terminals or 2.5kV rms for terminals enclosed in a weather proof box.
b)	For secondary winding	2 kV rms
k)	Temp. rise over an ambient temp. of 50 deg. C	As per IEC 60186
l)	Number of terminals in control Cabinet	All terminals of control circuits wired upto marshalling box plus 5 terminals spare.
m)	Rated total burden	100 VA
n)	Partial discharge level	10 Pico Coulombs max.
o)	Number of cores	As per details given in table-II below.
p)	Rated system voltage	72.5 kV (rms)
q)	Rated insulation levels -	
i)	1.2 micro sec. impulse	±325 kV (peak)
ii)	One minute power frequency withstand voltage	140 kVp
r)	HF Capacitance	4400 pF (nominal)

The location of core shall be as per protection SLD.

8 Tests

The current and voltage transformers shall conform to type tests and shall be subjected to routine tests in accordance with the relevant IS/IEC and shall also conform to the following additional type tests :

- i) Switching impulse withstand test.
- ii) Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic test circuit.
- iii) Seismic withstand test along with structure.
- iv) Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um).
- v) In addition to routine tests as per IEC/IS, measurement of partial discharge in continuation with power frequency withstand test required for 66 kV current transformer.

The type test reports shall not be older than FIVE years and shall be valid up to expiry of validity of offer. The above additional lists if not conducted earlier, shall be done under the subject project package at no extra cost.

9 Completeness of equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

10 Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

61. 66KV SURGE ARRESTORS

1. General (for 11 kV, refer Tech specification Section 6, Part 2)

The surge arrestors shall conform in general to IEC-60099-4 and IS:3070, Part-3 except to the extent modified in the specification and shall be in accordance with requirements under Part-I, shall be of ZnO gapless type.

Arrestors shall be hermetically sealed units, self-supporting construction, suitable for mounting on lattice type support structures.

2. Duty requirements

The Surge Arresters (SAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers and long lines.

The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. Values and calculations shall be furnished with offer.

The SAs shall be fully stabilised thermally to give a life expectancy of thirty (30) years under site conditions and take care of effect of direct solar radiation.

The SAs shall be suitable for circuit breaker duty cycle in the given system.

The SAs shall protect power transformers, circuit breakers, disconnecting switches, instrument transformers, etc. with insulation levels specified in this specification. The Bidder shall carry out the insulation coordination studies for deciding the rating and application of the SAs.

The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions.

3. Constructional features

Each Surge Arrester (SA) shall be hermetically sealed single phase unit.

The nonlinear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties.

SAs shall have pressure relief devices and arc diverting ports suitable for preventing shattering of porcelain housing and to provide path for flow of rated fault currents in the event of SA failure.

The SA shall not fail due to porcelain contamination.

Seals shall be effectively maintained even when SA discharges rated lightning current.

Porcelain shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto maximum design value for SA.

The end fittings shall be non-magnetic and of corrosion proof material.

The Bidder shall furnish the following:

- a) V-I characteristics of the disc/block.
- b) Metalizing coating thickness for reduced resistance between adjacent discs along with procedure for checking the same.
- c) Details of thermal stability test for uniform distribution of current on individual discs.
- d) Detailed energy calculations to prove thermal capability of discs.

4. Fittings and accessories

Each SA shall be complete with insulating base for mounting on structure.

SAs shall be provided with grading and/or corona rings as required.

Self-contained discharge counters, suitably enclosed for outdoor use (IP:55 degree of protection) and requiring no auxiliary or battery supply shall be fitted with each SA along with necessary connections to SA and earth. Suitable leakage current meters shall also be supplied in the same enclosure. The reading of milli-ammeter and counter shall be visible through an inspection glass panel to a man standing on ground. A pressure relief vent/suitable provision shall be made to prevent pressure build up.

5. Parameters

5.1 General

- | | | |
|----|--|--------------------------------|
| a) | System neutral earthing | - Effectively earthed |
| b) | Installation | - Outdoor |
| c) | Nominal discharge current | - 10 kA of 8/20 microsec. wave |
| d) | Rated frequency | - 50 Hz |
| e) | Long duration discharge class | - 3 |
| f) | Current for pressure relief test | - 31.5 kA rms |
| g) | Prospective symmetrical fault current | - 31.5 kA rms for 1 second |
| h) | Low current long duration test value (2000 micro sec.) | - As per IEC |

i)	Pressure relief class	-Class A of Table VII of IS:3070 or equivalent IEC.
j)	Partial discharge at 1.05 MCOV (Continuous operating voltage)	- Not more than 50 deg C.
k)	Siesmic acceleration	- 0.3 g horizontal
l)	Reference ambient temp.	- 50 deg. C

5.2 66 kV Class Surge Arrestor

a)	Rated system voltage	66KV
b)	Rated arrestor voltage	60 KV
c)	Minimum discharge capability	8 kJ/kV or corresponding to minimum discharge characteristics given whichever is higher.
d)	Continuous Operating Voltage (COV) at 50 deg. C	49 kV rms
e)	Max. switching surge residual voltage (1 kA)	165 kVp maximum
f)	Maximum residual voltage at	
i)	10kA nominal discharge current	180 kVp
ii)	20kA nominal discharge current	As per IEC
g)	High current short duration test value (4/10 microsec. wave)	100 kVp
h)	Min. Total creepage distance	1850 mm

- | | | |
|----|--|----------------------------|
| i) | One minute dry/wet power frequency withstand voltage of arrester housing | 140 kV (rms) |
| j) | Impulse withstand voltage of arrester Housing with 1.2/50 micro sec. wave. | ± 325 kVp |
| k) | RIV at 42 kV (rms) | Less than 1000 micro volts |

6. Completeness of equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

7. Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

62. 66 KV CABLE AND ACCESSORIES

1. Scope:

The scope under this section covers design, engineering, manufacture, testing, packing, supply of 66 KV, XLPE, insulated power cable for use with solidly grounded distribution systems. The XLPE cable and its accessories shall be complete with all fittings and components necessary for the satisfactory performance and ease of maintenance.

2. Standards:

Unless otherwise specified, the cables shall conform, in all respects, to IEC-502, IEC-60840 and IS: 7098 (Part-III) / 1993 with latest amendment or latest edition for cross linked polyethylene insulated Thermoplastic High Density Polyethylene sheathed cable for working voltage of 66 KV.

3. Climatic conditions:

The climatic conditions under which the cable shall operate satisfactorily are as follows:

a) Maximum ambient temperature of air in shade $^{\circ}\text{C}$	50
b) Minimum ambient temperature of air in shade $^{\circ}\text{C}$	4
c) Maximum daily average ambient temperature $^{\circ}\text{C}$	40
d) Maximum yearly average ambient temperature $^{\circ}\text{C}$	30
e) Maximum relative humidity %	95
f) Max. soil temp. at cable depth $^{\circ}\text{C}$	40
g) Max. soil thermal resistivity ohm-cm cm/watt	: 100-120 Deg C

4. Principal parameters:

4.1 66 KV (E) grade XLPE single core power cable of single length, with H.D. aluminium conductor, shielded with extruded semi-conducting layer, insulated with dry gas cured cross linked polyethylene (XLPE) insulation, insulation screened with extruded semi-conducting layer followed by semi-conducting non-woven water swellable tape, insulated core copper-wire, screened (suitable for 31.5KA for 1 sec) tapped with a combination of semi-conducting water swellable and poly aluminium laminated followed by black extruded Thermoplastic HDPE (Poly-ethylene) inner sheath. Single H.D. aluminium wire

armoured (suitable for 31.5KA for 1 sec) and graphite coating Thermoplastic HDPE outer sheathed overall cable, confirming to IEC-60840 for construction

and also confirming to IS : 7098 (Part-III) / 1993 or any latest amendments thereof.

4.2 Outer sheathing should be designed to afford high degree of mechanical protection and should also be heat, oil chemicals and weather resistant. Common acid. Alkalis and saline solution should not have adverse effect on the Thermoplastic HDPE sheathing material used.

4.3 The cable should be suitable for laying in covered trenches and / or underground for outdoor.

4.4. Cable parameters 66 KV (to be customized by utility as per requirements and capacity)

1	Voltage grade (Uo/U) KV	38/66
2	No. of cores	Single
3	Size (mm ²)	630
4	Nominal system voltage KV	66
5	Highest system voltage KV	72.5
6	System Frequency Hz	50
7	Variation in frequency	± 5 %
8	Fault level individually for	
9	Conductor	59.22 KA / 1 Sec.
10	Cu.screen	31.5 KA / 1 Sec.
11	Armour	31.5 KA / 1 Sec.
12	Maximum allowable temperature, deg c	
13	a) Design continuous operation at rated full load current, the max. temp. of conductor shall not exceed(deg c)	90
14	b) The conductor temperature after a short circuit for 1.0 sec. shall not exceed (deg c)	250
15	Basic insulation level.	
16	(1.2 / 50 Micro second wave)	350 kVp

17	1-min. power frequency withstand voltage	140 kV
18	System earthing	Solidly grounded

5 General technical requirements:

5.1 Conductor: The cable conductor shall be made from stranded H.D. aluminium to form compact circular shaped conductor having resistance within limits specified in IS: 8130 / 1984 and any amendment thereof. The conductor shall conform to IEC: 228 and the shape shall be compacted circular shaped.

5.2 Conductor shield: The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation; the semiconducting polymer shall be cross-linked.

5.3 Insulation: The XLPE insulation should be suitable for specified 66KV system voltage. The manufacturing process shall ensure that insulations shall be free from voids. The insulation shall withstand mechanical and thermal stressed under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cable shall be of high standard quality, generally confirming to IEC-60840 and I.S. 7098 part-III / 1993 (latest edition).

5.4 Insulation Shield: To confine electrical field to the insulation, nonmagnetic semi-conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion process. The XLPE insulation shield should be bonded type. Metallic screening shall be provided. The metallic screen shall be of copper wire having fault current capacity (31.5 KA for 1-sec.)

5.4 a) A semi-conducting non-woven water blocking tape shall be provided over the extruded semi conducting layer and over the copper wire metallic screen.

5.4 b) To avoid the ingress of moisture, poly-aluminium laminate tape shall be applied longitudinally with suitable overlap.

5.5 Inner-Sheath: The sheath shall be suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness, consistent quality and free from all defects. The sheath shall be extruded and of black Thermoplastic H.D.P.E. (Poly-ethylene).

5.6 Armour: Single H.D. Aluminium wire armouring shall be provided. The dimension of H.D. Aluminium wire armouring shall be as per latest IS:

3975/19988. The armour shall be having fault current capacity (31.5 KA for 1-sec.)

5.7 Outer Sheath: Extruded Thermoplastic HDPE outer sheath confirming to IEC: 502/1983, shall be applied over armouring with suitable additives to

prevent attack by rodents and termites. The outer sheath shall be coated with graphite throughout the length of cable.

5.8 Construction:

5.8.1 All materials used in the manufacture of cable shall be new unused and of finest quality. All materials should comply with the applicable provision of the tests of the specification. IS, IEC, CEA regulations, Indian Electricity Act and any other applicable statutory provisions rules and regulations.

5.9 Current Rating: The cable will have current ratings and derating factors as per relevant standard IEC.

5.9.1 The one-second short circuit current rating values each for conductor, screen & armour shall be furnished and shall be subject to the purchaser's approval.

5.9.2 The current ratings shall be based on maximum conductor temperature of 90 deg. C with ambient site condition specified for continuous operation at the rated current.

5.10 Operation:

5.10.1 Cables shall be capable of satisfactory operation under a power supply system frequency variation of $\pm 5\%$ voltage variation of $\pm 10\%$ and combined frequency voltage variation shall be $+10\%$ & -15% .

5.10.2 Cable shall be suitable for laying in ducts or buried under ground.

5.10.3 Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

5.11 Identification Marking: Identification of cables shall be 'provided externally at three meters' intervals to identify as under.

i) 'Name of manufacture'

ii) 'Per meter marking'

iii) 'Year of manufacture'

iv) 'Voltage grade' to be printed / embossed at the interval of one meter-length.

The identification, by printing or embossing shall be done only on the outer sheath. Name of the purchaser shall also be embossed.

6.0 Tests: (refer Tech specification Section 6, Part -2).

63. 66KV POST INSULATORS

1 General

The post insulators shall conform in general to latest IS:2544 and IEC-815.

2 Constructional Features

Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators shall be accepted. Height of post insulator shall be matched with the bus-bar and equipment line part elevation for required ground clearance.

The other requirements of insulator as given in technical specification of Auxiliary Items shall also be applicable.

3 Tests

3.1 In accordance with the stipulations under part-I the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS:2544, IEC-168 shall be carried out.

3.2 In addition to acceptance/sample/routine tests as per IS:2544, IEC-168, the following tests shall also be carried out.

- a) Ultrasonic tests on all cut shells as routine check.
- b) Visual examination and magnaflux test on all flanges prior to fixing.
- c) Check for uniformity of thickness and weight of zinc coating as a sample test from each lot of flanges prior to fixing.
- d) Bending load test shall be carried out at 50% minimum failing load in four directions as a routine test.
- e) Bending load in four directions at 100% minimum bending load guaranteed on samples as per clause-2.3 of IEC. Subsequently this post insulator shall not be used.
- f) Tests for deflection measurement at 20, 50, 70% of specified minimum failing load on sample.

3.3 The post insulator shall conform to following type tests as applicable according to voltage class:

- a) Switching Impulse withstand test (dry & wet)
- b) Lightning Impulse withstand test (dry)

- c) Power frequency withstand test (dry & wet)
- d) Test for deflection under load.

e) Test for mechanical strength,

4 Parameters

66 kV Class Bus Post Insulator

a)	Type		Solid core type
b)	Voltage class (kV)		66 kV
c)	Dry and wet one minute power frequency withstand voltage (kV)		140 kV
d)	Dry impulse withstand positive and negative (kVp)		±325kv
e)	Max. radio interference voltage (pV) for any frequency between 0.5 MHz at voltage of 42 kV (rms) between phase to ground.		1000
f)	Total min. cantilever strength (Kg)		600
g)	Min. torsional moment (Kg m)		As per IEC-273
h)	Total height of insulator (mm)		As per Requirement
	i)	Top p.c.d. (mm)	127
	ii)	Bottom p.c.d. (mm)	127
i)	No. of bolts :	Top	4
		Bottom	8
j)	Diameter of bolt holes (mm)		
	Top		M16
	Bottom		Dia 18
k)	Pollution level as per IEC – 815		Class III, Heavy
l)	Min. total creepage distance (mm)		1850

5 Completeness Of Equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the

satisfactory operation of the equipment, shall be deemed to have been included in this specification.

6 Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

1. Lighting

(refer Section 6, Part -2 for specifications)

2. LT Switchgear & DBS

(refer Section 6, Part -2 for specifications)

3. Battery & Battery Charger

(refer Section 6, Part -2 for specifications)

64. Control & Protection System For 66kv Sub-Station

1 Preamble

This specification is based on the understanding that the bidder shall supply and commission a completely integrated System for 66 kV Sub-station as-

1. Substation control system.
2. Substation protection system

2 General Requirements Of Control System

1. The Simplex panel shall be vertical and freestanding, floor mounted type with swinging door at the back of the panel.
2. The height and width of the panel shall be as per standard practices.
3. One panel should accommodate two bay controlling facilities.
4. Each bay control shall comprise of,
 - a. One wattmeter, one voltmeter with selector switch and one ammeter with selector switch, one varmeter.
 - b. One control switch having LED type red and green indication for breaker control.
 - c. Red /green LED type indication lamp for isolator indication.
 - d. Semaphore indicator for earth switch.
 - e. One synchronizing switch with key and sockets.
 - f. The bay control panel for transformer shall also include cut out for one no RWTL.
5. Annunciator with window type display shall be provided on each control panel for alarm annunciation. The display shall be of standard size and shall accommodate minimum two alarms simultaneously. The annunciator shall have accept, reset and test facilities.
6. The panel shall have the required control wiring. The wire shall be 1.5sqmm copper per connection. For CT connection only 2.5sqmm size cable per connection shall be used.
7. Necessary space heater, lighting arrangements shall be provided.
8. Independent transducer shall be provided for varmeter and wattmeter. One extra output of 4-20ma shall be provided on the transducer for owner use. The accuracy of the transducer shall be 0.5%.
9. One of the panels should house the Check syn relay and Guard relay for synchronization. The synchronizing bus shall be of 2.5sqmm cable. The inter-panel wiring with necessary connection to check syn switch shall form the syn

bus.

10. Bidder shall provide the syn scheme as per approval.

3 Panel Configuration

As per Sub-Station requirement (to be specified by Employer)

4 General Requirements Of Relays

- a. All relays and devices shall be of proven design and suitable make & type for the application satisfying the requirements specified elsewhere and shall be subject to the Employer's approval. Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide the required sensitivity to the satisfaction of the Employer.
- b. Relays shall be suitable for efficient and reliable operation of the protection scheme. The necessary auxiliary relays, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when the relay is de-energized, shall be employed in the circuits.
- c. Relays shall be provided with self-reset contacts except for the trip lockout, which shall have contacts with a manual reset feature.
- d. Suitable measures shall be provided to ensure that transients present in CT & VT connections due to extraneous sources in the EHV system do not cause damage to relays. CT saturation shall not cause mal-operation of relays.
- e. Only DC/DC converters shall be provided in solid state devices/relays wherever necessary to provide a stable auxiliary supply for relay operation.
- f. DC batteries in protective relays necessary for relay operation shall not be acceptable. Equipment shall be protected against voltage spikes in the auxiliary DC supply.
- g. The testing and commissioning protocols for the protection systems offered shall be approved by the Employer before commissioning on site.

5 EHV Line Protection

Each 66 kV line shall be provided with the following protection:

- i) 3-zone non-switched static distance protection (21) proven for EHV D/C line protection application.
- ii) Non directional 3-ph over current (51)-(Definite Time).
- iii) Non directional earth fault (51N)- (Definite Time).
- iv) Autoreclosing relay.
- v) Check syn relay.

6 Bus Coupler Protection

- i) Non directional 3 ph over current (51)
- ii) Non-directional delayed earth fault (51N)- (Definite Time).

7 66/11 kV Transformer Protections

- i) Static Biased differential protection. (87T) with 2nd harmonic resistant with high set. Unit.
- ii) High Impedance LV REF. (64)
- iii) HV Directional over current (67/50/51)
- iv) LV Back up Earth Fault (51N)

8 66 kV Bus PT

- i) Bus PT fuse failure relay.
- ii) 70% Bus under voltage relay.

9 Protection Philosophy

- i) The 66kv line distance protection shall be set to cover the line length as per the parallel line distance protection philosophy.
- ii) The over current and earth fault relay provided on bus coupler and line shall be coordinated in such a way that for a bus fault on any of the bus the bus coupler shall open first. Then after some time delay the corresponding line shall be tripped. This time shall be less than zone-2 times setting of the remote end distance protection.
- iii) Fault between the 66/11 kV transformer and corresponding CT shall be cleared by the corresponding directional earth fault relay.
- iv) The distance relay offered by the bidder shall be suitable for 3-zone distance protection of 66kv and above line of length not more than 2 KM. The relay shall give reliable operation under all system contingencies. E/F element characteristics shall be reactive type to limit the mal operation and shall be reliable under high resistance fault.
- v) The distance relay located at the both end of transmission line shall operate independent of PLCC link.
- vi) The LBB trip command shall be extended to bus coupler and same bus

breakers by appropriate isolators logic.

10 Auto-Reclose And Synchronizing Check

Auto-reclose (AR) and Synchronizing Check (SC) functionality shall be provided in a separate device. The interfacing between S/S Controller and Protection Units for achieving the AR function logic shall be achieved at Bay Level using communication LAN as well as standby hard-wired logic. The AR function shall meet the following criteria:

- Be of single shot type
- Have three phase reclosing facilities. It shall have a user-selectable option of three phase or non-auto reclosure mode.
- Incorporate a normal/delayed auto reclosure option with a time range of 1 to 60 s.
- Have a continuously variable three-phase and single-phase dead time of 0,1 to 5 s.
- Have a continuously variable reclaim time of 5 to 300 s.
- Incorporate the necessary auxiliary relays and timers to provide a comprehensive reclosing and synchronizing scheme.
- Have facilities for selecting check synchronizing or dead line charging features. The user shall have an option to change the required feature.

The built-in Synchronization Check feature shall determine the difference between the amplitudes, phase angles and frequencies of two voltage vectors. Checks shall be provided to detect a dead line or bus bar. The voltage difference, phase angle difference and slip frequency settings shall be adjustable.

11 66 kV Circuit-Breaker Protection

Each circuit breaker in the 66 kV bay shall be provided with following protection functions:

- i) Local Breaker Back up Protection Function: LBB protection function shall be provided for each circuit breaker in the 66 kV Sub-Station with following logic.
 - Be three pole type having three single phase units

- Shall operate for stuck breaker conditions
- Have an operating/resetting time each of less than 15 ms.

- The LBB function shall be initiated by external trip contacts from the Protection Units and after a set time delay shall energize the trip bus coupler.
- Have a setting range of 5 to 80% of rated current
- Have a continuous thermal withstand of 2 times rated current irrespective of the setting.
- Have time delay feature with a continuously adjustable setting range of 0,1 to 1 s.
- Shall be an individual phase comprehensive scheme.
- Shall not operate during the single-phase auto-reclosing period.

ii) Trip Coil Supervision: A Trip Coil supervision function shall be provided for each lockout trip relay and each of the circuit-breaker trip coils. It shall incorporate both the pre-close and post-close supervision of trip coils and associated trip circuits. An audible alarm shall be given in the event of operation of trip coil supervision function. It shall have a time delay on drop-off of not less than 200ms.

12 Energy Meters - Deleted

13 Panels

All panels shall be free standing, simplex type, floor mounting type and completely metal enclosed. Cable entries shall be from the bottom. Panels shall be of IP 31 class or better.

Panels shall have removable gland plates with glands made of brass and shall be suitable for armoured cables.

Panels shall be painted. The colour of paint for exterior of the panel shall be as follows:

Ends	Powder coated smoke grey to shade : 692 of IS-5 (Semi Gloss)
Front and Rear	-do-

Interior	White
Base	Black

14 Earthing

- a) The panels shall be equipped with an earth bus of at least 50x6mm² galvanized steel flat bar or equivalent copper.
- b) Earth buses of adjoining panels shall be connected for continuity. The continuous earth bus so formed shall be connected to the main earth grid at one end only.
- c) All metallic cases of the mounted equipment shall be separately connected to the earth bus by 2.5mm² copper wire. No loops in the earth wiring shall be permitted.
- d) CT/VT neutral secondary shall only be earthed at the terminal block of the panel through links, such that the earthing of one group may be removed without disturbing others.

15 Control Cabling Philosophy In Sub-Station

- a) Each secondary core of each phase CT/CVT shall be brought to the equipment marshalling box through independent cables.
- b) Each three phase secondary core of each CT/CVT shall be brought to the associated control/relay panel from the equipment marshalling box through independent cables.
- c) Single cores with at least 2.5mm² equivalent core cross-sectional area per connection shall be used for connection of all CT/CVT circuits.
- d) VT leads used for tariff metering shall have an equivalent core cross-sectional area of at least 2.5 mm² or equivalent per phase/neutral connection.
- e) Duplicate channels of protection shall have independent cables for tripping, DC supply, etc.
- f) For the following applications multiple cores with at least 2.5 mm² equivalent core cross - sectional area per connection shall be used:
 - i) DC supply to Bay Marshalling box
 - ii) DC supply to circuit-breaker cubicle
 - iii) DC looping for closing and tripping circuits of circuit-breaker
- g) Spare cores shall be provided as per following norms:

Up to 3-core cable

Nil

5 Core Cable

Min. 1 core

7 to 14 core cables	Min. 2 cores
More than 14 core	Min. 3 cores

h) For various field input from the breaker, transformer etc. for alarm, at least 1.5mm² equivalent cross section area per connection shall be used.

16 Factory Acceptance Tests (FAT)

All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the bidder and Employer’s representatives during manufacture, erection and on completion. The approval of the Employer or passing such inspections or tests will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service. The detailed requirement of operational and pre-FAT tests as well as FAT test (Integrated Test) is given in this Section.

The FAT shall be mutually agreed upon and approved by Employer during detailed engineering.

17 Operational And Pre-FAT Tests

a) The authorized quality assurance personnel of the manufacturer shall conduct all tests as per the requirements and fully satisfy themselves regarding completeness of hardware, software and full compliance with specification requirements by all equipment/sub-systems and the system as a whole before sending notification for FAT to the Employer. Bidder shall maintain accurate records for all pre-FAT tests which shall be properly documented and duly certified documents shall be furnished to Employer at least two weeks prior to FAT tests, while giving inspection call.

b) Each individual item of equipment/sub-system furnished by the Bidder as well as the complete system as per this specification shall be inspected and tested by the Bidder in his works for full compliance with specification requirements, completeness, proper assembly, proper operation, cleanliness and

state of physical condition as applicable.

- c) The Bidder shall conduct a point by point wiring continuity check to every input and output and verify that the wiring connections agree with the documentation.
- d) The pre-FAT report shall be in the format of FAT procedure as approved by the Employer. It shall be accompanied by a very detailed report, in a log form, of the performance of all pre-FAT Tests. These records shall list not only the successfully completed tests, but shall detail all system, test and component failures.
- e) Bidder shall send notification regarding readiness for FAT and indicate the proposed date for commencement of FAT to enable the Employer to depute representatives for participating in these tests. The notification shall be sent to the Employer not less than one month prior to commencement of the FAT along with the copies of documents covering pre-FAT results.
- f) The Bidder shall ensure that all hardware required for fully implementing the system as per requirements of this specification is available and the adequacy of hardware, system configuration, etc., is fully established during the pre-FAT Tests conducted by the Bidder. In case any deficiencies in hardware is noticed by the Bidder during the pre-FAT Tests, the Bidder shall make good all such deficiencies and re-conduct the required tests to fully satisfy himself regarding completeness of the system and full compliance with specification requirements before sending notification to the Employer regarding FAT Tests.

18 Site / Commissioning Tests

Site tests shall include all tests to be carried out at site upon receipt of equipment. It shall include but not be limited to testing calibration, configurations and pre-commissioning trials, startup tests, trial operation and performance and guarantee tests. The Bidder shall be responsible for all site / commissioning tests.

The Bidder shall maintain all tests, calibration records in Employer approved formats, and these shall be countersigned by authorized quality assurance personnel of the Bidder supervising these works.

The Bidder shall maintain master checklists to ensure that all tests and calibration for all equipment/devices furnished under these specifications are satisfactorily completed under the supervision of the authorized quality assurance personnel of the Bidder.

The site / commissioning tests shall be categorized under following categories:

- a) Startup tests
- b) Calibration and configuration checks

- c) Pre-commissioning tests
- d) Trial Operation

e) Availability Tests

19 Point-to-point testing shall include:

Verification of all status indications by operating the plant
 Verification of event / alarm indications by simulating alarm conditions
 Verification of all analogue indications by injection testing.
 Verification of control and protection logic.

20 System Hand-over and Final Acceptance

The system will be handed-over to the Employer for commercial operation after the site / commissioning tests have been completed to the satisfaction of the Employer. A hand-over certificate will be issued by the Employer. The Bidder will still be responsible for the Availability Tests.

Final acceptance of the system by the Employer will take place after the Availability Tests have been done to the satisfaction of the Employer.

21 Type Test Requirements

Test reports for following type tests shall be submitted for all relays.

A. Insulation Tests:

S.No.	Description	Standard
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5	Fast Transient Disturbance	IEC 60255-22-4, class IV 4kV, 2.5kHz applied directly to auxiliary supply 4kV, 2.5kHz applied to all inputs.
6	Surge Withstand Capability	IEEE/ANSI C37.90.1 (1989) 4kV fast transient and 2.5kV oscillatory applied directly across each output contact, optically isolated input and power supply circuit
7	Radiated Immunity	C37.90.2: 1995 25MHz to 1000MHz, zero and 100% square wave modulated. Field strength of 35V/m.
8	Electrostatic Discharge	IEC 60255-22-2 Class 4 15kV discharge in air to user interface, display and exposed metal work. IEC 60255-22-2 Class 3 8kV discharge in air to all communication ports. 6kV point contact discharge to any part of the front of the product.
9	Surge Immunity	IEC 61000-4-5: 1995 Level 4 4kV peak, 1.2/50ms between all groups and case earth. 2kV peak, 1.2/50ms between terminals of each group.
10	Capacitor Discharge	No change of state or any operation shall occur when a capacitor of capacitance shown below, charged to 1.5×Vn volts, is connected between any combination of terminals and any combination of terminals and ground. Master trip circuits – 10pF Other protection & control circuits – 2pF

C. EMC Tests:

Sl. No.	Description	Standard
1	Radio-Frequency Electromagnetic Non-Modulated Field,	IEC 60255-22-2, class III 10 V/m; 27 MHz to 500 MHz

2	Radio-Frequency Electromagnetic Field, Amplitude Modulated	ENV 50140, class III 10 V/m; 80 MHz to 1000 MHz; 80% AM; 1 kHz
3	Radio-Frequency Electromagnetic Field, Pulse Modulated	ENV 50140/ENV 50204 10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
4	Disturbances Induced by Radio Frequency fields, Amplitude Modulated	ENV 50141, class III
5	Power Frequency Magnetic Field	EN 61000-4-8, class IV 30 A/m continuous; 300 A/m for 3 sec; 50Hz
6	Interference Voltage, Aux. Voltage	EN 50081-*
7	Interference Field Strength	EN 50081-*

D. Atmospheric Environment Tests:

Sl. No.	Description	Standard
1	Temperature	IEC 60255-6 Operating -40C to +550C Storage and transit -40C to +700C IEC 60068-2-1 for Cold IEC 60068-2-2 for Dry heat
2	Humidity	IEC 60068-2-3 56 days at 93% RH and +400C

E. Mechanical Stress Tests:

Sl. No.	Description	Standard
1	Vibration (during Operation and Transportation)	IEC 255-21-1; Response Endurance Class 2 IEC Class 2 IEC 68-2-6 2
2	Shock (during Operation and Transportation)	IEC 255-21-2, class 1, IEC 68-2-27 Shock response withstand Class 2 Shock withstand Class 1 Bump Class 1
3	Seismic Vibration (during Operation)	IEC 60255-21-3 Class 2
4	Continuous Shock (during Transportation)	IEC 255-21-2, class 1, IEC 68-2-27

22 Settings

Fault levels will be provided to the Bidder by the Employer. The Bidder shall, based on this information, compile a complete and detailed report for the setting of the protection elements on all the protection equipment, to the approval of the Employer. Any additional information required to complete this exercise shall be timeously requested by the Bidder.

The bidder shall provide the Employer with a philosophy document clearly setting out the philosophy the bidder will use in determining setting levels. Each setting will have a brief description of the specific function or element. The setting calculation and formula will also be shown on the document. All relevant system parameters, line data, transformer data additionally used for calculating the setting will appear in the setting document. The bidder will conduct system studies in determining fault levels on different locations. These study results will also form part of the setting document. Any additional information required to complete this exercise shall be timeously requested by

the Bidder.

The setting document will be presented and discussed with the Employer prior to final issue of the document. The final accepted setting document should be made available to the Employer in PDF format.

It is the Bidder's responsibility to configure each protection relay to provide the protection and control facilities required. A full set of relay configuration and setting files shall be included in the design and documentation submissions. The bidder will issue three sets of setting documents once accepted by the client and consultant.

23 Completeness Of Equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

24 Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides

of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

65. SWITCHYARD AUXILIARY ITEMS

1. ACSR Conductor

a)	Code and standard	IS 398 (Part-II)
b)	Name	ACSR Equivalent to 261.5 sq.mm. area conductor/Panther
c)	Overall diameter	21.00 mm
d)	Weight	974 kg/km
e)	Ultimate tensile strength	89.67 kN minimum
f)	Strands and wire diameter of	
	Aluminium	30/3.00 mm
	Steel	7/3.00 mm

2. Clamps And Connectors

2.1 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.

2.2 The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.

2.3 Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

2.4 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

2.5 They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

2.6 Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

2.7 Current rating and size of terminal/conductor for which connector is suitable shall be embossed/punched on each component.

3. Insulator String Hardware

3.1 The insulator hardware shall be of bolted type and shall be of forged steel except for insulator cap, which can be of malleable cast iron. It shall also generally meet the requirements of clamps and connectors as specified above.

3.2 In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.

3.3 Disc Insulator

The disc insulator shall meet the following parameters:

Type	Antifog type insulator
Size of insulator	255x145
Electro mechanical strength	120kN
Leakage distance (mm)	430mm minimum or as required to meet the total creepage.
Power frequency withstand voltage	85 kV (dry), 50kV (wet)

4. Earthing Conductor

4.1 The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earthing conductors over the ground shall be of 75x12 mm GS flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GS flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire.

4.2 All conductors above the ground level shall be galvanised steel.

4.3 Earthwire for Lightning Protection

a)	Number of strands	7 of steel
b)	Strand diameter	3.15 mm
c)	Overall diameter	9.45 mm
d)	Weight	431.80 kg/km approx.
e)	Ultimate tensile strength	68.4 kN minimum
f)	Total cross-sectional area	54.55 sq.mm.
g)	Calculated DC resistance	3.375 ohms/km at 20 deg. C.
h)	Direction of lay of outer layer	Right hand
i)	Protective coating for storage	Boiled linseed oil to avoid wet storage stains (white rust)

4.4 Cable Support Structures & Accessories

4.4.1 The Bidder shall fabricate and install mounting arrangements for the support and installation of all the cables on angles in trenches. These mounting structures/cable racks shall be fabricated from structural steel members (channels, angles and flats) of the required size.

4.4.2 Cable supports shall be painted after installation. The painting shall be in conformity with stipulated in **Section 6, Part -2**. All welding works inclusive of the consumables required for fabrication and installation shall be in the scope of the Bidder.

5. Bushings, Hollow Column Insulators, Support Insulators, And Disc Insulators

5.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS:2544/IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.

5.2 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions

under which they will be used.

5.3 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.

5.4 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.

5.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage.

5.6 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.

5.7 Bidder shall make available data on all the essential features of design including the method of assembly of shells and metal parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

5.8 Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.

5.9 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

5.10 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.

5.11 Bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards.

5.12 Insulator shall meet requirement of IEC - 815 as applicable, having alternate long & short sheds.

6. Cabinets, Boxes, Kiosks And Panels, Etc.

6.1 All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, etc. shall generally conform to IS:5039, IS:8623 and IEC:439 as applicable.

6.2 They shall be of painted sheet steel or aluminium. The thickness of sheet steel shall be 2mm cold rolled or 2.5mm hot rolled. The thickness of aluminium shall be 3mm and shall provide rigidity. Top of the boxes shall be sloped towards rear of the box. The paint shall be of grey RAL 9002 on the outside and glossy white inside. However, the junction and switch boxes shall be of hot dip galvanised sheet steel of 1.6mm thickness.

6.3 The cabinets/boxes/kiosks/panels shall be free standing or wall mounting or pedestal mounting type. They shall have hinged doors with padlocking arrangement. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets.

6.4 The degree of protection of all the outdoor boxes shall not be less than IP 55 as per IS 2147.

6.5 The cable entry shall be from bottom, for which removable gasketed cable gland plates shall be provided.

6.6 Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.

6.7 The size of enclosure and the layout of equipment inside shall provide generous clearances. Each cabinet/box/kiosk/panel shall be provided with a 15A, 240V ac, 2 pole, 3 pin industrial grade receptacle with switch. For incoming supply, MCB of suitable rating shall be provided. Illumination of each compartment shall be with door operated incandescent lamp. All control switches shall be of rotary switch type.

6.8 Each cabinet/box/kiosk/panel shall be provided with two earthing pads to receive 75mmx12mm GS flat. The connection shall be bolted type with two bolts per pad. The hinged door shall be connected to body using flexible wire. The cabinets / boxes / kiosks / panels shall also be provided with danger plate, and internal wiring diagram pasted on inside of the door. The front label shall be on a 3mm thick plastic plate with white letters engraved on black background.

7. Bay Marshalling Box

7.1 Three no. bay MBs shall be provided located at a convenient location to receive and distribute cables one marshalling box should be used for

requirement of two bays. It shall meet all the requirements as specified for cabinets/boxes above.

7.2 It shall have three separate distinct compartments for following purposes:

- To receive two incoming 415V, three phase, AC supplies controlled by 25A four pole MCBs, and to distribute five (5) three phase ac supplies controlled by 8A four pole MCBs.
- 80 nos. terminal blocks in vertical formation for interlocking facility.

8. Terminal Blocks

8.1 They shall be non-disconnecting stud type of extensible design equivalent to Elmex type CAT-M4.

8.2 The terminal blocks shall be of 650V grade, and rated to continuously carry maximum expected current. The conducting part shall be tinned or silver plated.

8.3 The terminals shall be provided with marking tags for wiring identification.

8.4 The terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall also be provided with short circuiting and earthing facilities.

9. Wiring

9.1 All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows :

Wherever the cable size is specified that has to be used, otherwise,

- a. All circuits except PT/CT circuits 1.5 sq.mm
- b. PT/CT circuits 2.5 sq. mm.

9.2 All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

9.3 Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.

9.4 All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.

9.5 All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Interpole cabling for all equipment's shall be carried out by the Bidder.

10. Cable Glands And Lugs

10.1 Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.

10.2 The cable glands shall be tested as per BS:6121. The cable glands shall also be duly tested for dust proof and weather proof termination.

10.3 Cables lugs shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

11. Conduits, Pipes And Accessories

11.1 The Bidder shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes, etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc.

11.2 Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/ pipes shall be of a reputed make.

11.3 Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.

12. Auxiliary Switch

The auxiliary switch shall conform of following type tests:

- a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/visual defects/temperature rise test.
- b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/visual examination
- c) Heat run test on contacts
- d) IR/HV test, etc.

13. Type Tests

All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes, etc., shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections.

14. Completeness Of Equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

15. Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

66. 11 KV SWITCHGEAR**1. General**

This section of specification covers the design, manufacture, assembly, shop testing/inspection before dispatch, packing, forwarding, transportation to site, insurance (during transit, storage and erection), storage, erection, supervision, site testing and commissioning of 11 kV, 3 phase 50 Hz air insulated metal clad indoor switchgear unit with horizontal draw out circuit breaker at 66/11 kV Substation.

The scope of supply shall also include necessary special tools and plants required for erection, maintenance.

The switchgear panel should be complete in all respects with insulators, bimetallic connectors, interrupting chamber (vacuum circuit breaker), operating mechanisms control cabinet, interlocks, auxiliary switches indicating devices, supporting structures, accessories, etc., described herein and briefly listed in the schedule of requirements. The spares/attachments which are necessary for the smooth functioning of the equipment and specifically are not mentioned here shall be assumed to be included the scope of supply.

2. Standards

2.1 The circuit Breaker shall conform to the latest revision with amendment available of relevant standards, rules, and code. Some of which are listed herein for ready reference.

Sl. No.	IS	IEC	Item
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1	IS-13118 (1991)	IEC-56	Specification of High Voltage AC Circuit Breaker
	IS-12729	IEC-694	Common clauses for high voltages switchgear and control gear standards
2	IS-2705 (1992)		Current Transformer
3	IS-3156 (1992)		Voltage Transformer
4	IS-3231 (1987)		Relays
5	IS-1248		Ammeter & Voltmeter

6	IS-375		Arrangement of Breaker Busbars main connection and auxiliary wiring
7	CBIP REPORT NO.-88 (JULY) 1996	IEC-687	Static Energy Meter
8	IS-3072		Installation and maintenance of switchgear
9	IS : 9135		Guide for testing of circuit breakers with respect to out of phase switching
10		IEC : 60	High voltage testing technique
11	IEC-17A Study Group Dec. 1981		Sealing of interrupters/breakers
12	IS-3427		Metal enclosed Switchgear and Control gear
13	IS-1554	IEC-227	PVC insulated cables upto and including 1000 volts
14	IS : 5		Colors for ready mixed paints and enamels
15		IEC : 529	Degree of protection
16	IS : 996	IEC-34	Single phase Small AC and universal electrical motors
17	IS : 2629, 2633	Iso : 1460	Hot dip galvanising

2.2 Equipment conforming to other international standards will also be considered if they are ensuring performance and constructional feature equivalent or superior to the standard listed above. Bidder shall clearly indicate the standard as adopted.

3. Service Conditions

3.1 Climatic Conditions

The breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions.

