possible "Potential Induced Degradation".

xxiv. Reactive Power: The output power factor of the PCU should be of suitable range to supply or sink reactive power. The PCU shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line.

xxv. Isolation: The PCU shall have provision for input & output isolation. Each solid-state electronic device shall have to be protected to ensure long life as well as smooth functioning of the PCU.

xxvi. All inverters/ PCUs shall be three phase using static solid state components. DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. Circuit breakers used in the DC lines must be rated suitably.

a. Sinusoidal current modulation with excellent dynamic response.
b. Compact and weather proof housing.
c. Direct use in the outdoors with outdoor housing.
d. Comprehensive network management functions (including the LVRT and capability to inject reactive power to the grid).
e. No load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%.
f. Unit wise & integrated Data logging
g. Dedicated Prefab compartment required for Ethernet for networking.
h. PCU shall have protection against over current, sync loss, over temperature, DC bus over voltage, cooling fan failure (if provided), short circuit, lightening, earth fault, surge voltage induced at output due to external source, power regulation in the event of thermal overloading,

xxvi. It shall have bus communication via interface for integration, remote control via telephone model or mini web server, integrated protection in the DC and three phase system, insulation monitoring of PV array with sequential fault location

xxvii. Ground fault detector which is essential for large PV generators in view of appreciable discharge current with respect to ground.

xxix. The power conditioner must be entirely self-managing and stable in operation. A self- diagnostic system check should occur on start up. Functions should include a test of key parameters on start up.

xxx. Over voltage protection against atmospheric lightning discharge to the PV array is required.

xxxi. The power conditioner must be entirely self-managing and stable in operation. A self- diagnostic system check should occur on start up. Functions should include a test of key parameters on start up.

xxxii. **Standards and Compliances:**

The Bidder also has to confirm the PCU specifications in the Bid.

Table 5-2 Detailed Specifications of PCU

Sr.	Particulars	Details
1	PCU Mounting	As per the design
2	Nominal AC Output Power	≥ 1000KW
3	Nominal AC Output Voltage	415 Volts +15%/-10% AC / 270 V / As per design (Other equivalent technical option is also acceptable).
4	Maximum Input Voltage	800 V DC Extendable up to 1000 V or1500V
5	Wave Form	Pure Sine wave
6	DC voltage range, MPPT	450 to 800 volts DC (Other equivalent technical option is also acceptable).
7	Minimum Efficiency at 100% load The rated European efficiency (Euro Eta Efficiency) and peak efficiency	> 98% as IEC- 61683(Efficiency) > 98%, measured as per IEC 61683 standard for measuring efficiency. * Inverter No Load / Full Load Loss Calculation must be submitted by the Bidder.
8	Output frequency	50 Hz +3% to - 5% Hz
9	Power Factor	0.8 lag- 0.8 lead
10	Max. THD at rated power	Less than 3 %
11	Ambient dry bulb temperature range	0 to 50° deg C
12	Humidity	15% to 95 % non- condensing
13	Enclosure	IP 4X / IP 65 (Indoor/ Outdoor rated) IEC-60068-2 (environmental)
14	Protection rating (as per IEC-60721-3-3)	Classification of chemically active substances: 3C2 Classification of chemically active substances: 3S2
15	Grid Specifications	IEC 61727, VDE 0126 (Consider IEC Code for Central Inverter)
16	Nominal Voltage & Frequency	415 Volts & 50 Hz
17	Voltage Tolerance	+ 10% and -10%

a. PCU shall confirm to IEC 60068-2 standards for Environmental Testing.

b. All inverters shall be IEC 61000 compliant for electromagnetic compatibility, harmonics, etc.

c. All inverters shall be safety rated as per IEC 62109 (1 &2), EN 50178 or equivalent DIN or UL standard.

d. Each PCU shall be compliant with IEEE standard 929 – 200 or equivalent. The **Bidder should select the Central inverter as per its own system design so as to optimize the power output.**

xxiii. Display

a. The PCU shall have local LCD (Liquid crystal display) and keypad for system control, monitoring instantaneous system data, event logs, data logs and changing

set points. Control and read-out should be provided on an indicating panel integral to the Inverter. Display should be simple and self-explanatory. Display to show all the relevant parameter relating to PCU operational data and fault condition in form of front panel meters/ LEDs or two line LCD Display.

b. PCU front panel shall be provided with display (LCD or equivalent) to monitor the following

