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Technical specification

for

33kV Outdoor Metal Clad HT Switchgear (VCB) panels

for

100 MWp & 75 MWp Solar Photovoltaic Grid-connected Power plant

at

Raghanesda and Dhurvaran, Gujrat

Approved by:			
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1.0 Introduction

This specification is for 3-phase, 3-wire, 33 kV Metal Clad outdoor type HT panels with vacuum circuit breakers (VCBs), Bus PT Panels for **100MWp & 75MWp solar photovoltaic power plant at Raghanesda & Dhuvaran, Gujrat.** These VCB panels provide metering and protection for the 33 kV power line and the 5700 kVA (33kV on HV side), 3-phase, 3-winding, oil-immersion type, transformers (35 nos). Spares (Mandatory & Recommended) and accessories required for trouble free operation of the panels are also part of this specification.

1.1 Reference standards

1	IS: 996	Single Phase small AC and universal electric motors
2	IS: 722	AC Electricity Meters
3	IS: 1248	Direct Acting indicating analogue electrical measuring instruments and accessories
4	IS: 722	AC electricity meters.
5	IS: 996	Single phase small AC and universal electrical motors.
6	IS: 1248	Direct Acting indicating analogue electrical measuring instruments and Accessories.
7	IS: 13947	Degree of protection provided by enclosures for low voltage switchgear and control gear.
8	IS: 2544	Porcelain post insulators for systems with nominal voltages greater than 1000 Volts.
9	IS: 2705	Current transformers.
10	IS: 3156	Voltage Transformers
11	IS: 6005	Code of practice for phosphating of iron and steel.
12	IS: 5082	Specification for wrought aluminium and aluminium alloy bars, rods, tubes and selections for electrical purposes.
13	IEC: 61850	Communication Standard for Numerical relays
14	IEC: 61131-3	Automation Standard for Numerical relays
15	IS: 9046	AC contactors for voltages above 1000 volts and upto and including 11000 Volts.
16	IS: 13703	Low voltage fuses
17	IS: 9385	HV fuses
18	IS: 9431	Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 volts upto and including 300 kV
19	IS: 9921	A.C. disconnectors (isolators) and Earthing switches for voltages above 1000 V
20	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
21	IS: 13118	Specification for high voltage AC circuit breakers.
22	IEC: 60099-4	Metal oxide surge arrestor without gap for AC system
23	IS/IEC: 62271-100	High voltage alternating current circuit breakers.
24	IS/IEC: 62271-200	High voltage metal enclosed switchgear and control gear.
25	IEC: 60947-7-1	Terminal blocks for copper conductors
26	IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips

27	IEC:337 & 337-1	Control switches (LV switching devices for control and auxiliary circuits)
28	IS: 375	Marking and arrangement for switchgear bus bars, main connection and auxiliary wiring

1.2 Enclosed documents:

(a) Single line diagram (SLD) for the overall 100MWp power plant at Raghanesda vide BHEL drawing Rev 02 (Annexure-1):

(b) Single line diagram (SLD) for the overall 75MWp power plant at Dhuvaran vide BHEL drawing Rev 00 (Annexure-2)

1.3 Configuration & Location of the HT Panels:

(a) 33 KV VCB Stand alone Panel – 28 nos(16 nos for 100MW & 12 nos for 75MW Plant)
Location: In decentralized Inverter Block for 5MW Block 1 to 4 (except block 5) described in clause 5.0

(b) 33KV Main VCB Panels for 25MW pooling switchgear – (5I/C + 1 O/G + 1BUS PT)
7 nos(4 Nos for 100MW & 3 Nos for 75 MW plant)
Location: In decentralized Invertor Block for 5MW block 5 described in clause 6.0

(c)33KV VCB panels for 75MW combiner station at GSECL DHUVARAN Project 1 NO.
(3 I/C + 1 O/G + 1 BPT + 1 AUX Trx)
Location : In final evacuation point of 75MW described in clause no 7.0

(d)33KV VCB panels for 50MW combiner station at GSECL RAGHANESDA Project 2 NO
(2 I/C + 1 O/G + 1 BPT + 1 AUX Trx(for any one of the set))
Location : In final evacuation point of 100MW described in clause no 8

1.4 Two part bid:

The vendors are required to submit the offer in two parts viz. technical and price bids. Instructions to the vendors on bid submission are provided in a separate clause of this specification. Further, vendor shall go through the tender document that provides complete instructions and guidelines.

1.5 Clause-wise acceptance of this technical specification:

Vendors shall indicate their acceptance against each clause of this specification, in the column provided on the right side. In case of non-acceptance or deviation, vendors shall indicate and offer their comments.

2.0 Scope of supply

#	DESCRIPTION	Quantity
2.1	**Main equipment**	
2.11	**33 kV, 630A outdoor type HT Switchgear (VCB) Standalone for**	**28 Panels**

	5MW BLOCK 1 TO BLOCK 4 Panels –	**To be quoted on per Panel basis**
2.12	**33 kV,630A Outdoor type HT Switchgear (VCB) Panels – Main Panel** Consisting of 5 Incomers , 1 main outgoer Panel, and 1 Bus PT Panel (located near Central Control Room)	**7 Set** **(Each set consisting of 7 nos of Panels)** **to be quoted on per set basis**
2.13	33KV VCB panels for 75MW combiner station at GSECL DHUVARAN Project Consisting of 3 Incomers , 1 main outgoer Panel, 1 Bus PT Panel and 1 Aux Transformer : Located In final evacuation point of 75MW	**1SET** **(consisting of 6 nos of Panels)** **to be quoted on per set basis**
2.14	33KV VCB panels for 50MW combiner station at GSECL RAGHANESDA Project Consisting of 2 Incomers , 1 main outgoer Panel, 1 Bus PT Panel and 1 Aux Transformer(for any one set) :	**2SET** **(1 set consisting of 5 nos of Panels other one 4 nos of panel)** **to be quoted on per set basis**
2.2	**<u>Spares & Accessories</u>** **<u>1set consist of below mentioned BOQ</u>**	**2 set** To be quoted on per set basis with item-wise break-up prices.

#	Item	Qty
1	**Mandatory Spares**	
a)	Surge Arrestor / MOV	5% of total population of each type
b)	MCBs	5% of total population of each type
c)	Vacuum Interrupter	1 Nos
d)	CT – 600/1A	2 Nos
e)	CT – 120/1A	2 Nos
f)	Bus PT	2 Nos
g)	Line PT	2 Nos
h)	Spring charge motor	5 Nos
i)	Tripping coil	5 Nos
j)	Closing coil	5 Nos
k)	Digital voltmeter	1 No
l)	Indicating Lamps and Push-Buttons	30% of total population
m)	HT fuse - Primary (33kV)	10 nos

	n)	Control Fuses (HRC, etc)	5 nos. of each type and rating		
	o)	Switches – ON/OFF, Limit, BCS etc	1 no. of each type and rating		
	2	**Accessories**			
	a)	Earthing trucks Cable side earthing truck – 1 no Busbar side earthing truck - 1 no	1 Set		
	b)	VCB draw-out handle	12 nos		
	c)	Spring charging handle	12 nos		
	d)	Ramp	12 nos		
	e)	Door Keys	12 nos		

	Notes: (a) The above spare quantities are for contingency purposes over and above the warranty requirements. (b) "Population" stands for total quantity of the item used in the complete supply. (c) Where % qty is a decimal, same shall be rounded off to the next higher whole no. (d) Item-wise break-up prices shall be provided. (e) Successful vendor shall indicate the total quantity used in the complete supply for verification of % qty.	
2.3	**Installation and commissioning of HT Switchgear** **BHEL scope** of activities at site for installation and commissioning: (1) Movement and positioning of HT panels at the earmarked position in the inverter control rooms. (2) Making power cable interconnections between HT Panels and SCADA/ACDB/DCDB/Transformers. **Vendor scope** of activities at site for installation and commissioning: Vendor shall provide support to BHEL at the time of Installation of the HT panels at the project site. Accordingly, vendor shall depute I&C / service engineer to the site. a) Vendor shall carry out all electrical and mechanical interconnections within and between the HT panels. b) Vendor shall provide guidance / support for electrical interconnection of the HT panels with marshalling boxes of the ten transformers: For this, cables, cable glands, cable lugs, ferrules, cable ties will be provided by BHEL. Cable laying between HT panels and marshalling boxes will be within BHEL scope. Marshalling box drawing will be provided by BHEL. Whereas, cable crimping, routing within the panels, dressing and connections shall be provided by vendor. **Note:** Vendor shall indicate to BHEL the type and size of cables and lugs that will be required for this purpose within one	1 AU

	week after placing purchase order. Cable length will be decided by BHEL based on actual locations of panels and transformers at the site and the distance between them. c) Inter-panel simulation checks (HT panel to marshalling box of transformers) to confirm correct operation of the panel relays and interlocks. Vendor shall rectify, in case of any problems (for example, related to wiring, circuits, meters, relays, spring charge motor, etc.), observed during such functional checks. d) Megger / insulation / earthing checks and other electrical inspection checks on the HT panels after the installation. e) In addition, presence of service person at the site is required during commissioning of power plant to ensure that any technical problems encountered with HT panels is attended to and resolved immediately. A single lump-sum price for commissioning of all HT Panels in the total scope of supply shall be offered. The lump-sum price shall include all the costs that will be incurred by the vendor towards commissioning including travel, boarding, lodging and any other contingency expenses.	
2.4	**Warranty** Vendor shall provide warranty for **120 months** from the date of commissioning or **126 months** from the date of supply, whichever is earlier. Vendor shall enclose, along with technical bid, the complete scope, terms and conditions of the warranty. During the warranty period, whenever a technical problem is encountered with the HT Panels, BHEL will report the same to the vendor. Vendor shall ensure that the problem is attended to by their service engineer within two days from the date of reporting.	

3.0 INSTRUCTIONS TO VENDORS FOR BID SUBMISSION

3.1	- Offer shall be submitted in two-parts (Two part-bid). - Both parts to be in separate sealed envelopes as per instructions in tender. - The individual envelops shall, further, be enclosed in a common bigger envelope with markings (address, etc) as per instructions provided in tender.
3.2	First-part shall be techno-commercial bid. Following details shall be furnished: (a) Technical offer (b) Filled-up enclosures as per BHEL formats (meant for first-part) provided in tender. (c) Vendor has to enclose the deviation sheet clause wise separately in case any deviations are sought by the vendor. Absence of any deviation sheet shall be taken as compliance of BHEL specification in total without any deviation (d) Typical Overall General Arrangement for the panel. (e) List of spares offered, with item-wise quantity and without prices. (f) Type test certificates for 33kV VCB panels. See respective clauses.

3.3	Second-part shall be price bid with filled up enclosures as per BHEL formats provided in tender.
3.4	In addition to the above instructions, tender document provides detailed instructions for bid submission. Vendor shall submit the bid based on instructions in tender document.

4.0 Outdoor HT Switchgear (VCB) panels – General specifications

From this clause onwards, vendors shall indicate their compliance on the column provided on right side. In case of non-compliance or deviation, vendors shall indicate and offer their comments.

4.1 Panel enclosure

#	**BHEL specification**	**Vendor compliance** **(Yes / No)** **In case of non-compliance or deviation, comment shall be provided by vendor.**
a)	Installation: Outdoor	
b)	Protection Class: IP65 or better for Relay/PT compartment IP5X or better for all other compartments All louvers, if provided, shall have very fine brass or GI mesh screen. Tight fitting gaskets are to be provided at all openings in relay compartment. Numerical relays shall be flush mounted on the switchgear panels at a suitable height.	
c)	Paint Shade: Front & Rear (External and Internal) – RAL 9002 (Grey) End Covers (External and Internal) – RAL 5012 (Blue) All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder coating specification, seven tank process). The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.	
d)	Enclosure shall be made of rolled MS sheet / Aluzinc sections. Doors and covers shall be constructed from cold rolled steel sheets of thickness of 2 mm (minimum). Gland plates shall be 2.5 mm thick if made out of hot rolled or cold rolled steel sheets and for non-magnetic material it shall be 3.0 mm.	

e)	Base frame / channel (MS) with suitable anchor bolts and other hardware for welding of the grouting of the base frame shall be provided for all the panels.	
f)	View glass on the front door to see VCB ON/FF/Spring charged status.	
g)	Danger boards shall be fixed on the front door, for all the panels.	
h)	Name Plate and Labels: All panels shall be identified on front as well as backside by large engraved name plates giving the distinct feeder description along with panel numbers. Back side name plates shall be fixed in panel frame and not on the rear removable cover. Name plate shall be of non-rusting metal or 3-ply lamicoid with white engraved letterings, on black background. Inscriptions and lettering shall be subjected to Employer's approval.	
i)	Lifting hooks: Adequate number of lifting hooks shall be provided at the top of the panel to facilitate lifting and movement of the panels.	
j)	Doors shall be provided with suitable locks and keys, for all the panels.	
k)	The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction complying with clause No. 3.102 of IEC 62271-200, comprising of a row of free standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main busbars and auxiliary control devices. The adjacent panels shall be completely separated by steel / Aluzinc sheets except in busbar compartments where insulated barriers shall be provided to segregate adjacent panels. The Service Class Continuity of Switchgears shall be LSC 2B-PM (as per IS/ IEC 622771-200). However, manufacturer's standard switchgear designs without interpanel barriers in busbar compartment may also be considered	
l)	The circuit breakers and bus PT shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position. For complete withdrawal from the panel, the truck shall rollout on the floor or shall roll out on telescopic rails. In case the later arrangement is offered, suitable trolley shall be provided by the Bidder for withdrawal and insertion of the truck from and into the panel. The number of trolleys to be provided shall be as specified. Testing of the breaker shall be possible in Isolated position by keeping the control plug connected.	
m)	The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck in any position SERVICE, ISOLATED or removed, and all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets.	

n)	The Switchgear shall have an Internal Arc Classification of IAC FLR 10kA minimum for 0.1s. The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panels shall be specially designed to withstand these. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of protection of panels under normal working conditions. To demonstrate that the pressure relief device operates satisfactorily, the vendor shall carryout the test in line with IEC 62271-200 as a type test (also indicated under relevant testing clause). Wherever louvers are provided, the construction of louvers should be such that the IAC requirements are satisfied. Further, viewing glass windows shall have the same strength as the enclosure against Internal Arc.	
o)	Necessary guide channels shall be provided in the breaker compartments for proper alignment of plug and socket contacts when truck is being moved to SERVICE position. A crank or lever arrangement shall preferably be provided for smooth and positive movement of truck between Service and Isolated positions.	
p)	Safety shutters complying with IEC 62271-200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. In case, insulating shutters are provided, these shall meet the requirements of IEC 62271-200 and necessary tests as per IEC 62271-200 Clause 5.103.3.3 shall be carried out. A clearly visible warning label "Isolate elsewhere before earthing" shall be provided on the shutters of incoming and tie connections which could be energised from other end.	
q)	Switchgear construction shall have a bushing or other sealing arrangement between the circuit breaker compartment and the busbar / cable compartments, so that there is no air communication around the isolating contacts in the shutter area with the truck in service position.	
r)	The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors. Busbar and cabling compartments provided on the rear side shall have separate bolted covers with self retaining bolts for easy maintenance and safety. Breaker compartment doors shall be provided with single-shot latch type handle and shall have locking facility. Suitable interlock shall be provided, which will ensure that breaker is OFF before opening the back doors. Suitable interlock shall be provided to prevent opening of any compartment doors which has any of the HT equipment, in case the incoming supply is ON.	

s)	In the Service position, the truck shall be so secured that it is not displaced by short circuit forces. Busbars, jumpers and other components of the switchgear shall also be properly supported to withstand all possible short circuit forces corresponding to the short circuit rating specified.	
t)	Limiting Dimensions: The height of switches, pushbuttons and other hand operated devices shall not exceed 1800mm and shall not be less than 700mm.	