4. Configurations of different type of panels (to be customized by utility as per capacity and requirement)

TYPE	RATING	NO.
Incomer	1600A	2
Bus Coupler	1600A	1
Bus PT	$11000/\sqrt{3}/110/\sqrt{3}$	2
11 kV Feeder		
• CAPACITOR FEEDER	800A, SUITABLE FOR 2500 KVAR CAPACITOR CHARGING DUTY.	4
• NORMAL FEEDER	800A	12

5. Construction

5.1 The 11 kV HT Switch board shall be totally enclosed dust and vermin proof, sheet metal clad, floor mounted, free standing, indoor type and shall house circuit breakers, busbars, control equipments, cable termination, current transformers, potential transformers, instruments, relays and other accessories. All HT panels shall be with fully draw out type breaker carriages, compartmentalized design with cold rolled sheet steel (thickness 2.0 mm for non load bearing and 3.0mm for load bearing parts) and with IP-4X class of enclosure. The Circuit Breaker compartment, Busbar compartment, Cable compartment and LT compartment shall have its own pressure relief flaps/vents with a view to release pressure which would develop in the unlikely event of fault. The vents shall not allow entry of vermin in any case. Bus bar, metering, circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. All instruments shall be non-draw out type and safe guard in every respect from damages and provided with mechanical indicator of connection and disconnection position. The switchgear shall be completed with all necessary wiring fuses, auxiliary contacts terminal boards etc.

5.2 For each of the incoming and outgoing cubicles, the cable connection, HT bus bars and all low voltage control devices shall be housed in separate enclosures. These enclosures shall be necessarily isolated from that for main circuit breaker chamber to offer better safety and protection of working personnel. All doors other than cable chamber shall be of hinged and lockable type with Neoprene gaskets at all joints and the cable chamber shall be fixed with nuts and bolts. Additional wire mesh guards and gaskets shall be provided for cable chamber.

5.3 The arcing contacts and bus bar should be rated for 25ka for 1s Bus bars shall be capable of connecting one switchgear panel to other through proper insulated arrangement, which does not decrease the insulation strength of the bus bar at the point of connection between two panels. The panels shall be modular in design.

5.4 The breakers should be able to be drawn out in horizontal position at ground level [with vertical/horizontal isolation] when breaker is drawn out in horizontal position none of the live components inside the 11 KV switchgear panel should be accessible. The safety shutters shall be robust and shall automatically cover the live components when the breaker is drawn out. The switchgear shall have complete interlocking arrangements at the fully inserted and fully drawn out and test positions. Withdrawal of the breaker should not be possible in ON position, it should not be possible to close the circuit breaker in service unless the entire auxiliary and control circuit are connected.

5.5 Breaker should have three distinct positions inside the cubical; i.e. service, test and isolated.

5.6 The switchboard shall be suitable to handle full rated capacity in the naturally ventilated atmosphere and it shall be able to control and contain the high short circuit energy under internal arc conditions and ensure safety of the operating personnel in case of faults.

5.7 The cubicle door can be fully shut with breaker in 'ISOLATED' position to stop ingress of dust and vermin. All switching operations shall be performed with the door closed.

5.8 The VT/Relay compartments shall have degree of protective not less than IP52 in accordance with IS:13947. However remaining compartments can have

IP 4X type sealing. All louvers if provided shall have very fine Brass or GI mesh screen.

5.9 Safety shutters complying with IEC-60298 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. It shall also be possible to padlock shutters individually. In case, insulating shutters are provided, these shall meet the requirements of Clause 3.102.1 Note –2 of IEC-60298 and necessary tests are per IEC –60298 Clause 5.103.1 shall be carried out. A clearly visible warning label “Isolate elsewhere before earthing” shall be provided on the shutters of incoming and tie connections which could be energized from other end.

5.10 The switchboard shall have the facility of extension on both sides. Adopter panels and dummy panels required to meet the various busbar arrangement, cable / busduct termination and layouts shall be included in Bidder's scope of work.

5.11 Bus duct inter connection is also includes in the Bidder Scope of Work. The interconnection shall be top entry type with required enclosure and bus duct site. Adequate support shall be provided for this inter-connection by higher from roof.

6. Bus bars and connectors and insulators

6.1 Bus bars and all other electrical connection between various components shall be made of high conductive aluminum alloy of rectangular cross sections. The bus bars shall be able to carry the rated current of 1600 Amp continuously without excessive heating and for adequately meeting the thermal and dynamic stresses in the case of short circuit in the system up to full SC rating specified.

6.2 All bus bars connections shall be firmly and rigidly mounted on suitable insulators to withstand short circuit stresses and vibrations.

6.3 Adequate clearance between 11 KV point and earth and between phases shall be provided to ensure safety as per provision in the relevant Indian standard specification/CEA regulations and the same shall be capable of withstanding the specified high voltage tests as per IS-13118/IEC-56 and amendment thereof.

6.4 Sharp edges and bends either in the bus bars or bus bar connections shall be avoided as far as possible. Wherever such bends or edges are un-avoidable, suitable compound or any other insulation shall be supplied to prevent local ionization and consequent flashover.

6.5 Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage.

Busbar insulators shall be of arc and track resistant high strength, non-hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100 pico coulomb at rated capacity.

7. Circuit breaker

7.1 HT circuit breakers envisaged in the specification shall be designed to control and protect the power system. The circuit breaker shall conform to IS 13118: 1991, IS 3427: 1969, IEC 298, IEC : 694 and IEC publication 56.

7.2 All circuit breakers shall be of horizontal isolation & horizontal draw out type construction having easy manufacturing facility with separate lockable doors over their compartment. The circuit breakers shall be fitted with necessary safety mechanical interlocks.

7.3 The moving carriage of circuit breaker shall be provided with earthing contacts continuously so that the breaker remains positively earthed in “service” position and during withdrawal operation up to “test” position. The breaker shall have anti pumping features.

7.4 All circuit breakers shall have three operational positions such as “Service”, “Test” and “Isolated” position with positive indication for each position. All circuit breakers of identical rating shall be physically & electrically interchangeable.

7.5 The HT breaker shall be provided with motor operated; spring charged

independent closing mechanism. The mechanism shall have one geared motor which will automatically recharge the mechanism as soon as breaker is closed. These breakers shall have electrical and mechanical trip free features and an emergency mechanical push to trip the same. All the features of the equipment shall ensure complete safety of the operation and shall be complete with approved safety devices to protect against potential hazards to operating personnel or to the equipment around. The breakers shall also have facilities for manual operation during emergency and servicing. Mechanism shall be simple, rugged and reliable with minimum number of linkages. No damage to parts shall take place in case of any inadvertent attempt for wrong operation.

7.6 All HT breakers shall be provided with at least 8 potential free Aux. contacts to be used for interlocking / signaling purposes. Contact arrangement may be 4 NO + 4 NC and these shall be rated for 220 VDC, 6 Amp.

7.7 The circuit breakers shall be capable of rapid & smooth interruption of current under all conditions completely suppressing all undesirable phenomenon even under most severe & persistent short circuit condition or when interrupting small leading or lagging reactive current.

7.8 The circuit breaker and panel should be completely type tested for 25 KA for 1 sec. and Test Certificate from independent authority should be submitted along with the Tender.

7.9 Facilities to check contact erosion shall be provided particularly.

7.10 Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Isolation of circuit breaker from bus bar or insertion into bus bar shall only be possible when the breaker is in the open position.

7.11 Vacuum interrupter should have an expected life of 30000 operations at rated current and should be capable for operating more than 100 times at rated short circuit current.

7.12 The switchgear should be designed for 2500 KVAR charging duty.

7.13 Mechanical indicators shall be provided on the breaker trucks to indicate

OPEN / CLOSED conditions of the circuit breaker, and CHARGED/DISCHARGED conditions of the closing spring. An operation counter shall also be provided. These may be visible without opening the breaker compartment door.

8. Control and Interlocks

The circuit breaker will normally be controlled from local panels through closing and trip coils.

Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. These facilities shall be accessible only after opening the compartment door.

Each panel shall have two separate limit switches, one for the Service position and the other for Isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions.

Auxiliary Contacts of breaker / contactor may be mounted in the fixed portion or in the withdrawable truck as per the standard practice of the manufacturer, and shall be directly operated by the breaker / contactor operating mechanism.

Circuit breaker shall be provided with inter pole barriers of insulating materials. The use of inflammable materials like Hylam shall not be acceptable.

9. Protection relays

9.1 All the switchgears shall be provided with protective relays designed to disconnect faulty circuit with speed and discrimination and shall conform to IS-3231 (1987) or latest revision thereof regarding accuracy and other feature. Composite relay unit having S/C, O/C, E/F etc. shall be preferred.

9.2 All protective & auxiliary relays shall be in dust & vermin proof enclosure, flush mounted on front side of metering compartment and shall be draw out type.

9.3 Insulation of relays should withstand 2.5 KV AC (rms) at 50 Hz for one second between all circuits and the case and between all circuits not intended to

be connected together as per IS – 3231 : 1965.

9.4 Relays should be able to withstand Impulse and High Frequency Disturbance as per IS 8686: 1977.

9.5 All relays and timers shall be rated for control supply voltage as mentioned elsewhere and shall be capable of satisfactory continuous operation between 75-110% of the rated voltage.

9.6 Bidder shall furnish in their offers the details of Relays (make, type, range etc.) considered by them for each feeder in a tabular form together with descriptive literature of the Relays offered.

a) All relays shall be draw out type confirming to all requirements as per IS:3231 and shall be suitable for operation from CT secondaries as required. All static relays shall confirm to IS :8686 .

b) The protective relays, except for lock-out relays shall have self - reset contacts, and shall be suitable for efficient and reliable operation of the protective schemes

c) All timers shall be either electromagnetic or static type.

d) All relays & timers shall be designed for satisfactory performance under specified tropical and humid conditions.

e) The bidder shall include in his bid a list of installations where the relays offered are in trouble free operation.

f) The relays and timer shall operate under extreme conditions of control voltage variation.

g) They shall not have any inbuilt batteries, and shall operate on available DC supply. They shall be provided with hand-reset operation indicators (flags) or LEDs with pushbuttons for resetting and for analysing the cause of breaker operation.

h) Shall have built-in test facilities, or can be provided with necessary test

blocks and test switches. One testing plug shall be provided for each switchboard.

i) The auto reclose logic shall be generated from local panel. The logic shall be, with the tripping of the feeder breaker under faults after a time delay of 1000 ms. closing command shall be given to particular breaker. If the breaker close/trips then no further closing command shall be issued. However this shall not be used for, I/C, B/C and capacitor feeder.

j) Over voltage relay provided on bus PT shall be used as a backup.

k)The over voltage trip logic shall be extended only to capacitor feeder.

l) The protection relay should have potential free contacts as per the protection logic requirement.

m) Reverse blocking principle for the feeders with incomer shall be provided.

n)Intertripping of incomer with upstream breaker shall be provided.

o)Automatic power factor control relay shall be provided one in each section for switching on the capacitor

p)All equipment shall have necessary protections. However, following minimum protections shall be provided.

FEEDER TYPE	Differential (87T)	REF (64R)	Over Current -50	Over Current DMT(51)	Earth Fault (51N)	Under Voltage -27	Over Voltage -59	Fuse Failure
Incomer	Yes	Yes	Yes	Yes	Yes	-	-	-
Bus Coupler	-	-	-	Yes	Yes	-	-	-
Capacitor feeder	-	-	Yes	Yes	Yes	-	-	-

Normal feeder	-	-	Yes	Yes	Yes	-	-	-
Bus PT	-	-	-	-	-	Yes	Yes	Yes

q)The capacitor protection scheme shall be designed for the capacitor configuration given elsewhere.

10. Current transformers

10.1 Two core CTs shall be employed for measuring instruments and automatic tripping of circuit breakers on overload, Earth Fault and short circuit protection. CT can be mounted on cable side of breakers with easy accessibility. Class of accuracy and burden for protection CT shall be 5P10 and for metering CT the same shall be class 0.5. The VA burden of the CTs shall be min. 25% more than the calculated value. However, the min. VA burden of CTs shall be 20 VA. CT shall conform to IS : 2705 (Parts 1-4) 1992 with its latest amendments.

However bidder shall furnish the actual VA ratings calculation required for the CT considering the relays and meters provide, for employer approval.

10.2 All the CT’s shall be cast resin insulated, Bar primary/Wound secondary type. All secondary connections shall be brought out through conduits to terminal blocks having provision of shorting links.

10.3 Ratio of the CT’s shall be as indicated in the protection SLD.

10.4 Short time rating of CTs shall be 25 KA for 1 second. CTs shall be double core and dual ratio. Saturation factor for metering core shall not exceed 2.5.

10.5 The designed accuracy should be available even at the lowest ratios and all CTs shall withstand fault current corresponding to 25KA for 1 sec.

10.6 The secondary terminal of the current transformers shall be such that effective and firm wire terminations are possible. Shorting links of adequate capacity shall be provided at the terminal blocks for sorting of the leads from

secondary terminals of current transformers. The secondary terminal of the CTs shall be earthed at one point.

10.7 The secondary winding resistance of CTs shall be as low as possible but not greater than 0.2 Ohms per 100 turns.

11. Potential transformers (PT)

TWO (2) Nos. single phase units of $((11/\sqrt{3}) \text{ kV}/(110/\sqrt{3})\text{V})$ PTs shall be mounted on incoming panels. HRC fuse protection of adequate rating shall be provided on HT and LT side of PT. Accuracy class of PT shall be 0.5. The primary and secondary of these PTs shall be “Star” connected and used for, all protection and measuring purposes onboard viz. line volt meters, energy meters etc. PTs shall conform to IS:3156 (Parts 1-4):1992 with its latest amendments.

Potential transformers shall be cast resin, draw out type. PT changeover scheme shall be provided in the switchboard.

All PT should have suitable current limited fuse both at primary and secondary.

12. Cable glands and clamping arrangement for holding suitable cable boxes

12.1 Two nos, brass-wiping glands for each incomer and one no. Brass wiping gland for each outgoing panel of adequate dimension for XLPE cable of 3 crores up to 400 sq. mm size (to be customized by utility) shall be supplied along with panels. For bus coupler no cable glands should be provided.

12.2 Suitable cable boxes as per requirement of cable shall be arranged by the bidder. The panel shall however provide a flat of size $50 \times 6 \text{ mm}^2$ with suitable clamp made of $50 \times 6 \text{ mm}^2$ flat along with Nuts Bolts and Washers for holding the cable boxes. The flat should be fitted at a suitable height with allotted arrangement for adjustment of height from 300mm to 500mm at site. The clamp and flat shall have suitable stud type arrangement for earthing cable and cable box.

12.3 All control cable/wire entries shall be by means of suitable cable glands, such glands shall be of brass and tinned.

13. Auxiliary/control wiring

All the secondary wiring in the panel shall have high quality PVC insulation and the same shall have conductor size of not less than 2.5 mm² of copper. Colors of the secondary/auxiliary wiring should conform to IS 375/1963 and latest amendment thereof if any. All wiring shall be neatly run and group of wiring shall be securely fixed by clips so that wiring can be checked without necessity of removing the clamps. Wiring between fixed and moving portion of the panel shall be run in flexible tubes and the same shall be so mounted to avoid any damage to them due to mechanical movements. Ferrules with number shall be provided on both end of the wiring.

14. Static energy meters - Deleted**15. Painting**

All metallic surface [except enameled and bright parts] exposed to weather shall be given suitable primer coat and two coats of first quality paint of approved color. The supplier shall also supply adequate quantities of paints, Varnish etc. for use of finished cost and for use of patching up any scratches received during transport, handling erection testing and commissioning.

Instead of above proper powder coating after proper pre-treatment is acceptable and in that case earlier condition will not applicable.

16. Tests

The design of circuit breaker shall be proven through all the routine and type tests in accordance with IS 13118: 1991/IEC 56 and any amendment thereof. Photocopy of all the test reports must be enclosed with the tender. Type test report earlier than 5 year from the date of tender opening shall not be acceptable.

17. Technical Parameters (to be customized by utility as per capacity and requirement)

17.1 11 kV Circuit Breakers

Sl.No.	DESCRIPTION	VALUES
i)	Rate Voltage (kV rms)	11 kV
ii)	Rated frequency (Hz)	50
iii)	System neutral earthing	Solidly grounded system
iv)	Type of arc quenching medium	Vacuum
v)	Rated normal current at site conditions (Amps)	1600 Amp for I/C breaker and Bus Coupler and 800 Amp for Outgoing feeders
vi)	Number of poles	3
vii)	Installation	Indoor type
viii)	Temperature rise	As per IEC 56 (Table-4) Page-19
ix)	Rated short circuit	
	a) Interrupting capacity at 11 kV	25 kA
	b) The percentage DC components	As per IEC 56 & (Ref. Page 51, 21 of IEC)
	c) Minimum number of Short Circuit operation the Circuit Breaker can withstand	100
x)	Rated short circuit making capacity	62.5 KA
xi)	First pole to clear factor	1.5
xii)	Rated short time current carrying capacity	25 kA

xiii)	Rated duration of short circuit	1 Seconds
xiv)	Total break time for any current upto the rated breaking current with limiting condition of operating and quenching media pressure (ms)	As per IS/IEC
xv)	Closing time (rms)	As per IS/IEC
xvi)	Standard value of rated transient recovery voltage for terminal fault	As per IEC-56
xvii)	Standard value of rated line	
	Characteristics for short line faults	
	RRRV	KV/ms=0.214
	Surge Peak Factor	Factor K=1.6 A
	Impedance	Z (ohms) = 450
xviii)	Rated operating	
	a) Duty cycle	O-0.3 Second-CO-3 Minutes-CO
	b) Auto reclosing	Suitable for three phase Auto reclosing
xix)	Rated insulation level under heavy pollution condition 1.2/50 micro second lightning Impulse withstand voltage (kV peak) to earth	75 kV
xx)	Power frequency withstand voltage kV (rms) to earth (kV rms)	28 kV
xxi)	Rated characteristic for out of Phase breaking	

	a) Out of phase breaking capacity	25% of rated breaking capacity
	b) Standard values of transient recovery	As per IEC-56
	c) Operating mechanism	Spring operated, Anti pumping and Trip free mechanism
	d) Power available for operating mechanism	Three phase 415 Volts 50 C/S or single phase 50 C/S 240 Volts
xxii)	a) Rated supply voltage of closing and operating devices and auxiliary circuits	1) 220 VDC 2) 240 Volts AC 50 C/S single phase 3) 415 Volts 50 Hz three phase
	b) Permissible voltage variation	1) In case of DC Power supply voltage variation shall be between 85% to 110% of normal voltage. 2) In case of AC power supply voltage variation shall be of the normal voltage as per IS-15% to +10%
	c) Permissible frequency	±3% from normal 50 Hz as per IS : 2026 Part-I 1977 para 4.4
	d) Combined variation of frequency and voltage	±15%
xxiii)	Number of auxiliary contacts	10 NO and 10 NC on each pole Continuous current rating 10 Amps, DC breaking rating capacity shall be 2 Amps with circuit time constant less than 20 ms at 220/30 volts DC
xxiv)	Number of coils	1 (One) trip coils and 1 close coil with anti-pumping arrangement
xxv)	Rated terminal load	100 kg. Static. The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces.

18. Completeness Of Equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

19. Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

67. 11KV CAPACITOR BANK

1. General

The manufacturer with 2.5 MVAR, 11 kV class capacitors offered, should have designed, manufactured, type tested as per relevant IEC/IS, supplied in the last three years for system voltage of 11 kV or higher.

This specification covers the basic requirements in respect of Capacitor Banks with internal/external fuse, mounting racks, supporting structure complete in all respect along with series reactors.

2. Standards

The Shunt Capacitor Bank and associated equipment shall conform to the latest additions of the following standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in this specification.

Capacitor	IS : 13925
Series Reactor	IS : 5553
Internal Fuse	IEC 593/IS 12672
External Fuse	IEC 549/IS 9402

3. General arrangement of capacitor banks

a) The Capacitor Bank shall be of outdoor type suitable for operation in the climatic conditions as given in this specification and mounted on steel racks and structure with suitable insulators as required to be supplied by the bidder.

b) The bidder shall furnish details of connections between the Capacitor units and groups together with layout diagram showing the basic arrangement of banks complete with dimensions.

4. Design criteria requirement and constructional details of capacitor

i) Each bank shall be made up by two groups of star connected banks each star connected bank shall be unearthed, with a floating neutral, but interconnected by a Neutral Protective Current Transformer (NCT) of suitable ratio to operate protective relays. The NCT secondary current shall be 1A and its ratio decided by design to meet with the protection requirements specified.

ii) The protective scheme shall be either by two step current relay arranged as follows:

If the failure of one or more units causes an over voltage of less than 10% tolerable on the other remaining healthy units, then the unbalance current shall cause in the first step to sound an alarm. But if more than the above number of units fails causing a voltage rise of more than 10% the unbalance current shall cause to trip and isolate the capacitor bank instantaneously.

iii) The per phase and individual star group rating shall be built up by series – parallel combination of individual units so as to achieve the desired bank rating. The individual capacity ratings shall be as per IS: 2834.

iv) All parallel units in one series group shall preferably be arranged in different tiers that is one series group shall be duly insulated from one another by post insulators adequate to withstand the voltage that may be impressed and shall be sufficient to withstand even in case of total failure of all the parallel units in a series group. The complete assembly shall also be duly insulated from the earth potential by supporting post insulators.

v) Although the tolerances in the output rating of each individual unit shall be as per IS:2834 yet it shall be ensured that in a completely assembled bank, the departures from the nominal rating and within the specified tolerances values shall not cause nuisance alarm or tripping since such alarm or tripping shall be to meet only with the protective requirements specified.

vi) The tolerances in the output ratings shall not cause departures in the line currents by that value specified in IS: 2834. Besides it shall also be ensured that these unsymmetrical currents shall not cause unsymmetrical voltage rises, whether for short periods or during prolonged operation.

vii) Individual units shall be designed to meet with the requirements of the permissible overloads as specified as per IS: 2834. Each unit shall also be

provided with internal discharge devices complying with the requirements of the IS.

viii) The voltage rating of the NCT shall be decided by the Bidder by taking into consideration the voltage impressed on the NCT due to:

a) Voltage due to failure of one or more parallel units in a series bank.

b) Voltage impressed on the NCT when all the parallel units in one series bank fail simultaneously. The bidders shall furnish along with the bid design calculations for the same.

5. Capacitor units

a) Each capacitor unit in the Bank shall be self-contained outdoor type having 2 bushing suitably rating for series/parallel connections with other units to form the capacitor bank of rated capacity at 50 Hz. The bushing shall be of porcelain and shall be joined to the case by soldering or welding.

b) The capacitor unit shall be manufactured Hazy Polypropylene as dielectric using non PCB impregnation shall be carried out under high degree of vacuum and the unit shall be of totally sealed type.

c) Each capacitor unit shall be provided with a internal discharge resistor designed to drain the phase voltage of the bank to 50 V or less within 5 minutes after disconnection from the supply.

d) Each capacitor unit shall be suitable for continuous operation at least 1.3 times the rated current at rated voltage and frequency. This over current factor shall include the combined effect of presence of harmonics and over-voltage up to 1.1 times rated voltage.

e) The container of capacitor unit shall be of stainless steel or CRCA steel painted within suitable anti-rust primer and two finishing coats of paint as per manufacturers' standard practice. The container shall be made from sheet steel of suitable thickness designed to allow for expansion and contraction due to all ambient and loading conditions expected during the life of the unit.

f) In case of externally fused capacitors the rating of unit shall so chosen that failure of 2 units in a particular series group shall not cause over-voltage exceeding 10% on the other healthy unit in that same series group. Calculations on above showing the justification of the unit size shall be furnished by the bidder along with the offer.

g) The design of the internally fused capacitor unit shall be such that it shall permit up to 40% element failure in series group without passing more than 10% over voltage on the other healthy units.

h) Each capacitor unit shall be mounted so that it can be easily removed from the racks and replaced without removing other units, de-assembling any portion of the rack.

i) Protective fuses: the capacitor units shall be provided with either internal or external fuses as per standard practice of the manufacturer.

A. Capacitor units with internal fuses

The internal fuses shall conform to IEC:593/IS:12672 and the Bidder shall furnish type test certificates for compliance with IEC/IS. The design of the internal fuse shall be same that residues from fuse operation(s) shall not cause deterioration of the impregnating fluid. The fuse assembly shall be distinct and separate from element packs and so constructed that operation of a fuse indoor worst condition does not affect the other healthy elements. The fuses shall not melt or deteriorate when subjected to inrush currents, which occur during the life of the bank. The design of the fuse shall be such that it shall isolate only the faulty element and the operation of the fuse shall not affect the other healthy elements.

B. Capacitor units with external fuses

The external fuses shall be of current limiting (HRC) type. The fuse system shall in any event be designed to ensure that the energy released into a faulty capacitor unit is less than the value that will cause rupture or bursting of the container. The fuses shall conform to IEC: 549/IS: 9402 and Bidder shall furnish type test certificate for compliance with IEC/IS. The characteristics of

the fuse shall be such that it shall isolate the faulty unit only and prevent it from mechanical destruction due to internal faults. The capacitor unit together with external fuses shall be arranged in the bank by providing adequate clearance

between the body of the capacitor units of a phase and the line terminal or the common bus for the units of the other phases to obviate the possibility of occurrence of bird faults. The fuse shall isolate the faulty capacitor unit only and the healthy capacitor units shall not be affected in any way by the isolation of faulty unit. The fuses shall not melt or deteriorate when subject to inrush currents which occur during the life of the bank. The external distance between two metal ends of the fuse shall comply with specified creepage distance (i.e. the length of the insulating part of the fuse shall be such that the specified creepage distance is achieved). The selection of fuse to be done in such a manner that characteristic of fuse shall match suitably with over current withstand characteristic of associated capacitor unit.

The capacitor bank and protection shall be such that failure of one unit (i.e. one external fuse operation) does not cause tripping of the bank. The bidder shall furnish detailed calculations in evidence of above along with the Bid.

Metalised Polypropylene Type, self-healing design capacitor with internal safety design is also acceptable. Bidder shall explain the features and properties of the capacitor offered to meet the requirement described above. These shall have discharge resistance provided internally to eliminate stress in case of de-energisation.

6. Mounting racks

- a) The mounting racks shall be hot dip galvanized steel sections. Each end of the rack shall have provision to receive incoming line connection.
- b) The racks shall be complete with rack insulators, foundation bolts or any other hardware etc. for assembly into complete bank.
- c) The height of the racks of capacitor banks shall be such that for making electrical connections with other equipment, proper electrical clearances are maintained.
- d) The capacitor bank along with its mounting racks and series reactor and null CT shall be suitable for installation on the plinth and the enclosure shall be suitably fenced and interlocked as per safety requirements.

7. Tests

- a) Type Tests – The equipment shall comply with the requirements of type test

as per IS: 2834 and copies of these type test reports should be submitted along with offer. The capacitor offered must have been also endurance tested as per

IEC: 871-2/IS: 13925 and copies of reports submitted along with offer. The capacitors under the type tested as per relevant IS/IEC.

b)Acceptance and routine tests – The equipment shall comply with all routine and acceptance tests as per IS – 2834. Sampling to be done as per Appendix-E, IS-2834.

8. Series reactors

a)The series reactor of small size (as required) shall be used in the Capacitor banks for limiting the inrush current. The series reactor shall be outdoor type 50 Hz, air-cooled air core type and suitable for operation in climatic conditions specified.

b)Series reactors shall be capable of withstanding the specified short circuit currents.

c)The percentage series reactance shall preferably be 0.2%. However, the value of series reactance shall be decided during detailed engineering. The Bidder shall furnish calculations justifying the value selected.

d)The series reactors shall conform to type tests and shall be subjected to routine tests as per IS.

9. Technical parameters of capacitors and series reactors

The capacitor units and series reactors and other equipments/materials covered in this specification shall meet the technical requirements listed hereunder:

Capacitor Units (to be customized by utility)

S.No	ITEM	SPECIFICATIO N
a)	Nominal System Voltage (kV)	11
b)	MVAR Capacity required at nominal system voltage (MVAR)	2.5
c)	Rated voltage of this capacitor bank (kV)	12

d)	Protection of Capacitor units	Internal / External fuses
e)	Type of connection	Double Star
f)	Unit Size	Option of the manufacturer to chose the appropriate unit size and rating
g)	Power loss (tan delta including loss in the fuse)	Not to exceed 0.2 Watt per applicable standards.
h)	Permissible overloads	Max. permissible Overloads with reference to voltage current and reactive output shall conform to Applicable standards.
i)	Type of grounding	Ungrounded
j)	Type of discharge	Internally through Resistor provided within the capacitor unit
k)	Capacity to receive inrush current	Not less than 100 times rated current

1)	Temperature category	The capacitors shall be suitable for maximum ambient temperature of 50 deg. C adequate care should be taken to protect the capacitors from direct sun radiations on account of Outdoor
		installations.

10. Series reactors

S.No.	ITEM	SPECIFICATION
a)	Rated Voltage (kV)	12
b)	Type	Air core
c)	Rating of series reactors	0.2% of Capacitor bank rating to be connected on neutral end
d)	Insulation levels Impulse withstand voltage(KVp)	75
e)	Short time withstand capacity and duration	16 times of 130% rated current of capacitor bank for 3 seconds
f)	Linear characteristic	Upto 1.5 pu

g)	Continuous rating	130% of rated current of capacitor bank
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11. Completeness of equipment:

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

12. Packings:

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides

of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

68. Outdoor Non Sealed Type Three Phase 11 Kv/433v Station Transformers

(refer Section 6, Part -2 for Tech Specification)

69. ACSR Conductor

(refer Section 6, Part -2 for Tech Specification)

70. Installation

1. Earthing

The earthing shall be done in accordance with requirements. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.

2. Civil Works

The civil works shall be done in accordance with requirements stipulated under Section-17 of this specification.

3. Structural Steel Works

The structural steel works shall be done in accordance with requirements stipulated under Section-17 of this specification.

4. Bay Equipment

4.1 The disposition of equipment to be supplied is shown in enclosed single line diagrams and layout drawings.

4.2 The Bidder shall prepare layout drawings and submit the same for approval of the EMPLOYER. The approval of drg. shall not absolve Bidder from his responsibility regarding designing & engineering of Sub-Station and Bidder shall be fully responsible for all works covered in the scope of this specification.

5. Lightning Protection

Detailed drawings shall be submitted for approved locations on Sub-Station towers provision of lightning rod electrode at suitable Location.

5.1 Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which

they shall be directly connected to rod electrode.

5.2 Every down conductor shall be provided with a test joint at about 150 mm above ground level. The test joint shall be directly connected to the earthing system.

5.3 The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.

6. Equipment Erection Notes

a. All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity.

b. Where, assemblies are supplied in more than one section, Bidder shall make all necessary mechanical and electrical connections between sections including the connection between buses. Bidder shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Bidder at his own expense. The Bidder shall strictly follow manufacturer's recommendations for handling and erection of equipment.

c. The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength.

d. Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation.

e. Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.

f. For cleaning the inside and outside of hollow insulators only Muslin or leather cloth shall be used.

7. Storage Of Equipment

Bidder is responsible for the proper storage and maintenance of all materials/equipment to be supplied by him for the work. The Bidder shall provide & construct adequate storage shed for proper storage of equipment. Sensitive equipment shall be stored indoors. All equipment during storage shall be protected against damage due to acts of nature or accidents. Bidder shall take all required steps to carryout subsequent inspection of materials/equipment stored as well as erected until the same is taken over by the EMPLOYER. The storage instruction of the equipment manufacturers/ Engineer-in-Charge shall be strictly adhered to.

8. Cabling

8.1 Cabling shall be in trenches, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc.

8.2 Cables inside the Sub-Station shall be laid on angle supports at 600mm spacing with separate tiers for control and power cables.

8.3 All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be buried in the ground at a depth of 300mm.

9. Conduits, Pipes And Accessories

9.1 The bidder shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushings, reducers, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes etc. The size of the conduit/pipe shall be selected on the basis of maximum 40% fill criterion. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner, to prevent damage to threaded portion and entrance of moisture and foreign material.

9.2 Rigid conduits shall be flow-coat metal conduits of XXX (name) Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate coatings. The inner surface shall have silicone

epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/pipes shall be of a reputed make.

9.3 The hume pipes and accessories shall be of reinforced concrete conforming to class NP2 of IS: 458. All tests on hume pipes shall be conducted as per IS: 458.

10. Cable Tags And Marker

10.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

10.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

10.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.

10.4 The marker shall project 150mm above ground and shall be spaced at an interval 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

10.5 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, such as where a number of cables enter together through a gland plate.

10.6 Specific requirements for cabling, wiring ferrules as covered in respective equipment section shall also be complied with.

11. Storage And Handling Of Cable Drums

Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as practicable. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication the drums may be rolled in the same direction it was rolled during taking up the cables.

12. Cable Supports And Cable Tray Mounting Arrangements

12.1 In cases where no embedded steel inserts are available, the Bidder shall have to secure the supports on wall or floors by suitable anchoring at no extra cost to the Employer. Details of fixing steel plates by anchor fasteners shall be decided during detailed engineering stage.

12.2 The cable supports shall conform to the requirements of this Specification.

12.3 Insert plates will be provided at an interval of 600mm wherever cables are to be supported without the use of cable trays, while at all other places these will be at an interval of 2000mm.

13. Cable Terminations And Connections

13.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Employer.

13.2 The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking, (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

13.3 Cost of all consumable material shall be included in the erection rates quoted.

13.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Bidder shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

13.5 The Bidder shall tag/ferrule the control cable cores at all terminations, as instructed by the Employer. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.

13.6 Spare cores shall be similarly tagged with cable numbers and coiled up.

13.7 Control cables shall have stranded copper conductor. Bare portion of the solid conductors shall be tinned after removing the insulation and shall be terminated directly without using cable lugs.

13.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

13.9 If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Bidder as directed by the Employer.

14. Directly Buried Cables

The Bidder shall construct the cable trenches required for directly buried cables. The scope of work and unit rates for construction of cable trenches for cables shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and reaming, supply and installation of route markers and joint markers. The bidder shall ascertain the soil parameters prevailing at site, before quoting the unit rates. Laying the cable and providing protective covering shall be as per approved drawing.

15. Installation of Cables

15.1 Power and control cables shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.

a) Power cables on top tiers.

b) Control, instrumentation and other service cables in bottom tiers.

15.2 Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable.

15.3 Power and control cables shall be securely fixed to the supports. Trefoil clamps for single core cables shall be pressure die-cast aluminium (LM-6), Nylon-6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer, etc. these are required at every 2 metre of cable runs.

15.4 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:

	Type of cable & voltage grade	Minimum bending radius
a)	Power cable	12 D
b)	Control cables	10 D
c)		

Where D is overall diameter of cable.

15.5 Where cables cross roads, drains and rail tracks, the cables shall be laid in reinforced spun concrete or steel pipes, buried at not less than one metre depth.

15.6 In each cable run some extra length shall be kept at a suitable point to enable one (for LT Cables) or two (for H.T cables) straight through joints to be made, should the cable develop fault at a later date.

15.7 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. In case joints are necessary the same shall be supplied by the Bidder. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the Employer.

15.8 Control cable terminations inside equipment enclosures shall have sufficient lengths so that switching of termination in terminal blocks can be done without requiring any splicing.

15.9 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required.

15.10 Rollers shall be used at intervals of about 2.0 metres, while pulling cables.

15.11 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kink, sharp bends etc.

15.12 Cable ends shall be kept sealed to prevent damage.

15.13 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS: 1255 and other Indian Standard Codes of practices.

15.14 Wherever cables pass through floor or through wall openings or other partitions, wall sleeves with bushes having a smooth curved internal surface so as not to damage the cables, shall be supplied, installed and properly sealed by the Bidder at no extra charges.

15.15 The erection work shall be carried out in a neat workmanlike manner and the areas of work shall be cleaned of all scrap materials, etc. after the completion of work in each area every day. Bidder shall remove the RCC/steel bench covers before taking up the work and shall replace all the trench covers after the erection work in that particular area is completed or when further work is not likely to be taken up for some time.

15.16 Bidder shall furnish three copies of the report on work carried out in a particular week, such as cable numbers and a date on which laid, actual length and route, testing carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.

15.17 In case the outer sheath of a cable is damaged during handling/installation, the Bidder shall repair it at his own cost, and to the satisfaction of the Engineer-in-Charge. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable, at no extra cost i.e. the Bidder shall not be paid for installation and removal of the damaged cable.

15.18 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Bidder shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

16. Conduits, Pipes Installation

16.1 Bidder shall supply all conduits, pipes and ducts as specified and to be shown in detailed engineering drawing. Flexible conduit should be used between fixed conduit and equipment terminal boxes. Where vibration is anticipated, the flexible conduit shall be as per the relevant IS.

16.2 Bidder shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be

made smooth without leaving any sharp edges. Anti corrosive paint shall be applied at all field threaded portions. The Bidder shall supply and apply this protective material.

16.3 All conduit/pipes shall be extended on both sides of wall/floor/openings. Exposed conduits/pipes shall be adequately clamped at an interval of about 2m. The fabrication and installation of supports and the clamping shall be included in the scope of work by Bidder.

16.4 When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on any length to facilitate easy dismantling of two conduits.

16.5 Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. G.I. Pull wire of adequate size shall be laid in all conduits before installation.

16.6 Each conduit run shall be painted with its designation as indicated on the drawings, such that it can be identified at each end.

16.7 Embedded conduits shall have a minimum concrete cover of 50mm. Positioning and ensuring proper alignment during concrete by other agencies shall be the responsibility of the Bidder.

16.8 Conduit runs sleeves shall be provided with the bushings at each end.

16.9 Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end. Bushings shall have rounded edges so as not to damage the cables.

16.10 Where embedded conduits turn upwards from a slab or fill, the termination dimensions shown on the drawings, if any, shall be taken to represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half the arc length of the bend shall be embedded.

16.11 For underground runs, Bidder shall excavate and back fill as necessary.

ANNEXURE-I : Earthing Notes

1. General

1.1 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

1.2 Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules/CEA Regulations, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

1.3 Bolts and nuts required for earthing all main equipment structures and forconnecting with earthing system shall be in the scope of the Bidder.

2. Details Of Earthing System

Item	Size	Material
Main Earthing conductor	Suitable for a system current of 31.5 KA/1s as per IS	Mild Steel
Conductor above ground & earthing leads (for equipment)	To be submitted by the the vendor as per above	Galvanized Steel
Rod Electrode	Suitable for a system current of 31.5 kA/ 1s as per IS	Mild steel
G.I. Earthwire	7/8 SWG	GI

3. Earthing Conductor Layout

3.1 Earthing conductors in outdoor areas shall be buried at least 600mm below finished grade level unless stated otherwise.

3.2 Minimum 3000 mm spacing between rod electrodes shall be provided unless stipulated otherwise.

3.3 Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid at least 300 mm below them and shall be re-routed in case it fouls with equipment/structure foundations.

3.4 Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid. Otherwise, “earth insert” with temporary wooden cover or “earth riser” shall be provided near the equipment foundation / pedestal for future connections to the equipment earthing terminals.

3.5 Earthing conductor along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Earthing conductors along cable trenches shall be on the wall nearer to the equipment. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves.

3.6 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.

3.7 In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future, in case equipment is not available at the time of grid installations.

3.8 Earthing conductors crossing the road shall be either installed in hume pipes or laid at greater depth to suit the site conditions.

3.9 Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover.

4. Equipment And Structure Earthing

4.1 The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with engineer. The equipments shall be earthed at two distinctive points on panels.

4.2 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

4.3 Metallic conduits shall not be used as earth continuity conductor.

4.4 A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc.

4.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.

4.6 Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not.

4.7 Railway tracks within Sub-Station area shall be bonded across fish plates and connected to earthing grid at several locations.

4.8 Earthing conductor shall be burried 2000mm outside the Sub-Station fence. Every post of the fence and gates shall be connected to earthing loop by one lead.

4.9 Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

5. Jointing

5.1 Earthing connections with equipment earthing pads shall be of bolted type. Contact surfaces shall be free from scales, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint/compound.

5.2 Connection between equipment earthing lead and between main earthing conductors shall be welded/brazed type. For rust protections, the welds should be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.

5.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.

5.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

5.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

5.6 Bending of large diameter rod/thick conductor shall be done preferably by gas heating.

5.7 All arc welding with large diameter conductors shall be done with low hydrogen content electrodes.

6. Power Cable Earthing

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

7. Specific Requirement For Earthing Systems

7.1 Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid.

7.2 Earthing mat comprising of closely spaced (300mm x 300mm) conductors shall be provided below the operating handles of the isolators.

7.3 For specific requirements for earthing at panel refer to Section-Control and Relay Panel of this specification.

8. Specific Requirements For Lightning Protection System

8.1 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

8.2 Down conductors shall be cleated on the structures at 2000mm interval.

8.3 Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level.

8.4 Lightning conductors shall not pass through or run inside G.I. conduits.

8.5 Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules/CEA regulations, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

9. Procedure For Non Destructive Testing

A) LIQUID PENETRANT EXAMINATION OF WELDED JOINTS

a) Evaluation of indications – As per standard Test Procedure.