- Instantaneous DC power input
- DC input voltage
- DC Current
- Instantaneous active AC power output
- Instantaneous reactive AC power output
- AC voltage (all the 3 phases and line)
- AC current (all the 3 phases and line)
- Power Factor
- kWh Produced during entire day
- Total kWh produced during its life time
- Thermal loading (percentage)

PCU must be provided with display and also the same has to be made available at the SCADA monitoring & controlling desk installed in Main Control Room through Universal Open Protocol of Communication.

xxiv. Documentary Requirements & Inspection.

a. The bill of materials associated with PCUs should be clearly indicated while delivering the equipment.

b. The Contractor shall provide to HPGCL data sheet containing detailed technical specifications of all the inverters and PCUs. Operation & Maintenance manual should be furnished by the Bidder before dispatch of PCUs.

Note: The HPGCL or its authorized representative reserves the right to inspect the PCUs/ Inverters at the manufacturer's site prior to dispatch.

5.2.4 Cables and Wires

i. All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions for 25 years and voltages as per latest IEC standards. (Note: IEC standards for DC cables for PV systems is under development, the cables of 600- 1800 volts DC for outdoor installations should comply with the draft EN 50618 for service life expectancy of 25 years. Other equivalent standards are also acceptable).

i. Wires with sufficient ampacity and parameters shall be designed and used so that maximum voltage-drop at full power from the PV modules to inverter should be less than 1.5% (including diode voltage drop). PV Modules should be connected with USE-2/RHW-2 cables array to junction box conductors and junction box to photovoltaic disconnector with the THHN/THWN-2 sunlight resistant with 90°C wet rated insulation cable (Other equivalent standards are also acceptable). Due consideration shall be made for the de-rating of the cables with respect to the laying pattern in buried trenches / on cable trays, while sizing

the cables. The Contractor shall provide voltage drop calculations in excel sheet.

i. All cables shall be supplied in the single largest length to restrict the straight-through joints to the minimum number. Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted. All wires used on the LT side shall conform to IS and should be of appropriate voltage grade. Only copper conductor wires of reputed make shall be used. Straight joint is only applicable on 33 kV step up transformer to control room breaker connectivity.

iv. All wires used for connecting the modules and array should conform to the NEC standards. Modules should be connected with USE-2/RHW-2 cables array to junction box conductors and junction box to photovoltaic disconnector with the THHN/THWN-2 sunlight resistant with 90°C wet rated insulation cable (Other equivalent standards are also acceptable).

v. All high voltage cables connecting the main junction box/string inverters to the transformers should be PVC insulated grade conforming to IS 1554 and cables shall also conform to IEC 60189 for test and measuring the methods.

vi. Irrespective of utilization voltage and current rating all type of power cables shall be minimum of 1100 V grade PVC insulated conforming to IS 1554 / IS 694 for working voltage less than 150 V control cable shall be of minimum 500 V grade, the control and power cable has to be laid separately. All LT XLPE cables shall confirm to IS: 7098 Part I & II. All HT XLPE Cables (33kV) Shall confirm IS: 7098 PART-3 & IEC-60287, IEC-60332 and the Contractor to submit technical data sheet, Voltage drop calculation, Power Loss Calculation and type test report for the approval of client / consultants.

vii. The cables shall be adequately insulated for the voltage required and shall be suitably color coded for the required service. Bending radius for cables shall be as per manufacturer's recommendations and IS: 1255.

Table 5-3 Relevant Codes & Standards for Cable

Sr.	Item	Relevant IS	Relevant IEC
1	Conductors of Insulated Cables	IS: 8130 - 1984	**IEC: 228**
2	Impulse tests on cables and their accessories		**IEC: 230**
3	Extruded solid dielectric-insulated power cables for rated voltage from 1 KV upto 30 KV.		**IEC: 502**
4	Test methods for insulations and sheaths of electric cables and chords.		**IEC: 540**
5	Test on cable over a sheath which has special protective functions and are applied by extrusion.		**IEC: 229**
6	Calculations of continuous current rating of cables (100% load factor).		**IEC: 287**
7	Cross-linked polyethylene insulated PVC sheathed cable for voltage from 3.3 KV upto 33 KV.	IS: 7098 (Part II)	

8	PVC insulation & sheath of electrical cables.	IS: 5831 - 1984
9	Mild steel wires, formed wires and tapes for armouring of cables.	IS: 3975
10	Electrical test methods for electric cables partial discharge test.	**IEC: 885(2) - 1987 (Part II)**
11	Methods of test for cables.	IS: 10810
12	Common test methods for insulating and sheathing materials of electric cables.	**IEC: 811**
13	Impulse test on cables & other accessories	**IEC: 230**
14	Cable termination for gas insulated switchgear.	**IEC: 859**

5.2.5 TECHNICAL SPECIFICATION OF LT XLPE CABLES

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 upto 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 upto 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:

Up to and including 1100 Volts.

5.2.6 TECHNICAL SPECIFICATION OF HT XLPE CABLES

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.

- Voltage grade
- Year of manufacture
- Manufactures name
- Successive Length
- Size of cable
- ISI mark

viii. Packing and marking shall be as per clause No. 18 of IS 7098 (part I)/1988 amended up to date.

ix. 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.

x. 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.

xi. 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.

xii. The wiring for modules interconnection shall be in the GI pipe /HD Pipe of approved make.

xiii. 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.

xiv. Cable end terminations and joint kits shall comply with the latest version of the relevant IS standard.

xv. 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.

xvi. 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.

xvii. **Data sheets of the joints and kits shall be submitted for approval by HPGCL.**

5.2.7 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.

i 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.

ii 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	
•	For connection to ACSR/AAAC/ Aluminum terminal	Aluminum Alloy conforming to designate A6 as per IS 617
•	For connection to copper terminals, with crimping facility to connect ACSR/AAAC jumper	Electrolytic grade copper, forged and tinned
2.	Crimping type connection	

•	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 (525 sq.mm) 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. Not-withstanding anything stated above, the final decision regarding

acceptance of the type of clamps and connectors (conventional/PFWPT type) shall rest with HPGCL

5.2.8 Lightening 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 lightening 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 Lightening 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 Lightening protection system.

iv. The Contractor shall submit the drawings and detailed specifications of the PV array lightning protection equipment to HPGCL for approval before installation of system.

5.2.9 AC Network

i AC converted by the inverter is transmitted through the appropriate cables from the Inverter (1 no. of 1.25 MVA each) to appropriately sized power transformer and from transformer to RMU of the next inverter unit in the loop. (Selection of Transformer above 1.25 MVA is acceptable if the same technically approved and not incurring any extra losses.) RMU panel should consist of adequate size indoor AC bus/ cable, which can handle the current and the voltage safely as per the relevant, IS standards. RMU panel 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. RMU panel shall be provided in Inverter room. It shall have circuit breaker of suitable rating for connection and disconnection of PCU from grid. The busbar shall connect the AC distribution board to the transformer. It shall have provision to measure bus voltage, current and power of the transformer.

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 busbar. The bus-bars joints shall be provided with high tensile steel bolts, bellevelle washers and nuts, so as to ensure good contacts at the joints. The bus-bars shall be colour coded as per IS 375.

iv. **The Bidder shall submit the detailed specifications of the AC bus and panel in the Bid.**

v. The RMU 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.

vi. 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.

vii. The Contractor should submit theoretical design calculations and detailed explanations along with drawings shall be provided and approved by the Company.

33KV SUBSTATION BLOCK FOR 10MW (INFORMATIVE ONLY)

5.2.10 Step-Up Transformer

i. 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 33 kV at the location of the inverter, the solar plant shall be connected to control room. The capacity of the solar plant with provision of rated 33kV Vacuum Circuit Breaker panel with single outgoing connected. Provision of ABT meter will be connected with 33kV VCB panel. Appropriate size for the 6 MW solar photovoltaic power plant. However, design is open for selection of any configuration for the PV Plant.

ii. 3 phase, Oil Filled, 33 kV/, 50 Hz, Power Transformers with min power rating 1.25 times of the selected inverter rating and associated Switchgear of approved make should be utilized. 33 KV transformers can be off-load tap change type. The transformers shall be suitable for outdoor installation with 3 phase 50 Hz 33 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%. (Also 10% overloading criteria recommended as per IS is acceptable. For example, if 1000KW inverter is planned then suitable rating of transformer with 0.9 PF & 90% loading will becoming 1234.57 KVA which is near to 1.25 times).