4.2 Termination provisions for panels

a)	i) For VCB Panels placed in Inverter room incoming / outgoing termination shall be Rear and bottom entry. Both incoming and outgoing termination shall be through 1Rx1Cx300 sq-mm per phase, 33kV grade, aluminum conductor, armoured, XLPE insulation cable.4I/C ONE O/G panel placed near invertor room incoming cables are 1RX1CX300 sqmm per phase and out door is 1R X1C X630 sqmm per phase ii) For VCB Incomer Panel placed near Central Control Room incoming termination shall be through 1Rx1Cx630 sq-mm per phase, 33kV grade, aluminum conductor, armoured, XLPE insulation cable, and outgoing termination shall be through Al. busbar iii) For VCB outgoer Panel placed in Central Control Room incoming termination shall be through Al. Bus Bar and outgoing termination shall be through 2Rx1CX630 sq-mm per phase, 33kV grade, aluminum conductor, armoured, XLPE insulation cable.	
b)	<u>HT Cable terminations:</u> HT cable terminations shall be suitably provided for 1Rx1Cx300 (630) sq-mm, 33kV grade, aluminum conductor, armoured, XLPE insulation cable. Cables and termination kits, cable glands, cable lugs and connecting hardware shall be in BHEL scope. Final confirmation on the cable type and size selected shall be informed during drawing approval stage. A minimum clearance of 750mm shall be kept between cable lug bottom ends and gland plates for cable entry and termination.	
c)	For cable entry, gland plates shall be as per clause 4.1(d). Gland plates shall be provided with holes to match the entry of power and control cables.	
d)	BHEL will intimate the final sizes of power cables to the vendor at the time of panel construction. As regards control cables, vendor shall indicate the type and cable size for interconnection with SCADA panel, marshalling box of transformer, Battery (110V DC supply) and ACDB	

	panel (240V AC supply). BHEL will accordingly procure the cables.	

4.3 Bus bar specification:

a)	(i) Bus bar material: High conductivity Aluminium conductor (ii) Bus bar rating: 630A, 25 kA / 3 second (iii) Bus bar size: For main busbar and earth busbar – Of suitable size to meet functional requirement. Vendor to indicate size in the GTP during submission of technical offer. Busbar sizing calculations shall be provided by the successful vendor during detailed engineering. (iv) Bus bar insulation: PVC sleeved and colour coded.	
b)	Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage. Contact surfaces at all joints shall be properly cleaned and non-oxide grease applied to ensure an efficient and trouble free connection. All bolted joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance. Bimetallic connectors or any other technically proven method shall be used for aluminum to copper connections.	
c)	Busbar insulators shall be of arc and track resistant, high strength, non-hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100pico coulomb at rated voltage x 1.1 /√ 3. Use of insulators and barriers of in-flammable material such as Hylam shall not be accepted.	
d)	Successful Bidder shall furnish calculation establishing adequacy of busbar sizes for the specified continuous and short time current ratings.	

e)	The temperature of the busbar and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of relevant Indian Standards, duly considering the specified ambient temperature (50 deg.C). The temperature rise of the horizontal and vertical busbars when carrying the rated current shall in no case exceed 55 deg. C for silver plated joints and 40 deg. C for all other type of joints. The temperature rise at the switchgear terminals intended for external cable termination shall not exceed 40 deg. C. Further the switchgear parts handled by the operator shall not exceed a rise of 5 deg.C. The temperature rise of the accessible parts / external enclosure expected to be touched in normal operation shall not exceed 20 deg.C	

4.4 Earthing and Earthing Devices

a)	A copper / galvanized steel earthing bus shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.	
b)	The earth bus shall have sufficient cross section to carry the momentary short-circuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise.	
c)	Suitable arrangement shall be provided at each end of the earth bus for bolting to electrodes of earthing chamber. All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.	
d)	All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical continuity of the whole switchgear enclosure frame work and the truck shall be maintained even after painting.	
e)	The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. SERVICE and ISOLATED as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.	

f)	All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. Looping of earth connections which would result in loss of earth connection to other devices, when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.	
g)	VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.	
h)	Separate earthing trucks shall be provided by the vendor for maintenance work. These trucks shall be suitable for earthing the switchgear busbars as well as outgoing / incoming cables or busducts. The trucks shall have a voltage transformer and an interlock to prevent earthing of any live connection. The earthing trucks shall in addition have a visual and audible annunciation to warn the operator against earthing of live connections.	
i)	Interlocks shall be provided to prevent : 1) Closing of the earthing switch if the associated circuit breaker truck is in Service position. 2) Insertion of the breaker truck to Service position if earthing switch is in closed position. 3) Closing of the earth switch on a live connection. Three (3) nos. voltage capacitive dividers shall be provided on each phase of the section intended for earthing and three (3) nos. "RED" neon lamps connected to these on the panel front for visual indication. 4) Energising an earthed Section. Complete details of arrangement offered, describing the safety features and interlocks shall be provided by successful bidder.	
j)	The earthing device (truck / switch) shall have the short circuit withstand capability equal to that of associated switchgear panel. 4 NO + 4 NC of auxiliary contacts of the earthing device shall be provided for interlocking purpose.	
k)	All hinged doors shall be earthed through flexible earthing braid.	

4.5 Wiring and Ferrules

a)	All wiring shall be with 1100 V single core stranded copper wires with fire resistant material (HR-PVC-105 ^{o}C or equivalent) insulation.	

b)	CT circuits : 2.5 sq-mm control cable Other circuits: 1.5 sq-mm control cable These control cables shall be of 1100V grade PVC insulated, stranded, copper conductor.	
c)	Each wire shall be identified at both ends with permanent markers bearing wire numbers as per wiring diagram.	
d)	Wire termination shall be done with crimping type connectors with insulating sleeves.	
e)	Wires shall not be spliced between terminals.	
f)	All spare contacts shall be wired up to terminal blocks.	
g)	Control wiring – LT: All control wiring shall be terminated using eye type tinned copper lugs onto stud type terminals. More than 2 wires shall not be terminated onto a single terminal.	
h)	Control wiring – HT: Cables, when laid in HT bus bar chamber, shall be taken through PVC conduits. No joints or Ts shall be made in wires between terminals. Equipotential terminals shall have same ferrule nos.	
i)	All ferrules shall be made of non-deteriorating materials. They shall be white in color except in case of warning ferrules which shall be red in color. Ring type ferrules shall have the character engraved on it. Ferrules shall be firmly secured.	

4.6 Control and circuit protection

a)	All incoming control power circuits shall be fed through suitably rated incomer MCB.	
b)	Necessary circuits such as closing coil with anti-pumping circuit, tripping coil circuit, control circuits (motor, heater, etc.) and lamp indications circuit shall be provided. Each circuit shall be protected by independent fuses.	
c)	All fuses shall be HRC with insulating base and holder.	
d)	Fuses shall be easily accessible when standing on the floor.	
e)	Trip circuit supervision scheme shall be provided for each circuit breaker. The scheme shall be such that it will be possible to test the healthiness of the trip circuit irrespective of whether the breaker is in the closed or open condition.	