B) RADIOGRAPHIC EXAMINATION OF WELDED JOINTS to be carried out as per standard test procedure on 10% welded joint.

71. Technical Specifications For 66 kV Gas Insulated Switchgear

1.1 General

The specification covers scope of design, engineering, fabrication, manufacturing, shop assembly, inspection and testing before supply, transportation, delivery at destination, unloading & storage at site, site erection, site testing, commissioning and putting in to successful operation complete with all materials, support structures, anchoring bolts, accessories, commissioning spares & maintenance spares (utility to specify requirements), special spanners, tools & tackles, any specific required ancillary services, SF6 Gas for first filling & spare, etc., for efficient and trouble free operation along with for 66 kV metal (aluminum alloy) encapsulated SF6 gas insulated switch-gear suitable for INDOOR installation.

The scope also covers provision of additional bays (without equipment) over and above bays shown in SLD, with foundations & earthing arrangements so as to install the bay module as and when required without any works pending except the procurement of the required bay module and other related equipment.

1.2 Design Concept, construction & performance of SF6 GIS

1.2.1 It is understood that each manufacture has its own particular SF6 GIS design concept and it is not the purpose of this specification to impose unreasonable restrictions. However, in the interest of safety, reliability and serviceableness, the switch gear offered shall meet the following minimum requirements.

The station layout and equipment rating shall be based on the single line diagram and general layout enclosed. The supplier has to work out an optimum layout and building size based on the specific features of his product within the constraints of overall dimensions of the plot.

All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.

Furthermore, no part of the enclosure, or any loose parts may fly off the switchgear in such an event, and no holes may burn through the enclosure until the nearest protective relay has tripped. All grounding connections must remain operational during and after an arc fault.

Proper grounding for mitigating over voltages during disconnector operation shall be included.

Viewing windows shall be provided at the Disconnectors and earthing switches to ensure that each contact position can be inspected easily from the floor level. Each section shall have plug-in modules or easily removable connection pieces to allow for easy replacement of any component with the minimum of

disturbance to the remainder of the equipment.

The number of transport/shipping splits shall be minimized to keep installation time of GIS to a minimum.

The arrangement shall afford maximum flexibility for routine maintenance. Equipment removal and SF6 handling should be accomplished with ease.

The ease of operation shall be ensured.

In general the contours of energized metal parts of the GIS and any other accessory shall be such as to eliminate areas or points of high electrostatic flux concentrations. Surfaces shall be smooth with no projection or irregularities, which may cause corona.

1.2.2 Modular Design & Future extensions

The GIS switch gear shall be of modular design offering high degree of flexibility. Each module shall be complete with SF6 gas circuit breaker, Disconnectors, Maintenance Grounding switches, fast Earthing switches, Voltage transformers, Current transformers, bus & elbow sections, cable end enclosures, L.A., local control cubicle and all necessary components required for safe & reliable operation and maintenance. All the three phases of the busbars and associated equipments like breakers, disconnectors, instrument transformers & earthing switches etc., as detailed in enclosed single line diagram are to be encapsulated in a single gas filled metallic enclosure.

The bus bars shall be sub-divided into compartments including the associated bus bar disconnector. *Bus bars are partitioned at each bay with an objective to isolate Busbar compartment for the purpose of extension and at the same time avoid damage to adjacent bays in the event of fault.*

1.2.2.1 Materials used in the manufacture of the switchgear equipment shall be of the type, composition and physical properties best suited to their particular purposes and in accordance with the latest engineering practices.

1.2.2.2 The switchgear shall be of the freestanding, self-supporting dead-front design, with all high-voltage equipment installed inside gas-insulated, metallic grounded enclosures, and suitably sub-divided into individual arc and gas-proof compartments.

1.2.2.3 Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. In case of any internal arc fault in a busbar, busbar disconnector or circuit breaker, of double bus system, repair works must be possible without shutting down complete substation and at least one busbar and the undisturbed bays must remain in operation.

Where bus Coupler / sectionaliser is specified and in case of any

internal arc fault in a busbar, busbar disconnecter or sectionaliser, repair work must be possible without shutting down the complete substation and at least one half of the substation must remain in operation. Documents indicating sequence of repair work steps and description of necessary restrictions during work shall be submitted with the technical bid.

Each bay module should be equipped with suitable arrangement for easy dismantling and refitting during maintenance without disturbing other units.

1.2.2.4 The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

1.2.2.5 There shall not be any kind of interference to the connected & nearby equipment and system, when the equipment is operated at maximum service voltage.

1.2.3 Maintenance and repair of a circuit breaker

The positioning of the circuit breaker in the GIS shall be such that it shall be possible to access the circuit breaker of any feeder from the front side for **routine inspection**, maintenance and repair without interfering with the operation of the adjacent feeders.

The GIS shall be so designed that any component of the GIS can be removed easily. With minimum flexibility in the layout arrangement it shall be possible to remove the circuit breaker with both busbars remaining in service and it shall be possible to remove the disconnecter of the busbars, with one bus bar remaining in service.

1.2.4 Interchangeability

As much as possible, all the parts shall be of standard manufacture with similar parts and assemblies being interchangeable.

1.2.5 Future Extension

The modular design of GIS switch gear shall be capable of extension in the future **on either end** by the addition of extra feeders, bus couplers, busbars, circuit breakers, Disconnectors, and other switch gear components without **drilling, cutting, welding or** dismantling any major part of the equipment. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect. **The arrangement shall be such that expansion of the original installation can be accomplished with minimum GIS down time. In case of extension, the interface shall incorporate facilities for installation and testing of extension to limit the part of the existing GIS to be re-tested and to allow for connection to the existing GIS without further dielectric testing.**

1.2.6 The SF6 GIS shall be of **INDOOR** type and suitable for the atmosphere

of the location which is heavily polluted, windy, sandy desert & service condition **indicated at 2.1.**

1.2.7 The required switchgear shall be capable of being supplied in a completely gas-insulated version in which case all switchgear components including the bus-bars shall be of gas-insulated type.

1.3 Specification requirements

The 66 kV GIS switch-gear shall be of a **Double** bus design having three-phase common enclosure concept, and it shall consist of Line & transformer bays as indicated in attached Single line Diagram and General lay out plan. This configuration shall meet within the given area indicated in layout plan.

1.4 Current Rating

The current rating of the switchgear should be assessed on the following requirements-

- a) Capable of handling power to an extent of as to an ambient day-time mean temperature between – 5 deg C and + 50 deg C
- b) The switchgear described in this specification is intended for continuous duty at the specified ratings and under **all system operating conditions including sudden change of load and voltage within its ratings and at specified** ambient conditions 24 hours a day, 365 days a year unless indicated otherwise.

The installed capacity of the power transformers is given in SLD attached.

1.5 Electrical, Mechanical and Thermal Capability

The assembled equipment shall be capable of withstanding the electrical, mechanical and thermal ratings of the specified system. All joints and connections shall be required to withstand the forces of expansion, vibration, contraction, and specified seismic requirements without deformation or malfunction *and leakage*. The apparatus shall be capable of withstanding the specified environment.

1.6 Insulation level

The switchgear and other equipment shall be designed for a maximum operating voltage and rated impulse withstand voltage according as specified in cl. 2.3. The switchgear may require to be installed in an unmanned distribution network with predominantly over head interconnection or EHV cable as the case may be. Circuit breakers shall be capable of interrupting line, transformer & cable charging currents of the magnitude indicated in the data schedules.

1.7 Physical arrangement

- a) The layout shall be properly designed by the bidder to completely accommodate the present & future requirements of the substation as per the furnished single line diagram and the enclosed site plan. They may be adjusted as necessary to suit the manufacturer's standard design and Utility need.

- b) The arrangement of the switchgear offered must provide adequate access for checking and maintenance.
- c) *Optimized arrangements are required so as to reduce installation time, minimize maintenance & repair cost, provide ease of operation and facilitate future expansions.*

1.8 Gas Sectionalisation

- a) The switch-gear gas enclosures must be sectionlised, with gas tight barriers between sections or compartments.
- b) The sections shall be so designed as to minimize the extent of plant rendered inoperative when gas pressure is reduced, ether by excessive leakage or for maintenance purposes, and to minimize the quantity of gas that has to be evacuated and then recharged before and after maintaining any item of equipment.
- c) The arrangement of gas sections or compartments shall be such that it is possible to extend existing bus-bars without having to take out of service another section of the bus-bar at a time.
- d) For limitation of any internal arc to the concerned bay and to reduce the extent of necessary gas works of each section of the bus-bar must be sectionalized bay by bay.
- e) *Sectionalisation shall ensure that circuit breaker enclosure will not include any other equipment in its gas compartment.*

1.9 Expansion Joints and Flexible Connections

- a) The layout shall sufficiently take care to the thermal expansion / contraction of the assembly by the provision of expansion joints. Expansion joints shall be placed in between any bay section of the busbar. **All joint surfaces shall be machined, and all castings shall be spot faced for all bolt heads or nuts and washers.**
- b) If necessary, the number and position of expansion joints or flexible connections are to be determined by the manufacturer to ensure that the complete installation will not be subject to any expansion stresses which could lead to distortion or premature failure of any piece of the SF₆ equipment, support structures or foundations.

Bracing shall be provided for all mechanical components against the effects of short circuit currents specified under system parameter. The design of the equipment shall be such that the agreed permitted movement of foundations or thermal effects does not impair the assigned performance of the equipment.

The design calculations for all the supports shall be submitted to ensure care taken.

- c) The continuity of service during thermal expansion / contraction and vibrations shall be ensured. Expansion joints, flexible connections and adjustable mountings

shall be provided to compensate for reasonable manufacturing and construction tolerances in the associated equipment to which the GIS may be connected. ***Required sliding plug-in contacts for conductors shall be provided.*** This is to ensure that unreasonably excessive accuracy is not required when installing such equipment and constructing the associated foundations or support structures, e.g. transformers or the interconnection of isolated sections of switch-gear by means of long GIS bus-bar or duct installations. Flexible joints may also be provided to allow more efficient maintenance and future extensions of the GIS.

1.10 Barrier and Non-Barrier Insulators

- a) Support insulators shall be used to maintain the conductors and enclosure in proper relation. These support insulators may be of two types. Barrier insulators which are employed to isolate gas compartments and non-barrier insulators which allow the gas pressure to equalize.
- b) The gas barrier insulators sealing to the conductors and the enclosure wall shall be designed to withstand the maximum pressure difference that could occur across the barrier, i.e. maximum operating pressure at one side while a vacuum is drawn at the other side & in case of internal arc fault with a safety factor of 2.
- c) The support insulators and section barriers / insulators shall be manufactured from the highest quality material. They shall be free from all voids and the design shall be such as to reduce the electrical stresses in the insulators to a minimum. They shall also be of sufficient strength to ensure that the conductor spacing and clearances are maintained when short circuit faults occurs.
- d) Tests shall be carried out during the manufacture of the Switchgear to ensure that all parts of the equipment are free of partial discharge with a partial discharge extinction voltage which is at least 10% higher than the rated voltage.

1.11 Gas seals, Gas Density & pressure and other requirements.

- a) Single sealing of O-ring type shall be used for sealing the connections between the switch-gear modules. The leakage rates shall be kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. The guaranteed leakage rate of each individual gas compartment **and between compartments** must be less than **0.5% p.a. for the service life of equipment.**
- b) Piping and fittings for gas monitoring and gas supply shall be made of copper or brass. The gas monitor device should be installed at each individual compartment of the module. Each gas compartment must be independent, external gas pipe connections should be avoided to minimize leakage.
- c) All gas compartments shall be fitted with filter material which absorbs the residual moisture and moisture entering inside the High-voltage enclosure. Filters in gas compartments with switching devices must also be capable to absorb the gas decomposition products resulting from the switching arc.

- d) The rated pressure of the SF6 insulating gas in the metal-clad equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks.
- e) The SF6 switch-gear shall be designed for use with SF6 gas complying with the recommendations of IEC – 60376 at the time of the first charging with gas.
- f) *Connections including bolts and nuts shall be adequately protected from corrosion and easily accessible with the proper tools.*
- g) *All components shall be fire retardant and shall be tested in accordance with relevant standards. Gas emissivity when the Material is heated shall be minimal.*

1.12 Gas Treatment Requirements

Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. In all gas compartments permanent efficient filters and desiccants shall be effective for the duration of time between major overhauls. Notwithstanding this, the insulators in the circuit breaker shall be made of epoxy resin composition that will resist decomposition products in contact with moisture.

1.13 Gas Monitoring Devices

Gas density or pressure monitoring devices shall be provided for each gas compartment. The devices shall provide continuous and automatic monitoring of the state of the gas. The *SF6 gas* monitoring device shall have two *supervision and* alarm settings. These shall be set so that, an advanced warning can be given that the gas density/pressure is reducing to an unacceptable level. After an urgent alarm, operative measures can be taken to immediately isolate the particular compartment electrically by tripping circuit breakers and opening disconnectors. ***It shall be ensured that there is no chance of the gas liquefying at the lowest ambient temperature.***

The gas monitoring device shall monitor at least the following, locally and on remote.

- i) *"Gas Refill" Level- This will be used to annunciate the need for gas refilling.*
- ii) *"Breaker Block" Level- This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the device contact shall trip the breaker and block the closing circuits.*
- iii) *Over pressure alarm level- This alarm level shall be provided to indicate abnormal pressure rise in the gas compartment.*

It shall be possible to test all gas monitoring relays without de-energizing the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes; the pressure/density device shall be suitable for connecting to the male portion of

the plug.

Two potential free electrical contacts shall be provided with each and every alarm condition.

1.14 Conductors

The conductors shall be made of aluminum alloy suitable for specified voltage and current ratings. *The electrical connections between the various gas sections shall be made by means of multiple contact connectors (plug-in type) so that electrical connection is automatically achieved when bolting one section to another. Field welding of conductor is not acceptable. The surface of the connector fingers and conductor on such connections shall be silver plated.* Both, the conductors as well as the contacts for the conductor connections must be designed for the continuous rated current of the switch gear under the ambient conditions furnished, and shall not exceed the permissible temperature rise.

1.15 Enclosures

1.15.1 The metal enclosures for the SF6 gas insulated equipment modules shall be made from Aluminum alloy. Suitable anti corrosive paints shade 631 of IS:5, must be applied on the exterior of the enclosures. The enclosure shall be suitable for three phases, i.e. Single Enclosure. The external fixtures should be made of corrosion-resistant material and should be capped where required.

Bellow compensators shall be made of Stainless steel to preserve the mechanical strength of the equipment at the connection portions to deal with the following problems:

- a) Expansion and Contraction of outer enclosure and conductor due to temperature variations.
- b) Mismatch in various components of GIS
- c) Vibration of the transformer and switching equipment
- d) Dimensional variations due to uneven settling of foundation
- e) Seismic forces as mentioned in climatic condition.

1.15.2 Standard paint **shade 631 of IS:5** shall be used with satin mat finish having high scratch resistance.

1.15.3 The gas-filled enclosures shall conform to the pressure vessel code applied in the country of manufacturer. Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum pressure differential that could occur across the barrier, i.e., with a vacuum drawn on the one side of the barrier and on the other side, at least the maximum gas pressure that can exist under normal operating or maintenance conditions and in case of internal arc fault.

The finish of interior surfaces of the metal-clad enclosures shall facilitate cleaning and inspection. **High quality primer followed by two coats of anti corrosive paint of glossy white shade** shall be used such that they will not deteriorate when exposed to the SF₆ gas and other vapors, Arc products, etc., which may present in the enclosures. They shall also not contain any substances which could contaminate the enclosed gas or affect its insulating properties over a period of time.

1.16 General Finish and Cleaning

- a) The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness.
- b) Very dusty / sandy conditions may exist at the site hence, whenever possible, the complete feeders or major assembly of components should be shipped as transport units. Before the metal clad enclosed sections are joined together and charged with the SF₆ gas they must be thoroughly cleaned.
- c) Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale-off or crinkles or gets removed by abrasion due to normal handling.
- d) Sufficient quantities of all paints and preservatives required for touching up at sites shall be furnished with GIS.

1.17 Gas filling and Evacuating Plant/Gas reclaimer for 66 kV GIS unit.

- a) All apparatus necessary for filling, evacuating, and recycling the SF₆ gas into and from the switch-gear equipment shall be supplied by the bidder to enable any maintenance work to be carried out.
- b) Where any item of the filling and evacuating apparatus is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with facilities for lifting and moving with the overhead cranes.
- c) The apparatus for filling, evacuating and recycling all gases to be used shall be provided with all necessary pipes, couplings flexible hoses, tubes and valves for coupling to the switch-gear equipment.
- d) The gas compartments shall preferably be fitted with permanent vacuum couplings through which the gas is pumped into or evacuated from the compartments.
- e) Details of the filling and evacuating apparatus that will be supplied, and also a description of the filling, evacuating and recycling procedures, shall be provided with the bid.
- f) The initial gas filling of the entire switch-gear including the usual losses during commissioning shall be supplied over and above the required quantity of spare gas.

- g) An additional quantity of SF₆ gas for compensation of possible losses during installation and 10% extra quantity of SF₆ gas for future uses shall be supplied. The quantity of the same shall be indicated in GTP.

Such spare gas shall be supplied in sealed cylinders of uniform size, which shall be decided during detailed engineering.

- h) Gas reclaimer shall have gas storage facility of sufficient capacity.

- i) SF₆ Gas Processing Unit :

- A. An SF₆ gas-processing unit suitable for evacuating, liquefying, evaporating, filling, drying and purifying SF₆ gas during the initial installation, subsequent maintenance and future extension of GIS shall be provided. The cart shall be equipped with rubber wheels and shall be easily maneuverable within the GIS building.
- B. A wheeled maintenance unit shall be supplied which shall be self-contained (except for additional gas storage bottles and external power supply at 415 V AC, 3-phase, 50 Hz) and fully equipped with an electric vacuum pump, gas compressor, gas drier, gas filter, refrigeration unit, evaporator, gas storage tank, full instrumentation for measuring vacuum, compressor inlet temperature, tank pressure and temperature, valving and piping to perform the following operations as a minimum requirement:

- i) Evacuation from a gas filled compartment using the vacuum pump,
- ii) Transfer of SF₆ gas from a system at some positive or negative pressure to the storage tank via the gas drier and filter;
- iii) Recirculation of SF₆ gas in the storage tank through the drier,
- iv) Recirculation of SF₆ gas in any switchgear or bus duct compartment through the drier and filter;
- v) Evaporating and filling SF₆ gas,
- vi) Drawing off and liquefying SF₆ gas,
- vii) A combination operation of filling SF₆ gas into a gas system and evacuating a second gas system using the vacuum pump.

- C. Adequate length of hoses with necessary adaptors shall be provided for filling of SF₆ gas in any of the gas compartment with the help of gas cart.
- D. GA drawing and Schematic drawing for gas processing unit shall be submitted for approval.

1.18 Support Structures

All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied. Sufficient attachment points to the apparatus and concrete foundations shall be furnished to ensure successful installation, with required clearances, while

taking into account thermal expansion and contraction. Earthquake requirements are also to be considered.

Any scaffolding or a movable platform, required for maintenance, shall also be supplied.

All steel structure members shall be hot-dip galvanized after fabrication. Minimum thickness of Galvanizing shall be 610 grams per square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable.

Non-corrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels.

Foundation channels and anchor bolts shall be installed in the civil works in accordance with instructions provided by the manufacturer.

1.19 Auxiliary Equipment

The following items shall be included for a complete installation:

- a) Control system including local control cabinets
- b) Cable and wiring between individual items of supplied equipment.
- c) Nameplates
- d) All ladders, platforms, stairs, walkways, and supports necessary to operate and maintain all equipment safely and efficiently.
- e) Special tools and tackles for installation
- f) Special tools and tackles for maintenance

1.20 Safety Precautions

1 The switch-gear must provide a maximum degree of safety for the operators and others in the vicinity of the switch gear under all normal and fault conditions. The safety clearances of all live parts of the equipment shall be as per relevant standards.

2 It must be made impossible to touch any live part of the switch-gear unwillingly, i.e. without use of tools or brute force.

3 An operator standing in the normal operating position should not be endangered by any moving external part of the switch-gear.

4 Interlocks:

Mechanical & electrical interlocks must be provided to ensure absolute and reliable protection against potentially harmful Mal-operation of the switchgear. All interlocks that prevent potentially dangerous mal-operations shall be so constructed such that they cannot be defeated easily i.e. the operator must use tools and/or technique to over-ride them only in case of emergency.

The following functions shall be provided:

- 1) The operator must be forced in to the only safe and logical sequence to actuate the circuit breakers, disconnectors & earthing switches.
- 2) The actual, completely closed or completely opened position of all switching devices must be checked before and after each move.
- 3) Implementation of logic checks and issuing the resultant signals Enabled or Blocked for the switching device.

5 If in spite of all possible safety measures if any arc occurs, the following is required.

- i) The effects of an internal arcing fault must be limited to the related gas compartment.
- ii) Each gas compartment must have its own *automated external* pressure relief device to provide instant and safe discharge of accidental overpressure during internal arc. Rupture diaphragms shall be preferably used as pressure relief mechanisms. **The bursting pressure of relief device should be effectively coordinated with the rated gas pressure and the pressure rise due to arcing.** PRD shall be positioned such that it will not be below any circuit breaker or disconnector drive or LCC.
- iii) All earthing connections must remain operational.
- iv) The enclosure of the switch gear must withstand the thermal effects of an arc at the full rated short circuit current until the nearest protective relay has acted and tripped the breaker.
- v) To limit the effects of an internal arc the switch gear shall be suitably subdivided into individual arc and gas-proof compartments, at least for
 - Bus-bar together with bus-bar isolator and earthing switch
 - Circuit breaker
 - Line isolators and earthing switch, (Line, transformer)
 - Instrument transformers.

6 The following requirements are to be followed.

- i) The bracing/welding of all components subject to mechanical forces caused by short circuit currents shall be capable so as to withstand the effects of at least 2.5 times the rated symmetrical short time withstand current.
- ii) The thermal rating for all current carrying parts and insulating materials shall be a minimum of three seconds for the rated short time withstand current.
- iii) All components of the switch gear which are on ground potential shall be electrically inter-connected and effectively earthed.

1.21 Special tools, tackles and equipments

Special tools, tackles and equipment that are required to perform installation, commissioning, operation & maintenance of the gas insulated switch gear shall

be included in scope of supply. ***Minimum following tools shall be supplied.***

- 1 Dew point measurement meter
- 2 SF6 gas leakage detector
- 3 Precision pressure gauge
- 4 Gas-service carts
- 5 Any other special tool/tackle required.

The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

The requirement of HV testing during commissioning or repairing or replacement shall be fulfilled by successful bidder by arranging the required HV testing equipment at no extra cost to Utility. No delay shall be permitted on account of the non availability of the HV test equipments.

1.22 Grounding of GIS:

- a) GIS will be housed on GIS floor. The bidder will provide under-ground mat below the substation. The bidder shall also provide adequate number of Galvanized steel risers to be connected to grounding mat, as per relevant standards and in consultation with Utility during detailed engineering, in the event of an order.
- b) The bidder shall supply entire material for ground bus of GIS such as conductor, clamps, joints, operating and safety platforms etc. to be laid / embedded in GIS floors. The bidder is also required to supply all grounding connectors and associated hardware material for:
 - i) Connecting all GIS equipment, Bus duct, enclosures, control cabinets, supporting structures etc. to the ground bus of GIS
 - ii) Connecting ground bus of GIS to the ground mat risers.
- c) The grounding arrangement of GIS shall ensure that touch and step voltages are limited to safe values as per IEEE std. 80-2000. The enclosures of the GIS shall be grounded at several points such that there shall be a grounded cage around all live parts. The ground continuity between each enclosure shall be affected over flanges, with or without links or straps to bridge the flanges. Copper/Aluminum straps shall however bridge the metallic expansion bellows. *The grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed. The inductive voltage against ground in each part of the enclosure shall not be more than 65 Volts.*
- d) Where operating mechanism cabinets are mounted on the switchgear, the grounding shall be made by separate conductor. Bay control cabinets shall be grounded through a separate conductor.

- e) All conduits and control cable sheaths shall be connected to the control cabinet grounding bus. All steel structures shall be grounded.
- f) Each removable section of catwalk shall be bolted to the support structure for ground continuity.
- g) The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE Std. 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS.
- h) The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating by at least from two paths to ground from the main ground bus.
- i) Provisions of IEC 517 & 694 regarding safeguards in grounding of connected cables, testing during maintenance and other safety measures shall be ensured.
- j) *Earthing conductors shall be designed to allow flow of short circuit current. Conductors with copper bars are preferred over copper wires.*

2.0 Service Conditions:

2.1 Climatic Conditions:

The equipment and the accessories to be supplied against this technical specification shall be suitable for satisfactory continuous operation under the following tropical conditions (to be customized by utility as per requirement).

Max ambient temperature	50 deg C
Min. ambient temperature	-5 deg C
Max daily average ambient	38 deg C
Max relative Humidity (%)	As per IEC
Max altitude above M.S.L (meters)	< 1000
Average Annual Rainfall (mm)	1000
Max wind pressure (kg./sq.mtr.)	130
Isoceraunic level (days/yr)	50
Average no. of rainy days / annum	120
Condensation	Occasional
Induced electromagnetic	1.6 kV
Pollution class / Creepage distance	III / 25 mm/kV
Seismic Zone	Zone V
Acceleration due to gravity, g	0.5

2.2 System Particulars

2.2.1 Pole designation

2.2.1.1

Enclosure

2.2.1.1.1 Bus bar : Three Phase

2.2.1.1.2 Bay : Three Phase

2.2.1.1.3 Enclosure material : Aluminum Alloy

2.2.2 Standards

Common clauses for high voltage switchgear : IEC 60694
& control gear

High voltage metal enclosed switchgear for : IEC 62271-203
72.5 KV & above

Specification for acceptance of new Sulphur : IEC 60376
Hexa fluoride

Guide to checking of Sulphur Hexa fluoride : IEC 60480
taken from Electrical equipment

Surge Arresters : IEC 60099

Overhead line, Cable and Transformer Terminals : IEC 60137
Bushings for alternating voltages above 1000 V

Cable connections for gas insulated metal : IEC 60859
enclosed Switchgear for rated voltages of 72.5 KV above

High voltage test techniques : *IEC 60060*

Insulation coordination : *IEC 60071*

Electrical Relays : *IEC 60255*

High voltage switches : *IEC 60265*

Partial discharge measurement : *IEC 60270*

Degree of protection : *IEC 60529*

<i>Pollution levels</i>	:	IEC 60815
EMC	:	IEC 61000
<i>Use and handling of SF6 gas</i>	:	IEC 61634
<i>Standards for station grounding</i>	:	IEC 60364/ 60479/ IEEE 80
<i>Pressure vessel code</i>	:	CENELEC/SVDB
<i>Recommendation for heat treated Aluminum alloy busbar material of the aluminum-magnesium-silicon type</i>	:	IEC 60114
IEEE Guide for Gas-Insulated Substations	:	IEEE std C37.122.1- 1993
Seismic design	:	IEC 693

2.2.3.1 Instrument Transformers

Instrument transformers	:	IEC 60044
Current transformer	:	IEC 60185
Voltage transformer	:	IEC 60186

2.2.3.2 Circuit Breaker

High voltage Alternating current circuit breakers	:	IEC 62271-100
Report on Synthetic testing of high voltage Alternating Current Circuit breakers	:	IEC 60427

2.2.4 Disconnectors and earthing switch

Alternating current Disconnectors (isolators) and earthing Switch	:	IEC 60129 IEC 62271-102
Alternating current disconnectors, Bus transfer current Switching by disconnectors	:	IEC 61128
Alternating current earthing switches, induced current Switching	:	IEC 61129

2.2.5 <i>Artificial pollution test on HV insulators to be used on ac system</i>	:	IEC 60507
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2.2.6 <i>Gas insulated metal enclosed switchgear for rated voltages of 72.5 kV and above</i>	:	IEC 60517
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2.2.7 <i>Classification of degree of protection provided by enclosures</i>	:	IEC 60529
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2.3 Electrical data: ((To be customized by utility as per requirements & capacity)

Rated System Voltage / Highest System/Equipment Voltage	kV	66 / 72.5
One min. Power frequency withstand voltage	kV rms	140
Across open isolator	kV rms	160
Across the open gaps of CB	kV rms	140
Rated Lightning Impulse withstand voltage (1.2/50 micro second peak value)		
Phase to phase	kVp	350
Phase to earth	kVp	350
Across open isolator	kVp	375
Across the open gaps of CB	kVp	350
Rated Frequency	Hz	50
Rated Continuous current at 40 deg C ambient temperature Bus bar	Amps	1600
Feeder and Transformer Bay	Amps	1600
Rated Short circuit Withstand current for 3 seconds	kA	25
Rated dynamic withstand current	kAp	62.5
Partial Discharge (at 1.1 Un)	pico-coulombs	5(max.)
System Neutral earthing		Solidly earth
Maximum SF6 Gas leakage rate per year	% per year	0.5

2.3.1 Auxiliary Supply:

For Operation, control and signaling : 110 Volts DC (+10% & -20%) or as reqd by utility

For other loads : 440 / 230 Volts, AC 50 Hz.
(+10% & -15%)

2.4 Seismic requirements:

The GIS shall comply with IEEE STD 693 – 1984 guideline to ensure functional adequacy under seismic disturbances. The maximum ground acceleration shall be 0.5 g.

3 Detailed technical requirements for GIS Components

3.1 Circuit Breaker:

3.1.1 General:

3.1.1.1 The GIS circuit breakers shall comply with the following general requirements for circuit breakers and the latest revisions of the relevant IEC-62271-100 specifications

3.1.1.2 Circuit-breakers shall be of single pressure, single break, **self** compression *self blast* / auto puffer type with SF₆ as arc quenching & insulation medium and with a minimum- maintenance contact system

3.1.1.3 They shall be of three phase encapsulated type.

3.1.1.4 Ratings of the circuit breaker shall be as per enclosed technical parameters

3.1.1.5 They should be shipped as a completed three-phase unit within a complete bay module.

3.1.1.6 Each circuit-breaker shall have spring/*Hydraulic*/combined drive mechanism *ensuring proper closing and opening, and shall permit checking of adjustments and opening/closing characteristic*. The ON/OFF latches shall be mechanically interlocked with each other. The circuit breaker shall be completely factory assembled, adjusted and tested.

3.1.1.7 The total break time from energizing the trip coil at rated control voltage to final arc extinction shall be as short as possible, but in any event not greater than 3 cycles i.e. 60 ms.

3.1.1.8 The circuit breaker shall be capable of breaking all currents from zero up to the specified maximum fault current in accordance with the relevant IEC recommendations.

3.1.1.9 The breakers are to be restrike-free.

3.1.1.10 The circuit-breakers shall be capable of tripping and re-closing (Auto reclose) according to the specified duty cycle without derating: O-0.3 s – CO – 3 min. – CO.

Breaker shall be suitable for following switching duties:

- Terminal faults**
- Short line faults**
- Out of phase switching**
- Interruption of small inductive current including transformer**
- magnetizing inrush currents.**
- Interruption of line and cable charging currents.**

The circuit breaker shall meet all the double Circuit overhead transmission line and cable characteristics for any type of fault or fault location, and also for line charging and dropping when used on an effectively grounded system. Effect of second circuit in parallel shall also be considered.

The circuit breakers shall be capable of being operated locally or from remote. Local operation shall be by means of an open/close control switch located in the bay control cabinet.

The minimum guaranteed nos. of maintenance free operations of complete GIS shall be 10000 nos. at rated capacity.

3.1.1.11 The Drive shall have sufficient stored energy for completing 2 CO with auxiliary power switched off.

3.1.1.12 Circuit breakers, being an arcing device, shall not house any passive device like current transformer in its housing.

3.1.1.13 ***The breaker layout arrangement shall be vertical or horizontal but shall provide higher mechanical stability and ease in maintenance. The operating principle of the breaker shall ensure minimized dynamic floor loading. Low reaction forces on foundations especially dynamically, are favorable and considered in the elevation.***

3.1.2 Closing Devices

3.1.2.1 The closing coils shall be suitable for operation at any voltage between 110% and 80% of the nominal control voltage measured at the device terminals.

3.1.2.2 The breaker shall close correctly when an electrical closing pulse of 50 msec. duration is applied to the closing coil.

3.1.3 Tripping Devices

3.1.3.1 All electrical tripping coils shall be suitable for operation at any voltage between 110% and 70% of the nominal control voltage measured at the device terminals.

3.1.3.2 Each circuit-breaker shall be equipped with two shunt trip system. The one shunt trip system shall be electrically separated from the other system.

3.1.3.3 An emergency hand tripping (mechanical) device shall be provided in the operating mechanism.

3.1.4 Anti-Pumping

The circuit-breaker mechanism shall be provided with means to prevent pumping while the closing circuit remains energized, should the circuit breaker either fail to latch, or be tripped during closing due to the operation of the protective relays.

3.1.5 Operating Mechanism

3.1.5.1 The breaker **shall include suitable** spring/*Hydraulic*/combined operating mechanism to assure proper opening & closing operations. The provision shall be made for checking adjustments and opening characteristics. The mechanism shall be capable of re-closing within the range specified in the applicable standards. The mechanism shall include dual trip coils. ***Charging of opening mechanism shall be possible in the event of failure of the motor drive.***

Spring Operated Mechanism

a) Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

b) As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.

c) After failure of power supply to the motor, at least two close-open (C-O) operations of the circuit breaker shall be possible.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.

e) Motor rating shall be such that it requires only about 30 seconds for fully charging the closing spring.

f) Closing action of the circuit breaker shall compress the opening spring ready for tripping.

g) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation.

Hydraulic Operated Mechanism

a) Hydraulic operated mechanism shall comprise self contained operating unit with power cylinder, control valves, high and low pressure reservoir, motor, etc. A hand pump set shall also be provided for emergency operation.

b) The oil pressure controlling the oil pump and pressure in the high pressure reservoir shall be continuously monitored. Necessary hardware to achieve this, including the loose pressure gauge, instruments and interconnecting piping etc shall form integral part of this mechanism.

c) The mechanism shall be suitable for at least two close-open operations after failure of AC supply to the motor.

3.1.5.2 The mechanism shall be in a dust proof (**IP55**) box for this outdoor installation of Gas Insulated Switchgear.

One vermin-proof, sheet steel cabinet of adequate size shall be provided for housing the operating mechanism, aux relays, control and auxiliary equipment and for terminating all control, alarm and auxiliary circuits in suitable terminal boxes. The control cabinet shall be provided with hinged doors with provision for locking and removable cable gland plates for bottom cable entry. Viewing windows shall be provided for observation of the instruments without opening the cabinet. Suitably engraved nameplates shall be provided to identify all equipment in the control cabinet.

3.1.6 Auxiliary Switches

Each breaker shall have auxiliary switches with adequate number of NO and NC contacts all wired to terminals located in the local control cabinet of the circuit breaker bay. 20 % spare contacts should be provided.

3.1.7 Indicating Devices

3.1.7.1 Position indicators shall be provided to clearly indicate whether a circuit-breaker is open or closed.

3.1.7.2 Each circuit-breaker shall be provided with an operation counter to record the number of tripping operations performed. The counter may be located at the local control cabinet.

3.1.7.3 All position indicators and counters shall be readable at a convenient elevation i.e. from the place of operation.

3.1.8 Gas Connections

Necessary valves and connections shall be provided to assure ease in handling the SF6 gas.

3.1.9 Timing Test

Timing tests are to be carried out after the switch gear has been completely charged with SF6 gas.

3.1.9.1 *Testing instruments*

- _ Air / gas humidity tester,
- _ Gas purity detector for SO2, H2O, CF4, AIR etc.,
- _ Gas leakage tester,
- _ Breaker timing measurement kit,
- _ Set of equipment for pressure measurement and gas density meter.

3.1.9.2 **TESTING FACILITIES:**

Timing test facility shall be provided with switchgear such that it is not necessary to open up any gas section to make test connections to the circuit breaker terminals. All details of test facilities to be provided shall be submitted with technical bid.

3.1.10 Principle Parameters

The Circuit Breakers of GIS equipment shall confirm to the specific technical requirements given as under.

Circuit Breaker (To be customized by utility as per requirements & capacity)

S. No	Particulars	66 kV
1a)	Enclosure	Three Phase
1b)	Enclosure material	Aluminum Alloy
2)	Rated voltage	72.5 kV
3)	Rated current	1600A
4)	Rated frequency	50 Hz

5)	Rated short-circuit breaking current	25 kA rms, 3 sec
6)	Rated break-time	3 cycle
7)	Rated short-circuit making current	62.5 kA peak
8)	Difference for simultaneity of 3 poles	4 ms (Max.)
9)	Rated insulation level under minimum SF6 gas pressure	
a)	Power frequency withstand voltage	140 kV rms
b)	Lighting impulse withstand voltage	350 kV peak
c)	Rated operating sequence	O-0.3s-CO-3min-CO
10)	Type of operating mechanism for circuit Breaker	Spring – Spring/hydraulic
11)	Rated control voltage	110/220 VDC 110/220 VDC
	- Closing coil	
	- Tripping coil	
12)	Mechanical Endurance class	M1
13)	Electrical Endurance class	E1
14)	Restriking probability class	C1
15)	Rated line charging breaking current	10:00 AM
16)	Rated cable charging breaking current	125 A
17)	Rated capacitor bank switching current	410 A
18)	Rated out of phase making and breaking current in % of rated short circuit breaking current	25

19)	Characteristic for short line fault related to rated short circuit breaking current	As per IEC 62271 - 100
20)	TRV characteristics	As per IEC 62271 - 100
21)	Inductive current breaking capability	Switching No Load current of transformer
22)	First pole to clear factor	As per IEC 62271 - 100
23)	Opening time in ms	Not more than 40
24)	Closing time in ms	Not more than 100
25)	Noise level at the base of CB	As per NEMA standard
26)	No of tripping coils per breaker	2
27)	No of closing coils per breaker	1

3.2 Disconnect Switches and Maintenance Grounding switches

3.2.1 General

- a) The GIS disconnect switches and grounding switches shall comply with the following general requirements of disconnect switches and the latest version of the relevant specifications IEC 60129, 61128, 61129, 61259.
- b) Disconnect switches shall be three phase encapsulated, group operated, no break, with one common motor operated mechanism for all the three poles. They shall also have facilities for emergency manual operation and necessary handles shall be provided.
- c) Maintenance earthing switches shall be three phase encapsulated, group operated, no break, with one common motor operated mechanism for all the three poles. They shall also have facilities for emergency manual operation and necessary handles shall be provided.
- d) Disconnect switches and grounding switches shall have electrical and Mechanical interlocks to prevent grounding switch from closing on an

energized section.

Interlocks with other bays for bus transfer switching shall be done through bay control cabinets. Actuation of the emergency manual operating device shall also disable the electrical control. Disconnectors in open condition shall be secured against reclosure.

Disconnecting switches and adjacent safety grounding switches shall have electrical interlocks to prevent closure of the grounding switches when the disconnecting switches are in the closed position and to prevent closure of the disconnecting switch when the grounding switch is in the closed position. The disconnector shall be pad lockable in the close & open position.

Interlocks

Interlocking devices must provide absolute and positive protection against potentially harmful mal-operations of the switchgear. The following functions shall be assured:

- i) Forcing the operator into the only safe and logic sequence to actuate breakers, switches, isolators and grounding switches.*
- ii) Checking the actual fully closed or fully open position of all switching elements before and after each move.*
- iii) Providing the logical checks and issuing the resulting PERMISSIVE or BLOCKED signals for the switchgear.*
- iv) Indicating positively the absolute condition/position of the supervised equipment.*
- v) Local manual and remote electrical operation of all essential functions.*
- vi) Local emergency unlocking facilities via safety-key switches under the full responsibility of the operator.*

Intrabay and interbay interlocking shall be provided.

Electrical interlocking arrangement shall be fail-safe type.

Mechanical interlocks for isolator & Earthing Switch shall be fail-safe type.

- e) All main contacts, male and female, shall be silver plated.
- f) Each disconnect switch and grounding switch shall open or close only due to motor driven or manual operation independently. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact be held closed.

Operation of respective end position limit switches shall only disconnect the motor mechanism. There should also be a pre-set timer in motor circuit for

protection against time over–run in case of inadvertent failure of drive mechanism in any intermediate position of the disconnect travel path.

- g) The disconnect switches and grounding switches shall be located as shown in the Single Line Diagram.
- h) The disconnect switches shall be capable of interrupting the charging current of the connected GIS bus & associated components.

i) Duty requirements:

The disconnecting switches shall have breaking capabilities as per IEC requirements. Contact shielding shall be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when currents are interrupted.

The bus disconnecting switches shall reliably handle capacitive currents due to the making and breaking of switchgear components as well as commutation currents due to bus bar reconfiguration.

