Supply, installation and commissioning of

3-phase Grid-connected Power conditioning units (Outdoor type)

Of 5 MW Capacity

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00	11.11.2024	JK	VJ	PM / MS

0.0. INTRODUCTION:

This technical specification provides details of supply of Outdoor for 3-phase Grid-connected Power Conditioning Units (PCU). The scope also includes commissioning of the supplied units at the project site for synchronizing the generated ac power with LV side of a transformer that connects to 33kV grid on HV side.

1.0. SCOPE OF SUPPLY:

Sl.No	Item Description	Qty
1.1	**Supply of: Outdoor type inverters** a) Outdoor inverter consisting of 3-phase, Grid-connected Power Conditioning Unit (PCU). Outdoor type invertor shall be minimum IP65 protection for Power Electronics & IP54 for other parts including enclosure. Voltage Rating: 1500V Power Rating of each PCU: 5MW (Min) **Continuous rating of PCU shall not be less than 5MW at unit power factor at ambient temperature of 50 deg and 0.95 p.f. at 45 deg.**	**1 Set**
1.2	**I&C support of PCUs along with Training at site.** **BHEL scope of activities at site for installation and commissioning:** (1) Movement and positioning of outdoor PCU panels at the earmarked position on the outdoor RCC platform. (2) Crimping the incoming (DC side) and outgoing (AC side) cables (BHEL supply) using the cable lugs provided by the vendor. (3) Connecting at the respective termination ends of the panels using the cable glands and fastening hardware (nuts, bolts, washers etc) provided by the vendor. **Vendor scope of activities at site for commissioning:** (1) All the electrical checks that are required to confirm that solar DC parameters (current, voltage) are available at the DC input side of PCUs. (2) Service engineers shall be present at site during installation of PCUs, commissioning of solar power plant, providing all necessary guidance and support to achieve successful synchronization of PCU output with grid and also to trouble-shoot / resolve the technical problems associated with PCU. Commissioning / Service Engineer shall be from OEM. (3) Guidance and support to BHEL team, at the time of installation and commissioning of SCADA, in respect of connection of communication cables to PCUs and technical problems related to receiving data signals at SCADA station from PCUs. (4) Training: Vendor shall provide training at site to BHEL and customer's engineers during commissioning. Training shall cover various technical aspects such as functional/	**1 AU**

	operational features, trouble-shooting procedures, maintenance schedules, requirements, safety, emergency precautions etc. Both the theory and practical (hands on) training shall be covered. Note: Supply and installation of integrated SCADA system for the overall power plant is within BHEL scope. 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. **1 AU (Activity unit): For one PCU**	
1.3	**Comprehensive Annual Maintenance Contract after commissioning:** • Replacement of IGBTs, inductors, capacitors, electronic cards etc. as per OEM recommendations. • Minimum 2 visits to site for preventive maintenance as per OEM recommendations. Vendor shall provide the list of activities to de done during periodic maintenance, along with the offer. **1 AU (Activity unit): For one PCU of rated capacity for 10 years**	**1 AU**

2.0. WARRANTY

Vendor shall provide comprehensive warranty for **60 months from date of commissioning**. The warranty clause shall be read in conjunction with clause 1.3 regarding Comprehensive Annual Maintenance Contract (with warranty) after commissioning and during O&M period. Based on the commissioning schedules of the project, number of activity units shall be operated. 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 PCU, BHEL will report the same to the vendor. Vendor shall resolve the problem within two days from the date of reporting including the visit of their service representative, if required, within this duration for repair/replacement of failed items and re-commissioning of the PCU.

3.0. TECHNICAL DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER

1. 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.
2. Product datasheet of the offered PCU model(s).
3. Overall General Arrangement of PCU including DC and AC Combiner Panels.
4. Vendor shall provide list of major component spares and recommended spares in the offer. Item-wise BOQ and break-up prices shall be provided in the offer, along with confirmation for the price validity for entire warranty period.

5. List of type tests /IEC certifications available along with test certificates complying with Cl.4.12 of this specification. Supporting test reports shall be provided by vendor during detailed engineering.
6. List of activities to de done during periodic maintenance
7. Any other details asked in the specification elsewhere.

4.0. TECHNICAL SPECIFICATION OF POWER CONDITIONING UNITS

4.1 Basic requirements (PCU type, Standards, Technology, Interconnections, Interfaces etc.)

#	Parameter	BHEL specification
4.1.1	PCU type	Grid-interactive. PCU shall remain connected to the grid as per Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments (including 2019) and its components shall be designed accordingly. **Low power mode:** The control system that continuously monitors the output of the solar PV plant until pre-set value is exceeded and begins to export power provided there is sufficient solar energy and the grid voltage and frequency are in the specified range. Further, the inverter shall be capable of operation under reduced power mode and shall not trip when the PV array output voltage is below MPPT range under high temperature conditions. **Active MPPT mode (high power mode):** When solar radiation increases further, PCU shall enter maximum power point tracking (MPPT) mode and adjust the voltage of the SPV array to maximize solar energy fed into the grid. When the solar radiation falls below threshold level, the PCU shall enter lower power mode. **Sleep mode:** PCU shall automatically go into sleep mode when the output voltage of PV array and/or output power of the inverter falls below a specified limit. During sleep mode, the inverter shall disconnect from grid. Inverter shall continuously monitor the output of the PV array and automatically start when the DC voltage rises above a pre-defined level. During evening and night (non-solar generation hours) the PCU shall be in sleep mode in order to minimize the internal power loss. Maximum loss in sleep mode shall be less than 0.05% of PCU rated power. The above clause is applicable for unity power factor operation/no reactive power support to grid. In case reactive power is required to be supplied to grid, in that case the PCU shall remain connected to grid and supply reactive power as per grid requirement. Inverter shall continuously monitor the output of the PV array and

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<tr><td></td><td></td><td>automatically start active power generation when the DC voltage rises above a predefined level.
Low Voltage mode:
The Inverter shall be capable of operating under reduced power mode and shall not trip when the PV array output is below MPPT range under high temperature conditions.</td></tr>
<tr><td>4.1.2</td><td>Compliance with standards</td><td>
<table>
<tr><th>Sl.</th><th>Standard</th><th>Description</th></tr>
<tr><td>1</td><td>IEC 61683</td><td>Photovoltaic systems - