

General Constructional Features

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in original drums with manufacturer's name, size, and type, clearly written on the drums.

A. Material:

Medium voltage cable shall be XLPE insulated. PVC sheathed, aluminium or copper conductor, armoured conforming to IS: 7098 Part I.

B. Type:

The cables shall be circular, multi core, annealed copper or aluminium conductor, XLPE insulated and PVC sheathed, armoured.

C. Conductor:

Uncoated, annealed copper, of high conductivity up to 4 mm² size, the conductor shall be solid and above 4 mm², conductors shall be concentrically stranded as per IEC:228.

D. Insulation:

XLPE rated 70° c. extruded insulation.

E. Core Identification:

Two core	:	Red and Black
Three core	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green cable with Yellow strips for earthing

Black shall always be used for neutral.

F. Assembly:

Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

G. Armour:

Galvanised steel flat strip / round wires applied helically in single layers complete with covering the assembly of cores.

- For cable size up to 25 Sq. mm. : Armour of 1.4 mm dia G.I. round wire

- For cable size above 25 Sq. mm. Armour of 4 mm wide 0.8 mm thick G.I strip

H. Sheath:

The cable shall be rated extruded for XLPE 90 deg.C. Inner sheath shall be extruded type and shall be compatible with the insulation provided for the cables.

Outer sheath shall be of an extruded type layer of suitable PVC material compatible with the specified ambient temp 50 deg. C and operating temperature of cables. The sheath shall be resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The colour of outer sheath shall be black. Sequential length marking required at every 1.0 meter interval on outer sheath shall be available. The contractor has to furnish resistance / reactance / capacitances of the cable in the technical datasheet.

I. Rating:

Rating shall be as per IS 7098 (part-II).

5.3.6 Technical Specification for HT XLPE Cable

General Constructional Features

A. Conductors:

The conductor shall be of circular stranded Aluminium confirming to IS: 8130 & IEC: 228. It shall be clean, reasonably uniform in size & shape smooth & free from harmful defects. Any other form of conductor may also be accepted if in line with modern trends.

B. Semi-Conductor Barrier Tape/Tapes:

The semi-conducting barrier tape/tapes shall be provided over the conductors.

C. Conductor Screen:

The conductor screen shall consist of an extruded layer of thermosetting semi-conducting compound which shall be extruded simultaneously with the core insulation.

D. Insulation:

The insulation shall be super clean XLPE compound applied by extrusion and vulcanized to form a compact homogenous body.

E. Insulation Screen:

- a. Each insulation have an insulation screen in two parts consisting of:
- b. A water barrier tape/Non-metallic semi-conducting swellable tape part and a metallic screen part.
- c. The non-metallic part shall be directly applied upon the insulation of each core and may consist of an impregnated but nylon/PVC tape or a similar approved

material or, an extruded semi-conducting material extruded simultaneously with the conductor screen and insulation (triple extrusion).

- d. The semi-conductor shall be readily strippable and must not be bonded in such a manner that it has to be shaved or scraped to remove.
- e. The metallic part shall consist of a copper tape helical applied with a 30% overlap over the water barrier tape/blocking tape. A binder tape of copper shall be applied over the copper wire metallic screen.

F. Laying Up:

- a. The cores shall be identified on the non-metallic part of the insulation screen by legible printing on the length of each conductor or, by the inclusion of a marker tape.
- b. The cores shall be laid up with a right hand direction of lay.
- c. Binder tape/Moisture barrier:

During layup, a suitable open spiral binder may be applied, at the manufacturer's discretion, before the application of an extruded inner covering.

G. Fillers:

Fillers shall be polypropylene.

H. Inner Covering/Sheath:

The inner covering shall be extruded over the laid up cores to form compact and circular bedding for the metallic layer.

I. Metallic Layer:

The metallic layer shall be galvanised steel wire.

J. Outer Sheath:

The tough outer sheath, black coloured best resisting PVC polyethylene compound type ST-2 as per IS: 5831 for the operating temperature of the cable shall be provided over the armour as specified in relevant standards by extrusion process.