The fast acting ground switches, used for overhead double circuit lines and underground cable feeders shall be capable of switching induced current as per IEC requirement.

Short Circuit Requirements

The rated peak short-circuit current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:

- a) Mechanical damage to any part of the isolator or earthing switch.*
- b) Separation of the contacts or contact welding.*
- c) A temperature rise likely to damage insulation.*

j) Access for maintenance and repair:

Suitable means of access should be provided in each disconnect-switch and grounding-switch housing and mechanism for repair and/or maintenance of contacts.

3.2.2 Operation Mechanism.

3.2.2.1 Mechanism shall be arranged mechanically, electrically, so that all three phases of any particular disconnect switch or grounding switch operate simultaneously.

3.2.2.2 All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation. For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all necessary operation rods and rod guides. Manual operation shall be prevented if the interlocking system does not allow the operation of the switch.

3.2.2.3 The auxiliary supply shall be electrically decoupled from the motor

when the switch is operated manually.

3.2.2.4 The mechanisms shall be arranged for locking in the open and in the closed position. Facility shall be available to allow the switch to be padlocked in any position.

3.2.2.5 Disconnecting operating mechanism of all disconnecter/ isolator & earth switches shall be at easy operable height.

3.2.2.6 The isolator shall be provided with positive continuous control throughout the entire cycle of operation.

The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator.

It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced at any point in the travel sufficiently to a low improper functioning of the isolator when the isolator is opened or closed at any speed.

The operating mechanism design shall be such that during the operation of the isolator (especially manual operation), once the moving blades reach the sparking distance, springs shall take over to give a quick, snap action closing so that the isolator closing is independent of manual efforts. Similarly, the springs must assist during the opening operation to give quick breaking feature.

Disconnecter and high speed motor operated earthing switch mechanisms shall be provided with a mechanism with stored energy to always assure completed operations.

3.2.3 Auxiliary Switches:

All disconnecting switches shall be provided with electrically independent auxiliary switch, directly driven by the common operating shaft. Each disconnect switch and grounding switch shall be furnished with sufficient Nos. of NO – NC as per entire scheme requirement plus two (2) NO-NC electrically independent contacts terminated up to terminal board, at user's disposal. The auxiliary switches shall indicate the position of the switch contacts, and shall be independent of the motor operation.

3.2.4 Position Indicators

3.2.4.1 Mechanically connected position indicators shall be provided externally to permit observation of close/open position of the disconnect switch and grounding switch. The place of Position Indicators should be easily visible from the place of operation of respective equipment.

3.2.4.2 Visual verification shall be provided for each pole of each disconnect switch and grounding switch to permit visual inspection of each

switchblade position.

3.2.5 Technical Data Requirement: Disconnectors:

(To be customized by utility as per requirements & capacity)

Sr No.	Particulars	Parameters
1)	Enclosure	Three Phase
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage	72.5 kV
4)	Rated current	1600 A
5)	Rated short-time current	25 kA rms, 3 sec
6)	Rated control and operating voltage	110/220 V DC
7)	Type of operating mechanism	Motor operated
8)	Type	Mechanically ganged operated
9)	Rated insulation level	
a)	Power frequency withstand voltage	
	- phase to phase, between phases	140 kV rms
	- Across the isolating distance	160 kV rms
b)	Lightning impulse withstand voltage	
	- phase to phase, between phases	350 kV peak
	- Across the isolating distance	375 kV peak
10)	Mechanical Endurance Class	M1
11)	Bus transfer switching capability (% of rated current)	80
12)	Rated bus charging current	0.1 A

3.2.6 Low-voltage test provision:

A low-voltage test provision may be supplied with a grounding switch to permit test voltages of up to 10kV (optional 2.5kV) and upto 200 A to be applied to the conductor without removing SF6 gas or other components, except for ground shunt leads.

3.3 Fast Acting Grounding Switches

3.3.1 General.

3.3.1.1 Fast acting grounding switches can be located at the terminal of HV/EHV overhead line/ cable. They shall be able to switch safely load currents

of overhead lines. They must have fault making capability and be able to switch on a live line. Applicable standards are IEC 60129, 60517, 61129. The fast acting grounding switches shall comply with the following general requirements of fast acting grounding switches and the latest revision of the relevant IEC specifications.

3.3.1.2 Fast acting grounding switches shall be of three phase, encapsulated, three phase linkage group operated by a maintenance-free self contained electrical motor. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.

3.3.1.3 Fast acting grounding switches shall be electrically or mechanically interlocked with related disconnectors, to prevent the fast acting grounding switch from closing on an energized bus section.

3.3.1.4 All main contacts, male and female, shall either be silver plated or shall have silver inserts.

3.3.1.5 Each fast acting grounding switch shall open or close only due to motor-drive or manual operation but shall be operable from local only. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.

3.3.1.6 Each fast acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes. The insulation shall be capable of withstanding an applied power frequency voltage of 5 kV.

3.3.2 Operation Mechanism.

3.3.2.1 Mechanisms shall be coupled either mechanically or electrically or by both, so that all three phases of any particular fast acting grounding switch operate simultaneously *without any discrimination*.

3.3.2.2 All mechanisms shall be equipped with a motor suitable for operation from the auxiliary supply, and a set of springs so arranged that energizing of the motor will cause the springs to be charged and then released. The springs in turn shall close the fast acting grounding switch.

3.3.2.3 Motors shall be suitable for operation at any voltage between 80% and 110% of the rated auxiliary voltage, measure at the motor terminals.

3.3.2.4 For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all necessary operation rods and rod guides.

3.3.2.5 The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually.

3.3.2.6 The mechanisms shall be arranged for locking in the open and in the

closed position.

3.3.3 Auxiliary Switches

Each fast acting grounding switch shall be furnished with sufficient Nos. of **NO – NC as per entire scheme requirement** plus two (2) NO-NC electrically independent contacts, suitably terminated at terminal blocks, at user’s disposal. The auxiliary switches shall indicate the position of the switch contacts, and shall be independent of the motor operation.

3.3.4 Position Indicators

Mechanically connected position indicators shall be provided externally to ascertain the open/close position of the grounding switch. It should be easily visible from the place of operation of equipment.

Visual verification shall be provided for each pole of each disconnect switch and grounding switch to permit visual inspection of each switchblade position.

3.3.5 Test Facility

Each fast acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes. The insulation shall be capable of withstanding an applied power frequency voltage of 5 kV.

High speed earthing switches shall be capable of interrupting line coupling currents upon opening and in worst conditions closing.

3.3.6 Technical Data Requirement: High Speed Earthing Switch:

(To be customized by utility as per requirements & capacity)

S.No.	Particulars	66 kV
1)	Enclosure	Three phase
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage	72.5 kV
4)	Rated short-time current	25 kA rms, 3 sec
5)	Rated peak withstand current	62.5 kA peak
6)	Type of operating mechanism	Motor operated
7)	Rated control and operating voltage	110 / 220 V DC
8)	Power frequency withstand voltage	140 kV rms
	across the open gap	160 kV rms
9)	Lightning impulse withstand voltage	350 kVp
	across the open gap	375 kVp
10)	Electrical Endurance class	E1
11)	Rated induced current switching capability	As per IEC 62271 – 102 class B

Maintenance Earthing Switch: 66 kV

1)	Enclosure	Three phase
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage	72.5 kV
4)	Rated short-time current	25 kA rms, 3 sec
5)	Type of operating mechanism	Motor operated
6)	Electrical Endurance class	E0
7)	Power frequency withstand voltage	140 kV rms
	across the open gap	160 kV rms
8)	Lightning impulse withstand voltage	350 kVp
	across the open gap	375 kVp

3.4 Current Transformers:

3.4.1 General

3.4.1.1 The current transformers provided for each phase shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC 60044 specifications.

3.4.1.2 The current transformers must be suitable for continuous operation when installed on the conditions.

3.4.1.3 The current transformer shall be ring / toroidal type, multi ratio with fully distributed secondary windings with relay accuracy as per IEC 60185 (1987), incl. IEC 60044-4 (1992), multi core as per requirement and shall be mounted inside the high voltage enclosure.

3.4.1.4 The secondary terminals of current transformers shall be placed outside the high voltage enclosures, mounted in suitable, accessible terminal boxes and the secondary leads of all the current transformers shall be wired to shorting type terminals.

3.4.1.5 It shall be possible to test each current transformer without the removal of gas through the insulated grounding switches.

3.4.1.6 The number and position of the current transformers shall be relative to the circuit-breakers, disconnecting switches and ground switches as detailed in the single line diagram.

3.4.1.7 The rating, No of cores, ratios, accuracy class, characteristics etc. for the individual current transformer secondary cores shall be as specified. The various ratios of current transformers shall be obtained by changing the

effective number of turns on the secondary winding.

3.4.1.8 Each current transformer shall be provided such that the enclosure current does not affect the accuracy or the ratio of the device or the conductor current being measured. Provision shall be made to prevent arcing across the enclosure insulation.

3.4.2 Rating and Diagram Plates

Rating and diagram plates shall be provided. The information to be supplied on each plate shall be as specified in the relevant IEC specification, which shall be given for the tap for which the rated performance is specified and for each transformer core.

3.4.3 Technical Data Requirements (To be customized by utility as per requirements & capacity)

<u>66KV class CT - Bay wise core requirement considering 20 MVA Transformer</u>								
Core No	Purpose	Ratio	Output burden	Accuracy class	Instrument security factor	Min. Knee point voltage at highest rated current	Max. excitation current at KPV	Max. CT Rct Sec. at highest ratio
	Fee							
1	Metering	600-300 /	15	0.5	≤5	-	--	--
2	Dir. O/C-E/F Protection	600-300 / 1	10V A	5P	10	-	--	--
3	Dir. O/C-E/F Protection	600-300 / 1	10V A	5P	10	-	--	--
	Transformer bay (HV)							
1	Metering	200-	15	0.5	≤5		--	--
2	Non - Dir. O/C-E/F Protection	200-100 / 1	10VA	5P	10	-	--	--

3	Differential Protection	200-100 / 1	--	PS	--	600 V	25 mA	< 5 Ohm
4	Differential Protection	200-100 / 1	--	PS	--	600 V	25 mA	< 5 Ohm
Bus coupler bay								
1	Metering	600-300 /	15	0.5	≤5	-	--	--
2	Non - Dir. O/C-E/F Protection	600-300 / 1	10VA	5P	10	-	--	--
3	Non - Dir. O/C-E/F Protection	600-300 / 1	10VA	5P	10	-	--	--

3.5.1 VOLTAGE TRANSFORMER:

3.5.1.1 SF6 insulated:

Each voltage transformer shall be *metal enclosed*, SF6 insulated in accordance with relevant IEC 60044. The location, polarity, ratios, and accuracy shall be as specified.

3.5.1.2 Construction:

VTs should be in segregated compartment and not forming a part of bus bar. Transformers should be of either plug-in construction or the disconnect-link type, and be attached to the gas-insulated system in such a manner that they can be easily disconnected while the system is being dielectrically tested.

Alternately, a voltage transformer designed so that it does not have to be disconnected during dielectric testing may be specified. The metal housing of the transformer should be connected to the metal enclosure of the GIS with a flanged, bolted, and gasketed joint so that the transformer housing is grounded to the GIS enclosure. *Adequate measures shall be provided to prevent any unacceptable impact on the secondary control and protection circuits, which might result from fast transients (VFT) or Ferro-resonance.*

3.5.1.3 Covers and shields:

Special covers and any necessary corona shields should be supplied so that the system can be pressurized and dielectrically tested after removal of the transformer.

3.5.1.4 Primary and secondary terminals:

Primary and secondary terminals should have permanent markings for identification of polarity, in accordance with IEC.

3.5.1.5 Provision shall be made for grounding of the secondary windings inside the local control cabinet.

3.5.1.6 Test condition for tests at site: Power frequency tests for the completed GIS at site shall be possible without removing the VT. The primary and secondary neutral terminal points, intended to be earthed, should be insulated and shall withstand power frequency voltage of 3 kV rms for 1 minute. The VT shall be capable to withstand discharge current arising from capacitance of underground cable circuits.

3.5.1.7 Technical Data Requirement:

S. No.	Particulars	Parameters
1)	Rated voltage	66 kV
2)	Highest system voltage	72.5 kV
3)	Rated frequency	50 Hz
4)	P F (dry) withstand voltages	140 kV
5)	Voltage factor	1.2 continuous
6)	1.2/50 micro sec. lightning impulse withstand voltage	350 kVp
7)	Earthing	Effective

66 KV class PT Core Details

Core	Purpose	Ratio	Burden	Class of accuracy
1	Metering	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	0.5
2	Protection	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	3P
3	Protection	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	3P

3.5.2 BUSHINGS:

Outdoor bushings shall be provided for connection of conventional external conductors to SF6 GIS if asked in general layout plan.

Suitable clamp & connectors shall be supplied with bushing. The dimensional and clearance requirements for the metal clad enclosure shall be maintained as per requirement of relevant standards.

All the bushings shall have an impulse & power frequency withstand level that is higher or equal to the level specified in cl. 2.3.

Only SF6 insulated composite silicon bushings will be accepted. The terminals on the outdoor bushings shall be a solid stem with dimensions specified.

3.5.3 Metal-Enclosed Surge Arresters:

The 60 kV, hermetically sealed, Gapless, ZnO, Surge arrester, suitable for use with GIS, for each phase, at the 66 kV line underground cable entry terminals of GIS shall be provided, if indicated in Schedule of requirements. Each Surge Arrester shall be provided with self leakage current monitoring device at convenient elevation.

They shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. The surge arresters when provided with pressure relief devices shall be capable of withstanding the internal pressures developed during the above discharges without operation of the pressure relief devices.

Surge Arresters, if any provided, shall be of either the “plug-in” construction or the disconnect-link type and be attached to the gas-insulated system in such a manner that they can be readily disconnected from the system while the system is being dielectrically tested. The metal housing of the arrester shall be connected to the metal enclosure of the GIS with a flanged, bolted joint.

The ground connection shall be sized for the fault level of the GIS. It shall be insulated from the GIS-enclosure and grounded externally to permit periodic maintenance and monitoring of the leakage current.

If the arresters are not equipped with removable links, special covers and any necessary corona shields should be supplied so that the system can be pressurized and dielectrically tested after removal of the arrester.

Access to the arrester ground connection, when it is provided with means for leakage current monitoring should not be obstructed.

3.6 Insulating Gas and gas leakage rate

The GIS shall be furnished with sufficient sulfur hexa fluoride (SF6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density. The guaranteed leakage rate

of each individual gas compartment and between compartments must be less than 0.5% p.a. for the service life of equipment.

The quality of new filled-in SF6 gas shall meet the following requirements in line with IEC 60376.

SF6 > 99.90 % by weight

Air < 500 ppm by weight (0.25 vol.-%)

CF4 < 500 ppm by weight (0.1 vol.-%)

H2O < 15 ppm by weight (0.012 Vol-%)

Mineral oil < 10 ppm by weight

Acidity, in terms of HF < 0.3 ppm by weight

Hydrolysable fluorides,

In terms of HF < 1 ppm by weight

3.7 Reuse or recycling of removed gas:

The supplier should provide guidelines or recommended practices for the reuse or recycling of SF6 gas removed from the equipment. These guidelines should be consistent with current industry practices, as they pertain to the effect of SF6 on global warming; i.e. SF6 gas should be reused and recycled whenever possible and never be unnecessarily released into the atmosphere. *Clear instructions shall be provided by bidder about handling, recycling & treatment of new and used SF6 gas.*

During commissioning dew point of SF6 gas shall be measured and documented.

Components may be filled with N2 for transportation and refilled with SF6 at site.

3.8 Gas sections

The GIS enclosures (one enclosure for all the three phases) shall be divided into several gas sections separated by gas-tight barriers. Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section. **Location of gas barrier insulators is to be clearly discriminated outside the enclosure by a band of distinct colour normally used for safety purposes.**

The gas system proposed shall be shown on a “gas single line diagram” and submitted with the technical bid. **It should include the necessary valves, connections, density monitors, gas monitor system and controls, indication, orifices, and isolation to prevent current circulation. Means of calibrating density monitors without de-energizing the equipment should be specified by the supplier.**

For the purpose of gas monitoring and maintenance, the GIS shall be divided into various individual zones in each bay. **The CB gas zone shall be independent from all other gas compartments and shall meet the requirement of relevant IEC.**

Each gas zone shall be furnished with a gas monitoring system consisting of a gas density continuous monitoring device provided with two electrically independent contacts which operate in two stages as follows:

- a) First alarm : At a gas density normally 5 to 10% below the nominal fill density.
- b) Second alarm: Minimum gas density to achieve equipment ratings.

In special cases determined by the supplier, a third stage with a set of contacts may be necessary in certain areas.

Provisions shall be made for connecting pressure gauges, service cart, and moisture test instrumentation to any one of the gas sections.

Permanent Gas Treatment Devices:

Means shall be provided inside each enclosure for treating the SF6 gas by the use of Desiccants, driers, filter, etc. to remove impurities in the gas. All gas compartments shall be fitted with static filter material containers that will absorb residual and entering moisture inside the high voltage enclosures. Filters inside the breaker compartment shall also be capable of absorbing gas decomposition products resulting from the switching arc.

3.9 GIS Connection:

3.9.1 GIS to TRANSFORMER:

Transformers shall be connected to the GIS by termination of 66 kV XLPE power cable. The connection between GIS and high voltage cable at GIS end shall be done through cable termination / cable sealing end. For transformer end connection the cable termination on structure shall be provided outdoor, if specified in schedule of requirements. The plug in cable sealing ends for XLPE cables shall consist of gas tight plug in sockets and prefabricated plugs with grading elements of silicone rubber.

3.9.2 GIS to LINE:

The 66 kV line will be terminated to GIS by XLPE power cable

3.9.3 66 kV Power Cable connection:

The connection between GIS and high voltage cable at GIS end is done through cable termination / cable sealing end. Plug in cable sealing ends for XLPE cables shall consist of gas tight plug in sockets, and prefabricated plugs with grading elements of silicone rubber.

A separate cable basement is provided for cable entry, its distribution and installation.

The design of the cable end box shall fully comply with the IEC standard. The type and size of cable is specified. All end cable modules shall be suitable for connecting single core, XLPE specified cable.

Necessary provision for termination of specified nos. of such power cables shall be made in GIS. GIS supplier shall either carry out the work of termination or coordinate with cable terminator for such connection as specified in schedule of requirement. Provision shall be suitable for terminating cable size and type approved by utility.

3.10 Local & Remote Control and Operation

3.10.1 General

One local control cabinet (LCC) for GIS shall be supplied for the local control and operation of each bay. Each LCC shall contain the local control, interlocking, operation and indication devices for the associated GIS bay.

The LCC shall be mounted on each GIS bay. The LCC's shall be located with sufficient space for access and the possibility to work at the equipment even when the LCC doors are open, or directly at the switch-gear in front of the related circuit breaker.

The LCC's shall be installed indoor and care must be taken with the design to ensure that all LCC's are drip and splash proof. The LCC's shall also be dust and vermin proof. The control and operation circuits shall be well shielded and with safety measures to protect operator from touching energized parts. Power frequency withstand of control circuits shall be 2 kV for 1 minute.

The LCC should have required arrangement for control and operations of GIS from Remote i.e. from the control room through SCADA compatible control and protection panel.

The LCC shall include all required functions for control and supervision of a complete GIS as well as the marshalling of all connections to and from the GIS bays.

Safe station operation is ensured through following base functions.

- i) Feeder & station interlocking, depending on the position of all high voltage components with their blocking functionality.
- ii) Blocking of commands when crank handle of disconnector or earthing switches is introduced.
- iii) Extensive circuit breaker supervision through "Anti-Pumping", pole discrepancy, Gas density and position supervision of circuit breaker,

3.10.2 Required features for conventional local control cabinets

The LCC's shall be provided with the following features:

a) A mimic diagram showing the single line diagram. Position indicators, on/off switches for the HV devices and local / off / remote switches shall be installed on or adjacent to the various symbols of the mimic diagram.

The following devices shall be supplied as a minimum:

- Circuit breaker control switches with ON – OFF indicating lamps. – Circuit breaker “local-remote” selector switch.
 - Disconnect switch, control switch with ON – OFF indicating lamps.
 - Grounding switch, control switch with ON – OFF indicating lamps.
 - Mimic bus including symbols according to the single line diagram.
 - Monitoring control of all high voltage switching devices in a bay.
 - Digital display of current, voltage, active and reactive power, power factor etc.
- b) Any interposing relays and control switches associated with the circuit breakers disconnect switches, grounding switches etc.
- c) The alarm and indication for devices specified e.g. gas, DC & AC supervision.
- d) Fuses and links. These shall be installed in the interior of the LCC’s
- e) Terminal blocks for the terminating and marshalling of auxiliary supply circuits, control, interlocking, and indication & alarm circuits from the GIS and for cable connections to the remote control room or the owner’s control system.
- f) Each LCC shall be furnished with a guarded resistance heater to prevent the internal equipment from humidity deposit. The heater shall be rated 230 V AC and fed through a two pole fused disconnect switch.
- g) A fluorescent lamp and a duplex convenience outlet rated 230 V AC, 15 amps with ground fault interrupter shall be installed in each LCC.
- h) The Local control cubicle shall be fitted with pre wired interface terminal blocks for connection to user’s control & protection panels. The interface includes CT & PT inputs for protection & measuring system, Protection trip 1 & 2 signals, Aux switch contacts etc.

3.10.3 Wiring Requirements

- i) Each circuit breaker shall have control suitable for operation on 110 V DC with two electrically independent trip circuits. The miniature circuit-breakers (MCB) shall be provided for the closing circuit and an independent separate switch fuse unit of suitable rating shall be provided for the primary and back up trip circuits.
- ii) Wiring shall be complete in all respects to ensure proper functioning of the control, protection, and monitoring and interlocking schemes.
- iii) DC circuit for trip coil 1 & 2 shall be wired separately.
- iv) Wiring shall be done with flexible 1100V grade, FRLS, PVC insulated, switchboard wires with 2.5 mm² stranded copper conductor. *The control wire in*

a grouped environment shall not convey flame, continue to burn. Wiring between equipment and control cubicle shall be routed through G.I. rigid conduits and shall be done by PVC & screened cable only, with safety measures to protect operator from touching energized parts.

- v) Each wire shall identify at both ends with permanent markers bearing wire numbers as per Contractor's wiring diagram.
- vi) Wire termination shall be done with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.
- vii) All spare contacts of relays, push buttons, auxiliary switches etc. shall be wired up to terminal blocks in the control cubicle.
- viii) Terminal blocks shall be 1100V grade, stud type with engraved numbers suitable for termination of at least two numbers of 2.5 mm² stranded copper conductor. Terminal blocks for CT, PT, auxiliary AC & DC supply shall be disconnecting link type.

- ix) Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.
- x) Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- xi) Terminal connectors that carry power supply should be shrouded from adjoining connectors.
- xii) Manufacturer shall provide all control wiring and terminations internal to the switchgear, and connecting the switchgear to the bay control cabinets.
- xiii) All control cables shall be shielded. Cable shields shall be grounded. Grounding connections shall be as short and direct as possible and shall terminate at the point of entry to cabinets or terminal boxes.
- xiv) Co-axial type cable glands suitable for use with shielded cables shall be used at each termination.
- xv) All control cables shall be installed and terminated in such a manner as to limit the effects of transient electromagnetic voltages on the control conductors to an acceptable level.
- xvi) Any cabling within GIS shall be supported on cable tray. No cable shall be in hanging position.
- xvii) Insulator cones shall be embedded in full return current carrying metal fixing rings in order to avoid mechanical stresses to the cast resin part and to impart full conductivity across the flange connection. Earthing of different gas compartments/enclosures is not allowed with cross bonding with any metal strips.

3.10.4 Connections within the GIS and their LCC's

All cable connections between the various GIS modules and the LCC's shall be made by prefabricated multi-core cables *with multipoint plug in connections on both the ends. PTs & CTs circuit shall be wired with crimped type copper lugs.*

All cables shall be shielded and adequate for their application (indoor / outdoor). The cables shall be fire retardant low smoke.

The length and the number of terminal points of control wiring & SF6 gas connections shall be minimized.

The electrical connections between the various gas sections shall preferably be made by means of multiple contact connectors so that electrical connection is automatically achieved when bolting on section to another. The surface of the connector fingers and conductor tubes on such connections shall be silver plated.

3.11 Name plates

Name plates of the following types shall be furnished in a convenient central location to provide information for operation and maintenance.

- a) Gas Single Line Diagram showing all HV devices in a single line diagram with the gas sectionalizing of the GIS indicated. Also shown shall be the GIS nomenclature, a legend, Manufacturer's type and serial number and year of manufacture.
- b) GIS Rating / Name plate:

Manufacturer's name & address, type & designation, Sr. No, Maximum ambient temperature, System frequency, Maximum continuous voltage, Maximum continuous current at 40°C ambient temperature, Basic Impulse Level, Power Frequency one minute voltage, Short circuit current, rms., symmetrical Short time (rms) current & duration, symmetrical Momentary current, peak, Total weight of gas at rated density, Rated gas pressure at 20°C. Opening pressure of the bursting disc, recommended moisture limits of insulation gas (PPMV), Auxiliary voltages, Contract/Purchase Order numbers, Total weight of the equipment
- c) Equipment nameplate containing nameplate rating information for all HV modules (like circuit breaker, disconnect switches, current transformer, voltage transformer, surge arrester, etc.) as required in relevant IEC.
- d) Nameplates showing serial numbers and similar data specific to individual components shall be mounted on the components. *Each instrument transformer must have its own rating plate mounted adjacent to each terminal box cover, will all terminal and ratio markings. Each bay auxiliary control cubicle must be identified with its designation to which it is assigned.*

3.11.1 Bidder shall specify the number of skilled / semi-skilled / unskilled persons, supervisors and Engineers required to be deputed for complete

erection, testing, commissioning of GIS board.

3.12 Type Tests:

Following type test reports from NABL laboratory, as specified in IEC standard 62271 – 203 & 62271-100 (amended up to date) shall be submitted for the offered type, rating of GIS invariably with the technical bid. Bid without type test reports will not be considered for evaluation. The type test reports shall not be older than Fifteen years and shall be valid up to expiry of validity of offer.

1. Tests to verify the insulation level (Lightning impulse, Switching impulse and ac withstand test with PD) test on each GIS device (CB, Disconnecter, bus, etc).
2. Dielectric tests on auxiliary circuits.
3. Tests to prove the radio interference voltage (RIV) level.
4. Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.
5. Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.
6. Tests to verify the making and breaking capacity of the included switching devices.
7. Tests to prove the satisfactory operation of the included switching devices.
8. Tests to prove the strength of enclosures.
9. Verification of the degree of protection of the enclosure.
10. Gas tightness tests
11. Electromagnetic compatibility tests (EMC).
12. Additional tests on auxiliary and control circuits.
13. Tests on partitions.
14. Tests to prove the satisfactory operation at limit temperatures.
15. Tests to prove performance under thermal cycling and gas tightness tests on insulators.
16. Corrosion test on earthing connections (if applicable).
17. Tests to assess the effects of arcing due to an internal fault.
18. Tests on solid dielectric components (operating rods, spacers, etc)
19. Seismic test
20. Test on Auxiliary switches (Electrical & Mechanical Endurance, Heat run, IR & HV test)

Important note for type tests: *The type test report shall be submitted for the offered class and rating of GIS. However, the type test report for higher class/rating can be accepted for scrutiny of technical bid but the same test/s shall have to be carried out on the offered class/rating GIS. Bidder shall*

invariably confirm to carry out the required type test/s, special tests, before commencement of supply, without affecting delivery schedule, free of cost, at NABL approved laboratory, or at suppliers works in presence of Utility representative, in the event of order.

3.13 Routine / Acceptance Testing:

During manufacture and on completion, all equipment shall be subjected to the Routine tests as laid down in IEC Standard IEC 62271-203. All the acceptance tests shall be carried out in presence of Utility representative on offering the material for inspection and testing by successful bidder. Tests shall include the following:

1. Dielectric test on the main circuit.
2. PD test
3. Tests on auxiliary and control circuits.
4. Measurement of the resistance of the main circuit.
5. Tightness test.
6. Design and visual checks.
7. Pressure tests of enclosures.
8. Functional tests
9. Tests on auxiliary circuits, equipment and interlocks in the control mechanism.
10. Pressure test on partitions.

3.14 Test Certificates:

- a. Certified reports of all the tests carried out at the works shall be furnished in required number copies for approval of the Owner.
- b. The equipment shall be dispatched from works only after receipt of Owner/ Purchaser's written dispatch clearance & approval of the test reports.
- c. Routine test certificates of bought out components shall be furnished.
- d. Type test certificate on any equipment or component if so desired by the Owner shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

3.15 Tests after installation of complete GIS at Site:

After installation and before being put into service, the GIS shall be tested in order to check the correct operation and dielectric integrity of the equipment as laid down in IEC 62271-203. The successful bidder shall furnish a commissioning test plan and a statement method for the tests on site. Tests shall include the following:

1. Dielectric tests on the main circuits.
2. Dielectric tests on auxiliary circuits.

3. Measurement of the resistance of the main circuit.
4. Gas tightness tests.
5. Checks and verifications.
6. Gas quality verifications.
7. On site power frequency voltage withstand test with PD test.
8. Tests as per IEEE C37.122.1 clause 4.10.5
9. Functional & interlock tests for all items
10. Demonstration of operational compatibility with SCADA, if installed
11. Visual inspection, checks & verifications.
12. Mechanical operation tests of circuit breakers, Disconnectors and earthing switches and high-speed earthing switches
13. Insulation resistance measurement
14. Tests on CTs and PTs
15. Tests on Surge Arresters

3.15.1 Required test equipment

During the onsite tests, the supplier shall provide all necessary test facilities and equipment for the switch-gear power frequency tests, i.e. test bushing or test cable, test adapter, test transformer or resonant test set etc.

3.16 Spares:

Bidder shall submit a list and supply of following spares.

- i) Recommended spare parts for three (3) years after guarantee period of satisfactory and trouble-free operation.
- ii) Commissioning spares
- iii) Maintenance spares
- iv) Special tools, tackles & spanner required during commissioning, operation and maintenance.
- v) Viewing mechanism
- vi) Spare GIS modules of CT, Breaker and Isolator & LA. All spares indicated in list for above shall be considered in the scope of supply.

Each list shall be complete with specification, ratings, type, make, identification number, unit rate, quantity etc.

3.17 DRAWINGS, DATA & MANUALS:

Drawings, Data and Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions on Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

To be submitted with the Bid:

1. Typical general arrangement drawings of the equipments indicating space requirement, room dimensions, crane capacity etc.
2. Technical Specifications of equipment and special tools explaining construction features, principle of operation, special features etc.
3. Comprehensive QAP, FQP, SLD, Gas Schematic diagram, Technical brochures, building requirements, Earth mat design, List of recommended spares, special tools or fixtures, O&M manuals, environmental guide for handling SF6 gas & decommissioning, estimated time schedule for installation & commissioning, bill of materials, and any other documents required for successful commissioning & operation of complete GIS.
4. Control and protection:

Block & principle diagram showing proposed scheme, layout & equipment arrangement drawings, catalogues & brochures of offered devices.

Successful bidder shall submit 3 sets of spiral bound volume of following drawings & data for approval before commencement of supply:

1. A comprehensive Manufacturing Quality assurance plan with effective quality assurance system.
2. Field Quality plan indicating instruction & procedures sequenced for storage, assemble, maintenance and disassembly.
3. Assemble and maintenance clearance requirements.
4. Dimensional general arrangement drawing showing disposition of various fittings, name plates indicating equipment ratings.
5. Structure Plan with details and loading
6. Foundation plan indicating loadings for all GIS equipment, supporting structure and anchor bolt arrangements.
7. Assembly drawing for erection at site with part numbers and schedule of materials Transport/shipping dimensions with weights.
8. Control schematic and wiring diagrams.
9. Gas schematic Diagram
10. Gas system installation procedures, gas handling procedures.
11. Grounding arrangement and ground bus details including Manufacturer's recommendation on Grounding of reinforcement bars of Column foundation.
12. Calculation of Voltage rise for GIS enclosure
13. Calculated point to point resistance for each assembly.
14. Calculation for Surge Protection
15. Design Calculations for Bus-bar sizing, Short circuit forces and vibration on Bus-bar & each equipment, thermal stability and losses.

16. Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
17. Operating instruction & manuals for GIS and its accessories
18. The manual shall clearly indicate method of installation, checkups and tests to be carried out before commissioning of the equipment.
19. The bidder shall note that the approval of drawings & documents by the Owner does not relieve him of his contractual obligation.

The bidder may note that the drawings, data and manuals listed herein are minimum required only. The bidder shall ensure that all other necessary write-up etc. required to fully describe the equipment are to be submitted with the bid.

All drawings shall be prepared by using AutoCAD and documents shall be generated using Electronic version. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in AutoCAD and MS office format as applicable for Owner's future reference. Also AutoCAD version of Main GA drawings is to be submitted for Owner's layout finalization.

3.18 Maintenance:

The operational integrity of the GIS switchgear shall not subject to external influences, such as pollution, moisture, dust etc. As a consequence of this GIS switchgear should be practically maintenance free, however, the details of inspection required at regular interval shall be indicated in the offer. Visual inspection shall be required not below 2 (two) years interval.

Inspection shall not be required often than every 10 years. During inspection it must not be necessary to open the switchgear enclosures for interrupt operation of substation. Provision of functional testing of the close and trip coils, auxiliary switches, pressure and control switches etc. shall be provided. Following minimum maintenance period shall be accepted.

- (a) Circuit breaker: 5000 closing and opening or 20 interruption at max rated current
- (b) Disconnecter: 5000 closing and opening operations.
- (c) Fast acting earth switch: 2000 closing and opening operations or 2 making operations on to max rated fault current.

The bidder shall provide the services of experienced persons, supervisors, engineers, experts, etc., for complete specified work for satisfactory operation.

The bidder shall have dedicated localized after sales & service team which should be capable any activity to operate complete GIS satisfactorily.

3.19 GIS Building

The GIS building, if it is a part of schedule of requirements, shall comply with the requirements of Civil specifications.

The proposed arrangement of building and positions in which the switchgears shall be installed relative to lines, transformers, cable circuit and any other switchgear of any other voltages will be indicated in general arrangement layout. The overall height of building shall allow for overhead traveling crane.

3.20 Design information to be submitted by bidder.

The bidder shall provide complete floor plan detailing the fixing positions, levels and size of fixing bolt pockets and foundation required for all equipments. Drawings giving similar details shall be provided.

All static and dynamic loads plus dimensional tolerances shall be given on these drawings.

3.21 Guaranteed and technical particulars as called for in attached **SCHEDULE 'A'** shall be furnished along with the technical bid.

3.22 Training:

Training to (...) persons of Utility on construction, installation, commissioning and O&M shall be imparted by bidder free of cost.

Duration of the complete training shall be 7 working days, covering minimum below specified curriculum. Any other specific area may be brought to notice and included.

1. General Explanation for GIS
2. Layout and Architecture of GIS
3. Gas Sectionalisation of GIS
4. Construction of CB
5. Operating Mechanism of CB
6. Maintenance of CB
7. Overhaul of CB (Interrupting chamber)
8. Overhaul of CB (Operating Unit)
9. Construction of DS/ES
10. Maintenance of DS/ES
11. Overhaul of DS/ ES
12. Construction of Bus/ Cable head/ SF6 – air bushing
13. Maintenance of Bus/ Cable head/ SF6 – air bushing
14. Overhaul of Bus/ Cable head
15. Overhaul of various transformer connections
16. Operation of GIS with SCADA (if SCADA installed)
17. Construction & Maintenance of Lightning Arrester
18. Construction & Maintenance of VT/CT
19. Construction & Maintenance of Local control panel
20. Erection of GIS at site.

21. Installation & Testing of GIS at site

22. Type tests of GIS

23. Routine tests of GIS.

24. Faults simulation of GIS

25. Localization of GIS fault.

Bidder shall at his cost arrange for the above training facilities. The purchaser shall bear all TA/DA expenses of all the trainees.

3.23 Shipment storage and installation:

All equipments shall be suitably packed and protected during shipment/transportation. Each shipping unit shall be sealed in a clean dry condition with leak-tight shipping covers securely mounted for shipment. All covers to be removed during installation shall be clearly marked. Each shipping section shall be carefully sealed and filled with dry gas to a slightly positive pressure to prevent the entrance of moisture and contamination.

The packing method for the GIS equipment shall be standard and it shall be guaranteed that each component of the equipment will not be damaged, deformed or lost. The storage instructions shall be submitted by bidder for long term storage. Component requiring indoor storage shall be so identified. Gas insulated switchgear (GIS) shall be properly packed to protect during ocean shipment, inland transport, carriage at site and outdoor storage during transit and at the site. Completely assembled bays (subject to transport limitations) of the GIS shall be transported as one shipment unit.

Packing materials shall be dust and waterproof. All packages shall be clearly, legibly and durably marked with uniform block letters on at least three sides. Fragile items like bushings, CTs, VTs, LAs and fully assembled bays shall be securely packaged and shipped in containers. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment wherever necessary.

As far as possible, transshipment should be avoided.

Impact recorders (Accelerometers) shall be provided on the packages to confirm that GIS has not suffered any shocks during shipment, transport, handling, etc. The impact recorder readings are to be noted on receipt of equipment at site and reported to user & manufacturer, in case the readings are exceeding the permissible values. It shall be at discretion of user to accept or reject the same.

3.24 Quality Assurance

Superior quality control system shall be adopted to assure high product quality. Raw materials of the best commercial grade quality and high reliability shall be used in the manufacture of GIS. High reliability of materials shall be ensured so as to keep maintenance work to a minimum.

A quality assurance plan for major components such as breakers, disconnecting switches, lightning arrestors, earth switches, etc. with in-process inspection methods, tests, records, etc. shall be submitted with the technical bid. Customer hold points will also be included in

the plan, which shall be mutually agreed by the PURCHASER and MANUFACTURER, and approved.