4.7 Interlock provisions required in operating the VCB, Bus PT panels

a)	**<u>Interlock logic for the individual incomer panels in central control room:</u>** 1) With L/R switch in local position, incomer VCB can be closed through BCS in test position. 2) With L/R switch in local position, incomer VCB cannot be closed through BCS in service position. 3) Incomer VCB can be closed only when it is in service position with L/R switch in remote position and with the outgoer in service position & also in ON condition. 4) Incomer VCB cannot be closed when it is service position with L/R switch in remote position and with the outgoer in service position & also in OFF condition.	

b)	**Interlock logic for the outgoer panels:** 1) With L/R switch in local position, outgoer VCB can be closed through BCS in test position. 2) With L/R switch in local position, outgoer VCB cannot be closed through BCS in service position. 3) Outgoer VCB can be closed only when it is in service position with L/R switch in remote position and with all the five incomer VCBs in OFF condition.	
c)	**Interlock logic for the BusPT panel:** All the incomer VCBs shall be tripped upon fault sensing and activation by undervoltage / overvoltage relay (27/59) in BusPT panel.	
d)	While incomer / outgoer VCB is ON, it shall not be possible to insert the racking handle.	
e)	Incomer / outgoer VCB movement from test to service (and vice versa) shall be possible only when the VCB is in OFF condition.	
f)	It shall not be possible to close the incomer / outgoer VCB when it is in between test and service positions.	
g)	The circuit breaker will normally be controlled from remote control panels through closing and shunt trip coils. The Local control console of the relay flush mounted on the switchgear would normally be used only for testing of circuit breaker in isolated position, and for tripping it in an emergency. The closing and opening of the breaker shall also be possible from the Laptop through front serial port of the relay to facilitate commissioning activities. The basic control scheme shall be developed in the numerical relay using programmable (soft) logics. Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. Each panel shall have two separate limit switches, one for the Service position and the other for Isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions. Auxiliary Contacts of breaker may be mounted in the fixed portion or in the withdrawable truck as per the standard practice of the manufacturer, and shall be directly operated by the breaker operating mechanism. Auxiliary contacts mounted in the fixed portion shall not be operable by the operating mechanism, once the truck is withdrawn from the service position, but remain in the position corresponding to breaker open position. Auxiliary contacts mounted on the truck portion, and dedicated for customer's use shall be wired out in series with a contact denoting breaker service position. With truck withdrawn, the auxiliary contacts shall be operable by hand for testing. There shall be at lease 6 NO and 6 NC breaker / contactor original Auxiliary contacts made available for the customer's use.	

	The contacts of all limit switches and all breaker auxiliary contacts located on truck portion and fixed portion shall be silver plated, rated to make, carry and break 1.0A 240V DC (Inductive) / 10A 240V AC. Contacts of control plug and socket shall be capable of carrying the above current continuously. Movement of truck between SERVICE and ISOLATED positions shall be mechanically prevented when the breaker is closed. An attempt to withdraw a closed breaker shall not trip it. Closing of the breaker shall be possible only when truck is either in ISOLATED or in SERVICE position and shall not be possible when truck is in between. Further, closing shall be possible only when the auxiliary circuits to breaker truck have been connected up, and closing spring is fully charged. It shall be possible to easily insert breaker of one typical rating into any one of the panels meant for same rating but at the same time shall be prevented from inserting it into panels meant for a different type or rating. Indications shall be provided in the relay console flush mounted on the panel front as brought out in the specification elsewhere. It shall be possible to easily make out whether the truck in SERVICE OR ISOLATED POSITION even when the compartment door is closed.	

4.8 Supply voltage details:

a)	BHEL draws auxiliary power supply from the grid through a 33kV/415V transformer for consumption of utility power. This is also used to charge 2 nos. of 220V/150AH (min) lead acid battery using a battery charger. Accordingly, following supply will be available at the plant: (i) AC Auxiliary Supply: 240V AC 1 no. of 240VAC,1 Ph, 50 Hz, 63A shall be provided for space heater supply. Vendor shall provide necessary switch and fuse to receive, isolate and distribute to each panel. (ii) DC Auxiliary Supply: 110V DC Note: However, selection of supply (110VDC or 240V AC) for motors, coils, meters, relays, lamps, heaters, etc. shall be as mentioned under technical sections of incomers, outgoers, Bus PT panels. Scope of cables, lugs, glands and hardware shall be in BHEL scope.	
b)	Each sub circuit shall have separate fuses. Fuse size shall be determined so as to achieve selective clearance between main circuit and sub circuit in case of fault. Potential circuits for protection and metering shall also be protected by separate fuse. All fuses shall be of HRC link type conforming to IS: 13703 / 9385 mounted on suitable fuse bases. Fuses shall have operation indicators for indicating blown fuse condition.	

	Fuse carrier base shall have imprints of the fuse rating and voltage. All accessible live connection to fuse bases shall be adequately shrouded. All DC circuits shall be fused on both poles. Single phase AC circuits shall have fuses on line and link on neutral.	
c)	110V AC supply, wherever required, shall be drawn from secondary of Bus PT.	

4.9 Space Heater

a)	Each switchgear panel shall be equipped with thermostatically controlled space heater(s), suitably located in breaker and cable compartments to prevent condensation within the enclosure. The space heater shall be connected to 240V single phase AC auxiliary supply available in the switchgear, through switches and fuses provided separately for each panel.	
b)	A 240V single phase 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF switch for connection of hand lamp.	

4.10 Terminal Blocks

a)	Terminal blocks shall be 650V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design.	
b)	Terminal blocks for CT and VT secondary leads shall be of stud type, made up of unbreakable polyamide 6.6 grade. They shall be provided with links to facilitate testing, isolation star / delta formation and earthing. Terminal blocks for CT secondary shall have the short circuiting facility. The terminals for remote ammeter connection etc. shall also be disconnecting type only. All metal parts shall be of non-ferrous material. Screws shall be captive.	
c)	At least 10% spare terminals for external connections shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available in each panel.	
d)	There shall be minimum clearances of 250 mm between the terminal blocks and the cable gland plate and 150 mm between two rows of terminal blocks.	

e)	All panel wring for external connections shall terminate on separate terminal blocks which shall be suitable for connecting two (2) stranded copper conductors of 2.5 sq. mm on each side, or alternatively, the terminal blocks shall have the possibility of double shorting space to facilitate looping.	

4.11 Circuit Breakers

a)	The circuit breakers shall be of Vacuum type. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism	
b)	Circuit breaker shall be restrike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti-pumping features. An arrangement of two breakers in parallel to meet a specified current rating shall not be acceptable. .	
c)	During closing, main poles shall not rebound objectionably and mechanism shall not require adjustments. Necessary dampers shall be provided to withstand the impact at the end of opening stroke. Slow closing facility shall preferably be provided for checking and adjustment of arc chutes and poles when the breaker is completely withdrawn and isolated.	
d)	Plug and socket isolating Contacts for main power circuit shall be silver plated, of self-aligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material. Plug and socket contacts for auxiliary circuits shall also be silver plated, sturdy and of self aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.	
e)	All working part of the mechanism shall be of corrosion resisting material. Bearings which require greasing shall be equipped with pressure type grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately secured and locked to prevent loosening or change in adjustment due to repeated operation of the breaker and the mechanism.	
f)	The operating mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and shall not lead to closing or tripping of circuit breaker. Failure of any auxiliary spring shall also not cause damage to the circuit breaker or endanger the operator.	
g)	Mechanical indicators shall be provided on the breaker trucks to indicate OPEN / CLOSED conditions of the circuit breaker, and CHARGED / DISCHARGED conditions of the closing spring. An operation counter shall also be provided. These shall be visible without opening the breaker compartment door.	

h)	The rated control supply voltage shall be as mentioned under relevant clause of this specifications. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between 80-110% of DC Supply voltage. The shunt trip coil shall operate satisfactorily under all operating conditions of the circuit breaker upto its rated short circuit breaking current at all values of control supply voltage between 50-110% of DC supply voltage. The trip coil shall be so designed that it does not get energised when its healthiness is monitored by two indicating lamps (Red) and one trip coil supervision relay.	
i)	The breaker shall normally be operated by remote electrical control with electrical tripping by shunt trip coil. Provision shall be made for local electrical operation and mechanical operation.	
j)	Local / Remote selector switch of “stay-put” type. The selection of ‘local’ operation shall inhibit the operation of breaker from any remote source.	
k)	Emergency trip device, manually operated, shall be provided to facilitate manual operation in the event of failure of electrical supplies. The device shall be accessible without opening any access doors and distinctly labeled. It shall be shrouded and protected against inadvertent operation.	
l)	Provision for manual operation of these circuit breakers during failure of auxiliary power in addition to electrical operation.	

5.0 VCB Panels (SPV side): 28 panels (For 5MW block 1 to 4 as per SLD)
(28 panels in Inverter Rooms as per Clause 1.3.(a))

Each panel shall consist of following minimum provisions. Additional or alternate provisions, if any, as applicable to the specific design and operational requirements of panel, shall be indicated in the offer.

Note: In case of disparity in parameter values between SLD and this section, SLD values shall be considered as final.

5.1	Vacuum circuit breaker (Draw-out / isolation type), fitted with manual / motor operated spring charging mechanism with 110V DC motor and motor control switch, shunt trip coil (110V DC) and closing coil (110V DC) and auxiliary contact (6NO+6NC), mechanical ON/OFF indicator, mechanical operation counter, anti-pumping feature, automatic safety shutters and push button. Other details in line with relevant clause for 'Circuit Breakers'	33kV, 630A, 25 kA / 3 sec	1 No.	
5.2	Current Transformer, single phase, resin cast, 3 core: Ratio: 120 / 1-1 A Core-1: Cl-5P20; 5 VA for metering Core-2: Cl-0.5S; 5 VA for protection	33kV, 25 kA /3 sec	3 Nos (one per phase)	
5.3	Line PT – Required – 2 core Single phase, resin cast, fixed type Core -1 Cl: 0.5, 50VA, Core -1 Cl: 3P, 50VA,	33kV/√3/(110/√3)/(110/√3)	3 Nos (one per phase)	
5.4	Surge Arrestor	30kv ,10KA,CLASS III	3 Nos (one per phase)	
5.5	**Relays**			

a)	Numerical non-directional IDMT combined 3 O/C + 1 E/F Relay with IEC 61850 port (for interfacing with SCADA);	**Relay 50 / 51** **(R Y B N)** 110V DC	1 No.	
b)	Numerical UV/OV Relay with IEC 61850 port (for interfacing with SCADA);	**Relay 27/59** 110V DC	1 No.	
b)	Master trip relay, Electromagnetic relay Note: This can also be a built-in feature of main protection relay.	**Relay 86;** 110V DC	1 No.	
c)	Trip circuit supervision relay, Electromagnetic relay Note: This can also be a built-in feature of main protection relay.	**Relay 95 ABC;** 110V DC	1 No.	
d)	Transformer Auxiliary Relays for alarms and trips: (Electro mechanical type) 1) Buchholz trip 2) Winding temperature trip 3) Oil temperature trip 4) Pressure Relief Device trip 5) Buchholz alarm 6) Winding temperature alarm 7) Oil temperature alarm 8) Low oil level alarm	110V DC	Qty based on number of relays per set. For e.g., 3 sets of 3-in-1 can be used for these 8 relays	
e)	DC supervision relay (2 NC) Electro mechanical relay	**Relay 80DC** 110V DC	1 No.	
f)	Anti-pumping relay	**Relay 94**	1 No	
5.5	**Meters**			
a)	Digital Multi-function meter (MFM) 96 sq.mm; Cl: 0.2, CTR: 120/1 A; PTR: 33kV/√3 / 110V/√3, 110V/√3; with RS 485 communication port suitable for MODBUS protocol, for interfacing with SCADA.	110V AC Conzerv make Model : EM 6400	1 No.	
5.6	Space heater		As required	
5.7	Thermostat		As required	
5.8	**Lamps**			

a)	Panel Illumination lamp		1 No.	
b)	Test position indication lamp		1 No.	
c)	Service position indication lamp		1 No.	
d)	Indicating lamps (Cluster LED) Green: VCB OFF, 110V DC Red: VCB ON, 110V DC Amber: Auto trip, 11V DC Blue: Spring charge, 110V DC White: Trip circuit OK, 110V DC Yellow: DC failure, 110V DC		1 No each;	
5.9	**Switches**			
a)	Breaker control switch Close – Neutral – Trip		1 No.	
b)	Door limit switch		1 No.	
c)	Motor control switch		1 No.	
d)	Heater control switch		1 No.	
e)	Plug and socket with switch		As required;	
f)	Test limit switch		1 No.	
g)	Service limit switch		1 No.	
h)	Local / remote selector switch (Non-lockable)		1 No.	
5.10	Test Terminal Block (TTB)		As required;	
5.11	Mounting bases and carriers		As required;	
5.12	Contactor for service and test position	110V DC	As required;	
5.13	Neutral link (Copper strip)		As required;	
5.14	**Fuses and MCBs**			
a)	HRC Fuses for various circuits such as tripping circuit, closing circuit, indication circuit, motor control circuit, DC control circuit.		As required;	
b)	MCB, DC control circuit		As required;	
c)	MCB, AC control circuit		As required;	
d)	MOV/Surge Arrestor		As required	
5.15	**Annunciation windows**			
	1) Buchholz trip 2) Winding temperature trip 3) Oil temperature trip 4) Pressure Relief Device trip 5) Buchholz alarm 6) Winding temperature alarm 7) Oil temperature alarm 8) Low oil level alarm 9) Overcurrent + Earth fault	11 windows + 1 spares	12 Nos (total)	

	(50/51) 10) Transformer Differential 11) Master trip			
5.16	Any other provisions / components etc that shall be required to meet the operational requirements of the panel.	Vendor to include such provisions in bill of materials.	As required	

6.0 VCB panels for 25MW pooling switchgear: 7 Panels (5 I/C +1 O/G +1 BPT)
Panels as per Clause no. 1.3 (b)
6.1 INCOMER PANELS

Note: In case of disparity in parameter values between SLD and this section, SLD values shall be considered as final.

6.1	These five panels are similar to the **' VCB Panel OF 5MW BLOCK 1 TO 4 described in clause 5.0'** (including metering), except for the following differences :	
a)	Transformer Protection Relays – Not required for I/C 1 to I/C 4 Transformer Protection Relays – required for I/C 5	
b)	UV/OV relay not required	
c)	Line PT – Not Required	
d)	Surge arrester not required	
c)	Annunciation windows 1) Overcurrent + Earth fault (50/51) 2) Master trip	6 windows including spares
d)	Any other provisions / components etc that shall be required to meet the operational requirements of the panel.	Vendor to include such provisions in bill of materials.

6.2 OUT-GOER PANEL (as per SLD)
Outgoing to Evacuation point

Note: In case of disparity in parameter values between SLD and this section, SLD values shall be considered as final.

6.2	This panel is similar to the **'VCB Panel OF 5MW BLOCK 1 TO 4 described in clause 5.0'** (including metering), except for the following differences :	
a)	Transformer Protection Relays – Not required	
b)	C.T 2 Core C.T Ratio – 600/1-1 A instead of 120/1-1A Core-1: Cl-5P20; 5 VA for protection Core-2: Cl-0.5S; 5 VA for metering	

c)	Line PT required: Potential Transformer, single-phase, draw-out, resin cast type Core-1: Cl-0.2; 50 VA Core-2: Cl-3P; 50 VA 33kV/√3 / 110V/√3, 110V/√3	3 Nos (one per phase)
c)	Annunciation windows 1) Overcurrent + Earth fault (50/51) 2) Master trip	6 windows including spares
d)	Any other provisions / components etc that shall be required to meet the operational requirements of the panel.	Vendor to include such provisions in bill of materials.

6.3 Bus PT panel : 1 No. (as per SLD)
Panels as per Clause no. 1.3 (b)

Panel with Bus PT (draw-out, resin cast) shall be provided with following minimum provisions. Additional / alternate provisions, if any, as applicable to the specific design and operational requirements of the panel / circuits, shall be provided by the vendor.

Note: In case of disparity in parameter values between SLD and this section, SLD values shall be considered as final.