K. Cable Marking:

- a. Embossing on outer sheath:

The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

- GSECL SPVPP
- Voltage grade
- Year of manufacture

- Manufactures name
 - Successive Length
 - Size of cable
 - ISI mark
- i. Packing and marking shall be as per clause No. 18 of IS 7098 (part I)/1988 amended up to date.
 - ii. Cables inside the control room and in the switchyard shall be laid in Galvanized Cable Trays mounted on mild steel supports duly painted, in constructed trenches with RCC raft and brick sidewalls and provided with removable RCC covers.
 - iii. Cable terminations shall be made with suitable cable lugs & sockets etc, crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles.
 - iv. All cable/wires shall be provided with Punched Aluminium tags only. The marking on tags shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.
 - v. The wiring for modules interconnection shall be in the GI pipe /HD Pipe of approved make.
 - vi. Data sheets of individual cable sizes (HT & LT) shall be submitted for approval by the Company. Drum numbers and drum length details shall be submitted with each consignment.
 - vii. Cable end terminations and joint kits shall comply with the latest version of the relevant IS standard.
 - viii. The cable ends shall be terminated with adequate size copper lugs and sockets etc, single/double compression cable glands. Cable glands shall be of robust construction capable of clamping cable and cable armor (for armored cables) firmly without injury to insulation. The metallic glands shall be earthed at two locations. Suitable lock type crimping lugs shall be used for cable end terminations. Where cables are raising from ground, suitable PVC pipe guarding shall be provided for cable raising with sealing of the guarding PVC pipe including a suitable clamp.
 - ix. HT cable termination kits and straight through joints shall be selected as per the cable specifications. Installation shall be as per the instructions given in the manufacturer's manual. Heat shrinkable type kits only shall be used for HT and LT cables.
 - x. Data sheets of the joints and kits shall be submitted for approval by GSECL.

5.3.7 Clamps and Connectors

- i. The bus-support clamps, spacers, T-connectors and various equipment connectors shall be supplied as per the enclosed drawings. The material to be used for these items shall be generally as per the Table 5-4.
- ii. The materials shall be of the best workmanship, and all the sharp edges and corners shall be rounded off. The thickness of tinning, wherever applicable, shall be not less

than 10 microns. The minimum thickness of pads made of copper shall be 10 mm and those made out of Aluminium/Aluminium Alloy, shall be 12 mm, unless otherwise indicated in the specifications.

- iii. All the clamps and connectors shall be designed to carry a continuous current not less than 125% of the rated current of the conductor (twin/single as the case may be)/equipment terminal to which these are to be connected. Temperature rise of the connector under the above condition shall not be more than 50% of the temperature of the main conductor/equipment terminal.

Table 5-4 Clamps & Connectors

Sr.	Application	Material
1.	Bolted type connection	
2.	For connection to ACSR/AAAC/ Aluminum terminal	Aluminum Alloy conforming to designate A6 as per IS 617
3.	For connection to copper terminals, with crimping facility to connect ACSR/AAAC jumper	Electrolytic grade copper, forged and tinned
4.	Crimping type connection	
5.	For connection to ACSR/AAAC jumper	Electrolytic grade aluminum

- iv. All the fasteners (i.e. nut-bolts, washers, check-nuts, etc.) used in the clamps and connectors shall be of non-magnetic stainless steel. The straight bolts shall be fully threaded, and the U-bolts shall be threaded up to 30 mm from the ends. For connectors made out of Aluminium/Aluminium Alloy, the bolts shall be of 12 mm diameter, and for copper connectors the bolts shall be of 10 mm diameter.
- v. The clamps and connectors meant for ACSR and AAAC shall have the same crimping dimensions. It shall be possible to use the same clamp/connector for ACSR or AAAC, as would be required, without any modification/change at site.
- vi. The length of bolt shall be chosen such that after fully tightening the nut and check-nut, minimum 5 (five) threads of the bolt shall project outside the nut/check-nut.
- vii. As an alternative to the various types of clamps and connectors detailed under 2.0 above, the Contractors may offer connectors of Power Fired Wedge Pressure Technology (PFWPT). However, the same needs to be specified in the Bid.
- viii. Connectors of PFWPT type shall meet the general requirements for various connections/joints as indicated in the relevant drawings.
- ix. PFWPT type connectors shall comprise of:
 - a. Tapered 'C' - shaped spring member

- b. Wedge for connecting solid/stranded conductor along with handle, suitable for connection between:
 - Aluminium & Aluminium
 - Copper & Copper
 - Aluminium & Copper
 - Aluminium & Al. Alloy
 - Copper & Al. Alloy
 - Al. Alloy & Al. Alloy
- i. Components of the PFWPT type connectors shall be made of Aluminium Alloy suitably heat-treated to ensure that the required Mechanical & Electrical parameters are in line with ANS 1 specification no. C 119.4-1991. The connectors shall have 'self-cleaning' capability during application. The connector shall ensure stable and low contact resistance under varying load conditions and the thermal cycling effects.
- ii. The special tools and tackles required for installation of the PFWPT type connectors shall be identified in the offer. One set of these bolts and tackles shall be included in the scope of supply.
- iii. The Contractor shall furnish the following information in their bill of material:
 - a. Availability of the PGWT connectors indigenously.
 - b. Unit rate of each item
 - c. Notwithstanding anything stated above, the final decision regarding acceptance of the type of clamps and connectors (conventional/PFWPT type) shall rest with GSECL