BIDDING SCHEDULE (To be filled in and signed by the Bidder)

SCHEDULE 'A'

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR GAS INSULATED SUBSTATION

Sr No	Particulars	To be Filled by BIDDER
1	General	
2	Name of manufacturer (OEM)	
3	Country of Origin	
4	Delivery from (location)	
5	Type & Designation	
6	Type tested at	
	Name of Laboratory	
	Address of laboratory	
7	Installation (indoor or outdoor)	
8	Standards applicable	
9	No. of Phases	
10	Single or Three Phase design	
11	Configuration	
i	Number of Feeder bays	
ii	Number of transformer bays	
iii	Number of Bus coupler bay	
iv	GIS to transformer connection	
v	GIS to Feeder connection	
vi	Number of VT	
vii	Number of SA	
	Future extension possibility	
12	Service conditions	
i	Ambient Air Temp. in Deg. C	
ii	Max Temp. in Deg. C	
iii	Min Temp. in Deg. C	
iv	Daily Average Temp. in Deg. C	
v	Solar Radiation W/sq mtr	
vi	Altitude above MSL, in mtr	
vii	Pollution class	
viii	Creepage distance, in mm/kV	

ix	Relative humidity	
x	Condensation	
xi	Vibration level	
xii	Noise level	
xiii	Induced Electromagnetic Disturbance, in kV	
xiv	Seismic conditions	
a	Vertical	
b	Horizontal	
13	Enclosure	
i	Code of pressure vessel	
ii	Type of manufacturing	
iii	Design temperature in Deg.C	
iv	Material	
v	Material grade & applicable standard	
vi	Outside diameter in mm	
vii	Minimum Wall Thickness, in mm	
viii	Painting Shade & Thickness	
a	- External	
b	- Internal	
ix	Degree of Protection	
x	Inductance in H/mt	
xi	Capacitance in pF/mt	
xii	Resistance in Ohm/mt	
xiii	Expansion Bellow	
a	Material	
b	Min allowable adjustable displacement	
	Longitudinal	
	Transverse	
xiv	Sealing system	
a	Type	
xv	Estimated life in years	
xvi	Barrier	
a	Material	
b	Dielectric strength	
14	Support Structure	
i	Material	

ii	Minimum thickness of galvanizing	
iii	Foundation channels /Anchor bolts	
15	Grounding	
i	Grounding Material	
ii	Grounding of complete GIS	
iii	Grounding of individual compartment	
iv	Grounding at flange joints	
16	System Parameters	
i	Highest System voltage in kV	
ii	Rated voltage of System in kV	
iii	Rated voltage of Equipment in kV	
iv	Rated Insulation level Phase to Earth and between Phases	
a	One Min Power Frequency withstand voltage kVrms	
b	Switching impulse withstand voltage, kVp	
	- Phase to Earth	
	- Between Phases	
c	Lightning Impulse withstand voltage, kVp	
iv	Rated Frequency	
v	Rated current in Amp	
vi	Rated current at 50 °C (equipment) in Amp	
vii	Rated current at 50 °C (bus bar) in Amp	
viii	Rated short circuit withstand current kArms	
a	Duration in sec	
b	Peak, kAp	
ix	Enclosure withstand time for an internal fault in sec.	
x	Estimated total energy loss at	
	100 % of rated capacity	
	75 % of rated capacity	
	50 % of rated capacity	
	25 % of rated capacity	
xi	Measures taken to minimize Over Voltage	

xii	Phase labeling	
xiii	Auxiliary supply (AC Voltage, Frequency; DC voltage)	
	- Operation	
	- Control	
	- Illumination & heater	
17	Delivery conditions	
i	Bays fully assembled at works	
ii	Dimensions of longest section for transportation	
iii	Weight of heaviest package	
iv	Pressure of SF6 gas during transportation	
v	SF6 gas monitoring system provided during transportation	
18	Bus Bar	
i	Configuration (Single / Double)	
ii	Nos of Phases	
iii	Material	
iv	Size	
v	Rating	
vi	Current density adopted	
vii	Current density as per type test report	
viii	Short time current withstand rating in kA	
ix	Duration	
x	Resistance per phase	
xi	Surge impedance	
xii	SF6 immersed insulator	
a	Material	
b	Dielectric strength	
xiv	Maximum Partial Discharges measured at HSV	
19	SF6 Gas	
i	Applicable standard	
ii	Quantity of SF6 Gas of complete GIS at filling pressure, in kg	
iii	Quantity of SF6 Gas of largest compartment GIS at filling pressure, in kg	

iv	Nos of Gas compartments	
v	Quantity of SF6 Gas of individual compartment GIS at filling pressure, in kg	
vi	Maximum permissible dew point, in Deg.C	
vii	<i>Composition of Gas</i>	
a	<i>SF6 > 99.90 % by weight</i>	
b	<i>Air < 500 ppm by weight (0.25 vol.-%)</i>	
c	<i>CF4 < 500 ppm by weight (0.1 vol.-%)</i>	
d	<i>H2O < 15 ppm by weight (0.012 Vol.-%)</i>	
e	<i>Mineral oil < 10 ppm by weight</i>	
f	<i>Acidity, in terms of HF < 0.3 ppm by weight</i>	
g	<i>Hydrolysable fluorides,</i>	
	<i>In terms of HF < 1 ppm by weight</i>	
	PRESSURE	in MPa in kG/sqcm
vii	Design pressure	
a	Circuit breaker	
b	Other compartments	
ix	Rated filling pressure	
a	Circuit breaker	
b	Other compartments	
x	Type tested pressure.	
a	Circuit breaker	
b	Other compartments	
xi	Routine test pressure	
a	Circuit breaker	
b	Other compartments	
xii	Operating pressure of PRD	
a	Circuit breaker	
b	Other compartments	
xiii	Alarm Pressure	
a	Circuit breaker	
b	Other compartments	
c	CB lock out Pressure	

d	Over pressure signaling	
xiv	Maximum SF6 Gas leakage rate, in % per year	
xv	Density Monitor to be provided for each Individual gas compartment.	
20	Circuit Breaker	
i	Applicable standard	
ii	Type	
iii	Designation	
iv	Operating Mechanism type	
v	Nos. of phases	
vi	Rated current in Amp	
vii	Mechanical Endurance class	
viii	Electrical Endurance class	
ix	Restrike probability class	
x	Rated SC breaking current	
xi	Rated SC breaking current - single phase test	
xii	Rated Line charging breaking current	
xiii	Rated Cable charging breaking current	
xiv	Capacitor bank switching capability,	
	BC1	
	BC2	
xv	Inductive current	
xvi	Reactive current	
xvii	Out of phase making & breaking current	
xviii	Rated short line fault current	
xix	TRV characteristic	
xx	First Pole to Clear factor	
xxi	Nos. of interrupters per phase	
xxii	Type of arc control device provided, if any	
xxiii	Type of arcing contacts	
xxiv	Material of main contact	
xxv	Material of Arcing contacts	
xxvi	Filter material	
xxvii	Timings of operations	

a	- Opening at nominal control voltage	
	- Opening at minimum control voltage	
b	Closing time at nominal control voltage	
xxviii	Maximum pole discrepancy time	
	Tripping	
	Closing	
xxix	Rated operating duty cycle	
xxx	Tripping Coils	
	- No of coils	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
	- Resistance	
xxxI	Closing Coil	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
	- Resistance	
xxxii	Spring Charging Motor	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
xxxiii	Spring charging time at rated Aux supply	
xxxiv	Spring charging time at min Aux supply	
xxxv	Maintenance required after nos. of operation at	
i	No load	
ii	Rated current	
iii	25% of rated SC current	
iv	50% rated SC current	
v	Rated SC current	
e	Provision of anti pumping	
f	No of operations after switching off of motor Aux. supply	
xxxvi	Provision of Manual trip	
xxxvii	Electrical interlocking	

xxxviii	Padlocking	
xxxix	Type of Operation counter provided	
21	DISCONNECTORS	
i	Applicable standards	
ii	Type	
iii	Rated current in Amp for	
	- Bus disconnecter	
	- Line disconnecter	
	- Transformer disconnecter	
	- PT disconnecter	
iv	Maximum Current that can be safely interrupted by the Isolator (Amp).	
	- Inductive	
	- Capacitive	
v	Rate Short time withstand Current in kA, for 3 sec	
vi	Rated peak short time Current, kAp	
vii	Rated bus charging current, in Amp	
viii	Type of contacts	
ix	Material of contacts	
x	Current Density at minimum cross section (A/mm ²)	
xi	Rated lightning impulse withstand voltage across the open gap, kVp	
xii	Rated Power Freq withstand voltage across the open gap, kVrms	
xiii	Mechanical Endurance class	
xiv	Type of Operating Mechanism	
xv	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
xvi	Operating Time	
	- Closing	
	- Opening	
xvii	Mechanical indication on drive shaft	
22	Maintenance Grounding Switch	
i	Applicable standards	

ii	Type	
iii	Rate Short time withstand Current in kA, for 3 sec	
iv	Rated peak short time Current, kAp	
v	Rated lightning impulse withstand voltage across the open gap, kVp	
vi	Rated Power Freq withstand voltage across the open gap, kVrms	
vii	Type of Operating Mechanism	
viii	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
ix	Operating Time	
	- Closing	
	- Opening	
x	Mechanical indication on drive shaft	
23	Fast Acting Grounding Switch	
i	Applicable standards	
ii	Type	
iii	Rate Short time withstand Current in kA, for 3 sec	
iv	Rated peak short time Current, kAp	
v	Rated induced current switching capability	
	Rated capacitive current switching capability	
vi	Rated lightning impulse withstand voltage across the open gap, kVp	
vii	Rated Power Freq withstand voltage across the open gap, kVrms	
viii	Electrical Endurance class	
ix	Type of Operating Mechanism	
x	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	

	- Rated Watts	
xi	Operating Time	
	- Closing	
	- Opening	
xii	Mechanical indication on drive shaft	
24	Current transformers	
i	Type	
ii	Material	
iii	Position of Current Transformer	
iv	Reference Standard	
v	Rated Continuous thermal current	
vi	Rated Short Time current	
vii	Duration	
a	Feeder Bay CT	
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
b	Transformer Bay CT	
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	

	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Accuracy Class	
	- Minimum Knee Point Voltage at highest ratio	
	- Maximum Excitation Current at V_k	
	- Maximum Resistance at highest ratio	
iv	Protection Core -3	
	- Ratio	
	- Accuracy Class	
	- Minimum Knee Point Voltage at highest ratio	
	- Maximum Excitation Current at V_k	
	- Maximum Resistance at highest ratio	
c	Bus Coupler Bay CT	
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Burden	
	- Accuracy Class	
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Burden	
	- Accuracy Class	
	- ALF	
25	Voltage Transformer	
	Type	
	Position of Voltage Transformer	
	Reference Standard	
	Rated Over Voltage Factor - Continuous	
	Short Time Over Voltage Factor	
	Duration	
	Partial Discharge Level	

	Thermal Rating of Primary Winding	
26	Line & Bus VT	
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
iii	Protection Core -2	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
27	Enclosed Surge Arrester	
ii	Name of Manufacturer	
iii	Arrester Class & Type (with mfr type designation)	
iv	Applicable Standard	
v	Rated system voltage (kV)	
vi	Rated Arrester Voltage (kV)	
vii	Max continuous operating voltage (MCOV) – (kV)	
viii	i)Nominal Discharge Current (KA) with 8/20 Micro-second wave	
	ii)Max resistive component of cont current at MCOV-mA crest	
	iii)Max capacitive component of cont current at MCOV -mA crest	
ix	Long Duration Discharge Class	
x	Min. Energy Discharge Capability (KJ/KV rating)	
xi	Max. switching current impulse residual voltage (KVP) 1000 Amps 250 Amps	
xii	Pressure Relief Class KA (rms)	
xiii	High Current short duration impulse withstand level with 4/10 micro-second wave (KA) peak	

xiv	Over –voltage withstand capability – KV	
	a) 100 Seconds	
	b) 10 Second	
	c) 1.0 Second	
	d) 0.1 Second	
	e) Reference Voltage (KV)	
	f) Reference Current (KA)	
xv	Surge counter	
xvi	Leakage monitor	
28	Local Control Cubical	
i	Name of Manufacturer (OEM of GIS)	
ii	Location in GIS	
iii	Material	
iv	Sheet Thickness	
v	Degree of Protection	
vi	Padlocking arrangement	
vii	Major components of LCC	
	- Bay control mimic diagram	
	- Control Switches	
	- Indicating lamps	
	- Position indicators	
	- Annunciation scheme	
	- Auxiliary relays	
	- Contact multiplication relays	
	- System parameters display	
	- Heater with thermostat	
	- Interface terminal blocks for relaying & protection	
29	GIS to Line connection	
i	Nos of XLPE cable can be terminated	
ii	Type of cable termination required	
30	GIS to Transformer connection	
i	Nos of XLPE cable can be terminated	
ii	Type of cable termination required	
31	Maintenance	
i	Maximum down time for replacement or removal of any part	

ii	Maximum down time for degassing and re-filling the biggest compartment	
iii	Time between two refilling of SF6 gas.	
iv	Recommended period for overhauling	
v	Operation and Maintenance manual attached	
vi	Nearest local service centre	
vii	Minimum time of availability of local service	
viii	Availability of spares at local service centre	
ix	List of recommended spares attached?	
x	List of recommended special tools, etc attached?	
xi	List of commission spares attached?	
xii	List of maintenance spares attached?	

33kV GAS INSULATED SWITCHGEAR

1.0 SCOPE :

This specification covers design, manufacture, testing at manufacturer's works, packing, forwarding & supply of 33kV Gas Insulated Indoor Switchgear complete with all accessories for trouble free and efficient performance including installation and commissioning of SF₆ gas-insulated vacuum circuit breaker switchgear and associated equipment.

2.0 STANDARDS:

Switchgear	IEC 62271-200 / EN 62271-200
Switchgear	IEC 60694 / EN 60694
Behaviour in the event of internal faults	IEC 62271-200 / EN 62271-200
Three-position disconnector and disconnector	IEC 62271-102 / EN 62271-102
Busbare arthing switch	IEC 62271-102 / EN 62271-102
Circuit-breaker	IEC 62271-100 / EN 62271-100
Current transformer	IEC 60044-1 / EN 60044-1
Voltage transformer	IEC 60044-2 / EN 60044-2
Voltage detection systems	IEC 61243-5
Protection against accidental contact, foreign Objects and water	IEC 60529 / EN 60529
Installation	HD 637 S1

3.0 DESIGN CRITERIA:

3.1 OPERATING CONDITIONS:

Operating Conditions according to	IEC 60694 / EN 60694
Temperature of ambient air:	
Maximum value	50 °C

3.2 RATED NORMAL CURRENT:

The rated normal currents of components are stated in the Technical data and shall be valid for design ambient temperature of 50° C.

3.3 INTERNAL ARC FAULT:

Classifications to IEC 62271-200 – 25KA for 1 Sec
 Partition class- PM
 Internal arc classification - AFL (Authorized person access)

permitted from front & lateral side) for the panels with no rear access required.

3.4 INSULATING GAS:

Insulating gas Type SulphurHexafluoride (SF₆)

Design pressure at 20 °C for 36 kV Class - 0.05 MPa to 0.1 MPa

4.0 TECHNICAL DATA

4.1 BUS RATING:

33 kV GIS, 25 kA 3s, Single Bus Bar 800 A @ max. 50 °C

4.2 REQUIRED TECHNICAL PARAMETER:

Busbar System	Single busbar
Electrical Data:	
kV	Rated voltage 36
kV	Rated operating voltage 33
	Rated frequency [Hz] 50
	Rated power-frequency withstand voltage 70 kV
	Rated lightning impulse withstand voltage 170 kV
	Rated short-time withstand current 25 kA
	Rated short-circuit duration 3 s
	Rated Peak current 62.5kA
A	Rated operating current busbar 800
Degree of Protection:	
	Main circuits IP 65
	Drives IP 3X
	Cable connection compartment IP 3X
	Low voltage cabinet IP 4X
Auxiliary Voltage:	
DC	Control 48 V

	Motor	
	48 V DC	
	Protection system	48 V
DC		
	Remote control	48 V
DC		
	Socket/lighting/heating	230 V AC
IAC Classification acc. to IEC 62271-200		
	Classification IAC	AFL
	Internal arc tested minimum	25 kA 1 s
Dimensions:		
	Cubicle width max.	
	600mm	
	Cubicle depth maximum	2000 mm
	Cubicle height max.	2500
mm		
Properties:		
	Pressure relief duct	Not Required
	SF ₆ Pressure control	IDIS
	Voltage Indication System	
IVIS		
	Control Panel	
mechanical		
	Mech. Operation	Closed door

5.0 DESIGN FEATURES OF SF₆ GAS INSULATED SWITCHGEAR:

GIS Circuit Breaker shall be of fixed type enclosed in the SF₆ gas tank. Withdrawable facility is not applicable in case of GIS Switchgear.

5.1 GENERAL DESCRIPTION:

The SF₆ insulated switchgear shall be type-tested and of pre-fabricated metal construction.

The offered Indoor GIS shall have VCB, Three Position Disconnecting Switch and Bus Bars shall be enclosed in SF₆ Gas.

Single panels, each built up from a modular range of separate functional units, can be combined to produce the specified switchgear configuration. The modular units comprise of:

A) Standard basic module:

Incorporating the vacuum circuit-breaker.

B) Floor-pan module, flange-mounted to the lower part of the basic module, with:

- A wide range of cable connection options, appliance couplers for outer cone-type cable connection systems.
- Current transformers (toroidal type)
Busbar Module - A gas filled, clad compartment, which is totally segregated from the circuit breaker compartment with regard to gas handling. The busbar module incorporates:
 - Three-position switch.
 - Three-phase copper busbar system

C) Cable / Instrument Transformer compartment.

A metal-enclosed, air/gas insulated compartment for easy maintenance, with:

- Cable support for single and multiple cable installation
- Sufficient space for installation of current transformers

Circuit-breaker and three-position switch drives are to be designed with mechanical interrogation interlocks and shall include all necessary auxiliary devices (auxiliary switches, releases etc.)

The three-position disconnecter (ON-OFF-EARTH) is to be designed with separate manual and/or motorized drives for the disconnecter and earth switch functions.

All switching device drives shall be located outside of the gas compartments, for easy access. Under normal operating conditions for indoor switchgear units in accordance with IEC 50594 and when complying with the specified number of operations, no maintenance is required.

5.2 FUNCTIONAL COMPARTMENT:

- Circuit-breaker compartment – SF₆Gas insulated
- Busbar compartment – SF₆Gas insulated
- Cable connection / transformer clad compartment are to be equipped with individual pressure relief devices - Air Insulated / SF₆Gas insulated compartment for easy access and maintenance.

5.3 SWITCHGEAR OPERATOR INTERFACES REQUIREMENTS:

- A standard mechanical user interface, ergonomically Positioned at a convenient height, **must be visible directly without opening of doors etc.**
- The user interface comprises all the mechanical, panel-related interfaces and continuous interrogating interlocks.
- **All the basic mechanical ON/OFF of CB, disconnectors & earth switch operation, manual spring charge of CB must be possible without opening the door to ensure the operator safety.**
- **Mechanical mimic directly linked to mechanism should be provided at the panel front door.**
- The basic switchgear unit is to be designed for suitable free-standing installation within a switch room.
- The Interlocking shall be as per IEC.

5.4 FUNCTIONAL INTUITIVE OPERATOR INTERFACE DESIGN

The SF₆ Gas Insulated Switchgear shall be characterized especially by the following operating features:

- Ergonomic operability
- Logical operation
- Logical function states
- Good visual communication of the overall function and operating states
- Optimum operator guidance
- All operations can be performed optionally via a motor-operated mechanism

The mechanical control panel is located at an optimum height for operation and arranged in a recessed position on the switchgear front. Thus, the operating area is clearly visible while no control elements protrude from the switchgear front. The position of the individual elements has been selected according to their function, i.e. according to their allocation to the corresponding device functions. The elements which form part of a switching device, such as position indicators, crank ports or mechanical push buttons, are visually linked by a specific pattern and integrated in a mimic diagram. Mechanical operation is performed the same way as with the habitual operation with stationary switching devices. Separate control elements and mechanical switch position indicators are available for the following functions:

- Circuit-breaker ON - OFF
- Disconnecter ON – OFF-EARTH

5.5. BUSBAR / PANEL CONNECTIONS:

The gas-insulated busbar sections of the single panels shall be connected via single-pole solid-insulated connection elements which allows for easy exchange of a cubicle without SF₆ works. Busbar connection to be designed in such a way that no adjacent panels must be moved or opened for exchange of a Panel.

Busbar couplings between adjacent Panels should be designed with a minimized quantity of electrical sealing joints.

5.6 GAS COMPARTMENT TECHNOLOGY:

A Temperature Compensated Gas Monitoring Device shall be provided on the offered GIS to constantly monitor the Gas Pressure inside the Gas Tank.

By design there should be no need for gas works during the whole time on site, not even for exchanging a centrePanel or extending the switchgear at later stage, e.g. no gas handling shall be necessary during the anticipated service life of the switchgear, under normal operating conditions. (The gas-filled clad compartments are to be designed to be maintenance-free and hermetically sealed pressure systems in accordance with IEC 62271-200).

The Switchgear Panels shall be filled with gas and checked for leakage in the factory. For a proper recycling / emergency replacement, a gas valve in gas compartment has to be provided. In addition, the standard tools for filling the SF₆ Gas also have to be provided.

The switchgear units shall be divided into several gas-filled compartments, sealed from each other by gas-tight partitions including bus bar compartments of two adjacent panels, so that any leakage may be quickly localized and limited within enclosure of one panel & can be indentified immediately.

All the live parts including the VCB, Three position Disconnecter, and main busbar shall be encapsulated in stainless steel enclosure filled with SF₆ gas.

5.7 INSTALLATION FACILITY:

The panels are to be delivered to site as factory assembled and routine tested units. After linking the panels (or panel assemblies) by the busbar connection system and connection of the power and control cables the system should be ready for operation. No gas filling is required at site during bus bar connection & installation.

6.0 CIRCUIT BREAKERS:

The three-pole vacuum circuit breaker with its maintenance-free vacuum interrupters is installed horizontally in the gas compartment.

The CB shall be spring operated, motor charged, and manually released spring closing mechanism with three pole simultaneous operations. The speed of closing operation shall be independent of the hand-operating lever. The indicating device shall be **mechanical type directly linked to the mechanism & shall show the OPEN and CLOSE position of breaker visible from front of the cubicle**. The spring charging time of the motor shall not exceed **20sec** in case of Vacuum Circuit Breaker. The "TRIP" and "CLOSE" coils shall be of reliable design and low consumption.

The Breakers shall be capable of Making & Breaking the short time current in accordance with the requirement of IEC 62271-100 and latest amendment thereof. The continuous current rating of breaker shall not be less than 630 A at 50 Deg C design ambient.

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Two stage gas **density**, alarm and lockout system with local and remote indication shall be provided.

Mechanical trip push button on each CB shall be provided on Panel front & shall be accessible.

Spring charge indication to be provided.

The vacuum circuit-breakers are to be equipped with

- Spring-stored-energy operating mechanism with motor, auto-reclosing
- Mechanical OPEN and CLOSE button
- 1 closing solenoid
- 1 shunt release
- Operating cycle counter
- Auxiliary switch with at least 6NO + 6NC available
- Auxiliary switch for "spring charged" signal

The circuit-breaker has to control at least **10,000 Make-Break cycles (One operating cycle of making & Breaking) operations at rated current or 100 breaking operations at rated short-circuit breaking**

current without maintenance. The mechanical life of the vacuum interrupter has to comprise at least **20,000** operating cycles.

The operating mechanism must be maintenance-free without time limit up to 10,000 operating cycles.

7.0 DISCOONECTORS AND EARTHING SWITCHES:

Isolators Disconnectors or Discoonectors combined with earthing switches (3 position switches) shall be motor operated. In case of emergency, manual operation or through a separate switch must be possible.

The earthing position for all 3 phases must be visible via a mechanical position indicator (MIMIC) directly connected to the drive shaft on panel front Fascia.

The mechanical operation of isolator / 3 position disconnector switch must be possible with door closed for operator safety.

8.0 INSTRUMENT TRANSFORMERS:

Only Conventional inductive voltage and current transformers according to IEC 60044-1 and IEC 60044-2 or electronic current and voltage transformers to IEC 60044-7 and IEC60044-8 or a combination of both are acceptable. Current & Voltage Sensors are **not** acceptable.

IVT shall be placed in a separate Panel.

8.1 CURRENT TRANSFORMERS:

The **Current Transformers** shall be toroidal type. The Current Transformers shall be located outside the Gas Compartment.

The transformer ratio, the accuracy class and the performance load to be selected to suit the application requirements.

33kV Line CT

Toroidal type Current Transformer

CT Primary Current: 400-200 A

CT Secondary Current: 1-1-1A

Core 1: CI-0.2S / 15 VA,

Core 2: CI-PS .

Core3: CI-PS

33kV Transformer CT

Toroidal type Current Transformer

CT Primary Current: 400-200 A

CT secondary Current: 1-1-1A

Core 1: CI-0.2 S / 15 VA,

Core 2: CI-PS

Core 3: CI-PS

(The Contractor shall calculate the CT burden as per relay and metering requirement during detail engineering with CT/ VT Burden calculation)

Cable Termination:

Cable terminals to be readily accessible from the front and located at a convenient connection height. System shall be in accordance with EN 50181 for terminal cross sections up to 630 mm², up to incl. 36 kV. For connection of various cable types via cable screw-type plugs and terminal adapters Facilities to connect several cables per phase. With the cables connected, cable testing shall not require the installation of any supplementary equipment.

Cable testing must be feasible from the panel front and without disconnecting these cables.

Cable testing shall be possible from the panel front using DC or AC, with the cables connected.

Cable compartment shall be completely covered by metal enclosure for operator's safety.

"To provide a maximum of personal safety all operation and maintenance as well as connecting of cables must be possible from the front of the panels".

"Cable testing must be feasible from the panel front and without disconnecting these cables".

9.0 MECHANICAL SAFETY INTERLOCKING FEATURES:

Internal mechanical interlocks of the Panel.

- With the circuit-breaker closed, the interrogation slide is locked for the disconnecter and the earthing switch. (Restriction to the insertion of Hand Crank for Disconnector-Earth Switch when CB is ON)
- The interrogation slide always releases one insertion opening only (disconnecter or earthing switch), or both of them are locked.(To ensure that either Disconnector or Earth Switch operating at a time)
- The crank for the disconnecter and earthing switches can only be removed in its appropriate end position.
- When the crank on the disconnecter or earthing switch is still in place, or when the interrogation slide is open, the following components are locked:

- ON push button of circuit breaker
- ON pulse is interrupted

10.0 PROTECTION & CONTROL SYSTEM:

Following functions shall be available in the Protection Relay for Line feeders:

Current protection (Directional & Non-directional feeder Protection)

- * Over current instantaneous (50)
- * Over current IDMT (51)
- * Earth fault instantaneous (50N)
- * Earth fault IDMT (51N)
- * Directional Earth fault IDMT (67)
- * Directional over Current IDMT (67)
- * Auto Reclosure – 4 Shots

For Transformers, in addition to the above, the following protection shall be provided

- * Differential protection for transformer (87T)
- * Restricted earth-fault for transformer (87N)

11.0 BUS IVT

33kV Bus IVT shall be housed in a separate Panel Panel with plug in type with a disconnecter and it shall be air insulated / gas insulated.

Voltage protection (Bus VTs shall be Part of Feeder Protection relay)

- * Overvoltage (59)
- * Under voltage (27)
- * Frequency Relay (81 O/U)

Other protections and related functions (Part of Numerical Relay)

- * Lock-out (86)
- * Trip circuit supervision (95)

11.1 COMMUNICATION PROTOCOL:

The protection relay shall have communication protocol on IEC 61850 Protocol.

12.0 TESTS:

All tests shall be carried out according to relevant IEC

standards.

12.1 TYPE TESTS

The metal-enclosed switchgear is to be type tested at a recognized and internationally well-reputed test laboratory. Type test certificates shall be available for verification as evidence of successful completion of type tests.

The switchgear furnished under this specification shall be fully tested and documented by certified production test reports in accordance with IEC 62271-200.

12.2 ROUTINE TESTS

Tests shall be carried out according to IEC requirements.

12.3 FACTORY INSPECTION TESTS

Notification for factory tests along with list of proposed tests shall be submitted as required.

12.4 SITE TESTS

The site tests shall include the following:

- Insulation resistance
- Functional test of the fully installed and wired equipment delivered.

12.5 BASIC Technical Requirements-

The following Basic Technical Requirements at chapter-E24 are required to be furnished by the bidders for 33kV GIS:

Basic Technical Requirement for 33KV Cubicle GIS,
 Schedule GTP for 33KV GIS FOR BREAKERS / PANELS,
 Schedule GTP for 33KV CURRENT TRANSFORMERS,
 Schedule GTP for 33KV INDUCTIVE VOLTAGE TRANSFORMERS,

3 kV Indoor Switchgear Panel for GIS and AIS

1.0 SCOPE:

This specification covers design, engineering, manufacture, testing, and inspection of 33 kV indoor Switchgear Panel (provided with Vacuum circuit Breaker, CT, IVT, Disconnectoretc) for use in the 33/11KV primary substations under the distribution networks. The 33kV GIS Switchgear shall be with a Disconnecter.

In case of AIS Switchgear there shall not be any Disconnecter.

There shall be separate Indoor Panel for IVT.

The equipments must be type tested.

1.1 Description of the Switchgear Panels for GIS & AIS.

Indoor switchgears for GIS/AIS should be provided in a cubicle, which shall be erected inside a building. Separate switchgear panels for 33kV GIS & AIS and 11kV AIS system to be considered.

Care should be taken during manufacturing of the same as the equipment like VCB, Disconnecter switches, CT & IVT are to be installed in the panel individually.

The **33kV GIS Switchgear shall be with a Disconnecter** and **AIS Switchgear without any Disconnecter**. There shall be separate Indoor Panel for IVT.

Vibration is inevitable as mechanical operation for closing the VCB & disconnectors may cause problem and its performance will be affected.

In 33 KV GIS panel SF₆ gas will be filled as insulation at 0.3 bar relative pressure to ensure insulation and breaking operation. Sealed for life, the enclosure shall meet the “sealed pressure system” criterion in accordance with the IEC 62271-1. The manufacturer shall confirm that the maximum leakage rate is lower than 0.1% per year.

2.0 STANDARDS:

Except where modified by this specification, the circuit breakers and the accessories shall be designed, manufactured and tested in accordance with latest editions of the following standards.

IEC/ISO/BS	IS	Subject
IEC:56 IEC:62271-100 &200		High voltage alternating current Circuit Breakers general Requirement.

IEC:694	IS : 12729	Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000V).
IEC:60	IS : 9135	High Voltage testing techniques.
IEC:427	IS:13516	Method of synthetic testing of HV .A.C circuit breakers.
IEC: 1233		HV AC Circuit breakers- inductive load switching.
IEC: 17A/CD:474		HV AC Circuit breakers- capacitive switching.
IEC:529	IS: 13947	Degree of protection provided by enclosure.
IEC:137	IS: 2099	Insulating bushing for A.C. voltages above 1000V
IEC:233	IS : 5621	Hollow insulators for use in electrical equipment & testing.
IEC:273	IS: 5350	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC:815	IS: 13134	Guide for selection of insulators in respect of polluted conditions.
IEC: 34	IS : 996	A.C motors
ISO:1460 BS:729	IS:2629	Hot dip galvanizing
	IS:2633	Method of testing uniformity of zinc coated articles.
	IS: 5	Colour for ready missed paints and enamels
	IS: 6005	Code of practice for phosphating or iron and steel.
IEC: 227	IS:1554	P.V.0 Insulated cables for voltages up to and including 1100 Volt.
IEC:269	IS:13703	Low voltage fuses for voltages not exceeding 1000volt.
ISO:800	IS:1300	Phenolic moulding materials.
	IS:13118	Guide for uniform marking and identification of conductors and apparatus terminals.
IEC: 185	IS: 2705	Current transformers.
IEC: 296	IS: 335	Specification for unused insulating oil For transformer and switchgear.

IEC:186	IS: 3156	Potential transformers.
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CBIP Technical Report No. 88 revised July, 1996 read with amendment issued (April, 99, September, 99 and also any other amendment thereafter): Specification for AC Static Electrical Energy Meter.

3.0 TYPE OF SWITCHGEAR PANEL

The switchgear boards shall be indoor metal clad, single front, single tier, fully compartmentalized construction comprising of a row of free standing, floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker, main bus bars, current transformers cum cable compartment and low voltage compartment. Each compartment of individual cubicle shall be segregated by earth metallic sheet. **Cubicle should be type tested for internal arc in all three compartments for 25kA for 1sec as per IEC 62271-200.**

4.0 TYPE OF SHEET STEEL & CUBICLE

The cubicle shall be of bolted construction with minimum thickness of 3.0mm for load bearing & cable entry gland plate portion and for other non-load bearing members such as inter compartment partition etc can be of 2.0 mm. Sheet steel used for fabrication shall be cold rolled carbon annealed only and fabrication shall be done through CNC turret punch press and CNC bending machine. Sheet steel may be of aluzinc material or CRCA. All covers & doors shall be of folded design type with viewing window at rear cover (box type) of polycarbonate.

5.0 CIRCUIT BREAKER (VCB): 33 KV

The **AIS circuit breaker (VCB) shall be mounted on *Withdrawable Truck***, which shall roll out horizontally from service position to isolated position with ease and it shall also be possible to take out the breaker truck from cubicle smoothly on to the floor. It is preferred to provide with guides for withdrawal and insertion of truck into the cubicle with ball bearing arrangement on the top of the truck. Circuit breaker shall be of vacuum only and the truck shall have distinct '**SERVICE**' and '**TEST**' position. Special multi point hinged locking arrangement shall be provided to prevent opening of door in the event of internal arc in breaker compartment. Isolation shall be horizontal.

The **GIS Circuit Breaker** shall be of fixed type enclosed in the SF₆ gas tank. **Withdrawable facility is not applicable in case of GIS Switchgear.**

All the three interrupters of individual phases shall be fully encapsulated circuit breaker shall be vacuum type only. No separate fiberglass sheet barrier to be used.

It shall be operated through a common motor wound spring charged mechanism with electrical release coil for closing and shunt trip coil for tripping. Operating mechanism must have manual charging, closing and tripping facility with the provision locking facility in push to close & push to trip mechanical push button.

The mechanism shall be such that motor will automatically recharge the mechanism springs after a closing operation enabling breaker to perform OCO operation. The charging time of motor shall be less than 15 secs, making it suitable for rapid auto reclosing duty. Mechanical push to Trip button shall be provided for manual tripping with front door closed. All the 'MS' components of circuit breaker mechanism shall be treated properly with passivation for longer life even in adverse climatic condition. Yellow passivation shall not be acceptable. The normal current rating of circuit breaker shall be 630 Ampere, SCC 25 kA for 3 sec with duty cycle of 0-0.3 Sec- CO-3 min-CO & Bus-bar shall be 800 Amp for **Indoor Switchgear irrespective of AIS & GIS** and the same shall also be **indicated in panel name plate**. The mechanism and the connected interrupters shall satisfy the mechanical endurance requirements of IEC: 62271-100 & 200 and all additional requirements specified herein.

5.1 Interrupting media Vacuum:

In AIS vacuum circuit breakers, facilities shall be provided for monitoring the contact erosion and any change in contact gap. The vacuum bottles shall be easily replaceable on site and the mechanism shall be conveniently adjustable to permit resetting the contact gap. The current rating of the vacuum interrupters shall be 630Amp.

In case of GIS, the VCB is Fixed type and shall be Mounted inside the stainless tank insulated with SF₆ Gas. The Stainless Tank is sealed for Life time and Vacuum bottles are to be replaced by changing the gas, when required. The current rating of the vacuum interrupters shall be 630Amp.

The vacuum circuit breaker poles shall be sealed to prevent contamination of the spaces surrounding the interrupters. The bidder shall demonstrate how this is achieved by supplying technical details with the bid.

The circuit breakers shall be fitted with spring mechanism type. The inherent design of the circuit breakers shall be such that they shall satisfactorily perform all test duties and interrupt out-of-phase current and produce very low over voltage(**<2.5p.u**) on all switching circuits, capacitive and inductive to IEC:62271-100 & 200 and other associated standards mentioned in the clause of this specification.

5.2 Basic Technical Requirements of 33 KV VCB

SI. No	Particulars	Requirements
1	Service type	Indoor

2	No. of Poles	3
3	Nominal system voltage	33kV
4	Highest system voltage	36kV
5	Rated normal current at 50°C	
	i) For Bus-bar	800A
	ii) For Interrupter	630A
	iii) For Outgoing Feeders/ For Incomer	630A
6	Rated Internal Arc for Panels for 1 Sec	25kA
7	Rated short circuit making current (peak)	62.5 kA
8	Rated short time current withstand capability for 3 sec.	25kA
9.	Rated insulation level:	
	i) One minute power frequency withstand voltage to earth (wet and dry) rms	70kV
	ii) Impulse withstand voltage to earth with 1.2/50µsec, wave of +ve and -ve polarity (Peak)	170kV
10	First — pole — to clear factor	1.5
11	Rated operating sequence (for auto reclosing)	0-0.3 Sec- CO-3 min-CO
12	Maximum break time	3 cycles
13	Rated out of phase breaking current	25% of the symmetrical short circuit breaking current
14	Maximum pole scatter	10 mili seconds
15	Rated Auxiliary supply for spring charge motor, lamp & heater circuit.	230V A.C
16	Rated supply voltage for trip/close coil	48V D.C
17	No load line/cable breaking current capacity	25A
18	No load transformer breaking current capacity	25A

6.0 OPERATING MECHANISM

General

6.1 The operating mechanism of the circuit breaker shall be motor wound

spring charged type. It shall be electrically and mechanically trip free with anti-pumping device (as per IEC:694 definition). All working parts in the mechanism shall be of corrosion resistant material. Self-lubricating, wearing resistant bearings shall be provided in the mechanism.

6.2 The mechanism shall fully close the circuit breaker and sustain it in the closed position against the forces of the rated making current and shall fully open the circuit breaker without undue contact bounce at a speed commensurate with that shown by tests to be necessary to achieve the rated breaking capacity in accordance with IEC:56 or IS:13118. The mechanism shall be capable of being locked in either the open or closed position. The mechanism shall be capable of fully closing and opening again after the auto-reclose time interval specified as 0.3 second in this specification.

6.3 Spring mechanism (In case of Spring Charged VCB)

6.3.1 The spring operating mechanism shall be with spring charging motor, opening and closing springs with limit switches and all accessories necessary for automatic charging. In normal operation, recharging of the operating springs shall commence immediately and automatically upon completion of the closing operation so that a complete sequence of closing and opening operation should be possible.

6.3.2 It shall be possible to hand charge the operating spring with the circuit breaker in either the open or closed position conveniently from the ground level. Closure whilst a spring charging operation is in progress shall be prevented and release of the springs shall not be possible until they are fully charged.

6.3.3 The state of charge of the operating springs shall be indicated by a mechanical device showing '**SPRING CHARGED**' when closing spring is fully charged and operation is permissible and '**SPRING FREE**' when closing spring is not fully charged and the operation is not possible. Provision shall be made for remote electrical indication of 'Spring Charged' and 'Spring Free' conditions.

6.3.4 The operating mechanism shall be such that the failure of any auxiliary spring shall not cause tripping or closing the circuit breaker but shall not prevent tripping against trip command.

6.3. Closing action of the circuit breaker shall charge the opening spring ready for tripping. From the close position with spring charged, one open-close-open operation shall be possible without recharging the spring.

7.0 Operation and controls

The breaker shall normally be operated by electrical control with electrical tripping by **2nos shunt trip coil**. Provision shall be made for local electrical operation and mechanical operation.

The following facilities shall be provided in the circuit breaker local control cabinet:

- ON/NEUTRAL/ OFF control switch or ON and OFF push buttons. The push buttons shall be momentary contract type with rear terminal connections. The close push button shall be of **green colour** and the open push button **red colour**. There shall be separate switch for electrical operation of the VCB.
- 6 MECHANICAL EMERGENCY TRIP DEVICE: suitable for manual operation in the event of failure of electrical supplies. **The device shall be accessible without opening any access doors and distinctly labeled.** It shall be shrouded and protected against inadvertent operation.
- 7 Means shall be provided for manual operation of these circuit breakers during failure of auxiliary power in addition to electrical operation.
- 8 Means shall be provided to prevent the mechanism from responding to a close signal when the trip coil is energized or to reclosing from a sustained close signal either opening due to a trip signal or failure to hold in the closed position.

The circuit breaker shall be able to perform **10,000** operating cycles at no load in accordance with IEC:17A /474/CD for circuit breakers for auto reclosing duties.

8.0 Motor

The motor for spring charging shall be single phase 230 Volt AC. Continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment. It shall remain within its rated capacity at all operating points that will arise in service. It shall be protected by MCB. The motor shall comply with IEC: 34 or IS:996.

9.0 THERMAL RATING OF SWITCHGEAR

All current carrying parts including breaker relay shall be governed by IEC 62271-1. All isolating contacts shall be silver plated.

10.0 AUXILIARY POWER SUPPLY:

The operating mechanism shall be suitable to operate with the following auxiliary Power supplies.

- a) 230V,50Hz Single phase A.C - For spring charging motor
- b)DC supply 48 Volts - For close and open coils.

The DC supply shall be from **Battery Bank**.

The mechanism shall be designed to operate satisfactorily despite fluctuations of Auxiliary power supplies as under:

AC supply: Voltage from 85% to 115% of normal voltage
 Frequency: from -5% to +3% in variation of normal frequency

DC supply: Voltage for voltage variation of Tripping : 70% - 110%
 Voltage variation of Closing : 85% - 110%

11.0 INTERLOCKS

Circuit breaker can be inserted only in open position. Likewise circuit breaker in closed position cannot be withdrawn. Attempt to draw out closed breaker shall not trip the breaker.

For AIS, the circuit breaker shall operate only in one of the three defined positions i.e. service, test and isolated. The breaker shall not close in any of the intermediate positions.

For GIS, the 3-position of the DISCONNECTOR switch shall be ON-OFF-EARTH.

The circuit breaker cannot be inserted into service position till auxiliary contacts are made. Similarly interlock shall prevent auxiliary contacts from being disconnected, if circuit breaker is in service position.

12.0 SAFETY SHUTTERS

For AIS, Safety shutters shall be metallic and shall be provided to cover up the fixed High voltage contacts on bus bar and cable sides when the truck is moved to Test / isolated position. The shutters shall move automatically through a Linkage with the movement of the truck and shall be of gravity fall type only. It shall be possible to padlock shutters individually, i.e. on withdrawal of the breakers the shutters shall automatically operate to cover the contacts. Further,

all the compartments are electrically & mechanically segregated from each other. Hence it is possible to work on the Busbar compartment being completely isolated from the breaker compartment. There shall be positive indications for TEST/SERVICE position; However isolated position is indicative by the open door itself. But, 33kV GIS is Fixed Type and Mounted inside the stainless tank insulated with SF₆ Gas. The Stainless Tank is sealed for Life time.

For GIS, Safety shutters are not applicable.