General Specifications:

i. 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.

iv. Relevant national and international standards in this connection are mentioned in Table 5-6 General Standards for Transformers.

v. 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.

vi. 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 disconnectors (isolators) and earthing switches rating, design, construction, tests etc.
IS: 2705 Part 1 to 4 & IEC: 185	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 than1000 V
IS: 5621	Hollow Insulators for use in electrical equipment
IS: 5556	Serrated lock washers – specification
IEC: 186	Voltage transformer

vi 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.

vii 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.

ix 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.

x The reference ambient temperatures for which the transformers are to be designed are as mentioned in Table 5-7.

xi The rating and electrical characteristics of the MV 33 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	40 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	51.6%
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

Table 5-8 Rating and electrical characteristics of 33kV Power Transformer

Sr.	Particulars	Details
1	Continuous kVA ratings	1.25 times the rated power output of Inverter MVA
2	Type	Oil immersed
3	Frequency	50 Hz
4	Type of cooling	ONAN
5	No. of phases	Three
6	Rating voltage H.V. side	33 kV
7	Highest System voltage on H.V. side	36 kVr.m.s.
8	Rated voltage on L.V. side	LV (Output of the Inverter) kV r.m.s.
9	Vector Group	Dy5/Dy11
10	Connections a) H.V. Winding b) L.V. winding	 Delta Star
11	On / Off 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. Bidders can also use LT XLPE aluminum cable instead of bus duct.

5.2.11 Instrument Transformer

i 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 tank as well as top metallics shall be hot dip galvanized or painted Grey color as per RAL 9002.

- The instrument transformers shall be oil filled 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 500 kg.

5.2.12 Current Transformer

- Current transformers may be either of the bushing type or wound type. The bushing types are normally accommodated within the transformer bushings and the wound types are invariably separately mounted. The location of the current transformer with respect to associated circuit breaker has an important bearing upon the protection scheme as well as layout of, substation. Current transformer class and ratio is determined by electrical protection, metering consideration.

- Technical specifications – Current ratings, design, Temperature rise and testing etc. should be in accordance with IS: 2705 (part I to IV)

Type and Rating

a. The current transformer should be of outdoor/ indoor type, single phase, oil immersed, self-cooled and suitable for operation in 3 phase solidly grounded system.

b. Each current transformer should have the following particulars under the site conditions for the system under design (typical values for 33 kV systems are given).

c. General Parameters: 33kV CT.

d. Each current transformer should have the following particulars under the site conditions for the system under design (typical values for 33kV system are given).

Table 5-9 General parameters for 33 kV CT

Sr.	Particulars	Details
1	Highest system Voltage (Um)	36 kV rms
2	Rated frequency	50 Hz
3	System Neutral Earthing	Effective earthed
4	Installation	Outdoor/indoor(IP 65)
5	Rated short time thermal current	25 kA for 1 sec or appropriate thermal current as per design calculations
6	Rated dynamic current	63 kA (Peak) appropriate dynamic current as per design calculations
7	Rated min power frequency withstand voltage (rms value)	70 kV
8	Rated lightning impulse withstand voltage (peak value)	170 kV
9		

10	Minimum Creepage distance at 32 mm/kV	900 phase to earth
11	Temperature rise	As per -IS 2705/1992
12	Type of insulation	Class A
13	Number of cores	Two (2) with One (1) protection core and one (1) metering core of accuracy 0.5 class
14	CT secondary current	Protection cores – 1 Amp. Metering Core – 1 Amp (With Highest Accuracy Class)
15	Number of terminals in marshalling box	All terminals of control circuits wired up to marshalling box plus 20 terminals spare
16	CT ratio & Rated VA Burden, short time thermal rating ,class of accuracy	Minimum burden required : 1. Metering core – 40 VA 2. Protection core – 10 VA

5.2.13 General Parameters of 33 kV VT

The Bidder has to furnish the specifications of 33kV VT with the Bid.