5.3.8 Structural Steel Work

- i. The structural steelwork required for termination incoming 66 KV line/ Cable, equipment supports, lighting masts and for shielding towers together with all foundation bolts shall be included by the Bidder in its scope of work. The steel work shall be fabricated from galvanized structural sections. The height of structures for incoming line shall be as per the design developed by the Bidder and drawings submitted.
- ii. The incoming line gantry shall be designed on the basis of ACSR conductor/Cable considered in the design and also considering that GETCO terminal tower will be located at a distance of not more than 100 meters from the incoming gantry at SPV power station switchyard. The Bidder shall take into account wind load, temperature variation etc. while designing the gantry structure. The column shall be provided with step bolts and anti-climbing devices.
- iii. The entire structural steel work shall conform to IS: 802. The Bidder shall furnish design calculations for approval by Owner before procuring the material.
- iv. The design of the switchyard towers, gantries and equipment structures shall also be designed in conformity with the standards followed by the Company. Approval from the Company also shall be obtained by the Bidder if required.

5.3.9 Hardware

- i. Metal fittings of specified material for string hardware meant for power conductor and earth wire shall have excellent mechanical properties such as strength, toughness and high corrosion resistance. The suspension and tension clamps shall be made from aluminum alloy having high mechanical strength. Suspension and tension clamps offered shall be suitable for ACSR / AAAC conductor as per design.
- ii. All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching insulators to the tower or to the power conductor shall be so designed as to reduce (to a minimum) the damage to the conductor, insulator or the fitting arising from conductor vibration.
- iii. All drop-forged parts shall be free-from flaws, cracks, or other defects and shall be smooth, close-grained and of true forms and dimensions. all machined surfaces shall be true, smooth and well-finished. The thickness of all structural steel of Switchyard shall be minimum 80 microns measured at all points of the structure member when measured. No averaging is allowed. The gap between base plate of structural members and concrete top of foundation shall be filled with GP-2 grouting material of reputed make. The material of all J-bolts shall be of 8.8 Class.
- iv. All ferrous parts of hardware shall be galvanized in accordance with IS 2629. The galvanization shall withstand four dips of 1-minute duration each in copper-sulphate solution as per the test procedure laid down in the relevant ISS.
- v. The threads in nuts and tapped holes shall be cut after galvanizing, and shall be well-lubricated/greased. All other threads shall be cut before galvanizing.
- vi. Both the suspension and the tension hardware shall be of ball and socket type, and shall be with 'R' and 'W' type security clip of stainless steel or phosphor Bronze conforming to IS 2486. The tension clamps of both compression type and bolted type as shown in the relevant drawings shall be offered. Arcing horns shall be provided on the line side for both the suspension type and compression type hardware.
 - a. Danger Plates
- vii. Size of each Danger Notice plates shall be 200 mm x 150 mm made of mild steel sheet and at least 2 mm thick, and vitreous enameled white on both sides and with inscription in signal red colors on front side as required. The inscriptions shall be in Gujarati and English.
- viii. Fire Extinguishing System
- ix. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection
- x. Liquefied CO2 fire extinguisher shall be upright type of capacity 10 kg having IS: 2171. 7 IS: 10658 marked. The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes, Electrical Wiring, Live Machinery Fires, and All Flammable Liquid & Gas. Bidder shall provide portable fire extinguisher as given below:

DCP Type(ABC type)(10 kg Cap)	CO ₂ Type Hand 9 kg	Foam Type Hand 9 kg
1	1	1

- xi. The minimum 1 no. of fire extinguishers shall be required for every installations / building.
- xii. Sand bucket should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546.

5.3.10 Lightning Protection for PV Array

- i. The source of over voltage can be lightning or other atmospheric disturbance. Main aim of over voltage protection is to reduce the over voltage to a tolerable level before it reaches the PV or other sub-system components as per IS: 2309 – 1989 (Reaffirmed – 2005), Edition 3.1 (2006-01).
- ii. Necessary foundation / anchoring for holding the lightning conductor in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.
- iii. The lightning conductor shall be earthed through flats and connected to the earth mats as per applicable Indian Standards with earth pits. Two earth pits shall be provided for each lightning arrestor. Each lightning conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS & Earth Resistance of Lightning System must be less than one (1) Ohm.
 - a.If necessary more numbers of lightning conductors may be provided. The Contractor is also free to provide franklin rod / Early Streamer type of lightning arrestors on the MMS structure designed in such a way not to cast shadow on the next raw of solar PV modules. The Contractor to submit necessary calculations based upon rolling sphere method for the Lightning protection system.
- iv. The Contractor shall submit the drawings and detailed specifications of the PV array lightning protection equipment to GSECL for approval before installation of system.