13.0 FIXED ISOLATING CONTACTS

Switch gear cubicle shall have seal off bushing arrangement between the circuit breaker compartment and bus bar/C.T. cum cable compartment, i.e. the fixed isolating contacts shall be embedded in Epoxy Resin Cast bushing so these act as seal off bushing to prevent transfer of arc from one compartment to the other in the event of internal arc within the cubicle & must be tested for internal arc 25 kA for 1 sec in all three HV compartments as per new IEC 62271-200.

But, 33kV GIS is Fixed Type and Mounted inside the stainless tank insulated with SF₆ Gas. The Stainless Tank is sealed for Life time.

14.0 AUXILIARY SWITCH AND AUXILIARY PLUG & SOCKET

There shall be minimum 6NO and 6NC contacts in breaker auxiliary switch (10 amps DC rating) and shall be provided in each circuit breaker. However, additional contact shall be made available by using Contact Multiplier Relay/Contact Multiplication Relay.

15.0 ELECTRICAL & MECHANICAL POSITION INDICATION.

In addition to mechanical position indication in breaker for test and service position, electrical indication shall also be provided through limit switch. There shall be minimum 2NO +2 NC contacts available in each position for electrical indication and for any other interlocking purpose.

15.0 CURRENT TRANSFORMER

Current transformers, three per circuit breaker, shall be of indoor, single phase, resin cast and shall comply with IEC:185 and IS:2705, suitable for operation in hot and humid atmospheric conditions described in service condition. They shall be mounted inside the Panel.

16.1 Core

16.1.1 High grad non- ageing cold rolled grain oriented (CRGO M4 or better grade) silicon steel of low hysteresis loss and permeability shall be used for the core so as to ensure specified accuracy at both normal and over currents. The flux density shall be limited to ensure that there is no saturation during normal service.

16.1.2 The instrument security factor of the core shall be low enough so as not to cause damage to the instruments in the event of maximum short circuit current.

16.2 Windings

16.2.1 The secondary windings shall be made of electrolytic copper with suitable insulation. The conductor shall be of adequate cross-section so as to limit the temperature rise even during short circuit conditions. The insulation of windings and connections shall be free from composition liable to soften, ooze, shrink or collapse during service.

16.2.2 Polarity shall be indelibly marked on each current transformer and at the lead and termination at associated terminal blocks. CTs with multi ratio winding shall be clearly tabulated to show the connections required for different ratios. Similar numbers shall be marked on terminal block arrangement and wiring diagram. Apart from the above marking and those to be provided as per IEC-185 or IS-2705, other markings shall be provided in consultation with owner.

16.2.3 The continuous current rating of the primary winding shall be one hundred and **twenty** percent of the normal rated current.

16.2.4 Secondary windings of current transformers shall be used for metering, instrumentation and protection and shall be rated for continuous current of one hundred and **twenty** percent of normal rated current of primary winding.

Current transformers shall be three core window/bar primary for higher rating or wound primary for lower rating. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current 25 KA for 3 second. Out of three cores one Core having 0.2s class (Metering) & other two cores having PS (Protection) class accuracy.

Current Ratio: 400-200/1-1-1 Amp

No. of Cores: 03

Burden: 15 VA for each core

Technical Requirements

Sl. No	Particulars	Requirements
1	Function	To control 33kV Feeder & HV side of 33/11kV power transformers of ratings between 3.15MVA to 12.5MVA
2	Requirement	The CTs in the 33 kV Indoor VCB switchgear panel should have three cores as follows.

3	Transformation Ratio	Category- A (For TFR) 400-200/1-1-1-A	Category- B (For Feeder) 400-200/1-1-1 A
4	Rated Burden (VA)	Core:1: 15 VA , Core:2: 15 VA, Core:3:15 VA	Core:1: 15 VA , Core:2: 15 VA, Core:3:15 VA
5	Class of Accuracy	Core:1: 0.2s , Core:2: PS, Core:3: PS	Core:1: 0.2s , Core:2: PS, Core:3: PS
6	Instrument Security Factor	Core- 1:- <5	Core- 1:- <5
7	Purpose	Core:1: Metering , Core:2: Differential, Core:3:O/C& E/F & REF	Core:1: Metering , Core:2: Spare Core:3:O/C& E/F & REF
8	Rated/Highest system Voltage	33/36kV	
9	Short Time Rating	25KA rms for 3 seconds	
10	Power frequency 1 min voltage withstand level/ Insulation Level: -Impulse Voltage1.2/50 μ s wave withstand level -	70 KV/170KV	

17.0 Tests

The CTs shall be tested in accordance with the requirements of the type tests and routine tests as per the latest issues IEC:185 or IS:2705. The tests to be conducted shall include:

17.1 Type Tests:

Type tested equipment/materials are acceptable. Type tests should have been conducted in last five years. The Type Test must have been as per OPTCL requirement. If OPTCL desires another type test, it has to be conducted. In such case OPTCL will bear the transportation of equipment/material and type test charges.

- Lightning impulse voltage;
- Power frequency wet withstand voltage;
- Temperature rise;
- Short time current;
- Composite error;
- Accuracy test (for measuring core);
- Instrument security current (for measuring core);

17.2 Routine tests

- Verification of terminal marking and polarity;
- Power frequency dry withstand test on primary windings;
- Power frequency dry withstand test on secondary windings;
- Power frequency dry withstand test between sections;
- Over voltage inter-turn test;
- Composite error;
- Turn ratio;
- Accuracy test (for measuring core);
- Current error and phase displacement (for protection core);
- Knee point voltage and magnetizing current test (for PS class);
Secondary winding resistance (for PS class).

17.2 Indoor voltage transformer (IVT):

The 33 kV Indoor voltage transformers (IVT) are required to meet the following basic technical requirements (Reference standards: IEC:186, IS:3156 and associated standards listed in the specification):

Sl. No	Particulars	Requirements
1	Type	Single phase
2	Nominal system voltage, phase to phase	33 kV
3	Application	Instrumentation, Metering and Protection
4	Number of secondary windings	2
5	Rated normal burden*-(Core-I/II)	Each Core shall be 15VA
6	Rated primary voltage	$33000V/\sqrt{3}$
7	Rated secondary voltage	$110V/\sqrt{3}$ - $110V/\sqrt{3}$
8	Class of accuracy-(Core-I/II)	0.2/3P
9	Rated insulation level: (Primary winding) (Phase to earth)	
i)	One minute power frequency withstand voltage to earth rms	70kV

ii)	Impulse withstand voltage to earth with 1.2/50 μ sec wave of +ve and —ve polarity (peak)	170kV
10	One minute power frequency withstand voltage of secondary winding (rms)	
	Between phase to earth	3kV
	Between sections	3kV
11	Rated voltage factor	
	Continuous	1.2
	For 30 seconds	1.5

* The burden indicated is the minimum acceptable to the Owner. The Contractor shall ensure that the rated outputs of the voltage transformers are adequate to meet at least 120 percent of the connected load (burden).

18.0 GENERAL FOR IVT

18.1

The voltage transformers to be supplied under this specification shall be Epoxy Resin Cast of Indoor type with 3nos single phase in a separate Panel complying with IEC:185 and IS:3156, suitable for operation in hot and humid atmospheric conditions described in this document.

18.2 Duty requirement

33 KV Voltage Transformer for all the indicating instruments and measuring meters in the primary substation on 33 kV side. It shall be of indoor, 1-Phase or 3- phase **Epoxy Resin Cast type** complying with IEC 185.

18.3 Core

High grade non-ageing cold rolled grain oriented (CRGO-M4 or better) silicone steel of low hysteresis loss and permeability shall be used for core so as to ensure accuracy at both normal and or over Voltages. The flux density shall be limited to 1.6 Tesla at normal voltage and frequency. There shall be no saturation at any stage during operation.

The instrument security factor of the core shall be low enough so as not to cause damage to the instruments in the event of maximum short circuit current or over voltages.

18.4 Windings

The primary and secondary windings shall be electrolytic copper of high purity and conductivity and covered with double paper insulation. The conductor shall be of adequate cross-section so as to limit the temperature rise even during maximum over voltages.

The insulation of windings and connections shall be free from composition liable to soften, ooze, shrink or collapse during service.

- 18.5 The secondary windings of the voltage transformers shall also be suitable for continuous over voltage corresponding to the maximum system voltage at the primary winding. The winding supports shall be suitably reinforced to withstand normal handling and the thermal and dynamic stresses during operation without damage.
- 18.6 The voltage transformer secondary circuits will be taken out to form the star point and earthed at one point outside the voltage transformers.
- 18.7 Both primary and secondary winding terminals shall be clearly and indelibly marked to show polarity in accordance with IEC: 186. The connections required for different secondary windings in case of multi-winding voltage transformers shall be clearly indicated in terminal blocks and the wiring diagrams.

18.8 Fuse protection in IVT

For AIS, the Primary winding shall be protected by HRC Fuses in suitable holder, designed by the manufacturers. The secondary windings shall be protected by HRC cartridge fuses in fuse holder consisting of carriers and bases. The carriers and bases shall be of high grade flame retarding and non-hygroscopic molded insulating materials with hard glass surface. Each fuse shall be identified with engraved plastic label. Potential Transformer shall be 3nos single phase & there shall be two cores. One core having 0.2 Class (Metering) & other having 3P Class (Protection). **Bus IVT shall be in a separate Panel with extended Bus bar. Digital display voltmeter shall be installed on IVT panel.**

For GIS, Fuse Protection in is not applicable, since the IVT's are directly Plug-in type with disconnecting switch.

19.0 TEST AND INSPECTIONS

- 19.1 The voltage transformers shall be tested in accordance with the requirements of the type tests and routine tests as provided in the latest issues of IEC:186 or IS:3516.

The tests to be conducted shall include;

19.2 Type tests:

- Lightning impulse voltage test;
- High voltage power frequency wet withstand voltage;
- Temperature rise test;
- Short circuit withstand capability test;
- Determination of limits of voltage error and phase displacement

19.3 Routine tests:

- Verification of terminal marking and polarity;
- Power frequency withstand tests on primary winding;
- Power frequency dry withstand tests on secondary winding;
- Power frequency withstand tests between sections;
- Determination of limits of voltage errors and phase displacement;
- Insulating Resistance measurement.
- Partial discharge measurement.

Voltage Ratio: $33000/\sqrt{3} / 110/\sqrt{3}-110/\sqrt{3}$.

No. of Cores: 03

Burden: 15VA for Metering, 15 VA for protection

20.0 PRESSURE DISCHARGE FLAPS

Pressure discharge flaps shall be provided at the top in all high voltage compartments for the exit of hot gases in the event of internal arc in any of the compartments.

21.0 BUSBARS

Bus bar material shall be of high conductivity electrolytic copper only and accessibility of the same shall be from top only. All bus bars shall be tubular/rectangular design insulated with heat shrinkable BPTM compound sleeves and joints shall have sufficient clearances in order to meet the BIL (70kV RMS and 170 kip) withstand. Phase identification shall be made at the end by colored tape.

Note: - In GIS switchgear, Bus bars, VCB, Disconnect or shall be in the SF₆ Gas chamber. The bus bar shall not be solid insulated.

22.0 EARTH BUS

There shall be a continuous copper bus at the bottom of the panel. Earth bus shall be robust and shall be capable of carrying full short circuit current 25kA for 1 second. Doors, covers and all non-current carrying metallic parts shall be earthed through flexible copper braiding of adequate size. This also includes instrument casting and cable armor which are also connected to the earth bus. Earth bus must be tested for 25kA for 1 sec.

23.0 BUS & CABLE EARTHING

Each feeder shall be provided with fault make type **Earth** switch duly interlocked with circuit breaker. Unless the breaker is tripped & brought to test

position, the earthing switch cannot be operated. Earth Switch should be fully type tested for STC withstand of 25kA for 1seconds.

24.0 CABLE COMPARTMENT

For Visit shall be at the rear side with rear bolted box type back covers. There shall be an inspection window at the rear back cover enabling operator to have visual inspection without opening back cover in live condition. Viewing window at the rear side shall be of poly carbonate only and shall be tested for internal arc. The gland plate of cable chamber shall be of minimum 3mm thickness MS sheet in two halves section.

Sufficient headroom of maximum 750 mm shall be provided for cable termination.

For GIS, the GIS Cable compartment cover is interlocked with disconnect switch & CB. Therefore, unless the earth switch & CB is closed we cannot open the cable compartment door which ensures more safety.

25.0 LOW VOLTAGE COMPARTMENT

Low voltage compartment shall be mounted at the front on the top of breaker compartment and shall also have hinged type of door. All wiring shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover. For current transformer terminal shall be disconnecting link type only. The wire shall be of 1.1kV grade and suitable for 2kVrms for 1 minute power frequency high voltage.

26.0 CONTROL AND POWER CABLE ENTRY

Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side. Power cable entry shall be from rear bottom. Provision shall be available for entry of power cable from rear bottom.

The CR Panel (Instrument Chamber) should be mounted on top of the VCBPanel.

Control panel (**inbuilt**) with protective relay and meter shall be provided by the supplier suitable for above breakers. The equipment shall have protection scheme with the following relays:

27.0 Protection Relays FOR FEEDER:

The offered relays shall be multifunction numerical type only. The auxilliary relays for lockout, transfer fault indication etc can be electro-mechanical type. All Numerical relays shall have minimum following features:

- Relay shall be IEC 61850 compliant Numerical & suitable for 1A secondary CT current & 110V IVT secondary supply.

27.1 Over current & Earth fault relay:

- Relay shall have 3 phase directional and non-direction (site selectable feature) over current and earth fault protection. It shall have three

stages with first stage programmable as IDMT or DT. The second and third stages shall be programmable as DT or instantaneous.

- Relay shall have thermal overload protection.
- Relay shall have negative sequence over current protection.
- Relay shall have adoptive & creative logics for meeting the requirement
- Relay shall have 4 shots auto reclose function built-in
- Relay shall be with under and over voltage protection elements provided
- Relay shall have under frequency protection facility at least two stages.

28.0 Protection Relays FOR TRANSFORMER:

The offered relays shall be multifunction numerical type only. The auxiliary relays for lockout, transfer fault indication etc can be electro-mechanical type. All Numerical relays shall have minimum following features.

- Relay shall be IEC 61850 compliant Numerical & suitable for 1A secondary CT current & 110V IVT secondary supply.

28.1 Over current & Earth fault relay:

- Relay shall have 3 phase directional and non-direction (site selectable feature) over current and earth fault protection. It shall have three stages with first stage programmable as IDMT or DT. The second and third stages shall be programmable as DT or instantaneous.
- Relay shall have thermal overload protection.
- Relay shall have negative sequence over current protection.
- Relay shall have adoptive & creative logics for meeting the requirement
- Relay shall have 4 shots auto reclose function built-in
- Relay shall be with under and over voltage protection elements provided
- Relay shall have under frequency protection facility at least two stages.

28.2 Transformer Differential Relay:

The Transformer Differential protection relay shall consist of two winding protection, two REF protections, V/F protection etc. Differential protection besides REF protection is required for 3.15MVA, 5.0MVA & 8.0MVA Transformer. Over Fluxing Protection is standard protection of transformers. The input to this relay is the secondary IVT supply. However, setting will be decided at the time of commissioning.

28.3 Specification for Numerical Directional & Non-Directional Over Current and Earth Fault Protection.

28.3.1. General

A comprehensive communicable numerical protection should be offered by the relay. High level of security should be built-in the relay to avoid any mal operation causing over protection of the system or any non-operation of the relay causing under protection. Should have flexibility to customize the relay for intended applications as may be desired at site, in other words the relay should

not have very limited features rendering it equipment specific. The relay should have high immunity to electrical and electromagnetic interference. It should have also continuous supervision of hardware and software to ensure enhanced system reliability and availability. The relay should have auto diagnostic fault indication to facilitate fault location and repair after detection of internal relay fault. The compulsory features required by the relay to be fulfilled are listed as below

28.3.2. Application

The relay will be required for applications where time graded Directional & Non-Directional (site selectable feature) O/C and E/F protection is required. The Directional & Non-Directional (site selectable feature) earth fault protection should provide suitable sensitivity for most systems where the earth fault current is limited. Typically the relay should be applied for all incoming transformers, capacitors and plant feeders for any application. The relay should be designed in such a way that it operates for a wide range of AC and DC auxiliary power supplies.

28.3.3 General requirements

The relay in addition to protection and control should display and store all parameters necessary for post fault analysis. The relay shall have a back light LCD display. It shall be possible to view the measurement values. The relay shall record all the events affecting the relay performance. All the time stamped data should be available via a RS232 serial communication port for access locally and/or remotely via a computer. All the events, faults and disturbance records shall be extracted via a RS485 /RS232/USB/RJ45(Ethernet)serial port.

28.3.4 Operating Principle

The sampling frequency of the digital/analogue converter should be synchronised to power frequency by suitable frequency tracking methods to improve both accuracy of measurement and harmonic rejection. The relay should necessarily have software filtering to prevent induced ac signals in the external wiring causing operation of logic inputs.

28.3.5. Functional Description

a) Directional O/C protection:

The relay should have 4 independent time delayed Directional O/C stages which can be selectable either as directional or non-directional. MTA shall be adjustable anywhere within -180 degrees to + 179 degrees. The first and second stages shall be programmable to have either a DMT characteristics or IDMT characteristics (as per IEEE/IEC Standards for O/C Relay, Stage- 1 & 2 can be used either a DT or IDMT characteristics & 3rd & 4th Stage shall be with Instantaneous Definite Time. However, directional or non-directional features are site selectable) described as follows:

1. The low set phase current should start when the current of any phase exceeds the set value.

The first and the second current stage shall have a current setting range of

0.10 - 4.00 I_n and time setting range of 0.06 sec to 300 sec.

2. The Third, fourth stage of protection shall be with instantaneous operation or DT having a current setting range as 0.1 to 20 I_n and a time delay of 0.06 sec to 300 sec for stage III and IV. These stages may have the flexibility to be configured for a busbar protection scheme using blocking logic at a later date. Facility available in the relays for this flexibility may be highlighted.

b) Directional Earth fault Protection:

The relay should have at least 2 independent time delayed Directional/Non-Directional E/F stages suitable for networks with different earthing types(solidly earthed, resistive earthed, Petersen coil earthed systems).The relay shall also be suitable where ever a selective and sensitive earth fault protection is needed. It shall also be possible to detect intermittent earth faults. MTA shall be adjustable anywhere within -180 degrees to + 179 degrees. The first and second stage shall be programmable to have either a DT characteristics or IDMT characteristics described as follows:

The low set phase current should start when the current of any phase exceeds the set value. For E/F Relay, Stage- 1 & 2 can be used either a DT or IDMT characteristics. 3rd & 4th Stage shall be with Instantaneous Definite Time. However, directional or non-directional features are site selectable.

Both the stages Shall have a current setting range of 0.01 to 8 Amp and time setting range of 0.1 sec to 300 sec. The lower setting is critical to take care of systems which have low earth fault currents. Additionally there shall be four non-directional earth fault stages where the first stage can be programmed either to IDMT or DT and the rest 3 stages shall be of definite time type.

c) Sensitive Earth Fault/Restricted Earth Fault.

The relay shall have five CT input to take care of transformers applications where Restricted Earth fault and standby earth fault is required. It shall be possible to either measure the value of neutral current through available C.T I/Ps or derive it internally within the relay and use the same for applications as described above. The Relay shall be able to accept input from Core balance current transformer to detect earth faults of very low amplitude. The setting range shall be settable to a minimum of 0.005 Amps. The relay shall have restricted earth fault protection feature of high Impedance type.

d) Over Voltage & Under Voltage

If the system goes for very high under and over voltages in case of Supply or Load unbalance it shall be possible to grade the system for Voltage protections. Relay shall have 3 under voltage stages and 3 over voltage stages respectively.

e) Residual voltage protection:

The relay shall have at least 2 residual voltage stages in order to give an unselective backup for existing earth fault protection. The stages shall have a setting range of 1-60 % U_{0N} with a time delay settable from 0.3 – 300.0s (in steps of 0.1 s).

f) Under frequency/Over Frequency /ROCOF:

The relay shall have four frequency stages out of which it shall be possible to program at least 2 of them to under or over frequency to be suitable for various load sharing applications. The under frequency stages shall be settable anywhere within a frequency range of 40.0 - 60.0 Hz. With the flexibility to block any mal operation on event on under voltage. All stages shall be of definite time type with a setting range of 0.10 – 300.0 s (in steps of 0.02 s).

The relay shall also have the facility to detect a rate of change of frequency for load shedding applications , to speed up operation time in over- and under-frequency situations and to detect loss of grid. Pick up setting shall be settable from 0.2 – 10.0 Hz/s (step 0.1 Hz/s).

g)The relay in addition to the above basic function should also provide the following functions:

1. The relay should have the protection feature which allows the relay to trip the upstream circuit breaker when a local breaker failure condition is detected and should be energised both from operation of the relay or by an external trip.
- 2.The relay shall also have the feature of auto reclosure with independently programmable dead time and reclaim time for each shot. The function shall be programmable for at least 4 shots of auto reclosure.
3. The relay should measure the following standard quantities:
 - j) It shall be possible to view the current voltage phasors as well in the graphical mimic display.However, MIMIC display is not mandatory.
 - k) Phase current(Positive, negative and zero sequence currents)
 - l) Phase Voltage(Positive, negative and zero sequence voltages)
 - m) Neutral current
 - n) Frequency
 - o) Active and Reactive Power
 - p) Power factor
 - q) Harmonics of current and voltages which shall be possible to view as a diagram on the display. Display of harmonics in relay is not mandatory.
 - r) Relay should be able to measure the true RMS value up to 15thharmonics
4. The relay shall have at least two independent setting groups. The relay shall automatically switch from one setting group to another depending on system conditions (such as failure of incomer supply, which causes fault level to decrease etc.)
5. The relay shall have a facility to have communication on IEC61850 protocol through redundant rear port (**i.e. RJ45 or FO**) for SAS connectivity without

use of any external converter. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these. The relay shall support peer to peer communication.

The relays shall generate GOOSE messages as per IEC 61850 standards for interlocking/tripping and also to ensure interoperability with third party relays.

- f) Necessary user friendly configuration tool shall be provided to configure the relays. It should be compatible with SCL/SCD files generated by a third party system.
- g) Goose signals shall be freely configurable for any kind of signals using graphic tool/user friendly software.

Bidder shall also ensure adequate hardware.

6. The Relay shall have facility for Time synchronization on IRIG B or SNTP port.

h. Relay hardware:

The relay should be modular type. It will be installed on the top of the Switchgear Panel. Standard terminal blocks should be located at the rear of the relay providing connections for all input and output circuits.

i. Output relays:

The relay should have up to 2-CT inputs. They should provide at least 6 optically isolated inputs and atleast7 programmable outputs.They should be arranged in response to any or all of the available functions by suitably setting the output relays. The protection and control function to which these relays respond should be selectable via the menu system of the relay.One output relay shall be permanently assigned for self-supervision.

H. The Relay shall also have the following functionality/Features..

* Thermal overload protection.

- iv)* Negative sequence over current.
- v)* Permanent Self-Test.
- i.) Circuit breaker maintenance information.
- ii.) Broken conductor detection by measuring I_2/I_1 .
- iii.) Cold load pickup function to change the settings when the protected object is connected to a network i.e., at starting allowing the set value being lower than the connected inrush current.
- iv.) The relay shall also have the feature of Inrush blocking through 2nd harmonic detection.
- v.) Disturbance recorder & Event recorder facilities.8 fault records shall be possible in each protection stage.
- vi.) Front RS232/USB port for communication to LAPTOP .
- vii.)The relay shall have a facility for C.T. Supervision, P.T. Supervision and

Trip Circuit Supervision.

Relay shall support customer-defined programmable logic for Boolean signals. It shall be possible to form equations using AND, OR, NOT gates.

29.0 Detail on Differential Protection:

- a) Transformer differential protection scheme shall be of numerical relay (low impedance type) suitable for two winding Transformer.
- b) Shall be triple pole type with faulty phase identification/indication.
- c) Shall have an operating time not greater than 30ms at 5 times the rated current.
- d) Shall have three instantaneous high set over current units.
- e) Shall have an adjustable bias setting range of 10 – 50%.
- f) Suitable for rated 1 amp current.
- g) Shall have 2nd harmonics or other inrush restraint features and also should be stable under normal over fluxing conditions. Magnetizing inrush features shall not be achieved any intentional time delay.
- h) Shall have an operating current setting of 15% or less.
- i) Shall have an internal feature of the relays to take care of the angle and ratio correction.
- j) Shall have provision of self monitoring and diagnostic feature.
- k) Shall have provision of recording features to record graphic from of instantaneous values during faults and disturbances for the pre and post fault period and during running conditions.
- l) Current in all the windings in separate analog channels and voltage in one channel.

The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.

- * REF protection operated.
- * HV breaker status
- * LV breaker status.
- * Buchholz /OLTC Buchholz /PRV alarm/trip.
- * WTI/OTI alarm/trip
- * MOG alarm

Necessary hardware and software for automatic up-loading the data captured by disturbance recorder to the personal computer. Downloading from the relay memory to the computer memory will be done.

The relay shall have three stages of definite time overcurrent protection as backup operating with separate measuring systems for the evaluation of the three phase currents, the negative sequence current and the residual current. In addition the relay shall have three stages of Inverse time overcurrent protection operating on the basis of one measuring system each for the three phase currents ,the negative sequence current and the residual current.

Shall have feature of two nos. of independent REF protection for two winding power transformers.

This function should be provided to maximize the sensitivity of the protection of earth faults. The REF function should be a Low impedance element. The REF function should be able to share CT's with the biased differential function. As in traditional REF protections, the function should respond only to the fundamental frequency component of the currents.

Shall have feature of V/F protection of different stage setting.

1. over fluxing protection to suit the transformer.
2. Wide range of setting to suit the worst condition of the highest system voltage and worst system frequency).
3. Alarm and trip setting separately.
4. Thermal slope setting.

Shall be numerical type and shall have continuous self-monitoring and diagnostic feature.

29.1 Additional Protection Function

1. Differential Unit protection (87) which includes:

- *Three phase differential protection
- *Digital correction of vector group and Ratio
- ***Homopolar DC component relay** filter, which is used to remove the Homopolar component from the phase currents is DC component and the relay shall have the filter component.

- *Instantaneous Differential Trip.
- *2nd and 5th harmonic restraint features.

2. Restricted Earth Fault Protection (87G)
3. Current Unbalance (46), which protects against current unbalances resulting from anomalies in the power system or unbalanced loads.
4. Thermal image (49), which protects the transformer against damage resulting from heating up during overloads.
5. Breaker Failure Protection(50BF),Which verifies the breaker correct actuation for clearing a fault,otherwise, the trip of the necessary breakers to clear that fault
6. Phase over current protection (3*50/51) with time delayed and two instantaneous levels, as a backup protection for Transformer external faults, if external faults are not cleared by primary protections
- 7.Over Excitation protection (V/Hz) (24) with two independent levels, which prevents transformers from at a greater flow density than that for which they were designed. And also avoiding heating and consequent damage in the transformer due to over excitation.
8. Over Excitation protection (5th harmonic)
9. Neutral Earth fault with time delayed and Instantaneous for each winding as for backup protection
10. Frequency protection (81O/U)
11. Over Voltage protection (59)
12. Ground Over current Protection (50G/51N), which act as an over current function by using the current measured at the grounding of the power transformer, being its function to detect faults to earth.

29.2 Automatisms

- 1, The user can configure up to 15 logic signals that can be assigned to output relays, Led's or input for protection functions blocking features.
- 2, A lockout relay (86) function is needed. Relay programme with this function will act when differential unit acts (At instantaneous) so that they can be used as a locking device for breaker close circuits.

29.3 Monitoring Functions

1. Breaker monitoring needed
2. Trip and close circuit supervision needed for detecting any anomalies in the circuit with the open or close.
- 3.The unit temperature measurement supervision needed.(to know transformer oil and winding temperature, which is optional)
- 4.The Battery voltage (DC supply)supervision needed.

29.4 Data Acquisition Functions

- I. The following Measurements should be available

- *Current in each winding (A)
- *Average current in each winding (A)
- *Differential current (A)
- *Voltage (KV)
- *Frequency (Hz)

29.5 Oscillograph data recorder

- I.All the units should needed an Oscillograph data recorder with the next characteristics,
 - *Each Record comprises the samples from analog signals and the status of 32 selectable digital signals
 - ***16** or more samples per cycle.
 - *Configurable pickup.
 - *Records in non volatile memory.
 - *The disturbances are collected and exported in COMTRADE format.
- II. Event Recording:

The relay should store minimum 8 numbers or more last events in a nonvolatile memory, which can retrieved from a PC with the following data,

 - *Date and time of the Event.
 - *Descriptive text of Event.
 - *Values of Electrical parameters.
- III. A queue of minimum **8 disturbance** records is stored in the nonvolatile memory.
- IV. Fault Recorder

Minimum **5** or more faults are stored in the nonvolatile memory, with the following data

 - *Date and time of the fault pickup, beginning and end.
 - *Prefault and fault values of electrical parameters.
 - *Duration and Type of Fault.

*Level of Electrical parameters at the faults occurrence time.

V. Time synchronization Via communication Via demodulated IRIG-B/SNTP input

VI. Setting Group

Independent setting groups should be available.

VII. Communication Ports

As indicated above .

29.6 Other technical characteristics

*Have self diagnostic feature and watchdog output.

*Have front RS232 port/USB port and rear Redundant port remote communications. The communication shall be on **IEC 61850**.

*Closed terminal needed for **06 CT input** for differential (LV & HV side of Transformer), **02 CT input** (HV & LV neutral of Transformer) for REF and three voltage input (for over fluxing protection, PT supply from LV/HV side).

* Have programmable minimum of **5** digital Inputs, **minimum of 8** digital outputs, minimum **of 13** numbers programmable LED .

* Necessary latest version /communication software should be supplied for configuration, setting modification, event analysis, and SCADA communication.

*Programmable system frequency should be 50 Hz and operating range should be $f_n = \pm 5\text{HZ}$.

*The contact of the relay shall have the following Minimum rating.

Make and carry continuously	:	5A
Make and carry for minimum 1Sec.	:	30A

* Current balancing transformers, shall form a part of the relay. The successful Bidder shall furnish sufficient data to prove stability of the equipment up to 10 times full load through fault current. Interposing C.Ts if necessary for current balancing shall be within the scope of supply. I.C.Ts shall be of universal type of setting different ratios.

30.0 OVER FLUXING RELAY:(V/f)

(a) Suitable relay with v/f characteristics shall be provided to defeat the over fluxing condition of the transformer.

(b) The relay shall be a separate electromechanical relay to be connected in parallel to the over fluxing relay, if, available in any of the numerical relay i.e. if the same software is available in the numerical differential protection relay.

(c) Shall have inverse time characteristics, matching with transformer over fluxing withstand capability curve. The input to this relay is the secondary IVT

supply. However, setting will be decided at the time of commissioning.

(d) Shall provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of v/f between 100% to 130 % of rated values.

(e) Tripping time shall be governed by v/f Vs time characteristic of the relay.

(f) have a set of characteristics for various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at v/f values of 1.4 and 4.5 times, the rated values, respectively.

(g) have an accuracy of operating time, better than +/-10 %.

31.0 TESTS

Following tests as indicated should have been conducted for the above relays:

31.1 Soak test:

All solid state equipment/system shall be subject to the Hot Soak Test as a routine test in accordance with the procedure detailed in the following paragraph.

All solid state equipment shall be burn-in tested for minimum of 120 hours continuously under operational conditions. During the last 48 hours of testing, the ambient temperature of the test chamber shall be 50°C. The temperature of the interior shall not exceed 65°C.

31.2 Type tests:

1. Impulse voltage withstand test as per Clause 6.1 of IS 8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS-8686).

2. High Frequency Disturbance test as per Clause 5.2 of IS 8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS 8686). Type tests listed under IEC-Technical Committees recommendation 'TEC-57' (IEC 61850 – Communications, IEC 60255 -Insulation / Dielectric / EMC / Mechanical / Environmental etc) and functional type tests listed under **CIGRE Study Committee 34** (Protection) Report on simulator, Network analyser or PTL as applicable.

31.3 Routine tests: Contact insulation resistance test as per Clause 10.5 of IS-3231.

Insulation withstand capability as per Clause 10.5 of IS-3231 on all AC/DC relays.

32.0 MULTIFUNCTION METER

GENERAL: Multifunction Meter will be installed on the top of the Switchgear Panel.

*. Each bay should be provided with a Multifunction meter having

following features:-

- * Features: By level monitoring of all electrical parameters of V,I, ϕ , $\cos \phi$, Hz, KVA, KVAR, KW&KWH. TrueRMS measurement
- * Accuracy: 0.2s
- * User selectable display ranges. (CT/PT).
- * Auto scrolling/Manual display
- * RS 485 communication port with MODBUS RTU protocol. Compatible for data logging & SCADA application.
- * Inbuilt Real time clock with calendar.
- * 3phase,4 wire,3 element or as per requirement.(to be decided during detail Engineering).
- * Quadrant of operation: 04 Quadrant.
- * Display: Bright red 7-segment LED display.
- * HMI: Through Front panel tactile keys.
- * Indication: Phase voltage, Phase current ,Line voltage, Frequency, Power factor, KVA,KVAR,KW,KVAH,KVARH,KWH.
- * Voltage input: 63.5/110V
- * Current Input: 1 A
- * Auxiliary supply: 85-250 V AC or 48 V DC
- * VA burden: 15VA
- * Frequency Range: 45 to 55 Hz
- * Power factor range: 0.1 lag -1 -0.1 lead
- * Over voltage: 130% continuously & 200% for 30 sec
- * Over current: 2 times continuous, 20 times for 1 sec.
- * Response time: 200 ms
- * Class of accuracy: 0.2s as per IEC 60687, IS 14697
- * Complies to EMI: IEC 61000-4-5,3,4
- * Display resolution: upto 1 decimal
- *.Output: Two communication port with optical isolation.RS 485 communication port with MODBUS RTU protocol.
- *.CT shorting provision should be there.
- *.Mounting: Flush panel mounting.
- *. Dimensions:144X144 mm
- *.Ambient condition: working: 0-55 deg cent,5-95% RH.

N.B – 1no optical and 1no RS 485 communicating on MODBUS protocol is also acceptable.

32.1

- (a)** A flag operated master trip relay should be provided (48 V DC with N/C contact in series with the relay coil): Electromechanical relay having sufficient output contact (N/O & N/C) should be available for interlock, indication & other SCADA purpose.
- (b)** Other electromechanical auxiliary relays as required as per the scheme to be provided.
(for contact multiplication, Transformer trouble shooting like Oil temp AI& trip, Winding temp AI & Trip, Bucholtz Alarm & Trip, MOG alarm, PRV Trip etc)

(c) A12 Window static annunciator with Test, Accept & Reset arrangement and with Buzzer & Bell.

32.2 Test terminal Blocks- Test terminal Block need be provided for testing meters in test position.

32.3	Indication Lamp(24DC LED type)	Red- Breaker 'ON' Green Breaker 'OFF' Amber- Breaker 'AUTO TRIP' Blue- Spring charge indication. White-Healthy Trip illuminated push bottom switch
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33.0 Panel wiring and accessories.

Wiring: Each panel shall be supplied with all internal wiring complete.

33.1 Panel wiring shall be suitably bunched and clamp for neat appearance. The conductors used for wiring purpose shall be **PVC** insulated 1100 volt grade semi- flexible heat resistant, flame retardant and vermin proof electrolytic copper cable conforming to IEC:227, 502 or IS:1554. The wiring shall be securely supported and taken though PVC through PVC troughs. Each wire shall be continuous from end to end without any joint in between. All panel wiring shall be capable of withstanding a voltage of 2kV AC 50Hz for one minute.

33.2 Cable and wire for connections within the switchgear and between the switchgear and terminal blocks shall have a minimum temperature rating of 90 degree Celsius. The size of the conductors for panel wiring shall be not less than 2.5mm². For CT secondary wiring, two such wires shall be used in parallel.

33.3 Panel wiring protection

The panels shall be equipped with links and HRC cartridge fuses conforming to IEC:269 or IS:13703 in 1100 Volt grade phenolic moulded fuse holder consisting of fuse carrier and base or miniature circuit breakers conforming to IEC:947-2 or IS:13947-2 at appropriate locations. The carriers and bases shall be made of high grade flame retardant and non hygroscopic phenolic moulded material with hard glass surface. Each fuse or MCB shall be identified with engraved plastic label.

33.4 In general, fuses and MCBs shall be limited to the minimum required for safety.
The protection scheme shall include fuses for VT secondary circuits and DC supply to each panel and fuses for MCB for spring

charging motor and incoming AC supply.

34.0 Terminal blocks

Terminal blocks of brass studs rated for 10 amps continuous current, 1100 volt. DC grade covered by moulded insulating materials with adequate electrical clearances shall be provided for terminating the panel wiring and outgoing connections. The termination shall be made by crimping lugs or bare conductor with insulating sleeves at ends. The arrangement can be horizontal or vertical as per standard practice adopted by the manufacturer. All terminals must be numbered and wire termination provided with numbered ferrules for identification. All numbering and marking including those in wiring diagram shall follow the guidelines provided in IS:11353. All circuit breaker auxiliary contacts including spare contacts shall be wired to the terminal blocks. Ten percent spare terminals shall be provided.

35.0 Colour and numbering

The wiring used for 230V AC supply for illumination lamp, panel heater and other devices shall be coloured. The colour of wires connecting directly to Earth shall be green. CT & PT connection wires shall be of R, Y & B colour. Engraved core identification plastic ferrules marked to correspond with the panel wiring diagram shall be fixed at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from the terminal block. Number 6 and 9, if used shall be under scored to enable differentiation.

36.0 Circuit diagram

A durable copy of the circuit wiring diagram shall be affixed to the inner side of the door of the switchgear compartment. Labels shall be provided inside the compartment to describe the functions of the various items of equipment.

The scope of the supply shall include the panel mounting foundation bolts, nuts and washers necessary for making the supporting.

37.0 DISCONNECTORS (In GIS Panel):

Disconnectors shall be provided in the GIS Switchgear panel. There shall be interlock with the VCB.

Rating: 630A.

SCC: 25 KA for 3 sec.

Internal Arc 25 kA 1 sec

Material: Electrolyte copper.

38.0 AUXILIARY SUPPLY

Control supply for closing and tripping shall be 48 Volts D.C. through external battery source. 230 Volts single phase A.C. supply shall also be available for the operation of spring charging motor and cubicle space heater.

39.0 DIMENSION

The dimension for **33kV GIS** shall not exceed
600mm (Width) X 2000mm (Depth) X 2500mm (Height)

The dimension for **33kV AIS** shall not exceed
1200mm (Width) X 3200mm (Depth) X 2700mm (Height)

The dimension for **11kV AIS** shall not exceed
 800 mm (Width) X 2100mm (Depth) X 2500mm (Height)

40.0 TYPE TEST OF THE 33 KV SWITCH GEAR (VCB) PANEL.

Following type test reports shall be submitted during the detailed Engineering and approval of drawings.

All short circuit duties including single phase and double line to ground as per IEC 62271-100 or as per latest amended IEC.

- **Short time rating for 3 seconds** as per IEC 62271-100, 62271-200 or as per latest amended IEC.
- **Temperature rise test** as per IEC 62271-200 or as per latest amended IEC.
- **Capacitor bank switching** for 400A minimum & cable charging 25 A test as per IEC 62271-100 For test duties 1 to 4 or as per latest amended IEC.
- **Degree of protection test** as per IEC 62271-200 or as per latest amended IEC.
- **Lightning impulse voltage test** as per IEC 62271-100, 62271-200 or as per latest amended IEC.
- **Internal arc test of 25 kA 1sec** in all the three high voltage compartments as per IEC 62271-200 or as per latest amended IEC.

41.0 QUALIFYING REQUIREMENT.

The equipment offered shall be procured from short listed vendor at E-23 and shall have been successfully Type Tested during last five years on the date of bid opening. The **front page** of the Type Test report showing the evidences of the tests, duly signed by the bidder shall be uploaded along with the bid.

The following Type tests of VCB should have done:

- 1) Short Time withstand current
- 2) Temperature Rise
- 3) Lightning Impulse Test
- 4) Internal Arc Test
- 5) Make & Break Test duties
- 6) Power frequency voltage test
- 7) Partial discharge test
- 8) Resistance measurement test
- 9) Tightness test
- 10) Closing Characteristic test
- 11) Opening Characteristic tests

The VCB shall be of **M2, C2 & E2 duty class.**

11KV Indoor Switchgear Panel for AIS

1.0 REQUIREMENTS

This specification covers design, engineering, manufacture, testing, and inspection of 11 KV indoor Air Insulated Switchgear Panel (provided with Vacuum circuit Breaker & CT, IVT etc) for use in the 33/11KV primary substations under the distribution networks. 11 kV Switchgear shall have Vacuum breakers & CT etc. The 11kV side of 33/11kV Sub-station shall be of AIS switchgear irrespective of AIS / GIS Sub-station. Hence, there shall not be any Disconnecter on 11kV side Indoor Switchgear. There shall be separate Indoor Panel (2nos.) for IVT at 11kV side. The Switchgear must have type tested.