6.3.1	Potential Transformer, single-phase, draw-out, resin cast type Core-1: Cl-0.2; 5 VA	33kV/√3 / 110V/√3, 110V/√3	3 Nos (one per phase)	
6.3.2	Digital Voltmeter 96 sq.mm, 0 – 40 kV; PTR: 33kV/√3 / 110V/√3, Cl 1.0 Aux supply 110V AC	Conzerv make DM 3210 or equivalent	1 No.	
6.3.3	Voltage transducer		1 No.	
6.3.4	Space heater		Qty as required	
6.3.5	Thermostat		Qty as required	
6.3.6	**Lamps**			
a)	Panel Illumination lamp Incandescent / CFL type		1 No.	
b)	RYB: Phase indication Cluster LED		3 Nos.	
6.3.7	**Switches**			
a)	Door limit switch		1 No.	
b)	Heater control switch		1 No.	
c)	Plug and socket with switch		As required;	
6.3.8	Test Terminal Blocks		As required;	
6.3.9	Mounting bases and carriers		As required;	
6.3.10	Neutral link (Copper strip)		As required;	

6.3.11	**Fuses and MCBs**			
a)	HTFS, PT Fuse - Primary	33kV, 2A, HRC type	3 Nos.	
b)	Fuse at secondary side of Potential Transformer	110V AC, 2A, HRC type	6 Nos.	
c)	HRC Fuse for DC control circuit		As required;	
d)	MCB, AC control circuit		As required;	
e)	MCB, PT circuit		As required;	

7.0VCB PANEL FOR 75MW COMBINER STATION AT GSECL DHUVARAN PROJECT (3 I/C + 1 O/G + 1 BPT + 1AUX Trx)
7.1 INCOMER PANELS (as per 75MW SLD)

Note: In case of disparity in parameter values between SLD and this section, SLD values shall be considered as final.

7.1	These three panels are similar to the **' VCB Panel OF 5MW BLOCK 1 TO 4 described in clause 5.0'** (including metering), except for the following differences :	
a)	Transformer Protection Relays – Not required	
b)	UV/OV relay not required	
c)	Line PT – Not Required	
d)	CT 2 core : 600/1-1 instead of 120/1-1	
c)	Annunciation windows 3) Overcurrent + Earth fault (50/51) 4) Master trip	6 windows including spares
d)	Any other provisions / components etc that shall be required to meet the operational requirements of the panel.	Vendor to include such provisions in bill of materials.

7.2 OUT GOER PANEL
Note: In case of disparity in parameter values between SLD and this section, SLD values shall be considered as final.

7.2	This panel is similar to the **'VCB Panel OF 5MW BLOCK 1 TO 4 described in clause 5.0'** (including metering), except for the following differences :	
a)	Transformer Protection Relays – Not required	

b)	C.T 4 Core C.T Ratio – 1600/1-1-1-1 A instead of 120/1-1A Core-1: Cl-0.5S; 5 VA for metering Core-2: Cl-5P20; 5 VA for protection Core-3: Cl:PS Differential CT Core-4: cl:PS REF CT	
c)	Line PT required: Potential Transformer, single-phase, draw-out, resin cast type Core-1: Cl-0.2; 50 VA Core-2: Cl-3P; 50 VA 33Kv/√3 / 110V/√3, 110V/√3	3 Nos (one per phase)
d)	VCB rating shall be 1600A instead of 630A	
c)	Annunciation windows 3) Overcurrent + Earth fault (50/51) 4) Master trip	6 windows including spares
d)	Any other provisions / components etc that shall be required to meet the operational requirements of the panel.Provision for differential & REF of power transformer	Vendor to include such provisions in bill of materials.

7.3 BUS PT

Similar to BUS PT in 25MW POOLING SWITCH GEAR as per clause 6.3

7.4 Auxilary transformer panel

7.4	This panel similar to the **' VCB Panel OF 5MW BLOCK 1 TO 4 described in clause 5.0'** (including metering), except for the following differences : to protect 50KVA ONAN Aux Trx.	
a)	Transformer Protection Relays – Not required	
b)	UV/OV relay not required	
c)	Line PT – Not Required	
d)	CT 2 core : 25/1-1 instead of 120/1-1	
c)	Annunciation windows 5) Overcurrent + Earth fault (50/51) 6) Master trip	6 windows including spares
d)	Any other provisions / components etc that shall be required to meet the operational requirements of the panel.	Vendor to include such provisions in bill of materials.

8.0 VCB panels for 50MW combiner station for GSECL Raghanesda 100MW PLANT: 2SETS

(2 I/C + 1 O/G + 1 BPT + 1AUX TRX (FOR 1SET)

8.1 same as Dhuvaran as per clause no 7.1

8.2 OUT GOER :

8.2	This panel is similar to the **'VCB Panel OF 5MW BLOCK 1 TO 4 described in clause 5.0'** (including metering), except for the following differences :	
a)	Transformer Protection Relays – Not required	
b)	C.T 2 Core C.T Ratio – 1200/1-1 A instead of 120/1-1A Core-1: Cl-0.5S; 5 VA for metering Core-2: Cl-5P20; 5 VA for protection	
c)	Line PT required: Potential Transformer, single-phase, draw-out, resin cast type Core-1: Cl-0.2; 50 VA Core-2: Cl-3P; 50 VA 33Kv/√3 / 110V/√3, 110V/√3	3 Nos (one per phase)
d)	VCB rating shall be 1250A instead of 630A	
c)	Annunciation windows 5) Overcurrent + Earth fault (50/51) 6) Master trip	6 windows including spares
d)	Any other provisions / components etc that shall be required to meet the operational requirements of the panel.Provision for differential & REF of power transformer	Vendor to include such provisions in bill of materials.

8.3 BUS PT
Similar to BUS PT in 25MW POOLING SWITCH GEAR as per clause 6.3

8.4 Aux Transformer

Similar to Dhuvaran As Per Clause no 7.4

10.0 Output signals and termination provisions for SCADA

a)	All the SCADA outputs shall be brought out and wired to suitable terminal blocks with identification labels / inscriptions. For the HT Panels located in the Central Control Room, all the SCADA terminations shall be available in the Bus PT Panel. For the HT Panels located in the Inverter Rooms these outputs shall be located in the individual HT Panels with identification labels/inscription.	
b)	**Display on SCADA** All relays shall have output contacts for suitably interfacing with the Solar SCADA system for dynamic SLD display, status monitoring, measurements, event / alarm displays, reports, etc. Following are outputs required for SCADA interconnection: VCB ON/OFF/SPRING CHARGED feedback from incomer and outgoer panels. Transformer protection alarm and trip signals: Buchholz, PRV, Low oil level (alarm only), Oil temperature, Winding temperature Master Trip Trip circuit supervision healthy DC circuit failure Overcurrent/Earth FaultTrip Overvoltage/Undervoltage All the balance protection functions available from numerical relays through IEC 61850 port.	
c)	**Remote Control through SCADA** The circuit breaker will normally be controlled from SCADA through closing and shunt trip coils. The Local control console of the relay flush mounted on the switchgear would normally be used only for testing of circuit breaker in isolated position, and for tripping it in an emergency. Suitable termination of VCB contacts required for remote operation shall be available in the panels as detailed in (a) above.	

11.0 Technical specifications – Major panel components

11.1 Vacuum circuit breaker (VCB)

11.1.1 Technical data

a)	Number of poles	3	
b)	Nominal system voltage	33 kV	
c)	Highest system voltage	36 kV	
d)	Rated frequency	50 Hz	
e)	Rated normal current at 50 °C	630 A	
f)	Rated short circuit breaking current	26.3 kA (rms) for 1 second	
g)	Rated short circuit making current	63 kA peak	
h)	Rated short time current withstand capability	26.3 kA for 1 seconds	
i)	Power frequency withstand voltage (1 min)	70 kV rms	
j)	Lightning impulse withstand voltage	170 kV peak	
k)	First pole to clear factor	1.5	
l)	Rated operating sequence	0 - 0.3 sec – CO – 3 min - CO	
m)	Maximum break time	3 cycles	
n)	Rated out-of-phase breaking current	25% of symmetrical short circuit breaking current	
o)	Maximum pole scatter	10 milliseconds	
p)	Operating cycles at no load for auto reclosing duties	Minimum 10,000 as per IEC:17A/474/CD	
q)	Rated auxiliary supply for spring charge motor, lamp & heater circuit	110V DC	
r)	Rated supply voltage for trip/close coil	110V DC	
s)	Minimum creepage distance	350 mm	
t)	Minimum protected creep distance	280 mm	
u)	Auxiliary voltage 1) Closing coil 2) Shunt tripping coil	 110V DC (80% to 110%) 110V DC (50% to 110%)	
v)	Interchangeability of VCBs	Yes	
w)	Reclosing	Single, three phase high speed auto reclosing	
x)	Total closing time	≤ 100 ms	
y)	Auxiliary contacts	Min 6 NO + 6 NC	
z)	3-pin power socket with switch	Yes in each panel	
aa)	Anti-pumping feature to be provided	Yes	

11.1.2 Current transformer

a)	Type	Resin cast, Number of cores as per SLD	
b)	CTR, VA, accuracy	As per SLD	
c)	Highest sys voltage, freq	36 KV, 50 Hz	
d)	System neutral earthing	Effectively earthed	
e)	Short time rating	26.3 KA for 1 sec	
f)	Dynamic stability current	63 kA peak	
g)	Partial discharge level	10 pico coulombs max.	
h)	Insulation level	Impulse withstand voltage of 170KV peak; Power freq withstand voltage of 70 kV rms.	
i)	Temperature rise	As per IEC 60044	
j)	Type of insulation	Class A	
k)	Applicable standard	IS 2705	
l)	Terminal box	IP-55	
m)	Ratio, acc class, VA	See incomer, outgoer panel sections.	