5.3.11 AC Network

AC converted by the inverter is transmitted through the appropriate cables from the Inverter to appropriately sized Inverter transformer and from transformer to adequate rating of 11 KV VCB breakers. VCB breakers should be equipped with adequate protection relays, fuses, annunciations and remote operating and controlling facility from the Main Control Room. Relevant national & international codes to be follows:-

Table 5-5 Relevant National & International Code

Sr.	Item	Relevant IS	Relevant IEC
1	Power transformer	IS 2026	IEC 76
2	Fittings & Accessories	IS 3639	
3	Climate Proofing	IS 3202	IEC 354
4	Loading of Transformer	IS 6600	IEC 296
5	Oil	IS 335	IEC 137
6	Bushings	IS 20650	IEC 144
7	Degree of Protection	IS 2147	IEC 76
8	Testing, Tolerances on guaranteed Particulars	IS 2026	IEC 76
9	Buchholz Relay	IS 3637	
10	Electrical Insulation	IS 1271	IEC 85

- i. Radial scheme through VCB panel is acceptable. It shall have circuit breaker of suitable rating for connection and disconnection of PCU from grid. The bus bar shall connect the AC distribution board to the transformer. It shall have provision to measure bus voltage, current and power of the transformer. Outdoor inverter & **RMU** panel with IP65 or above are acceptable. In case of outdoor inverters, the inverter station should be properly provided with canopy structure and working platform.
- ii. Bus-bars shall be of high conductivity Aluminium alloy or Copper of adequate size. The bus-bars shall be adequately supported by non-hygroscopic, non-combustible track resistant and high strength type polyester fibre glass moulded insulators. Separate supports shall be provided for each phase and neutral bus bar. The bus-bars joints shall be provided with high tensile steel bolts, Belleville washers and nuts, so as to ensure good contacts at the joints. The bus-bars shall be colour coded as per IS 375.
- iii. The Bidder shall submit the detailed specifications of the AC bus and panel in the Bid.
- iv. The VCB panel with thermal over current and earth fault releases. The incomer shall be selected one size higher than the required rating as per Type 2 selection chart (**For LV switchgear**).
- v. Removable gland plates with gaskets shall be provided in the cable alleys for glanding the power and control cables. The distance between the gland plate and the incomer terminals shall not be less than 450 mm.
- vi. The Contractor should submit theoretical design calculations and detailed explanations along with drawings shall be provided and approved by the Company.

11 KV SUBSTATION BLOCKS:

5.3.12 Step-Up Transformer

- 1 The Contractor shall provide the complete turnkey design, supply, erection, testing and commissioning of transformers and transformer substation to first step-up the output of the inverter to 11 kV at the location of the inverter. Solar plant with provision of rated 11 kV Vacuum Circuit Breaker Stand Alone Panel. Provision of ABT meter will be connected with 11 kV VCB panel as mentioned in **Error! Reference source not found.**
- 2 3 phase, Oil Filled, 11 kV, 50 Hz, Step Up Transformer with min power rating 1.25 times of the selected inverter rating and associated Switchgear of approved make should be utilized. 11 KV transformer can be off-load tap change type. The transformer shall be suitable for outdoor installation with 3 phase 50 Hz 11 KV system in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 10% to minus 15%. Bidder shall have to consider transformer MVA rating as per AC capacity with adequate design margin.
- 3 Cumulative loss shall be as per IGBC guidelines. All electrical equipment and installation shall confirm to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified for installation and operation of electrical plants.
- 4 Relevant national and international standards in this connection are mentioned in Table **5-6 General Standards for Transformers.**
- 5 All working parts, insofar as possible, are to be arranged for convenience of operation, inspection, lubrication and ease of replacement with minimum downtime. All parts of equipment or of duplicate equipment offered shall be interchangeable.
- 6 The quality of materials of construction and the workmanship of the finished products/ components shall be in accordance with the highest standard and practices adopted for the equipment covered by the specification.