1.1 Description of the Switchgear Panels for 11 kV AIS.

Indoor switchgear for AIS should be provided in a cubicle, which shall be erected inside a building. Separate Switchgear Panels for feeder & transformer of 11 kV AIS system are to be considered. Care should be taken during manufacturing of the same as the equipment like VCB & CT are to be installed in the panel individually. The 11kV side of 33/11kV Sub-station shall be of AIS switchgear irrespective of AIS / GIS Sub- Station. Hence there shall not be any Disconnecter on 11kV side Indoor Switchgear. **There shall be separate Indoor Panels (2nos.)for IVT at 11kV side.** Vibration is inevitable as mechanical operation for closing the VCB may cause problem and its performance will be affected. Foundation shall be designed to take care of the vibration and dynamic force during closing and tripping.

The circuit breakers switchgear panels to be supplied against this specification shall be required to control the LV side of 33/11 kV power transformers in the primary sub-stations and also the incoming 11kV feeders or the outgoing feeders in these sub-stations. The switchgear panels shall be suitable for 3 phase 50Hz solidly grounded neutral system and shall have normal current carrying capacity of 630 Amp & **Bus-bar shall be 1250 Amp** for Indoor Switchgear and symmetrical short circuit breaking capability as mentioned hereunder.

2.0 STANDARDS:

Except where modified by this specification, the circuit breakers and the accessories shall be designed, manufactured and tested in accordance with latest editions of the following standards.

IEC/ISO/BS	IS	Subject
IEC:56 IEC: 62271-100 & 200		High voltage alternating current circuit breakers general Requirement.
IEC:694	IS : 12729	Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000 V).
IEC:60	IS : 9135	High Voltage testing techniques.
IEC:427	IS:13516	Method of synthetic testing of HV A.C circuit breakers.
IEC: 1233		HV AC Circuit breakers- inductive load switching.
IEC: 17A/CD:474		HV AC Circuit breakers- capacitive switching.
IEC:529	IS: 13947	Degree of protection provided by enclosure.
IEC:137	IS: 2099	Insulating bushing for AC voltages above 1000V

IEC:233	IS : 5621	Hollow insulators for use in electrical equipment & testing.
IEC:273	IS: 5350	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC:815	IS: 13134	Guide for selection of insulators in respect of polluted conditions.
IEC: 34	IS : 996	AC motors
ISO:1460 BS:729	IS:2629	Hot dip galvanizing
	IS:2633	Method of testing uniformity of zinc coated articles.
	IS: 5	Colour for ready mixed paints and enamels
	IS: 6005	Code of practice for phosphating of iron and steel.
IEC: 227	IS:1554	P.V.C Insulated cables for voltages up to and including 1100 Volt.
IEC:269	IS:13703	Low voltage fuses for voltages not exceeding 1000Volt.
ISO:800	IS:1300	Phenolic moulding materials.
	IS:13118	Guide for uniform marking and identification of conductors and apparatus terminals.
IEC: 185	IS: 2705	Current transformers.
IEC: 296	IS: 335	Specification for unused insulating oil for transformer and switchgear.
IEC:186	IS: 3156	Potential transformers.

CBIP Technical Report No. 88 revised July, 1996 read with amendment issued (April, 99, September, 99 and also any other amendment thereafter): Specification for AC Static Electrical Energy Meter.

3.0 BASIC TECHNICAL REQUIREMENTS:

The Vacuum circuit breakers shall comply to E2, M2 and C2 category and are required to meet the following basic technical requirements.

(Reference standards IEC:62271 - 100 & 200 or as per latest amended IEC and associated standards listed in this specification.

Basic Technical Requirements

Sl. No	Particulars	Requirements
1	Service type	Indoor
2	No. of Poles	3
3	Nominal system voltage	11kV
4	Highest system voltage	12kV
5	Rated normal current at 50°C	
	For Bus-bar	1250A
	For Interrupter	630A
	For Outgoing Feeders/ For Incomer & Bus Sections	630A

6	Rated Internal Arc tested for 1 Sec	25kA
7	Rated short circuit making current (peak)	62.5 kA
8	Rated short time current withstand capability for 3 sec.	25kA(Panel)/25kA (Interrupter)
9.	Rated insulation level:	
	One minute power frequency withstand voltage to earth (wet and dry) rms	28kV
	Impulse withstand voltage to earth with 1.2/50 μ sec, wave of +ve and —ve polarity (Peak)	75kV
10	First — pole — to clear factor	1.5
11	Rated operating sequence (for auto reclosing)	0-0.3 Sec- CO-3 min-CO
12	Maximum break time	3 cycles
13	Rated out of phase breaking current	25% of the symmetrical short circuit breaking current
14	Maximum pole scatter	10 mili seconds
15	Rated Auxiliary supply for spring charge motor, lamp & heater circuit.	230V A.C
16	Rated supply voltage for trip/close coil	48 V D.C

4.0 SYSTEM CONDITIONS:

The breakers are to be suitable for indoor operation. Please refer chapter E3 of Technical Specification on SYSTEM conditions.

5.0 11 KV VACUUMCIRCUIT BREAKERS

5.1 GENERAL

The circuit breakers mounted on a withdrawable truck for AIS along with CT, Control & relay Panels shall be suitable for indoor installations with vacuum as interrupting media incorporating separate interrupters of 630A rating for each phase mounted on single frame. Internal Arc withstand for 11kV & 33kV VCB must be 25kA for 1 sec. **There is no line PT in the scope. Bus IVT will be in a separate Panel.** There shall be a common drive mechanism actuating for interrupters, which must work in synchronism. These shall be a common drive mechanism actuating the interrupters, which must work in synchronism. These breakers shall be provided with suitable local control while provision shall be made for remote control. All the signals going in DCS shall be through hardwire.

5.2 The entire circuit breaker with its operating mechanism shall be mounted on a **horizontal draw-out type chassis/ trolley inserted into a floor standing sheet steel(Withdrawable truck for AIS)** enclosure suitable for withstanding electromagnetic/ electro-dynamic forces of both symmetrical and asymmetrical faults. It shall have plug- in off load type isolating main and auxiliary contacts with all necessary safety features, door limit switch etc.

5.3 The Panel shall be fabricated from 2 mm thick **CRCA Sheet Steel/ Alu-Zinc** while load bearing member and cable entry plate shall be of 3mm thick. The partition /inside wall suitable for coupling with identical units on either sides to form Switch board. The circuit breaker Panel shall be such that when the withdrawable part is being removed the metal shutters can be opened with a lever, for an example to inspect the mating contacts or locked with a padlock. The upper portion (access to the Bus bar) and the lower portion (access to the termination compartment) can be unscrewed with the metal shutters closed. This makes it possible to work in the Busbar compartment with the termination compartment fully partitioned off, and vice versa. The breaker shall be provided with **three** distinct positions namely **Service, Test** and **Isolate**.

- 5.4** The circuit breakers shall be fitted with spring mechanism type. The inherent design of the circuit breakers shall be such that they shall satisfactorily perform all test duties and interrupt out-of-phase current and produce very low over voltage (**<2.5pu**) on all switching circuit, capacitive and inductive to IEC:62271 - 100 & 200 and other associated standards mentioned in the clause of this specification.
- 5.5** The **connecting terminal for Cables** shall have silver plating of at least **10** micron thickness. The design of the circuit breaker shall be such that inspection and replacement of contacts, coils, vacuum bottles and any worn or damaged components can be carried out quickly and with ease. The contact gaps shall be adjustable to allow for wear.
- 5.6** The mechanism and the connected interrupters shall satisfy the mechanical endurance requirements of IEC: 62271 - 100 & 200 or as per latest amended IEC and all additional requirements specified herein.

6.0 Interrupting media (Vacuum):

- 6.1** The vacuum bottles shall be easily replaceable on site and the mechanism shall be conveniently adjustable to permit resetting the contact gap. The current rating of the vacuum interrupters shall be 630Amp.
- 6.2** The vacuum circuit breaker poles shall be sealed to prevent contamination of the spaces surrounding the interrupters. The bidder shall demonstrate how this is achieved by supplying technical details with the bid.

7.0 Auxiliary contacts

- 7.1** Auxiliary contacts (6NO + 6NC) of 48 Volt D.C grade and 10 amps DC rating shall be provided in each circuit breaker. However, additional contact shall be made available by using contact multiplier relay/Contact multiplication relay can be used.

8.0 Indication

- 8.1** A mechanically operated circuit breaker position indicator of non-corroding material shall be provided in a location visible from the operating side of the breaker without the necessity to open the mechanism door. **The word 'OFF' in white letter on green background** shall be used to indicate that the breaker is in the opening position and the word **'ON' in white letters on a red background** to indicate that the breaker is in the closed position. The drive for the device shall be positive in both directions and provision shall be made for local and remote electrical indication.
- 8.2** Indication of spring charging condition shall be provided as mentioned in this Specification. Mechanical counters to record the number of closing operations shall be provided for each circuit breaker mechanism.

9.0 Operation and controls

- 9.1** The breaker shall normally be operated by electrical control with electrical tripping by **2 nos. Shunt trip coils**. Provision shall be made for local electrical operation and mechanical operation. There shall be a separate switch for electrical operation of the VCB.
- 9.2** The following facilities shall be provided in the circuit breaker local control cabinet:

- ON/NEUTRAL/ OFF control switch or ON and OFF push buttons. The push buttons shall be momentary contact type with rear terminal connections. The close push button shall be of **green colour** and the open push button **red colour**. There shall be a separate switch for electrical operation of the VCB.
- 9 Mechanical push to trip button shall be provided for manual tripping with front door closed in the event of failure of electrical supplies. **The device shall be accessible without opening any access doors and distinctly labeled.** It shall be shrouded and protected against inadvertent operation.
- 10 Means shall be provided for manual operation of these circuit breakers during failure of auxiliary power in addition to electrical operation.
- 9.2** Means shall be provided to prevent the mechanism from responding to a close signal when the trip coil is energized or to reclosing from a sustained close signal either opening due to a trip signal or failure to hold in the closed position.
- 9.3** The circuit breaker shall be able to perform **10,000 operating cycles** at no load in accordance with IEC:17A/474/CD for circuit breakers for auto reclosing duties.

10.0 CURRENT TRANSFORMERS

10.1 Current transformers, three per circuit breaker, shall be of indoor, single phase, resin cast and shall comply with IEC:185 and IS:2705, suitable for operation in hot and humid atmospheric conditions described in service condition. They shall be mounted inside the panel. The Class of insulation for CT's shall be **CLASS E or better. The CT/PT's shall be cast Epoxy Resin Cast type and shall be either window or wound type.**

10.2 Core

10.2.1 High grad non-ageing Cold Rolled Grain Oriented (CRGO M4 or better grade) silicon steel of low hysteresis loss and permeability shall be used for the core so as to ensure specified accuracy at both normal and over currents. The flux density shall be limited to ensure that there is no saturation during normal service.

10.2.2 The instrument security factor of the core shall be low enough so as not to cause damage to the instruments in the event of maximum short circuit current.

10.3 Windings

10.3.1 The secondary windings shall be made of electrolytic copper with suitable insulation. The conductor shall be of adequate cross-section so as to limit the temperature rise even during short circuit conditions. The insulation of windings and connections shall be free from composition liable to soften, coze, shrink or collapse during service.

10.3.2 Polarity shall be indelibly marked on each current transformer and at the lead and termination at associated terminal blocks. CTs with multi ratio winding shall be clearly tabulated to show the connections required for different ratios. Similar numbers shall be marked on terminal block arrangement and wiring diagram. Apart from the above marking and those to be provided as per IEC 185 or IS 2705, other markings shall be provided in consultation with the Owner.

10.3.3 The continuous current rating of the primary winding shall be **120%**(one hundred and twenty percent) of

the normal rated current.

10.3.4 Secondary windings of current transformers shall be used for metering, Instrumentation and protection and shall be rated for continuous current of **120%** (one hundred and twenty percent) of normal rated current of primary winding.

Current transformers shall be three core window/bar primary. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current 25 kA for 3 second. Out of three cores one Core having **0.2S class** (Metering) & other two cores having **PS** (Protection) class accuracy.

10.3.5. FEEDER PANEL:

Current Ratio: 400-200/1-1-1 Amp

No. of Cores: 03

Burden: 15 VA for each core

10.3.6 TRANSFORMER PANEL:

Current Ratio: 400-200/1-1-1 Amp

No. of Cores: 03

Burden: 15 VA for each core

11.0 Fittings and accessories

11.1 Fittings and accessories listed below shall be supplied with each current transformer:

- 11 Bimetallic connectors suitable for connecting 185-400mm² XLPE insulated Aluminium Cables.
- Two earthing terminals and strips with necessary nut, bolts and washers;
- 12 Name and rating plate;
- 13 LV terminals with connection diagram;
- 14 Mounting nuts, bolts and washers;

11.2 Any other fittings deemed essential by the Supplier shall also be supplied with each current transformer.

11.3 Basic technical requirement for CT's

Knee Point Voltage shall be 400V for both 33kV & 11kV CT.
Maximum excitation current at V_k=25mA.

Ratings: The CTs shall confirm to the following ratings and other particulars of the circuit breakers:

Technical Requirements

Sl. No	Particulars	Requirements
1	Function	To control 11 kV Feeder & LV side of 33/11kV power transformers of ratings between 3.15MVA to 12.5MVA

2	Requirement	The CTs in the 11 kV Indoor VCB switchgear panel should have three cores as follows.	
3	Transformation Ratio	Category- A (For TFR) 400 - 200/1-1-1-A	Category-B (For Feeder) 400-200/1-1-1 A
4	Rated Burden (VA)	Core:1: 15 VA , Core:2: 15 VA, Core:3:15 VA	Core:1: 15 VA , Core:2: 15 VA, Core:3:15 VA
5	Class of Accuracy	Core:1: 0.2S , Core:2: PS, Core:3: PS	Core:1: 0.2S , Core:2: PS, Core:3: PS
6	Instrument Security Factor	Core- 1:- <5	Core- 1:- <5
7	Purpose	Core:1: Metering , Core:2: Differential, Core:3:O/C& E/F & REF	Core:1: Metering , Core:2: Spare Core:3:O/C& E/F & REF
8	Rated/Highest system Voltage	11/12 kV	
9	Short Time Rating	25 kA rms for 3 seconds	
10	Power frequency 1 min voltage withstand level/ Insulation Level: -Impulse Voltage1.2/50 µs wave withstand level -	28 kV/75kVp	

120 Tests

121 The CTs shall be tested in accordance with the requirements of the type tests and routine tests as per the latest issues IEC:185 or IS:2705.

The tests to be conducted shall include:

122 Type Tests:

- 5 Lightning impulse voltage;
- 4 Power frequency wet withstand voltage;
- 5 Temperature rise;
- 6 Short time current;
- 7 Composite error;
- 8 Accuracy test (for measuring core);
- 9 Instrument security current (for measuring core);

123 Routine tests

- 3 Verification of terminal marking and polarity;
- 4 Power frequency dry withstand test on primary windings

- 5 Power frequency dry withstand test on secondary windings
- 6 Power frequency dry withstand test between sections;
- 7 Over voltage inter-turn test;
- 8 Composite error;
- 9 Turn ratio;
- 10 Accuracy test (for measuring core);
- 11 Current error and phase displacement (for protection core);
- 12 Knee point voltage and magnetizing current test (for PS class);
- 13 Secondary winding resistance (for PS class).

Routine test of brought out equipment shall be carried out by the respective Vendor in presence of the Owners(OPTCL) representative.

13.0 POTENTIAL TRANSFORMER

13.1 BASIC TECHNICAL REQUIREMENTS**

The 11 kV Indoor voltage transformers(**IVT**) are required to meet the following basic technical requirements (Reference standards: IEC:186, IS:3156 and associated standards listed in the specification):

Sl. No	Particulars	Requirements
1	Type	Single phase
2	Nominal system voltage, phase to phase	11 kV
3	Application	Instrumentation, Metering and Protection
4	Number of secondary windings	2
5	Rated normal burden*	15VA for each Core
6	Rated primary voltage	11000/√3
7	Rated secondary voltage	110V/√3-110V/√3
8	Class of accuracy	0.2/3P
9	Rated insulation level: (Primary winding)	
	i) One minute power frequency withstand	28kV
	ii) Impulse withstand voltage to earth with 1.2/50	75kV
10	One minute power frequency withstand	
	i) Between phase to earth	3kV
	ii) Between sections	3kV
11	Rated voltage factor	
	i) Continuous	1.2
	ii) For 30 seconds	1.5

* The burden indicated is the minimum acceptable to the Owner. The Contractor shall ensure that the rated outputs of the voltage transformers are adequate to meet at least 120 percent of the connected load (burden).

****There is no line PT. Bus IVT (PT) will be in separate panel. Burden will be 15VA for each Core.**

13.2 GENERAL

The voltage transformers to be supplied under this specification shall be of Indoor, single phase **Epoxy Resin Cast type** complying with IEC:185 and IS:3156 suitable for operation in hot and humid atmospheric conditions described in this document.

13.3 Duty requirement

- 13.3.1** 11 kV Voltage transformer for all the indicating instruments and measuring meters in the primary substation on 11kV side. It shall be of indoor, **1-Phase or 3- phase Epoxy Resin Cast type**.

13.4 Core

- 13.4.1** High grade non-ageing Cold Rolled Grain Oriented (CRGO-M4 or better) silicone steel of low hysteresis loss and permeability shall be used for core so as to ensure accuracy at both normal and or over Voltages. The flux density shall be limited to **1.6 Tesla** at normal voltage and frequency. There shall be no saturation at any stage during operation.
- 13.4.2** The instrument security factor of the core shall be low enough so as not to cause damage to the instruments in the event of maximum short circuit current or over voltages.

13.5 Windings

- 13.5.1** The primary and secondary windings shall be electrolytic copper of high purity and conductivity and covered with double paper insulation or super enamel coating. The conductor shall be of adequate cross-section so as to limit the temperature rise even during maximum over voltages.
- 13.5.2** The insulation of windings and connections shall be free from composition liable to soften, ooze, shrink or collapse during service.
- 13.5.3** The secondary windings of the voltage transformers shall also be suitable for continuous over voltage corresponding to the maximum system voltage at the primary winding. The winding supports shall be suitably reinforced to withstand normal handling and the thermal and dynamic stresses during operation without damage.
- 13.5.4** The voltage transformer secondary circuits will be taken out to form the star point and earthed at one point outside the voltage transformers.
- 13.5.5** Both primary and secondary winding terminals shall be clearly and indelibly marked to show polarity in accordance with IEC:186. The connections required for different secondary windings in case of multi-winding voltage transformers shall be clearly indicated in terminal blocks and the wiring diagrams.

14.0 Fitting and Accessories

- 14.1** Fittings and accessories listed below shall be supplied with each voltage transformer:

6 HV terminals

- Two earthing terminals with necessary nuts, bolts and washers
- Name and rating plate
- Secondary terminal box with LV terminal connections
- Mounting nuts, bolts and washers

- LV HRC cartridge fuses for the protection of secondary winding
- HV HRC cartridge fuses for the protection of Primary winding

14.2 Any other fitting deemed essential by the contractor shall also be supplied along with each voltage transformer:

14.3 The name and rating plate shall contain all the particulars as provided in IEC:186 and also the name of the Owner and year of manufacture. They shall comply with the clause termed label in this specification.

15.0 Fuse protection

The Primary winding shall be protected by HRC Fuses in suitable holder designed by the manufacturers.

15.1 The secondary windings shall be protected by HRC cartridge fuses in fuse holder consisting of carriers and bases. The carriers and bases shall be of high grade flame retarding and non-hygroscopic moulded insulating materials with hard glass surface. Each fuse shall be identified with engraved plastic label.

16.0 Circuit diagram

16.1 A durable copy of the circuit wiring diagram shall be affixed to the inner side of the terminal box cover. Labels shall be provided inside the cover to describe the functions of various items of equipment.

17.0 TERMINATION

17.1 The equipment shall be supplied with HV electrical connection terminals of a size and rating appropriate for all the duties, including overload duty specified for the equipment. The terminals shall be of the bi-metallic type.

18.0 EARTHING TERMINAL

18.1 Two earthing terminals complete with necessary hardware shall be provided on each voltage transformer for connection to earth continuity conductors. They shall be of electroplated brass and of adequate size to carry the earth fault current.

18.2 The earthing terminals shall be identified by means of appropriate symbol marked in a legible and indelible manner adjacent to the terminals.

19.0 TEST AND INSPECTIONS

19.1 The voltage transformers shall be tested in accordance with the requirements of the Type tests and Routine tests as provided in the latest issues of IEC:186 or IS:3516.

Type tested equipment/materials are acceptable. Type tests should have been conducted in last five years. The Type Test must have been as per OPTCL requirement. If OPTCL desires another type test, it has to be conducted. In such case OPTCL will bear the transportation of equipment/material and type test charges.

The tests to be conducted shall include;

19.2 Type tests:

- Lightning impulse voltage test
- High voltage power frequency wet withstand voltage
- Temperature rise test
- Short circuit withstand capability test
- Determination of limits of voltage error and phase displacement

19.3 Routine tests:

- Verification of terminal marking and polarity
- Power frequency withstand tests on primary winding
- Power frequency dry withstand tests on secondary winding
- Power frequency withstand tests between sections
- Determination of limits of voltage errors and phase displacement
- Insulating Resistance measurement
- Partial discharge measurement

19.4 TEMPERATURE RISE:

The temperature rise of any part of the voltage transformer under continuous operating and exposed in the direct rays of the sun shall not exceed the permissible limits as provided in IEC publication 186 or IS:3156. These shall not be exceeded when corrected for the difference between the ambient temperature at site and the ambient temperature specified in the standard 62271-200/100, with silver plate joint. The correction proposed shall be stated in the bid.

20.0 PROTECTIVE RELAY & CONTROL PANEL

20.1 The CR Panel (Instrument Chamber) should be mounted on top of the VCB Panel.

Control Panel (**in-built**) with protective relay and meter shall be provided by the supplier suitable for above breakers. The equipment shall have protection scheme with the following relays:

- (i) Triple pole IDMTL type combined over current (3Nos) & Earth fault (1No) relay (Draw out type) preferably Communicable numerical relay of reputed make with supporting Protocol IEC:61850 and that should be type tested with IEC protocol 61850.

The detailed Specification are as indicated in 33 kV Indoor Switchgear Panel (SINo. 14)

21.0 MULTIFUNCTION METER**GENERAL**

Multifunction Meter will be installed on the top of the Switchgear Panel.

- *. Each bay should be provided with a Multifunction meter having following features:-
- * Features: By level monitoring of all electrical parameters of V,I, Φ , $\cos\Phi$,Hz,kVA,kVAR,kW&kWH.True RMS measurement
- * Accuracy: 0.2s.
- * User selectable display ranges. (CT/PT).
- * Auto scrolling/Manual display
- * RS 485 communication port with MODBUS RTU protocol.Compatible for data logging & SCADA application.
- * Inbuilt Real time clock with calendar.
- * 3phase,4 wire,3 element or as per requirement.(to be decided during detail Engineering).
- *. Quadrant of operation: 04 Quadrant.

- *. Display: Bright red 7-segment LED display.
- *. HMI: Through Front panel tactile keys.
- *. Indication: Phase voltage, Phase current ,Line voltage, Frequency, Power factor, kVA,kVAR,kW,kVAH,kVARH,kWH.
- *. Voltage input: 63.5/110V
- *. Current Input: 1 A
- *. Auxiliary supply: 85-250 V AC or 48 V DC
- *. VA burden: 15VA
- *. Frequency Range: 45 to 55 Hz
- *. Power factor range: 0.1 lag -1 -0.1 lead
- *. Over voltage: 130% continuously & 200% for 30 sec.
- *. Over current: 2 times continuous, 20 times for 1 sec.
- *. Response time: 200 ms
- *. Class of accuracy: 0.2s as per IEC 60687, IS 14697
- *. Complies to EMI: IEC 61000-4-5,3,4
- *. Display resolution: upto 1 decimal
- *.Output: Two communication port with optical isolation.RS 485 communication port with MODBUS RTU protocol.
- *.CT shorting provision should be there.
- *.Mounting: Flush panel mounting.
- *. Dimensions:144X144 mm
- *.Ambient condition: working: 0-55 deg cent,5-95% RH

N.B – 1no optical and 1no RS 485 communicating on MODBUS protocol is also acceptable.

21.1

(a) A flag operated Master trip relay should be provided (48 V DC with N/C contact in series with the relay coil): Electromechanical relay having sufficient output contact (N/O & N/C) should be available for interlock, indication & other SCADA purpose.

(b) Other electromechanical auxiliary relays as required as per the scheme to be provided.

(for contact multiplication, Transformer trouble shooting like Oil temp alarm& trip, Winding temp alarm& Trip, Bucholtz Alarm & Trip, MOG alarm, PRV Trip etc)

(c) A 12 Window static annunciator with Test, Accept & Reset arrangement and with Buzzer & Bell.

(i) Test terminal Blocks- Test terminal Block need be provided for testing meters in test position.

- | | |
|--------------------------------------|---|
| e) Indication Lamp(48 V DC LED type) | Red- Breaker 'ON'
Green- Breaker 'OFF'
Amber- Breaker 'AUTO TRIP'
Blue- Spring charge indication.
White- Healthy Trip illuminated push bottom switch |
|--------------------------------------|---|

21.2 In Built Control- Relay Panel in the In Door VCB (Mounted on the Top of VCB Panel)

220 Panel wiring and accessories.

221 Wiring

Each panel shall be supplied with all internal wiring complete.

222 Panel wiring shall be suitably bunched and clamp for neat appearance. The conductors used for wiring purpose shall be **PVC** insulated 1100 volt grade semi-flexible heat resistant, flame retardant and vermin proof electrolytic copper cable conforming to IEC:227, 502 or IS:1554. The wiring shall be securely supported and taken though PVC through PVC. Each wire shall be continuous from end to end without any joint in between. All panel wiring shall be capable of withstanding a voltage of 2kV AC 50Hz for one minute.

223 Cable and wire for connections within the switchgear and between the switchgear and terminal blocks shall have a minimum temperature rating of 90 degree Celsius. The size of the conductors for panel wiring shall not be less than 2.5mm². For CT secondary wiring, two such wires shall be used in parallel. CT, PT & all other control wiring shall be 2.5 Sq mm.

224 Panel wiring protection

The panels shall be equipped with links and HRC cartridge fuses conforming to IEC:269 or IS:13703 in 1100 Volt grade phenolic moulded fuse holder consisting of fuse carrier and base or miniature circuit breakers confirming to IEC:947-2 or IS:13947-2 at appropriate locations. The carriers and bases shall be made of high grade flame retardant and non hygroscopic phenolic moulded material with hard glass surface. Each fuse or MCB shall be identified with engraved plastic label.

225 In general, fuses and MCBs shall be limited to the minimum required for safety. The protection scheme shall include fuses for VT secondary circuits and DC supply to each panel and fuses for MCB for spring charging motor and incoming AC supply.

23.0 Terminal blocks

23.1 Terminal blocks of brass studs rated for 10 amps continuous current, 1100 volt DC grade covered by moulded insulating materials with adequate electrical clearances shall be provided for terminating the panel wiring and outgoing connections. The termination shall be made by crimping lugs or bare conductor with insulating sleeves at ends. The arrangement can be horizontal or vertical as per standard practice adopted by the manufacturer. All terminals must be numbered and wire termination provided with numbered ferrules for identification. All numbering and marking including those in wiring diagram shall follow the guidelines provided in IS:11353. All circuit breaker auxiliary contacts including spare contacts shall be wired to the terminal blocks. **10%** (Ten percent) spare terminals shall be provided.

24.0 Colour and numbering

The wiring used for 230V AC supply for illumination lamp, panel heater and other devices shall be coloured. The colour of wires connecting directly to Earth shall be **green**. CT & PT connection wires shall be of **R, Y & B colour**.

24.1 Engraved core identification plastic ferrules marked to correspond with the panel wiring diagram shall be fixed at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from the terminal block. **Number 6 and 9, if used shall be under scored to enable differentiation.**

25.0 Circuit diagram

26.1 A durable copy of the circuit wiring diagram shall be affixed to the inner side of the door of the switchgear compartment. Labels shall be provided inside the compartment to describe the functions of the various items of equipment.

26.2 The scope of the supply shall include the panel mounting foundation bolts, nuts and washers necessary for making the supporting.

26.0 OPERATING MECHANISM

26.1 General

26.1.1 The operating mechanism of the circuit breaker shall be motor wound spring charged type. It shall be electrically and mechanically trip free with anti pumping device (as per IEC:694 definition). All working parts in the mechanism shall be of corrosion resistant material. Self lubricating, wearing resistant bearings shall be provided in the mechanism.

26.1.2 The mechanism shall fully close the circuit breaker and sustain it in the closed position against the forces of the rated making current and shall fully open the circuit breaker without undue contact bounce at a speed commensurate with that shown by tests to be necessary to achieve the rated breaking capacity in accordance with IEC:56 or IS:13118. The mechanism shall be capable of being locked in either the open or closed position. The mechanism shall be capable of fully closing and opening again after the auto-reclose time interval specified as 0.3 second in this specification.

26.2 Spring mechanism (In case of Spring Charged VCB)

26.2.1 The spring operating mechanism shall be with spring charging motor, opening and closing springs with limit switches and all accessories necessary for automatic charging. In normal operation, recharging of the operating springs shall commence immediately and automatically upon completion of the closing operation so that a complete sequence of closing and opening operation should be possible.

26.2.2 It shall be possible to hand charge the operating spring with the circuit breaker in either the open or closed position conveniently from the ground level. Closure whilst a spring charging operation is in progress shall be prevented and release of the springs shall not be possible until they are fully charged.

26.2.3 The state of charge of the operating springs shall be indicated by a mechanical device showing '**SPRING CHARGED**' when closing spring is fully charged and operation is permissible and '**SPRING FREE**' when closing spring is not fully charged and the operation is not possible. Provision shall be made for remote electrical indication of 'Spring Charged' and 'Spring Free' conditions.

26.2.4 The operating mechanism shall be such that the failure of any auxiliary spring shall not cause tripping or closing the circuit breaker but shall not prevent tripping against trip command.

26.2.5 Closing action of the circuit breaker shall charge the opening spring ready for tripping. From the close position with spring charged, one open-close-open operation shall be possible without recharging the spring.

26.3 Motor

The motor for spring charging shall be single phase 230 Volt A. C motor. Continuous motor

rating shall be at least ten percent above the maximum load demand of the driven equipment. It shall remain within its rated capacity at all operating points that will arise in service. It shall be protected by MCB. The motor shall comply with IEC:34 or IS:996.

26.4 AUXILIARY POWER SUPPLY

26.4.1 The operating mechanism shall be suitable to operate with the following auxiliary power supplies.

- a) 230V,50Hz Single phase- For spring charging motor AC
- b) DC supply 48 Volts- For close and open coils.

26.5 The DC supply shall be from **Battery Bank**

26.6 The mechanism shall be designed to operate satisfactorily despite fluctuations of auxiliary power supplies as under:

AC supply: Voltage From 85% to 115% of normal voltage
 Frequency variation From -5% to +3% in variation

DC supply: Voltage for voltage variation of Tripping : 70% - 110%
 Voltage variation of Closing : 85% - 110%

26.7 Temperature Rise test:

The temperature rise and the maximum temperature of any part of the circuit breaker under continuous load condition and exposed in the direct rays of the sun shall not exceed the permissible limits as provided in Table V of IEC publication 694 or table 4 of IS:12729. These limits shall not be exceeded when corrected for the difference between the ambient temperature at site and the ambient temperature specified in the standard. The correction proposed shall be stated in the tender.

27.0 TESTS

27.1 Type test and Routine test

The circuit breakers shall be subjected to routine and type tests in accordance with the standards listed in this specification including the following IEC and IS standards with the latest amendments:

- Circuit breaker IEC:62271 - 100 & 200 and relevant other standards
- Porcelain insulator IEC:233 and IS:5621 and relevant other standards

The tests shall include but not limited to the following:

27.2 Short circuit tests

The circuit breaker shall satisfactorily perform the out of phase and short circuit duties specified in **IEC: 62271-100 & 200**, IEC: 17 A(Sect.) 438 and IEC:17A/CD/474 and IS:13516.

The circuit breaker shall be capable of performing at least twenty five (25) open operations at the rated

short circuit current before maintenance or inspection is required.

27.3 Dielectric tests

At zero gauge loss of vacuum inside the interrupter chamber, the open contacts shall withstand continuously, the rated phase to ground voltage and it shall be possible to break normal current in these conditions. During the dielectric type tests, no flashover external or internal shall be acceptable.

The circuit breakers shall be subjected to a power frequency AC voltage test for one minute in dry and wet conditions and there shall be no external flash over to earth.

27.4 Mechanical endurance

In addition to the requirements of IEC:56, an extended mechanical endurance test is required to show that the circuit breaker is capable of at least 10,000 operations at no load in accordance with IEC:17A/474/CD or as per latest amended IEC. Between the specified test series in IEC:17A/474/CD, some maintenance such as lubrication and mechanical adjustment is allowed and shall be performed in accordance with manufacturer's instructions. Change of contracts is not permitted.

27.5 Duty requirement tests

Apart from auto-reclosing and the other duties mentioned above, the breakers shall be able to perform the following duties for which type tests are to be conducted as per IEC:56 or IS:13118.

1. Breaking the steady and the transient magnetising current of the transformer.
2. Breaking 25% of rated fault current at twice the rated voltage as per IEC/IS.
3. Cable charging breaking current.
4. Single capacitor bank breaking current.
5. Capacitor bank in rush making current.

Test for the resistance of the main circuit shall also be conducted.

27.6 Temperature rise test

Temperature rise test is to be conducted on the circuit breaker and the accessories in accordance with **IEC:62271-100 & 200 or latest amended IEC**. The temperature rise shall be limited as per this specification.

28.0 PERFORMANCE REQUIREMENTS

The supplier shall declare the circuit breaker opening and closing times at 120 percent, 100 percent and 70 per cent of the rated voltage of the opening and closing devices when measured at the terminals of the trip and closing coils. The minimum make break time at rated voltage and total break time of the CB shall be stated. The total break time must not exceed 60ms.

29.0 EARTHING

- 29.1 All metal parts not intended for carrying current or not alive shall be connected to duplicate earthing system and suitable electroplated brass earthing terminals shall be provided on each circuit breaker in

conformity with **IEC:62271-100 & 200**. Suitable identification mark for the earth terminals shall be provided adjacent to the terminal.

29.2 The size of the earth continuity conductor shall be large enough to reduce the potential rise of the metal frame of the breaker in the even of fault to minimum but in any case not more than 10V. The size of the conductor shall also be adequate to restrict the temperature rise without causing any damage to the earth connection in the case of fault. No riveted joints in the earth conducting path shall be permissible and only bolted joints of adequate size shall be provided with nuts, bolts and plain spring washers. The surfaces to be jointed shall be perfectly flat without any unevenness to ensure that there is no contact resistance.

29.3 An earth busbar of copper strip shall be provided inside the local control cabinet to which all earthing connections must be made. The earth busbar shall be terminated into two electroplated brass earthing terminals of adequate size with nuts, bolts and washers for connecting to earth continuity conductor mentioned above.

30.0 QUALIFYING REQUIREMENT.

The equipment offered shall be procured from short listed Vendor at E-23 and shall have been successfully Type Tested during last five years on the date of bid opening. The **front page** of the Type Test report showing the evidences of the tests, duly signed by the bidder shall be uploaded alongwith the bid.

The following Type tests of VCB should have been done:

- 1) Short Time withstand current
- 2) Temperature Rise
- 3) Lightning Impluse Test
- 4) Internal Arc Test
- 5) Make & Break Test duties
- 6) Power frequency voltage test
- 7) Partial discharge test,
- 8) Resistance measurement test
- 9) Tightness test
- 10)Closing characteristic test
- 11) Opening Characteristic tests

The VCB shall be of **M2, C2 & E2 duty class**.

71. Provision for Grouting/Support for HT & LT Lines

33kV Lines

Support foundation:

Cement concrete in mixture 1 part cement, 3-part coarse sand, 6 part 40mm size aggregate stone chips (1:3:6) shall be used in all the types of 33 kV line supports.

While erecting supports (poles), shuttering must be used for concreting so that proper quantity of cement concrete mixture be used and assessed during inspection. During concreting proper compaction by means of mobile vibrator be provided. While starting work of support erection, gang wise shuttering and mobile vibrator shall be offered for inspection to Project Manager. While erecting support, mercury level gauge must be used to ensure vertical erection of support.

250mm dia X 12” inch size muffing shall be provided on steel tubular and H-Beam poles to prevent direct entry of rainwater along the poles. Cement Concrete of 1:2:4 (1 part Cement, 2 parts coarse sand and 4 parts 20mm aggregate stones chips) shall be used for individual poles.

Steel plate shall be used in steel tubular poles and cement concrete reinforced plate shall be used as base plate for PCC poles.

11kV Lines

Support foundation:

Cement concrete in mixture 1 part cement, 3-part coarse sand, 6 part 40 mm size aggregate stone chips (1:3:6) shall be used in steel tubular poles and H-Beam 11 kV line supports.

In rural areas, PCC pole pit shall be refilled with 200 mm average size of bolder mixed with excavated earth. Proper ramming shall be performed for better compaction. All Double pole (DP), Triple pole (TP), cut point poles, Distribution Transformer substation poles and poles erected on water logging area shall be grouted using cement concrete mixture similar to H-Beam & Tubular poles. Prior approval of Project Manager shall be obtained for concreting of PCC poles in water logging area. While preparing route survey report, water logging areas shall be earmarked.

While erecting supports (poles), shuttering must be used for concreting so that proper quantity of cement concrete mixture be used and assessed during inspection. During concreting proper compaction by means of mobile vibrator be provided. While starting work of support erection, gang wise shuttering and mobile vibrator shall be offered for inspection to Project Manager. While erecting support, mercury level gauge must be used to ensure vertical erection of support.

250mm dia X 12” inch size muffing shall be provided on steel tubular and H-Beam poles to prevent direct entry of rainwater along the poles. Cement Concrete of 1:2:4 (1 part Cement, 2 parts coarse sand and 4 parts 20mm aggregate stones chips) shall be used for individual poles.

Steel plate shall be used in steel tubular poles and cement concrete reinforced plate shall be used as base plate for PCC poles.

LT Lines

Support foundation:

Cement concrete in mixture 1 part cement, 3-part coarse sand, 6 part 40 mm size aggregate stone chips (1:3:6) shall be used in steel tubular poles and H-Beam LT line supports.

In rural areas, PCC pole pit shall be refilled with 200 mm average size of bolder mixed with excavated earth. Proper ramming shall be performed for better compaction. PCC pole at cut point and PCC poles erected on water logging area shall be grouted using cement concrete mixture similar to H-Beam & Tubular poles. Prior approval of Project Manager shall be obtained for concreting of PCC poles in water logging area. While preparing route survey report, water logging areas shall be earmarked.

While erecting supports (poles), shuttering must be used for concreting so that proper quantity of cement concrete mixture be used and assessed during inspection. During concreting proper compaction by means of mobile vibrator be provided. While starting work of support erection, gang wise shuttering and mobile vibrator shall be offered for inspection to Project Manager. While erecting support, mercury level gauge must be used to ensure vertical erection of support.

250mm dia X 12” inch size muffing shall be provided on steel tubular and H-Beam poles to prevent direct entry of rain water along the poles. Cement Concrete of 1:2:4 (1 part Cement, 2 parts coarse sand and 4 parts 20mm aggregate stones chips) shall be used for individual poles.

Steel plate shall be used in steel tubular poles and cement concrete reinforced plate shall be used as base plate for PCC poles.

72. Specification for Wide Parallel Beam GI Poles 160X160mm (11Mtr & 13Mtr)

1. Wide Parallel Beam GI Poles (160x160 mm) – 30.44kg per meter

1.1. Scope:

This specification covers design, manufacture, testing and supply of 160mm x 160mm GI WPB 11 Meter. & 13 Meter long having unit weight of 30.44Kg per Meter.

1.2. Standards:

The GI WPB Pole shall comply with the requirements of latest issue of IS – 12778:2004 & IS 2062:2011 or latest amendments if any with Grade destination E350 (Tensile strength: 440N/mm²) & Quality “A” in respect of “dimension & section properties” and steel specification respectively.