11.1.3 Potential transformer

a)	Type	Epoxy cast single phase. Number of cores as per SLD	
b)	PT ratio, accuracy, VA	As specified under previous clauses.	
c)	Connection	3-phase, Star / Star	
d)	System neutral earthing	Effectively earthed	
e)	Voltage factor	1.2 continuous for all PTs, 1.9 for 30 sec for star connected PTs	
f)	System fault level	26.3 kA	
g)	Neutrals	To be brought out for earthing: LV, HV sides	
h)	Insulation level	Impulse withstand voltage of 170 kV peak; Power freq withstand voltage of 70 kV rms.	
i)	Temperature rise	As per IEC 60044	
j)	Protection	HV side: 33kV HT fuse (primary) LV side: Link type HRC fuse	
k)	Mounting of PT	Horizontal draw-out truck with service / test position	
l)	Number of terminals in control spare	All terminals of control circuits wired; Cabinet up to marshaling box plus 10 terminals.	
m)	Partial discharge level	10 pico coulombs max.	
n)	Applicable standard	IS: 3156	

11.1.4 Relays – Overall requirements

a)	Protective relays, except for the lock-out electro mechanical relays, shall be of numeric communicable type (MODBUS outputs) with self-monitoring features, IEC 61850 communication ports, for interfacing with SCADA. Under voltage / Over voltage relay, IDMT OC-cum-Earth fault relays shall be numeric relays. Numerical relays shall have feature for Time Synchronization through the SCADA system.	
b)	For numerical relays, technical catalogues, type no., test certificate shall be provided.	
c)	MODBUS (RS 485) port /IEC 61850 port from various relays and load manager shall be brought to separate TB with identification for employing in SCADA.	
d)	All relays and timers shall be flush mounted with connections from inside. They shall have transparent & dust tight cover, removable from front, draw out construction (conforming to IS: 3231) for easy replacement from the front. The auxiliary relays and timers may be in non-draw out cases.	
e)	Relays shall be suitable for operation from CT/PT as required.	
f)	Numeric relays shall have self - reset contacts and shall be suitable for efficient and reliable operation of the protective schemes.	
g)	A combination of electromechanical & numerical communicable type relays for main protections is not acceptable.	
h)	Relays and timers shall be designed for satisfactory performance under specified tropical and humid conditions. These shall operate under extreme conditions of control voltage variation.	
i)	Relays shall not have any inbuilt batteries and shall operate on available DC supply. Relays shall be provided with hand-reset operation indicators (flags) or LEDs with pushbuttons for resetting for analyzing the cause of breaker operation.	
j)	Relays shall have built-in test facilities (or) alternatively, the relays can be provided with necessary test blocks and test switches. One testing plug shall be provided for switch board.	
k)	Alarm / trip contacts from the transformer protection relays shall be brought on to suitable terminal blocks. The trip contacts shall be interlocked to the master trip circuit. Also, these contacts shall be identified at the TB with corresponding inscriptions to facilitate further wiring to indoor annunciator panel.	
l)	**NUMERICAL RELAYS AND NETWORKING** (1)All circuit breaker feeders shall be provided with communicable numerical relays (IED, i.e. Intelligent Electronic Device) complying with IEC-61850, having protection, control, measurement and monitoring features. These relays shall be networked and suitably interfaced with the Solar SCADA system for dynamic SLD display, status monitoring, measurements, event / alarm displays, reports, etc. The relays shall be flush mounted on panel front with connections from the inside. These numerical relays shall be of types as proven for the application and shall be subject to BHEL/BHEL Customer approval. Numerical relays shall	

have appropriate setting ranges, accuracy, resetting ratio and other characteristics to provide required sensitivity. All equipment shall have necessary protections as detailed in the standard scheme drawings / module type descriptions.

(2) One No. of master IED per switchgear / board shall be provided which shall have interlocks / logics common to the board like alarm / trip on failure (IRF) of any feeder IED, Circuit Breaker Failure (CBFP) alarm / trip, auto-changeover, etc.

(3) The numerical relay shall be capable of measuring and storing values of a wide range of quantities, events, faults and disturbance recordings. The alarm / status of each of protection function and trip operation shall be communicated to Solar SCADA. The numerical relays shall have built in feature / hardware interface to provide such inputs to Solar SCADA / DDCMIS for analog / digital values.

(4) All relays shall be rated for control supply voltage as mentioned elsewhere under parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Contacts for breaker close and trip commands shall be so rated as to be used directly used in the closing and tripping circuits of breaker without the need of any interposing / master trip relays. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage.

(5) One minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms).

(6) Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

(7) Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data

(8) All numerical relays shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per the requirement of control schematics. Master IED shall have 32BI + 32BO. The quantities of such input / outputs shall be finalized during detailed engineering.

(9) All the numerical relays shall have communications on two ports, local front port communication to laptop and rear port on IEC 61850 to communicate with the interface equipment for connectivity with the Solar SCADA.

(10) All the numerical relays shall have adequate processor memory for implementing the programmable scheme logic required for the realization of the protection / control schemes, in addition to the built in protection algorithms.

(11) All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power- factor and energy parameters

(12) Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.

(13) Master trip (86) and non-86 trips shall be software configurable to output contacts and no separate master trip relay shall be used

(14) All numerical relay shall have key pad / keys to allow relay settings

	from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote. (15) Relays shall have suitable output contact for breaker failure protection. (16) Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures and a separate output contact for indication of any failure. (17) Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC / ANSI programmable characteristics. (18) Design of the relay must be immune to any kind of electromagnetic interference. Vendor shall submit all related type test reports for the offered model along with the offer. (19) All cards / hardware of numerical relays shall be suitable for operation in Harsh Environmental conditions with respect to high temperature, humidity & dust. (20) Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature. (21) All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc. (22) Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc. (23) Numerical relays shall have feature for Time synchronization through the SCADA System / networking. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system. (24) Relays & Ethernet switches shall be suitable to accept both AC & DC supplies with range 120V or 240V with tolerance of 70 % to 120 % of rated voltage & shall be finalized during detailed engineering. (25) Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.	

12.0 Tests and test certificates

a)	**ROUTINE TESTS** All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price. An indicative lists of tests / checks is indicated at Annexure-2 (QA Tests on 33kV Switchgear Panels). However, the successful vendor shall furnish a detailed Manufacturing Quality Plan (MQP) indicating the practice and procedure along with relevant supporting documents. The same shall be subject to BHEL/BHEL Customer approval.	
b)	**COMMISSIONING CHECKS / TESTS** After installation of panels, power and Control wiring and connections, Contractor shall perform commissioning checks as listed below to verify proper operation of switchgear / panels and correctness of all equipment in all respects. In addition to the checks below, the vendor shall carry out all other checks and tests as per standard commissioning procedure. **General** (a) Check name plate details according to specification. (b) Check for physical damage (c) Check tightness of all bolts, clamps and connecting terminals (d) Check earth connections. (e) Check cleanliness of insulators and bushings (f) Check heaters are provided (g) H.V. test on complete switchboard with CT & breaker in position. (h) Check all moving parts are properly lubricated. (i) Check for alignment of busbars with the insulators to ensure alignment and fitness of insulators. (j) Check for interchange ability of breakers. (k) Check continuity and IR value of space heater. (l) Check earth continuity for the complete switchgear board. **Circuit Breakers** (a) Check alignment of trucks for free movement. (b) Check correct operation of shutters. (c) Check slow closing operation (if provided) (d) Check control wiring for correctness of connections, continuity and IR values. (e) Manual operation of breakers completely assembled. (f) Power closing / opening operation, manually and electrically at extreme condition of control supply voltage. (g) Closing and tripping time.	