Table 5-6 General Standards for Transformers

IS: 2026 (Part 1 to 4)	Specifications for Power Transformer
-------------------------------	---

IS: 2099	Bushings for alternating voltage above 1000 V
IS: 3639	Fittings and accessories for power transformer
IEC: 60076 (Part 1 to 5)	Specifications for Power Transformer
IS: 9921 Part 1 to 5	Alternating currents dis-connectors (isolators) and earthing switches rating, design, construction, tests etc.
IS: 2705 Part 1 to 4 & IEC:	Current transformer
IS: 3156 Part 1 to 4	Voltage Transformer
IS: 3070 part 1 to 3	Lightning arrestors
IS: 2544	Porcelain insulators for system above 1000 V
IS: 5350	Part III – post insulator units for systems greater than 1000 V
IS: 5621	Hollow Insulators for use in electrical equipment
IS: 5556	Serrated lock washers – specification
IEC: 186	Voltage transformer

- i. All items of equipment and materials shall be thoroughly cleaned and painted in accordance with relevant Indian Standards. The finish paint shall be done with two coats of epoxy based final paint of colour Shade RAL 7032 of IS:5 for indoor equipment
- ii. Any fitting or accessories which may not have been specifically mentioned in the specification but which are usual or necessary in the equipment of similar plant or for efficient working of the plant shall be deemed to be included in the contract and shall be provided by the Contractor without extra charges. All plant and apparatus shall be complete in all details whether such details are mentioned in the specifications or not.
- iii. All equipment shall be designed for operation in tropical humid climate at the required capacity in an ambient air temperature of 50°C. Equipment shall be suitable for an ambient temperature of 50°C. Maximum relative humidity of 100% shall also be taken into consideration for design of equipment.

- iv. The reference ambient temperatures for which the transformers are to be designed are as mentioned in **Error! Not a valid bookmark self-reference.**
- v. The rating and electrical characteristics of the MV / 11 kV Outdoor type transformer (typical) shall be as mentioned in Table 5-8.

Table 5-7 Reference Weather Conditions for Transformer Design

Sr.	Particulars	Specifications
1.	Maximum ambient temperature	50 degree C
2.	Maximum daily average ambient temp	45 degree C
3.	Maximum yearly weighted average ambient temp	40 degree C
4.	Minimum ambient air temperature: (Cooling medium shall be Air)	Minus 5 degree C
5.	Climatic Conditions :	
5.1	Maximum relative humidity	100%
5.2	Yearly average number of thunder storms	Varies from 30 to 50
5.3	Average no. of rainy days per annum	60 days
5.4	Fog	The atmosphere is subject to fog for two month in winter
5.5	Number of months during which tropical monsoon conditions prevail	3 months
5.6	Dust storms	occur at frequent intervals
5.7	Average annual rainfall	60 cms
5.8	Maximum wind speed	180 kmph

CODES & STANDARDS

IS:13118/IEC56	Specification for High voltage Alternating Current Circuit Breakers.
----------------	--

IS9921	AC dis-connectors(isolators) and Earth switches for voltages above1000volts
IS-2705	Current transformers
IS-3156	Voltage transformers
IEC-60358	Coupling capacitors and capacitor dividers
IEC-60044	Instrument transformers
IEC-60481	Coupling devices for power line carrier systems
IS-3070	Lightning arresters "for" alternating current systems: Metal oxide lightning arrestors without gaps.
IEC-60099	Metal oxide surge arrestors without gaps
IS-8792	Line traps for AC power system
IS-8997	Coupling devices for PLC systems
IEC-60353	Line traps for AC power systems
IEC-6_____0	Communication Network and Systems in Substations

Table 5-8 Rating and electrical characteristics of 11kV Power Transformer

Sr.	Particulars	Details
1	Continuous kVA ratings	1.25 times the rated power output of Inverter MVA
2	Type	Oil immersed (Natural)
3	Frequency	50 Hz
4	Type of cooling	ONAN
5	No. of phases	Three
6	Rating voltage H.V. side	11 KV
7	Highest System voltage on H.V. side	As per IS
8	Rated voltage on L.V. side	LV (Output of the Inverter) kV r.m.s.
9	Vector Group	Dy11/As per Design
10	Connections a) H.V. Winding b) L.V. winding	Delta Star
11	On load taps on H.V. Side (for H.V. Variation)	+ 10 to – 15.0 % (in steps of 1.25%)

12	Impedance voltage (%) as per IS 2026	5-6%
13	Minimum Creepage distance at 32 mm/kV	400 phase to earth
14	Transformer connections	LV side – Bus Duct with weather proof enclosure, HV Side – Bushing with enclosure

5.3.12.1 Functional Specification for New Natural Ester Less-Flammable Transformer Dielectric Coolant

5.3.12.1.1 Scope: This specification describes a non-toxic (in acute aquatic, and oral toxicity tests), biodegradable, fire resistant, bio-based natural ester dielectric fluid. It is intended for use in electrical equipment as an environmentally preferred, less-flammable insulating and cooling medium complying to IEC 62770 standards.