1.3. Climatic Conditions:

The climatic conditions at site under which the store shall operate satisfactory, are as follows

Maximum temperature of air in shade	45°C
Maximum temperature of air in shade	0°C
Maximum temperature of air	50°C
Maximum rain fall per annum	2000mm
Maximum temperature of air in shade	45°C
Maximum ambient temperature	45°C
Maximum humidity	100%
Av. No. of thunder storm days per annum	70
% Av. No. of dust storm per annum	20
Av. Rain fall per annum	150mm

1.4. Wide Parallel Beam

- a. The Wide Parallel Beam support structures shall be fabricated from mild steel, grade A and in lengths dictated by design parameters. The WPB, may include, but shall not be limited to the following sizes:

1.5. Dimensions and Properties:

Sl No.	General Technical Particulars	WPB 160 x 160 mm X 30.44Kg	To be filled by Bidder
1	Length of Joist in Mtr with +100mm/- 0% Tolerance	13 mtr 11Mtr	
2	Weight in kg/m with $\pm 2.5\%$ Tolerance	30.44 Kg/ Mtr.	
3	Sectional Area (cm ²)	38.8	
4	Depth(D) of Section (mm) With +3.0mm/ - 3.0mm Tolerance a	152mm	
5	Width(B) of Flange(mm) $\pm 0.7\text{mm}$ Tolerance	160mm	
6	Thickness of Flange (Tf) (mm) with ± 1.5 mm Tolerance	9	
7	Thickness of Web(Tw) (mm) with ± 1.0 mm Tolerance	6	
8	Corner Radius of fillet or root (R1) (mm)	15	
9	Corner Radius of Toe (R2) (mm)		
10	Moment of Inertia		
	Ixx (cm ⁴)	1673	
	Iyy (cm ⁴)	615.6	
11	Radius of Gyration (cm)		
	Rxx	6.57	

	Ryy	3.98	
	Modulus of Section Zxx(cm ³)		
	Zyy(cm ³)	220.1	
	Zxx(cm ³)	76.9	
	GI Base Plate in mm	300 x 300 x 12	
	GI Stiffener Flange	150 x 60 x 6	
	GI Stiffener Web	150 x 100 x 6	

1.6. Mechanical properties:

Tensile Test :	Requirement as per IS:2062/ 2011 Grade-A	To be filled by Bidder
Yield Stress (Mpa)	Min 350	
Tensile Strength(Mpa)	Min 490	
Lo=(5.65 So)Elongation%	Min 22	
Bend Test	Shall not Crack	

Supplier has to supply Baseplate with dimension 300mm x 300mm x 12mm Thickness along with Stiffener 150 x60x6 & 150x 100x6. Drawing to be submitted by BA for approval.

However, In case of any discrepancy between the above data & the relevant IS, the values indicated in the IS shall prevail. The Acceptance Tests shall be carried out as per Relevant IS.

1.7. Galvanising

WPB Pole shall be hot dip galvanized, are as following:

All galvanizing shall be carried out by the hot dip process, in accordance with Specification IS 2629. However, high tensile steel nuts, bolts and spring washer shall be electro galvanized to Service Condition 4. The zinc coating (785 gms per sq.mt / 100Micron) shall be smooth, continuous and uniform. It shall be free from acid spot and shall not scale, blister or be removable by handling or packing.

There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before picking, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paints, varnish, oil, welding slag and other foreign matter completely removed. All protuberances which would affect the life of galvanizing shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard IS 2629 and shall not less than 0.785kg/mtr^2 with a minimum thickness of 100 microns.

Parts shall not be galvanized if their shapes are such that the pickling solutions cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanized unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanizing the method used for repair shall be subject to the approval of the Engineer in Charge or that of his representative.
In no case the repair of galvanization on site will be permitted.

The threads of all galvanized bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Engineer in Charge. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. To avoid the formation of white rust galvanized materials shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization. The galvanized steel shall be subjected to test as per IS-2633.

Quality of Hot Dip Galvanisation should comply with IS 2629, ISO1461 & should be guaranteed for any type of damage due to harsh climatic condition for 10Years. These poles are to be used in coastal areas of Odisha where climate is hot, humid & saline. These areas are prone to flood & frequent rainfall.

1.8. Embossing on each WPB Pole:

Following distinct non-erasable embossing is to be made on each WPB Poles to be supplied to DOSCOM under this Tender.

Name of the Owner – DISCOM B.I.S Logo (ISI Mark).

Size of the WPB Pole:

Name of manufacture: WO No & Dt.

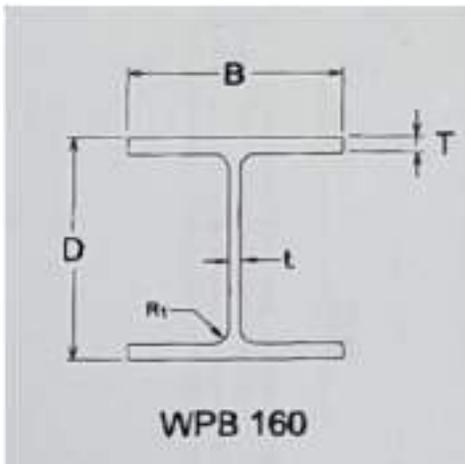
1.9. Drawing Submission and Approval

The relevant drawings and GTPs need to be submitted within two weeks of receipt of firm purchase order by the successful bidder to DISCOM for approval. In case, re-submission of drawings is required on request of DISCOM, same needs to be submitted back to DISCOM within 5 days of such request.

1.10. Guarantee Period

The Guarantee Period will be equipment/service/work specific and shall be as specified in the Standard Specifications of DISCOM for the equipment/material/service/work and where standard specifications are not part of contract documents or guarantee period is not specified in the standard specifications, the guarantee period shall be as per the Special Terms and Conditions of the Contract. In case of no mention of the guarantee period in standard specifications or SCC Guarantee Period will be 12 Months from the Date of Commissioning or 24 months from the date of delivery of final lot of supplies made, whichever is earlier.

1.11. Drawing



Section	Mass (kg/m)	Sectional Area (cm ²)	Dimensions (mm)						
			D (Depth)	B (width)	t (web thick)	T (flange thick)	Flange slope, a deg.	R ₁ Root radius	R ₂
WPB 160	30.44	38.78	152	160	6	9	-	15	-

1.12. Inspection, Dispatch, Acceptance & Testing:

a) Inspection:

The supplier shall submit their offer for inspection of materials at least 10 days before actual date of inspection proposed at their factory premises. The Inspectors duly authorized by the purchaser shall be deputed to conduct the Inspection & Testing of WPB pole at the suppliers' works before dispatch, on receipt of offer for inspection from the supplier. The purchaser at his discretion may engage a third party for above inspection. The Pre-dispatch inspection shall be carried out as per relevant ISS / Tender Specification / GTP enclosed in the Purchase Order. The supplier shall extend all necessary assistance / co-operation to the authorized inspectors of the buyers.

b) Despatch instruction:

The authorized inspectors shall furnish their Inspection Report to the undersigned for approval. On receipt of successful Pre dispatch inspection, the undersigned shall issue dispatch instruction to the supplier. On receipt of such dispatch instruction the materials shall be dispatched by the supplier to the consignee.

c) Acceptance of materials:

However the lot of materials dispatched as above shall be accepted after due physical verification at our Stores in respect to dimensions & weight as per our GTP.

d) Random testing of materials supplied after delivery / acceptance:

In case any doubt arises in the quality of materials supplied, the authority reserves the Right to take out a Sample Test Piece of the WPB Pole from a lot delivered at our Stores, for relevant tests in the Govt. approved Testing Laboratory of their choice for confirmation of the Chemical & Mechanical properties of the materials supplied as per IS. The sample test piece so collected by the authorized representative of DISCOM shall be done in presence of the authorized representative of the supplier. If the materials fail to confirm the specified tests given in the relevant IS, the entire lot of the supplied materials shall be rejected & the financial loss incurred by the purchaser as ascertained by the authority shall be recovered from the supplier.

1.13. Rejection of Materials:

In the event, any of the materials / equipment supplied by the Contractor is found defective due to faulty design, bad workmanship, bad materials used or otherwise not in conformity with the requirements of the Specification, the Purchaser shall either reject the materials / equipment or ask the Contractor in writing to rectify the same. The Contractor on receipt of such notification shall either rectify or replace the defective equipment free of cost to the Purchaser. If the Contractor fails to do so, the Purchaser may :

- a) At its option replace or rectify such defective equipment and recover the extra costs so Involved from the Contractor plus fifteen percent and / or.
- b) Terminate the contract for balance work / supplies with enforcement of penalty Clause as per contract for the undelivered goods and with forfeiture of Performance Guarantee/ Composite Bank Guarantee.
- c) Acquire the defective equipment / materials at reduced price considered equitable under the circumstances.

2. Wide Parallel Beam GI Poles (160x160 mm) – 23.84 kg per meter

2.1. Scope:

This specification covers design, manufacture, testing and supply of 160mm x 160mm GI WPB 11 Meter. & 13 Meter long having unit weight of 23.84 Kg per Meter.

2.2. Standards:

The GI WPB Pole shall comply with the requirements of latest issue of IS – 12778:2004 & IS 2062:2011 or latest amendments if any with Grade destination E350 (Tensile strength: 440N/mm²) & Quality “A” in respect of “dimension & section properties” and steel specification respectively.

2.3. Climatic Conditions:

The climatic conditions at site under which the store shall operate satisfactory, are as follows

Maximum temperature of air in shade	45°C
Maximum temperature of air in shade	0°C
Maximum temperature of air	50°C
Maximum rain fall per annum	2000mm
Maximum temperature of air in shade	45°C
Maximum ambient temperature	45°C
Maximum humidity	100%
Av. No. of thunder-storm days per annum	70
% Av. No. of dust storm per annum	20
Av. Rain fall per annum	150mm

2.4. Wide Parallel Beam

- a. The Wide Parallel Beam support structures shall be fabricated from mild steel, grade A and in lengths dictated by design parameters. The WPB, may include, but shall not be limited to the following sizes:

2.5. Dimensions and Properties:

Sl No.	General Technical Particulars	WPB 160 x 160 mm X 23.84Kg	To be filled by Bidder
1	Length of Joist in Mtr with +100mm/- 0% Tolerance	13 mtr 11Mtr	
2	Weight in kg/m with ±2.5% Tolerance	23.84 Kg./ Mtr.	
3	Sectional Area (cm ²)	30.37	

4	Depth(D) of Section (mm) with +3.0mm/ - 3.0mm Tolerance a	148mm	
5	Width(B) of Flange(mm) ± 0.7 mm Tolerance	160mm	
6	Thickness of Flange (Tf) (mm) with ± 1.5 mm Tolerance	7	
7	Thickness of Web(Tw) (mm) with ± 1.0 mm Tolerance	4.5	
8	Corner Radius of fillet or root (R1) (mm)	15	
9	Corner Radius of Toe (R2) (mm)		
10	Moment of Inertia		
	Ixx (cm ⁴)	1282.88	
	Iyy (cm ⁴)	478.73	
11	Radius of Gyration (cm)		
	Rxx	6.50	

Sl No.	General Technical Particulars	WPB 160 x 160 mm X 23.84Kg	To be filled by Bidder
	Ryy	3.97	
	Modulus of Section Zxx(cm3)		
	Zyy(cm3)	173.36	
	Zxx(cm3)	59.84	
	GI Base Plate in mm	300 x 300 x 12	
	GI Stiffener Flange	150 x 60 x 6	
	GI Stiffener Web	150 x 100 x 6	

Minimum Guarantee Required for materials

The bidder shall ensure that the materials supplied by them

2.6. Mechanical properties:

Tensile Test :	Requirement as per IS:2062/ 2011 Grade-A	To be filled by Bidder
Yield Stress (Mpa)	Min 350	
Tensile Strength(Mpa)	Min 490	
Lo=(5.65 So)Elongation%	Min 22	
Bend Test	Shall not Crack	

Supplier has to supply Baseplate with dimension 300mm x 300mm x 12mm Thickness along with Stiffener 150 x60x6 & 150x 100x6. Drawing to be submitted by bidder for

approval.

However, In case of any discrepancy between the above data & the relevant IS, the values indicated in the IS shall prevail. The Acceptance Tests shall be carried out as per Relevant IS.

2.7. Galvanising

WPB Pole shall be hot dip galvanized, are as following:

All galvanizing shall be carried out by the hot dip process, in accordance with Specification IS 2629. However, high tensile steel nuts, bolts and spring washer shall be electro galvanized to Service Condition 4. The zinc coating (785 gms per sq.mt / 100Micron) shall be smooth, continuous and uniform. It shall be free from acid spot and shall not scale, blister or be removable by handling or packing.

There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before picking, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paints, varnish, oil, welding slag and other foreign matter completely removed. All protuberances which would affect the life of galvanizing shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard IS 2629 and shall not less than 0.785kg/mtr^2 with a minimum thickness of 100 microns.

Parts shall not be galvanized if their shapes are such that the pickling solutions cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanized unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanizing the method used for repair shall be subject to the approval of the Engineer in Charge or that of his representative.

In no case the repair of galvanization on site will be permitted.

The threads of all galvanized bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Engineer in Charge. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one

immersion.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. To avoid the formation of white rust galvanized materials shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization. The galvanized steel shall be subjected to test as per IS-2633.

Quality of Hot Dip Galvanisation should comply with IS 2629, ISO1461 & should be guaranteed for any type of damage due to harsh climatic condition for 10Years. These poles are to be used in coastal areas of Odisha where climate is hot , humid & saline. These areas are prone to flood & frequent rainfall.

2.8. Embossing on each WPB Pole:

Following distinct non-erasable embossing is to be made on each WPB Poles to be supplied to DISCOM under this Tender.

Name of the Owner – DISCOM B.I.S Logo (ISI Mark).

Size of the WPB Pole:

Name of manufacture: WO No & Dt.

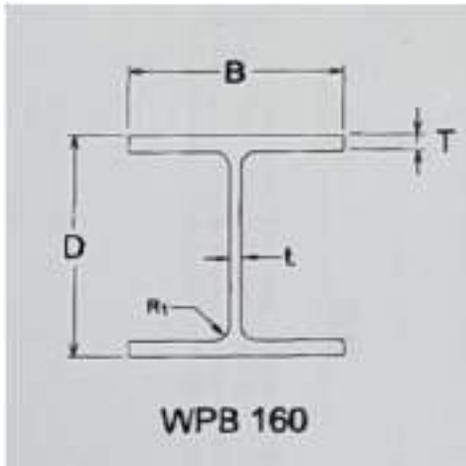
2.9. Drawing Submission and Approval

The relevant drawings and GTPs need to be submitted within two weeks of receipt of firm purchase order by the successful bidder to DISCOM for approval. In case, re-submission of drawings is required on request of DISCOM, same needs to be submitted back to DISCOM within 5 days of such request.

2.10. Guarantee Period

The Guarantee Period will be equipment/service/work specific and shall be as specified in the Standard Specifications of DISCOM for the equipment/material/service/work and where standard specifications are not part of contract documents or guarantee period is not specified in the standard specifications, the guarantee period shall be as per the Special Terms and Conditions of the Contract. In case of no mention of the guarantee period in standard specifications or SCC Guarantee Period will be 12 Months from the Date of Commissioning or 24 months from the date of delivery of final lot of supplies made, whichever is earlier.

2.11. Drawing



Section	Mass (kg/m)	Sectional Area (cm ²)	Dimensions (mm)						
			D (Depth)	B (width)	t (web thick)	T (flange thick)	Flange slope, a deg.	R ₁ Root radius	R ₂
WPB 160	23.84	30.37	148	160	4.5	7	-	15	-

72. Minimum Guarantee/Warranty Required for supplied Materials

Notwithstanding any of the specifications above, the minimum Guarantee/Warranty requirement for major materials shall be as per below table:

Sr. No.	Material	Guarantee / Warranty
1	Power Transformers	120 months from Commissioning
2	Single Phase Oil Immersed Distribution Transformers (Outdoor Type)	60 months from Commissioning
3	3-Phase Distribution Transformers 11 kV/433-250V (Outdoor Type), 630 KVA, 400 KVA and 250 KVA	72 months from Commissioning
4	3-Phase Distribution Transformers 11 kV/433-250V (Outdoor Type), 100 KVA & below	60 months from Commissioning
5	11 & 33 KV Outdoor Type Current Transformer	36 months from Commissioning
6	33 & 11 kV Outdoor Type Potential Transformer	36 months from Commissioning
7	11 kV AND 33 kV Vacuum Circuit Breakers	36 months from Commissioning
8	11 kV 350MVA 1250 AMP VCB Switchgear Panels (MC VCB) – Indoor	36 months from Commissioning
9	Batteries and Charger	36 months from Commissioning
10	LT upto (1100 V) XLPE Insulated	36 months from Commissioning
11	LT Aerial Bunched Cables	36 months from Commissioning
12	XLPE Power Cables (11kV & 33 kV)	36 months from Commissioning
13	DT Capacitor	60 months from Commissioning
14	12 KV Capacitor Bank	60 months from Commissioning
15	33 KV & 11 KV 3/4/5 Way RMU	60 months from Commissioning
16	RTU and FRTU	60 months from Commissioning
17	Cable Jointing Kit	36 months from Commissioning

- **For 5 MVA/10 MVA/20 MVA or above Power Transformers:**

The material will be guaranteed for a period of at least 120 calendar months from the date of installation at the site or 126 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the "maintenance period." If the material is damaged within the guarantee period, it shall be replaced/repared by the supplier free of cost within three months of receipt of intimation.

If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 12 months. The total guarantee period will now be 132/138 months as applicable."

Both stage and final inspection of 100 percent repaired transformer will be carried out at the manufacturer's works.

In case, the repair work/replacement of transformer is not affected within six months of the above notice/intimation, the consignees will ensure deduction of the amount equal to the price of new transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

The outage period i.e., period from the date of failure till unit is repaired/replaced shall not be counted for arriving at the guarantee period.

In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

Further, installation of 100 percent Power Transformers (both new and repaired) shall be carried out in the supervision of manufacturer's representative.

For 250 KVA, 400 KVA, 630 KVA Distribution Transformer.

The material will be guaranteed for a period of at least 72 calendar months from the date of installation at the site or 78 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the "maintenance period." If the material is damaged within the guarantee period, it shall be replaced/repared by the supplier free of cost within one month of receipt of intimation.

If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 12 months. The total guarantee period will now be 84/90 months as applicable."

Both stage and final inspection of at least 30-50 percent of the quantity of repaired transformer will be carried out at the manufacturer's works/local repairing center. The manufacturer has to inform the address of the local repairer in advance.

In case, the repair work/replacement of transformer is not effected within three months of the above notice/intimation the consignees will ensure deduction of the amount equal to the price of new

transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

The outage period i.e., period from the date of failure till unit is repaired/replaced shall not be counted for arriving at the guarantee period.

In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

Further, installation of 20 percent Distribution Transformers (both new and repaired) shall be carried out in the supervision of manufacturer's representative.

- **For Distribution Transformers 100 KVA & below :**

The material will be guaranteed for a period of at least 60 calendar months from the date of installation at the site or 66 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the "maintenance period." If the material is damaged within the guaranteed period, it shall be replaced/repared by the supplier free of cost within one month of receipt of intimation.

If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 24 months. The total guarantee period will now be 84/90 months as applicable."

Both stage and final inspection of at least 10-20 percent of the quantity of repaired transformer will be carried out at the manufacturer's works/local repairing center. The manufacturer has to inform the address of the local repairer in advance.

In case, the repair work/replacement of transformer is not effected within three months of the above notice/intimation the consignees will ensure deduction of the amount equal to the price of new transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

The outage period i.e., period from the date of failure till unit is repaired/replaced shall not be counted for arriving at the guarantee period.

In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

Further, installation of 10 percent Distribution Transformers (both new and repaired) shall be carried out in the supervision of manufacturer's representative.

73. Letters for Amendment in Technical Specification

The bidder shall ensure that due attention has been given in supply of materials and erection works as per latest amendments issued by REC from time to time. Some amendment letters are attached herewith for reference of the bidder.



रुल इलेक्ट्रिफिकेशन कारपोरेशन लिमिटेड

Rural Electrification Corporation Limited

(भारत सरकार का उद्योग) / **A Government of India Enterprise**

Regd. Office: Core-4 SCOPE Complex, 7, Lodhi Road, New Delhi 110 003

Tel: 011-24369851 FAX: 011-24369850, Email:- ddugjyquality@gmail.com

CIN: L40101DL1969GO1005095 Website: www.recindia.nic.in

Ref. No. REC/DDUGJY/SBD/ 749.

Dated: 27-07-2016

To
All Project Implementing Agencies
(DISCOMs/SEBs/CPSUs/Power Departments)
RE-DDUGJY Projects

Sub: Amendment in Technical Specification of 11 kV Composite Insulators -reg

Sir/Madam,

This has reference to the Standard Bidding Document Vol -III Section-I Technical Specification of 11 kV Composite Insulators to be used under DDUGJY scheme. The clause no. 5 of technical specification has been amended which is as here under:

Existing Provision in the Clause	Amended Clause
The minimum shed diameter for long rod insulator should be 100 mm	The minimum shed diameter for long rod insulator should be between 75-100 mm

This is for kind information please.

Yours sincerely,

(G S Bhati)

General Manager (DDUGJY)

Copy to:
ZM/CPM- Please circulate to PIAs in the states of your purview.

Zonal Offices : Hyderabad, Kolkata, Mumbai, Panchkula & Lucknow
Project Offices : Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu, Patna, Ranchi, Shillong, Shimla, Thiruvananthapuram & Vadodara
Sub Offices : Dehradun, Raipur
Training Centre : Central Institute for Rural Electrification (CIRE), Hyderabad





रूरल इलेक्ट्रीफिकेशन कारपोरेशन लिमिटेड
Rural Electrification Corporation Limited

(भारत सरकार का उद्यम) / (A Government of India Enterprise)
 Regd. Office: Core-4, SCOPE Complex, 7 Lodi Road, New Delhi 110 003
 Tel: +91-11-4102 0101 Fax: +91. 11.2436 0644 E-mail: recocorp@recindia.nic.in
 CIN : L40101DL1989GO0005095 Website: www.recindia.nic.in

Ref. No. REC/DDUGJY/SBD/११०

Dated: 05-08-2016

To
 All Project Implementing Agencies
 (DISCOMs/SEBs/CPSUs/Power Departments)
 RE-DDUGJY Projects

Sub: Amendment in Technical Specification of Piercing Connector -reg

Sir/Madam,

This has reference to the technical Specification of Piercing Connector to be used under RE-DDUGJY (erstwhile RGGVY) XII Plan & DDUGJY schemes. The clause no. 5.4.1 of technical specification which shall constitute Acceptance Tests for Insulation Piercing Connectors (IPC) has been amended which is as here under:

Existing Provision in the Clause	Amended Clause
<ul style="list-style-type: none"> • Visual • Dimensional (as per SCD and overall dimensions submitted with Tender Offer) • Electrical Ageing Test • Dielectric and Water Tightness Test. • Mechanical Tightening Test • Effect of Tightening on Main Core • Effect of Tightening on Branch Core 	<ul style="list-style-type: none"> • Visual • Dimensional (as per SCD and overall dimensions submitted with Tender Offer) • Dielectric and Water Tightness Test. • Mechanical Tightening Test • Effect of Tightening on Main Core • Effect of Tightening on Branch Core

This is for kind information please.

Yours sincerely,

(G S Bhat)

Executive Director (DDUGJY)

Copy to:

1. ZM/CPM- Please circulate to PIAs in the states of your purview.

Zonal Offices : Hyderabad, Kolkata, Mumbai, Ranchi & Lucknow
Project Offices : Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu Patna, Ranchi, Shilong, Shimla, Thiruvananthapuram & Vadodara
Sub Offices : Dehradun, Raipur
Training Centre : Central Institute for Rural Electrification (CIRES), Hyderabad



No. REC/DDUGJY/SBD/DTR-TS/ 469

Dated: 29.09.2016

To,

All PIAs /DISCOMs/Power Deptt.

Subject: Methodology of Loss Capitalisation in Technical Specification of Distribution Transformer under DDUGJY -reg.

Dear Ma'M / Sir,

Ministry of Power vide OM No 44/15/2015 dated 14.08.2015 had formed two committees viz. Committee 'A' & 'B' to facilitate and handhold states in mobilizing major materials with Standard Technical Specifications at competitive prices through a transparent bidding process under DDUGJY / IPDS Schemes. Committee A had identified the major high value items viz., Power Transformers, Distribution Transformers, Conductor, AB Cables & Energy Meter, finalized their Technical Specification and aggregated the quantity.

During the meeting held on June 29, 2016 under the Chairmanship of Hon'ble MoS (IC) for Power, Coal and New & Renewable Energy, it was decided that states are free to procure the materials on their own, if it is felt that their rates are lower than CPP rates. Accordingly, REC vide letter no. REC/DDUGJY/NIMM/745 dated 26.07.2016 (copy enclosed) allowed full turnkey mode of execution under DDUGJY and revised Standard Bidding Documents for full turnkey execution were circulated to all States vide REC letter No. REC/DDUGJY/SBD/239 on 22.08.2016.

The Technical Specification of Distribution Transformer, finalized by Committee 'A', mentioned the methodology for computing total owning cost based on loss capitalization. Since it would be practically not feasible to implement the Loss Capitalisation methodology for tender evaluation in full turnkey projects, the methodology of Total Owning Cost based on Loss Capitalisation may not be insisted upon for full turnkey tenders. However, States opting to go for direct procurement of Distribution Transformers may take care of this methodology based on their State practice.

This is for kind information and further needful action please.

Thanking You.

Yours Sincerely,



G S BHATI

Executive Director (DDUGJY-III)

Copy for kind information to:

1. The ZMs/CPMs, REC ZO/POs – to circulate to all PIAs in the states of their jurisdiction



रुल इलेक्ट्रिफिकेशन कारपोरेशन लिमिटेड

Rural Electrification Corporation Limited

(भारत सरकार का उद्यम) / A Government of India Enterprise

Regd. Office: Core-4 SCOPE Complex, 7, Lodhi Road, New Delhi 110 003

Tel: 011-24369851 FAX: 011 24369850, Email: rdugjy@quality@gmail.com

CIN: L40101DL1969GD1005095 Website: www.recindia.ltd.in

No. REC/DDUGJY/SBD/2017-18 / 239

Dated: 15.05.2017

To,

All Project Implementing Agencies
DISCOMs /Power Deptt./ SEBs/CPSUs

Subject: Regarding Technical Specifications of LTDB in Standard Bidding Documents for DDUGJY

Ma'M / Sir,

This has reference to revised Standard Bidding Documents for full turnkey contracts under DDUGJY & IPDS circulated vide letter No. REC/DDUGJY/SBD/239 dated 22.08.2016. The Technical Specification of LTDB (Low Tension Distribution Boxes) specifies metallic boxes using deep drawn methodology. In addition to this, "Low Tension Distribution Box (LTDB) can also be manufactured by sheet bending process for developing three side walls (from a single sheet) with top & bottom walls welded to the same and front door fabricated separately and hinged."

This is for kind information and further needful action please.

Thanking You,

Yours Sincerely,

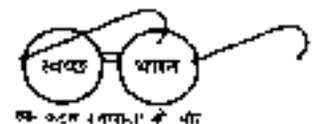
G S BHATT

Executive Director (DDUGJY)

Copy for kind information to:

1. All ZM/CPM - Please circulate to PIAs in the states of your purview.

Zonal Offices	: Hyderabad, Kolkata, Mumbai, Panchkula & Lucknow
Project Offices	: Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu, Patna, Ranchi, Shillong, Shimla, Thiruvananthapuram & Vadodara
Sub Offices	: Dehradun, Raipur
Training Centre	: Central Institute for Rural Electrification (CIRE), Hyderabad



REC/DDUGJY/SBD/2017/2148

To,
All PIAs
(States Discoms/Power Departments)

Sub: Modification in technical specification for CTs, PTs under DDUGJY Scheme.

Sir / Madam,

A representation was received from MPPKVCL seeking clarification in technical specification for CTs & PTs under DDUGJY scheme. In this connection, following modification has been made in the technical specification for CTs & PTs :

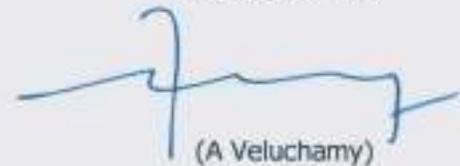
Sl No	TS Clause No	Existing Technical Specification	REC Comments / Clarification
1	TS for current Transformers Clause No. 4.7. (1)	The primary terminal shall be of standard size of 30mm dia X 80 mm length of heavily tinned(min. thickness 15 micron) electrolytic copper of 99.9% conductivity.	<u>Clause may be modified to :</u> The primary terminal shall be of maximum size of 30mm dia X 80 mm length of heavily tinned(min. thickness 15 micron) electrolytic copper of 99.9% conductivity. Manufacturer shall design the diameter of primary terminal keeping current density 1.6 A per sq. mm for the given capacity of CT.
2	TS for potential Transformers Clause No. 7	The secondary terminals studs shall be provided with at least 3 nuts and two plain washers. These shall be made of brass duly nickel plated. The min. stud outer dia shall be 10 mm & length 15 mm.	<u>Clause may be modified to :</u> The secondary terminals studs shall be provided with at least 3 nuts and two plain washers. These shall be made of brass duly nickel plated. The min. stud outer dia shall be 6 mm & length 15 mm.
3	TS for metering units, Clause No.9	Brass rods 12mm dia for Primary and 6mm dia for secondary.	Keeping current density of 1.6 A per sq. mm size of rod may be designed by manufacturer for given CT / PT.

Sl No	TS Clause No	Existing Technical Specification	REC Comments / Clarification
4	TS for Metering Units, Clause No 10.b	Tank including top cover shall be Hot Dip Galvanized.	Existing clause of TS will prevail. However state may decide to use Hot dip galvanized / Epoxy paint tank for CT/PT unit as per their prevailing state practices.

This is for your kind information and necessary action please.

Thanking You,

Yours faithfully,



(A Veluchamy)
Addl. General Manager
DDUGJY-Q&FM

Copy for kind information to:

1. The Sr. CPM / CPM, REC Regional office, for kind information please.

REC/DDUGJY/SBD/TS/2017-18/D.No.3091

Dated: 25.08.2017

The Chairman / Managing Director / Chief Engineer
All Project Implementing Agencies (PIA)/DISCOM/
State Power Utilities/ Power Department

Sub: Clarification in Technical Specifications of various equipment included in the Standard Bidding Document (SBD) of DDUGJY/IPDS

Dear Sir/Madam,

Following clarification pertains to technical specification of DDUGJY scheme are hereby conveyed:

Sl. No.	Name of materials	Particulars	Provision in SBD	Amended Provision
1	Distribution Transformers	Vacuum type test on transformer tank	Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested at an internal pressure of 0.35 kg per sq. cm absolute (250 mm of Hg) for one hour. (clause no.-31.10- pgno-80)	"Vacuum Type Test on Transformer Tank" shall be carried out as per IS-1180 (Part-1): 2014 i.e. The transformer tank shall be subjected to air pressure 80 kPa for 30 minutes and vacuum of 250 mm of mercury for 30 minutes.
2	Power Transformers	Maximum temperature rise over ambient temperature for oil/winding above ambient temperature	Permissible Temperature rise over ambient temperature shall be as per IS-2026 (point no.-25 page no.-6)	The maximum temperature rise over ambient temperature for oil/winding above ambient temperature shall be as per IS-2026(Part-2):2010. i.e. Maximum temperature rise over ambient temperature for top oil measured by thermometer should be 50 degree C. and for winding measured by resistance should be 55 degree C
3	XLPE Power Cables	Bleeding blooming type test	Bleeding and blooming tests (for outer sheath) (clause no-6.0, pgno-367)	"Bleeding Blooming Test" is deleted for XLPE cables.

Sl. No.	Name of materials	Particulars	Provision in SBD	Amended Provision
4	Isolators & AB switches	Maximum temperature rise over ambient temperature.	The maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed to the direct rays of Sun shall not exceed 45 degree above ambient (clause no.-4- pgno-488)	Maximum permitted temperature rise over ambient temperature will be as per Table-4 of IS-9921 (Part-2).
5	Power Transformers	Noise level measurement type test	Noise Level Measurement IEC 551 Table : 6 Transformer Type Tests ambient (clause no.-8.2.1 pgno-31)	No change
6	XLPE Power Cable	Drum length	All Power Cables shall be supplied in drum length of 1000 m. Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. (clause no.-5.0 pgno-366)	Drum length for power cable shall be 200/300/500m as per requirement of utility/Discom.
7	11 kV AB Switch	Number of Post Insulator per stack	The complete set of three phase AB Switches shall have stacks of post insulators. 11KV AB Switches : 3 No. 11KV Post Insulator per stack (clause no.- 3 pgno-487)	For 11kV AB switch, one (1) no. 11 kV post insulator per stack shall be permitted.
8	33 kV AB Switch	Number of Post Insulator per stack	The complete set of three phase AB Switches shall have stacks of post insulators. 33KV AB Switches : 3	For 33kV AB Switch, two (2) no. 22 kV post insulator or 3 No 11 KV post Insulators shall be permitted in each stack

Sl. No.	Name of materials	Particulars	Provision in SBD	Amended Provision
			No. 33KV Post Insulator per stack (clause no.- 3 pgno-487)	
9	11 kV Isolator	Number of Post Insulator per stack	11 KV isolators shall comprise of three numbers 11 KV insulators per stack and 9 such stack shall be supplied with each isolator. (clause no.- 9 pgno-484)	Post insulators for the 11kV isolators shall comprise of one (01) no. 11kV insulator per stack and nine (9) such stack shall be supplied with each isolator.
10	33 kV Isolator	Number of Post Insulator per stack	33 KV isolators, two numbers 33 KV insulators per stack and 9 stacks shall be supplied with each isolator (clause no.- 9 pgno-484)	Post insulators for 33kV isolators shall comprise two (02) nos. of 22kV insulators or 3 No of 11 KV post insulators or One no 33kV post insulator per stack and nine (9) such stack shall be supplied with each isolator

This is issued with the approval of the competent authority

Thank you

Yours faithfully,



(A. Veluchamy)
Addl. General Manager
(DDUGJY-QA&FM)

Copy for uploading in DDUGJY web portal



REC/DDUGJY/SBD/2017-18/609

Date: 05.10.2018

To
All Project Implementing Agencies,
DDUGJY-RE Projects XII Plan & DDUGJY/IPDS Scheme

Sub: Amendments in technical specification of AB Cable Accessories and Insulation Piercing Connectors (IPC) provided in Standard Bidding Document for DDUGJY-RE 12 Plan and DDUGJY/IPDS scheme.

Sir,

This has reference to the technical specifications of AB Cable accessories and Insulation Piercing Connectors (IPC) to be used DDUGJY-RE Projects XII Plan & DDUGJY/IPDS Schemes. In this connection, please find enclosed the amendments/corrections in clause 5.1.10.4, 5.2 & 5.3 of technical specification of AB Cable Accessories and Insulation Piercing Connectors (IPC) provided in Standard Bidding Document.

This is for information and further needful action please.

Yours sincerely,


G S BHATI

Executive Director (PMD-II/QA)

Copy to:

Sr. CPM/CPM, REC RO/SO- with a request to please circulate to PIAs in the states of your purview.

AMENDMENT PROPOSED IN TECHNICAL SPECIFICATIONS OF CABLE ACCESSORIES OF SBD (DDUGJY)

Sl No	Clause No. of SBD	Heading in clause	Provision as per Technical Specification of SBD	Amendments/ Recommendation
1	5.1.10.4	Insulation Piercing Connector (IPC)	<p>The following shall constitute Type Tests for IPC :</p> <ul style="list-style-type: none"> • Electrical Ageing Test • Dielectric and Water Tightness Test. • Mechanical Tightening Test • Effect of Tightening on main Core • Effect of Tightening on Branch core • Over-current Test (if applicable) \ 	<p>The following shall constitute Type Tests for IPC :</p> <ul style="list-style-type: none"> • Electrical Ageing Test • Dielectric and Water Tightness Test. • Mechanical Tightening Test • Effect of Tightening on main Core • Effect of Tightening on Branch core • Over-current Test (Applicable as per relevant clause of latest version of NFC 33020)
2	5.1.10.4	Suspension Assembly (SA)	<p>The following shall be Type Test for Suspension Assembly (SA)</p> <ul style="list-style-type: none"> • Mechanical Test • Voltage Test • Climatic Aging Test • Corrosion Test • Endurance Test under Thermal & Mechanical Stresses. 	<p>The following shall be Type Test for Suspension Assembly (SA)</p> <ul style="list-style-type: none"> • Mechanical Test • Voltage Test • Climatic Aging Test • Corrosion Test • Endurance Test under Thermal & Mechanical Stresses (optional till testing facilities are available in India)
3	5.1.10.4	Anchoring Assemblies (AA)	<p>The following shall be Type Tests for Anchoring Assemblies (AA)</p> <ul style="list-style-type: none"> • Mechanical Test • Voltage Test • Dynamic Test • Climatic Aging Test • Corrosion Test • Endurance Test under Thermal & Mechanical Stresses 	<p>The following shall be Type Tests for Anchoring Assemblies (AA)</p> <ul style="list-style-type: none"> • Mechanical Test • Voltage Test • Dynamic Test (Applicable for areas having sub zero minimum temperature) • Climatic Aging Test • Corrosion Test • Endurance Test under Thermal & Mechanical Stresses

SI No	Clause No. of SBD	Heading in clause	Provision as per Technical Specification of SBD	Amendments/ Recommendation
4	5.2	Anchoring Clamp for Insulated Messenger	<p>The clamps should be designed to Anchor LT-AB cable with insulated messenger. The clamp should consist of an Aluminium alloy corrosion resistant castled body, bail of stainless steel and self adjusting plastic wedges which shall anchor/hold the neutral messenger without damaging the insulation.</p> <ul style="list-style-type: none"> • No losable part in the process of clamping arrangement • The clamp should conform to the standard NFC 33041 and 33042 or equivalent I.S. if any. • The clamp body should be made of corrosion resistant Aluminum alloy, bail should be of stainless steel and wedges should be weather and UV resistant polymer. • Ultimate tensile strength of the clamp should not be less than 15 km for 50/70sq.mm insulated messenger wire / 10 KN for 25/35 sq.mm insulated messenger wire. • Slip load of the clamp should not be less than 3 KN for 50/70 sq.mm. messenger wire / 2 KN for 25/35 sq.mm. messenger wire. 	<p>The clamps should be designed to Anchor LT-AB cable with insulated messenger. The clamp should consist of an Aluminum alloy corrosion resistant body, bail of stainless steel and self adjusting plastic wedges which shall anchor/hold the neutral messenger without damaging the insulation.</p> <ul style="list-style-type: none"> • No losable part in the process of clamping arrangement • The clamp should conform to the standard NFC 33041 and 33042 or equivalent I.S. if any. • The clamp body should be made of corrosion resistant Aluminum alloy, bail should be of stainless steel and wedges should be weather and UV resistant polymer. • Ultimate tensile strength of the clamp should be as per Table-6 of Technical Specification.
5	5.3	Suspension Clamp for insulated neutral messenger	<p>The clamp should be designed to hang L.T – AB cable with insulated neutral messengers. The neutral messengers should be fixed by an adjustable grip device. A movable link should allow longitudinal and transversal movement of the clamp body.</p>	<p>The clamp should be designed to hang L.T – AB cable with insulated neutral messengers. The neutral messengers should be fixed by an adjustable grip device. A movable link should allow longitudinal and transversal movement of the clamp body.</p>

SI No	Clause No. of SBD	Heading in clause	Provision as per Technical Specification of SBD	Amendments/ Recommendation
			<ul style="list-style-type: none"> • No losable part in the process of clamping arrangement. • The clamp should conform to the standard NFC 33040 or equivalent I.S, if any. • The clamp and the link made of Polymer should provide an additional insulation between the cable and the pole. • The clamps and movable links should be made of weather and UV resistant glass fibre reinforced polymer. • Clamps should be fixed with pole by eye hook / bracket. Bracket should be made of corrosion resistant aluminum alloy. • Ultimate tensile strength of the clamp should not be less than 15 KN for 50/70 sq.mm. Insulated messenger wire 4.3 KN for 25/35 sq.mm. Insulated messenger wire. • Maximum allowable load of the clamp should not be less than 20 KN for 50/70 sq.mm. insulated messenger wire/15 KN for 25/30 sq.mm insulated messenger wire. 	<ul style="list-style-type: none"> • No losable part in the process of clamping arrangement. • The clamp should conform to the latest version of standard NFC 33040 or equivalent I.S, if any. • The clamp and the link made of Polymer should provide an additional insulation between the cable and the pole. • The clamps and movable links should be made of weather and UV resistant glass fibre reinforced polymer. • Clamps should be fixed with pole by eye hook / bracket. Bracket should be made of corrosion resistant aluminum alloy. • Ultimate tensile strength of the clamp should be as per Table-10 of Technical Specification. <p style="text-align: right;">pg. 3</p>