	(h) Trip free and anti-pumping operation. (i) IR values, resistance and minimum pick up voltage of coils. (j) Simultaneous closing of all the three phases. (k) Check electrical and mechanical interlocks provided. (l) Checks on spring charging motor, correct operation of limit switches and time of charging (m) All functional checks. **Current Transformers** (a) Megger between windings and winding terminals to body. (b) Polarity tests. (c) Ratio identification checking of all ratios on all cores by primary injection of current. (d) Magnetisation characteristics & secondary winding resistance. (e) Spare CT cores, if any to be shorted and earthed. **Potential Transformers** (a) Insulation resistance test. (b) Ratio test on all cores. (c) Polarity test. (d) Line connections as per connection diagram. **Cubicle Wiring** (a) Check all switch developments. (b) It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked. (c) All the wires shall be meggered to earth. (d) Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component / equipment. (e) Check terminations and connections. (f) Wire ducting.	
c)	**TYPE TESTS** All equipment to be supplied shall be of type tested design. Vendor shall submit the following type test reports during bid submission. These test reports shall have been carried out on equipment of similar rating within last ten years. However if the vendor is not able to submit report of the type test(s) conducted on similar equipment, or in the case of type test report(s) are not found to be meeting the specification requirements during document approval stage, the vendor shall conduct all such tests free of at no additional cost to BHEL, either at third party lab or in presence of BHEL/BHEL customer and submit the reports for approval.	

(i)	**Type test reports of the following tests carried out on circuit breaker / circuit breaker panels, of same voltage class and current rating shall be submitted**. 1) Short circuit duty test on circuit breaker, mounted inside the panel offered along with CTs, bushing and separators. 2) Short time withstand test on circuit breaker, mounted inside panel offered together with CTs, bushings and separators. 3) Power frequency withstand test on breaker mounted in side panel. 4) Lightning impulse withstand test on breaker mounted in side panel. 5) Temperature rise test on breaker and panel together. For this test, the test set up shall include three panels with breakers, the test breaker and panel being placed in the center. The adjacent panels shall also be loaded to their rated current capacity. Alternatively, the test panel may be suitably insulated at the sides, which will be adjoining to other panels in actual site configuration 6) Internal Arc Test as per IEC 62271-200 7) Measurement of resistance of main circuit. 8) Mechanical operation test. 9) Short circuit withstand test of earthing device (truck / switch)	
(ii)	**Type test reports for the following tests on the model of the Numerical relays being offered by vendor:** 1**) Functional requirements** (a) Features and logic (b) Checking of compatibility with co-operating devices (c) Communication **2) Mechanical construction requirement** (a) General inspection (b) Inspection of marking and data (c) Clearances and creepage distances (d) Degree of protection test of enclosure **3) Insulation requirement** (a) Dielectric test (b) Impulse voltage test (c) Insulation resistance measurement **4) Accuracy requirements** (a) Measurement accuracy of characteristic quantity and specified time (b) Limits of frequency range and frequency dependence (c)Limits of ambient temperature and ambient temperature dependence	 IEC 61850 IEC 61850 IEC 61850 Manufacturer's doc IEC 60255-6 IEC 60255-5 IEC 60529 IEC 60255-5 IEC 60255-5 IEC 60255-5 IEC 60255-6 IEC 60255-6 IEC 60255-6

	(d) Limits of operative range of auxiliary energizing inputs and auxiliary voltage dependence	IEC 60255-6
	5) Rated burden requirement	
	(a) Measuring circuits	IEC 60255-6
	(b) Auxiliary circuits	IEC 60255-6
	(c) Signalling inputs	IEC 60255-6
	6) Thermal requirements	
	(a) Temperature rise	IEC 60255-6
	(b) Limiting continuous thermal withstand values	IEC 60255-6
	(c) Limiting short time thermal withstand values	IEC 60255-6
	7) Limiting dynamic value requirements	IEC 60255-6
	8) Power Supply requirements	
	(a) Limiting duration of interruptions to dc auxiliary voltage	IEC 60255-11
	(b) Limiting value of ripple in dc auxiliary voltage	IEC 60255-11
	(c) Limiting value of voltage dips to ac auxiliary voltage	IEC 60255-4-11
	(d) Limiting duration of interruptions to ac auxiliary voltage	IEC 60255-4-11
	(e) Limiting variations of ac auxiliary voltage	IEC 60255-4-11
	9) Electromagnetic compatibility requirements	
	(a) High frequency disturbance test	IEC 60255-22-1
	(b) Electrostatic discharge test	IEC 60255-22-2, 61000-4-2
	(c) Radiated, radio-frequency, electromagnetic field immunity test	IEC 60255-22-3, 61000-4-3
	(d) Fast transient disturbance test	IEC 60255-22-4, 61000-4-4
	(e) Surge immunity test	IEC 60255-22-5, 61000-4-5
	(f) Immunity to conducted disturbances, induced by radio-frequency fields	IEC 60255-22-6, 61000-4-6
	(g) Power frequency immunity test	IEC 60255-22-7
	(h) Conducted and radiated radio-frequency emission tests	IEC 60255-22-25, EN55011-CISPR11
	(i) Power frequency magnetic field immunity test	IEC 61000-4-8
	10) Environmental requirements	
	(a) Dry cold test	IEC 60068-2-1
	(b) Dry heat test	IEC 60068-2-2
	(c) Storage temperature test	IEC 60068-2-8
	(d) Damp heat test, cyclic (12+12 hour cycle)	IEC 60068-2-30
	11) Contact performance requirement	
	(a) Make and carry for DC	IEC 60255-23
	(b) Breaking capacity for DC	IEC 60255-23
	(c) Make and break AC	IEC 60255-23
	12) Mechanical performance requirements	
	(a) Durability of relay operation	IEC 60255-6
	(b) Durability of plug in relays	IEC 60255-6

	(c) Durability of relay setting controls (d) Vibration response and endurance test (e) Shock response and withstand test (f) Bump test	IEC 60255-6 IEC 60255-21-1 IEC 60255-21-2 IEC 60255-21-2
(iii)	**Degree of Protection Test** Testing to observe compliance to degree of protection, shall be checked for each switch board enclosure and busbar chambers during routine inspection shall be as under. (b) IP-5X: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	

13.0 Documents to be submitted after receipt of purchase order

13.1	Following documents shall be submitted for BHEL approval within seven days from date of purchase order. 1. HT Panel GTP/Datasheet 2. Overall General Arrangement of panels in inverter rooms. 3. Overall General Arrangement of panels in central control room. 4. Detailed Bill of materials for each type of incomer / outgoer / Bus PT panels. Minimum particulars such as item description, item quantity, make, type, rating etc shall be provided. 5. List of spares offered with item-wise quantity (with % details with respect to main supply items). 6. Type test certificates for 33kV VCB panels and numerical relays. See respective clauses. 7. All the above documents shall be submitted to BHEL for final approval – GA and Layout Drgs, Foundation Drgs, Datasheet, Detailed BOM, Manufacturing Quality Plan (MQP) including Final Test Procedure. All these documents shall be submitted in soft copy with BHEL drawing nos. which shall be informed during detailed engineering. Vendor shall proceed with Manufacturing only after final approval of all the listed documents.	

14.0 Documents to be submitted along with consignment

14.1	Following documents shall be submitted at the time of dispatch: Test reports on individual HT Panels and Bus PT Panels Technical manual with system specifications, installation guidelines, commissioning guidelines, schematic drawings, calibration settings, cable schedule, general arrangement drawings, panel details. Operations and maintenance manual Product catalogues / datasheets of all BOM items	