5.3.12.1.2 Requirements

- i. Fluid Manufacture: Fluid manufacturer shall have a minimum of ten (10) years' experience of producing and testing dielectric coolants with atleast one plant in India to assure long term supplies. Manufacturer upon request shall provide AC withstand and impulse withstand for both gap and creep from 3mm to 150mm for the supplied fluid.
- ii. Dielectric Coolant:
 - a. The dielectric coolant shall be a bio based biodegradable, be FM Global Approved or UL® Classified as a less-flammable fluid for transformer application.
 - b. The base fluid shall be derived from naturally occurring seed oils.
 - c. The offered dielectric coolant should have undergone accelerated aging studies via sealed tube and Locke test methods, and have published it's A & B factors.

- d. The offered fluid should have been used in Indian environmental conditions for at least 3 years with at least one 20MVA or higher rating transformer also commissioned in India.
- e. The offered fluid should have DGA guidelines published in IEEE standards
- iii. Acceptable values for receipt of shipments of new natural fluid are shown in Table 5-9 below:

Sr.	Characteristics of NATURAL ESTERS (NE) Insulating oil	Requirement	Method of Test
1	Appearance	clear, free from sediments and suspended matter.	Visual
2	Viscosity, mm ² /sec - At 1000 C - At 400	Max. 15 Max. 50	ISO 3104 ISO 3104
3	Pour point	Max -100 C	ISO 3016
4	Water content, mg/kg (ppm)	Max.200	IEC 60814
5	Density, gm/ Cm ³ @ 200C	Max.1.0	ISO 3675 or ISO 12185
6	Dielectric breakdown voltage (2.5 mm gap)	Min 35 kV	IEC 60156
7	Dielectric Dissipation factor (Tan δ) at 900 C	Max.0.05	IEC: 60247
8	Soluble acidity, mg KOH/gm	Max.0.06	IEC:62021-3
9	Appearance	clear, free from sediments and suspended matter.	Visual
10	Viscosity, mm ² /sec - At 1000 C - At 400	Max. 15 Max. 50	ISO 3104 ISO 3104
11	Pour point	Max -100 C	ISO 3016
12	Water content, mg/kg (ppm)	Max.200	IEC 60814

iv. Environmental and Health Third Party Validations: The fluid shall have a US EPA Environmental Technology Verification (ETV) Statement published. The offered fluid should be aquatic non-toxic as well as ultimately biodegradable as per US EPA OPPTS method 835.3110.

v. Packaging: The electrical insulating fluid shall be furnished in sealed vessels suitable for the purpose, including 208-Liter drums, 1000 Liter totes, or in bulk. Each vessel shall have tampering indicating devices.

5.2.12.1.3 Applicable Standard

- IEC 60076-1 – Power Transformers – Part 1: General
- IEC 60076-14 – Power transformers – Liquid-immersed power transformers using high-temperature insulation materials
- IEC 62770 – Fluids for electro technical applications – Unused natural esters for transformers and similar electrical equipment
- IEEE C57.147 - IEEE Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers
- IEEE C57.155 - IEEE Guide for Interpretation of Gases Generated in Natural Ester and Synthetic Ester-Immersed Transformers

5.3.13 Circuit Breaker

i. The scope generally describes to design, manufacture, assemble, connect, wire, supply, test and commission 11KV vacuum circuit breaker panel. The unit shall consist off tee off spring assisted three position, three pole vacuum circuit breaker. All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) except where modified and/or supplemented by this specification. The equipment shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules and regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

ii. The switchgear enclosure shall conform to the degree of protection IP-4X. The minimum thickness of sheet steel used shall be 2mm CRCA steel. The switch gear assembly shall comprise a continuous, dead-front, line-up of free standing, vertical cubicles. Each cubicle shall have a front hinged door with latches and a removable back cover. All covers and doors shall be provided with recessed neoprene gaskets. All doors shall have pad locking arrangement. Switchgear shall be fire retardant type. Circuit breakers, instrument transformers, bus-bars, cable compartment etc., shall be housed in totally isolated air tight separate compartments within the cubicle. The design shall be such that failure of one equipment shall not affect the adjacent units. Suitable venting arrangement shall be provided to release the gas pressure developed due to the operation of the breaker or due to live arc of fault. Each cubicle shall be separated from adjacent one by grounded sheet steel barrier and bus sealing arrangement. The switchgear panel shall be of arc proof version. Test report as per DIN VDE 0670 part 601, IEC-694/IEC-298 shall be furnished.