Table 5-10 General parameters for 33 kV VT

Sr.	Particulars	Details
1	Highest system voltage (Um)	36 kV
2	System neutral earthing	effective earthed
3	Installation	Outdoor (IP 65)
4	System fault level	Appropriate
5	Rated min power frequency withstand voltage (rms value)	70 kV
6	Rated lightning impulse withstand voltage (peak value)	170 kV
7	Standard reference range of frequencies for which the accuracy are valid	96% to 102% for protection and 99% to 101% for measurement
8	Rated voltage factor	1.2 continuous & 1.9 for 30 sec
9	Class of Accuracy	0.5 / 3P, IS3156/1992
10	Minimum Creepage distance at 32 mm/kV	900 phase to earth
11	Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:358
12	One Minute Power frequency Withstand voltage for secondary winding	3 kV rms
13	Temp. rise over an ambient temp. of 50 deg. C	As per IS 3156/1992
14	Number of terminals in control spare.	All terminals of control circuits wired Cabinet up to marshalling box plus 10 terminals
15	Rated total thermal burden	350 VA

16	Number of cores	2 (two) – 1 for protection and one for metering with 0.5 class accuracy.
17	Rated Output, insulation level, transformation ratio, rated voltage factor	Should be provided by the Contractor.

5.2.14 Circuit Breaker

i The circuit breakers shall be capable of rapid and smooth interruption of currents under all conditions completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small currents or leading or lagging reactive currents. The circuit breakers shall be 'Restrike-Free' under all operating conditions. The details of any device incorporated to limit or control the rate of rise of restriking voltage across, the circuit breaker contacts shall be stated. The over voltage across, the circuit breaker contacts shall be stated. The over voltage caused by circuit breaker while switching inductive or capacitive loads shall not exceed 2.5 times the highest phase to neutral voltage. The actual make and break times for the circuit breakers throughout the ranges of their operating duties shall be stated in the offer and guaranteed.

i The arc quenching chambers shall have devices to ensure almost uniform distribution of voltage across the interrupters.

i Appropriate & adequate Capacity 415V AC indoor air Circuit Breaker as per the IEC 60898 / IEC 62271 – 100 or equivalent Indian Standards along with control circuit and protection relay circuit, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

iv. Circuit breaker shall be C2/MI class under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 6 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.

v. The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 33 kV transformers. It shall also be capable of breaking line charging currents as per IEC- 62271-100 with a voltage factor of 1.4.

vi The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC: 62271-100.

vi The Bidder shall indicate in the Bid, the noise level of breaker at distance of 50 to 150 m from base of the breaker.

vi 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 etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non- simultaneity between same pole and poles and show how it is covered in the guaranteed total break time

ix. 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.

x. The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated.

xi. All the duty requirements specified above shall be provided with the support of adequate test reports.

xii. Circuit breaker shall be SF6 / Vacuum type with electrically spring charged mechanism. The operating mechanism shall be anti-pumping and trip free (as per IEC definition) electrically 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. The circuit breaker shall be able to perform the duty cycle without any interruption.

xiii. Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. 'Local / remote' selector switch and close & trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided. The SF6 / VCB coil DC supply through appropriately rated battery bank and charger to be supplied by the Contractor.

xiv. 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.

xv. Mounting and supporting structure for Circuit Breaker. The circuit breakers should be self-supporting type. However, if necessary for the purpose of minimum ground clearance the circuit breakers should be mounted on raised steel structures which should be included in the scope of supply of circuit breaker.

xvi. Following information and data for design of foundations from the supplier of the circuit breaker be obtained.

a. Dead weight per pole for complete circuit breaker.
b. Static bending moments above the feet of each pole and for complete circuit breaker.
c. Static shear force at the foot of each pole and for complete circuit

breaker.

d. Maximum height of the steel supporting structure.

e. Maximum diameter of the pole.

f. Maximum horizontal force acting at upper terminal of each pole due to impact of closing/opening of the circuit breaker.

g. Max. Impact loading in terms of equivalent static load both compression and upward due to opening/closing of the breakers. It shall be clearly stated whether these forces shall act simultaneously or at different timing.

h. No. of steel supporting columns provided for mounting the equipment.

i. The above data should represent static reactions for the worst windage or operation conditions. Circuit breakers whether of self-supporting type or on raised steel structure should ensure minimum sectional clearance (say 3500 mm for 33 kV).

j. Necessary connecting materials such as clamps, bolts, nuts, washers etc. and fixing bolts for mounting the equipment on the supporting structures wherever required should be obtained from the circuit breaker supplier.

xv. **Applicable Standards:** The materials shall conform in all respects to the relevant Indian Standard Specifications/ IEC Standards, with latest amendments indicated below in Table 5-11.

Table 5-11 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: Outdoor/ Indoor Vacuum type Circuit Breaker.