iii. All relays, meters, switches and lamps shall be flush mounted on the respective cubicle door or on control cabinet built on the front of the cubicle. Each switchgear cubicle shall be provided with a thermostat controlled space heater and single phase plug point operated at 230 V AC. 50 Hz. Bus connection from bus compartment to breaker compartment & breaker compartment to cable compartment and bus compartment to adjacent panels shall be through sealed resin cast bushing assembly. Each breaker cubicle shall be provided with 'service' and 'test' position limit switches, each having at least 4 NO & 4 NC contacts. All fixing bolts, screws, etc. appearing on the panel shall be so arranged as to present a neat appearance. The swing of the door shall be more than 90 deg C. Each breaker cubicle shall be provided with 'service' and 'test' position limit switches, each having at least 4 NO & 4 NC contacts. All fixing bolts, screws, etc. appearing on the panel shall be so arranged as to present a neat appearance. The swing of the door shall be more than 90 deg C.

iv. The main buses and connections shall be of high conductivity copper, sized for specified continuous and fault current ratings with maximum temperature limited to 85 deg C (i.e.35 deg C rise over 50 deg C ambient). Adequate contact pressure shall be ensured by means of two bolts connection with plain and spring washers and locknuts. Bimetallic connectors shall be furnished for connections between dissimilar metals. All Busbars, Jumpers and connection shall be fully insulated for working voltage with adequate phase/ground clearances. Epoxy cast-resin

shrouds for joints shall be provided. All jointing hardware shall have nylon caps. All busbars, links, jumpers etc. shall be sleeved with sleeves of Raychem/DSG make and non-in flammable heat shrinkable type. Busbars, links, live parts etc. shall have nonflammable shrouds. No paper/cotton based insulation shall be used any where in the switch gear. Minimum amount of combustible and low smoke generation type insulating material shall be used. Safety shutter, phase barrier, busbar seal-off bushing plate, support insulators etc. shall be non-inflammable high tracking fiber glass/epoxy insulation system of grade 94V-O as per UL. All buses and connections shall be supported and braced to withstand dynamic electro-magnetic stresses due to maximum short circuit current and also to take care of any thermal expansion. Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from front of the switchgear assembly. The successful tenderer shall submit the calculation in support of selection of busbar conductor size, spacing and short time withstand capability.

v. Circuit breaker shall be triple pole, single throw, Vacuum type. Circuit breaker shall be drawout type, having SERVICE, TEST and DISCONNECTED positions with positive indication for each position. Circuit breakers of identical rating shall be physically and electrically interchangeable. Circuit breaker shall have motor wound spring charging facility with Mechanical & Electrical anti-pumping features and shunt trip. In addition facility for manual charging of spring shall be provided. The motor shall be suitable for operation with voltage variation from 85% to 110% of rated voltage. Spring charging motor shall be in a standard enclosure. For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor.

vi. Mechanical safety interlock shall be provided to prevent The circuit breaker from being racked in or out of the service position when the breaker is closed, Racking in the circuit breaker unless the control plug is fully engaged, Closing & opening of the breaker in an intermediate position between 'service' & 'test' and between 'Test' and 'Disconnected' position. Automatic safety shutters shall be provided to fully cover the female primary contacts when the breaker is withdrawn from service position. Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF indication, an operation counter and mechanism charge/discharge indicator. The manual trip device shall be located on the front door. Indicators with shrouds will

be visible from front door even when breaker is closed. Suitable padlocking arrangement shall be provided as stated below:

- Circuit Breaker operating handle in the OFF position.
- Each feeder panel operating handle in CLOSED, OPEN, EARTH position.

Each breaker shall be provided with following:

- Auxiliary switch, with 6 NO + 6 NC contacts, mounted on the draw out portion of the switchgear Position/cell switch with minimum 3 NO + 1 NC contacts, one each for TEST and SERVICE position.

vii. Auxiliary switch, with 4 NO + 4 NC contacts, mounted on the stationary portion of the switchgear and operated mechanically by a sliding lever from the breaker in SERVICE position.

viii. Limit/auxiliary switches shall be convertible type that is facility for changing N.O. contact to N.C. and vice-versa. Switch contact shall be rated 10A A.C. and 2A D.C. at operating voltage. Circuit breaker shall be draw out type, complete with transfer trunks, self-aligning primary and secondary disconnects, positive guides to ensure proper alignment. Each breaker shall be provided with suitable encased rollers. The trip coils shall be operated satisfactorily at voltage between 70 % and 110 % of rated control supply voltage. Each circuit breaker cubicle shall be provided with an earthing facility to earth the incoming or outgoing feeders by the arrangement specified below. Earthing facilities shall be fully interlocked to prevent faulty operation e.g. earthing of live parts. Separate earthing trunk, which can be inserted in place of circuit breakers, one trunk suitable for incoming and the other for outgoing circuits shall be provided. Positive earthing of circuit breaker frame shall be maintained when it is in the connected position and in all other positions in which the safety shutters are in open position. Insulation used for auxiliary switches shall be anti tracking type.

Each breaker cubicle shall be equipped with following:

One (1) number heavy duty spring return type TRIP-NORMAL-CLOSE control switch with pistol grip handle Three (3) indicating lights front of compartments:

- GREEN : Breaker Open
- RED : Breaker Closed
- AMBER : Trip

ix. CURRENT TRANSFORMER: Current transformers shall be bar primary, cast resin type. All secondary connections shall be brought out to terminal blocks where Y or D connection will be made.

- Class PS for differential & restricted earth fault relaying.
- Class 5P20 for other relaying.
- Accuracy Class 0.2s and ISF < 5 for metering

The current transformer shall be capable of safely withstanding the short circuit, stresses corresponding to the fault level as indicated & shall be able to meet the short-time requirement specified. All CT secondary shall be earthed through separate switch link on terminal block. The secondary terminals of the CTS shall have the provision of shorting and disconnecting facilities by links. CT terminals & their polarities shall be clearly marked.

x. VOLTAGE TRANSFORMER: Voltage Transformer shall be cast-resin, draw out type and shall have an accuracy class of 2.0, 3P. Voltage Transformer mounted on breaker carriage is not acceptable. High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position. Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switchgear is energised. The connections from main circuit to PT shall be capable of withstanding short circuit stresses.

xi. RELAYS : Protective relay shall be micro processor based. Relays shall be of draw out design with built-in site testing facilities. Small auxiliary relays may be in non-draw out execution and mounted within the cubicle. Relays shall be rated for operation on 110 V secondary voltage and 5 A secondary current as shown on drawings. Number and rating of relay contacts shall suit the job requirements.

- xii. Circuit Breaker Panel must be with all Analogue Voltmeter, Ammeter as well as KWH Meter. Protection & Metering Compartment must be separate and at the top of the panel. All the meters & Annunciator must be positioned at the eye level. Annunciator must be with Hooter sound. All type of fault tripping and alarm must be provided. Minimum 12 Window Annunciator is must for each Circuit Breaker.
- xiii. Applicable Standards: The materials shall conform in all respects to the relevant Indian Standard Specifications/ IEC Standards, with latest amendments indicated below:

Table 5-9 Applicable Standards for Circuit Breakers

Indian Standard	Title	International & Internationally recognized standard
ISS-13118/1991	General requirements for Circuit breakers for voltage above 1000 V	IEC 62271-100-1/2001
ISS-2705/1992	Current Transformers	
ISS-2099/1986	Bushings for alternating voltages above 1000 V	
ISS-2633/1964	Methods of testing uniformity of coating of zinc coated articles	
ISS-3231/1986	Electrical relays for power system protection	
ISS-1248/1983	Specification for Ammeters & Voltmeters	
ISS-335/1983	New insulating oils Electrical Clearances	IEC 71 (For oils in CTs)
ISS-2147/1962	Degree of protection provided by enclosures for low voltage switchgear & control gear	

xvi General Parameters of Circuit Breaker: General parameters: Indoor Vacuum type Circuit Breaker.

Table 5-10 General Parameters for Vacuum Type Circuit Breakers

SR. NO.	PARTICULAR	DETAILS	DATA TO BE FILLED BY THE BIDDER
1.0	GENERAL :		
1.1	Make	As per Tender	
1.2	Model & Type no.	Pl. Furnish	
1.3	Ambient temperature	45 deg. C	
1.4	Atmosphere	Corrosive, Humid, Dusty	
1.5	Location	Indoor	
2.0	ELECTRICAL DATA :		
2.1	Type of breaker	Vacuum Circuit Breaker	
2.2	Service	Continuous	
2.3	Voltage	11 KV \pm 10%	
2.4	System earthing	Solidly earthed	
2.5	Frequency	50 Hz. + 5% to - 5 %	
2.6	No. of phase	3	
2.7	System fault level	350 MVA	
2.8	Fault current	18.37 KA	
2.9	Max. system voltage	12 KV	
2.10	Power Pack unit	110V D.C derived from power pack connected on incoming	