Table 5-12 General Parameters for 33KV Vacuum Type Circuit Breakers

Sr.	Particulars	Details
1.	Type of circuit breaker	Vacuum type
2	Highest System Voltage	36 kV

3	Rated operating voltage	33 kV
4	Rated frequency	50 Hz (+3% to -5%)
5	Number of poles	Three (3)
6	Rated/minimum power frequency Withstand voltage	70 kV
7	Rated lightning impulse Withstand voltage	170 kV
8	Minimum Creepage distance at 32 mm/kV	900 phase to earth
9	Rated operating duty cycle	0 - 0.3 sec. - CO – 3 min. – CO
10	Rated line charging breaking	As per IEC
11	Reclosing	Single and three phase high speed auto reclosing
12	Maximum fault level	25 kA (rms) for 1 sec.
13	Auxiliary contacts	As required plus 6NO and 6NC contacts per pole as spare.
14	Noise level	Maximum 140dB at 50m distance from base of circuit breaker
15	Seismic acceleration	g horizontal

General Parameters for 11KV Vacuum Type Circuit Breakers

Sr.	Particulars	Details
1	Type of circuit breaker	Vacuum type
2	Highest System Voltage	11 kV
3	Rated operating voltage	12 kV
4	Rated frequency	50 Hz (+3% to -5%)
5	Number of poles	Three (3)
	*Other technical parameters will be offered	/indicated by the bidder.

xx General Parameters of SF6 Insulated Ring Main Unit (RMU):

Table 5-13 General Parameters for 33KV SF6 Type RMU

Sr.	Particulars	Details
1	Type of Ring Main Unit	Metal enclosed, compact module, panel type, IEC 62271-200
2	Highest System Voltage	36 kV
3	Rated operating voltage	33kV
4	Rated frequency	50 Hz (+3% to -5%)
5	Number of poles	Three (3)
6	Rated/minimum power frequency Withstand voltage	70 kV
7	Rated lightning impulse Withstand voltage	170 kV
8	Rated Current Busbar	630A
9.	Insulation Gas	SF_6
10	Minimum Creepage distance at 32 mm/kV	900 phase to earth
11	Rated operating duty cycle	0 - 0.3 sec. - CO – 3 min. – CO

12	Rated line charging breaking	As per IEC
13	Reclosing	Single and three phase high speed auto reclosing
14	Maximum fault level	21 kA (rms) for 1 sec. Or appropriate as per design
15	Rated Making Capacity	52 kA
16	Rated Breaking Capacity	21 kA
17	Auxiliary contacts	As required plus 6NO and 6NC contacts per pole as spare.
18	Noise level	Maximum 140dB at 50m distance from base of circuit breaker

xx Co-ordination of rated voltages, short circuit breaking current and rated normal current for guidance as per IS 13118 for rated voltage 33 kV and above as commonly used are as given in Table 5-14

Table 5-14 Circuit Breaker Co-ordination parameters

Rated Voltage (kV)	Rated Short Circuit Breaking Current (kA)	Rated Normal Current (A)				
36	8	630	1250	1600	2500	4000
	16	630	1250	1600		
	40					

xxi Circuit Breaker protection against

- Over Current
- Earth fault
- Under voltage & over voltage protection
- Under frequency & over frequency
- SF6 gas pressure low (where applicable)
- DC supply failure

5.2.15 Protective Relays

i The Solar PV system and the associated power evacuation system interconnections should be protected as per IEC 61727 Ed.2, norms. Over current relays, reverse power relays, differential protection relays (For 6 MVA And Above Transformer Rating) and earth fault relays have to be essentially provided as per technical requirements. All relay should be numerical type & should be remote operating and controlling facility from the control room.

i. The numerical relays shall have RS 485 port for communication.

ii. The operating voltage of the relays shall be 110 V DC/220 V DC as per battery bank rating.

iv. Detailed Design calculations shall be provided on fault power computations and the philosophy of protective relaying with respect to short circuit kA calculations. Design, drawing and model of protection relay shall be approved by the Company/Electricity Authority.

5.2.16 Earthing for PV Array

i. The photovoltaic modules, BOS and other components of power plant requires adequate earthing for protecting against any serious faults as guided by IEC 60364.

ii. The earthing system shall be designed with consideration of the earth resistivity of the project area. The earth resistivity values shall be measured prior to designing the earthing system. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed.

iii. The permissible system fault power level at 33 kV also shall be kept in consideration while designing the earthing system. Each array structure of the PV yard, LT power system, earthing grid for switchyard ,all electrical equipment ,control room ,PCU, All junction boxes, ACDB& DCDB ,all motors and pumps etc .shall be grounded properly as per IS 3043 - 1987. All metal casing / shielding of the plant shall be thoroughly grounded in accordance with Indian electricity act / IE Rules.

iv. The earthing for array and LT power system shall be made of 3.0 m long 40 mm diameter perforated Cu/GI/ chemical compound filled, double walled earthing electrodes including accessories, and providing masonry enclosure with cast iron cover plate having pad-locking arrangement, chemical compound mix as required as per provisions of IS: 3043.

v. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

vi. Each string/ array and MMS of the plant shall be grounded properly. The array structures are to be connected to earth pits as per IS standards. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

vii. The complete earthing system shall be mechanically & electrically connected to provide independent return to earth.

viii. For each earth pit, a necessary test point shall be provided.

ix. In compliance to Rule 11 and 61 of Indian Electricity Rules, 1956 (as amended

up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode.

x The Contractor should submit the earthing system design calculations along with the system layout for the Company's approval prior to the installation of the system

xi Unless otherwise specified, the earthing system primary and secondary grid conductors, equipment connections shall be constructed with galvanized iron flat. However the earthing of transformer neutrals, plc and inverter terminals and electronic earthing shall be provided using copper earthing conductor only.

xii Earthing Mesh is to prepared and installed in entire power plant.

5.2.17 Lightening Protection for PV Plant & Earthing

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 IEC 60099 / IS: 2309 – 1989 (Reaffirmed – 2005), Edition 3.1 (2006-01). Lightening Protection System required for Solar PV Plant, Inverter Room, and Substation Structure & Control Room within the EPC scope of work. The intent of specification can be conventional as per IS : 2309 or can be Early Streamer Emission Type depending upon Area, Protected Equipment & Technical feasibility. Necessary concrete foundation 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. We recommended going with Early Stream Emission Air Terminal Technology as per NFC 17-102 / IEC 62305-2. Level of Protection must be defining as per Rolling Sphere Method LPL-I, LPL-II, LPL-III & LPL-IV where the radius shall be of 20mtr, 30mtr, 45mtr & 60mtr respectively.

i Rp(h) : Protection radius at a given height (h) $Rp(h) = \sqrt{2rh - h2 + \Delta(2r + \Delta)}$ (for $h \geq 5$ m) For $h < 5$ m, refer to the table below h : Height of the OPR tip above the surface(s) to be protected r(m) : Standardized striking distance Δ(m) = 106 .ΔT (OPR efficiency)

OPR radius of protection

Protection level	I (r = 20 m)			II (r = 30 m)			III (r = 45 m)			IV (r = 60 m)		
OPR	OPR 30	OPR 45	OPR 60	OPR 30	OPR 45	OPR 60	OPR 30	OPR 45	OPR 60	OPR 30	OPR 45	OPR 60
h (m)	Radius of protection Rp (m)											
2	19	25	31	22	28	35	25	32	39	28	36	43
3	29	38	47	33	42	52	38	48	58	43	57	64
4	38	51	63	44	57	69	51	65	78	57	72	85
5	48	63	79	55	71	86	63	81	97	71	89	107
6	48	63	79	55	71	87	64	81	97	72	90	107
8	49	64	79	56	72	87	66	82	98	73	91	108
10	49	64	79	57	72	88	66	83	99	75	92	109
15	50	65	80	58	73	89	69	85	101	78	96	111
20	50	65	80	59	74	89	71	86	102	81	97	113
45	43	65	76	58	75	89	75	90	105	89	104	119
50	40	65	74	57	75	88	75	90	105	89	104	119
55	36	65	72	56	75	86	74	90	105	90	105	121
60	30	65	69	52	75	85	73	90	105	90	105	120

ii The lightning conductor shall be earthed through flats and connected to the earth mats as per applicable Indian Standards with earth pits. 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, chemical compound as per provisions of IS.

iii. If necessary more numbers of lightning conductors may be provided as per design calculation

iv. The Contractor shall submit the drawings and detailed specifications of the PV array lightning protection equipment.

v. The design, manufacture, inspection, testing and performance of Lightning Arrester shall comply with all currently applicable statutes, safety codes, provision of latest Indian Electricity Act, Indian Electricity Rules and Regulations of Statutory Authorities.

vi. Contractor shall provide dedicated two earth pits for Lightening Arrestor as per relevant IS standard.

5.2.18 Isolators cum Earthing Switches, Contacts, Insulators, Busbars

i. This specification covers design, manufacture, testing and supply of manually operated 33 KV, 800 Amps Upright mounting type with manually operated with earth switch Isolators. The Isolators and Isolator-cum-Earthing Switched shall comply with the requirements of the IS: 9921 and IEC: 129 (latest edition) except specified herein. The Insulators shall comply with the requirements of IS : 2544 and IEC : 168-1988 (latest edition) for 33 kV pole mounted structure wherever required. 33kV pole mounted structure would be supplied, installed and commissioned by the Contractor wherever required.

i. The isolator shall be of the manual operated type with earthing switches and shall complete with all parts and accessories including insulator operating rods, mounting attachments, necessary for their efficient operation. The equipment shall confirm in all respect to high standards of engineering Equipment shall capable of performing in continuous commercial operation up to the suppliers guarantee in a manner acceptable to the client, The equipment offered shall be complete with all components necessary for its effective and trouble free operation along with associated equipments, interlock, protection schemes, etc. Such components shall be deemed to be within the scope of the Contractor's supply irrespective of whether those are specifically brought out in this specification or not. All similar parts particularly removable ones shall be interchangeable.

i. Each pole shall have three Pedestal type of Insulator's stacks. Necessary arrangements shall be provided for proper alignment of the contacts. Gange operated links shall be so designed that all phases shall make and break simultaneously. The design of Isolators and Isolator-cum-Earthing Switches shall be provided for positive control of blades in all positions with minimum mechanical stress on the Insulators. Fixed guides shall be so provided that proper setting of contacts shall be obtained, when a blade is out of alignment even by 25mm in either direction. All movable parts which may be in current path shall be shunted by flexible copper conductor of adequate cross-section and capacity, which shall be furnished under bill of material.

Service Condition:

The 33 kV triple pole air break isolators are intended to be used primarily for sectionalizing 33 kV UG cable portion of the line with 33 kV overhead portion of the line.

Isolator shall confirm IS: 9921(Part 1 to 4) & IEC 600 - 129 "alternating current disconnects (Isolators) and earthing switches", and IS 9921 (Part-I to IV) "Specification for alternating current disconnects (isolators) and earthing switches for voltages above 1000V"

a. The moving & fixed contacts shall be made of hard drawn electrolytic grade copper strips and shall be heavy duty self- aligning & high pressure type preferably which applies pressure to the contact surfaces after the blades are fully closed and release the pressure before they start to open. High pressure type contacts shall wipe the contact surfaces, while opening and closing. The contacts shall be so designed that wiping, action shall not cause securing or abrasion on the contact surfaces. The wiping action shall be sufficient to remove oxide film, formed during the operation of the switches. The pressure shall be developed by rotation of the entire blade.

b. The temperature rise of contacts due to the flow of rated short circuit current for a period of 3 seconds shall not cause any annealing or welding of contacts.

c. The moving contacts, if provided, shall close first and open last so that no damage is caused due to arcing whatever to the main contacts. **The Successful Bidder shall give full details of such contacts with necessary drawings.**

d. The arcing contacts, if provided shall close first and open last so that no damage is caused due to arcing whatever to the main contacts. The Contractor shall give full details of such contacts with necessary drawings.

e. The female contact and its tensioning by spring shall be such that there will, always, be a positive contact with adequate pressure to give enough contact surface for the passing of current. The springs provided should not go out of alignment or get entangled with the male contact during operation. The details of springs shall be furnished on the G.A. drawing.

INSULATORS: The isolator shall be provided with solid core insulators.

i. These shall be of stacking type to be used. The dimensions and other parameters unless otherwise specified shall generally conform to IS - 5350-Part-11 & IEC 273.

ii. The cylindrical type post insulators shall be of solid core type. Insulators of similar type shall be interchangeable. The mechanical strength class for outdoor cylindrical post insulators shall be of strength class 6, corresponding mechanical strength in tension, compression and torsional shall be as per IS : 53550 Part - II. When operated at maximum system voltage, there shall be no electrical discharge. Shielding rings, if necessary shall be provided.

iii. The parameters of the insulators required shall conform to IS : 0350 - Part - II - 1973 or IEC 273.

iv. The cylindrical post insulators shall consist of single unit only.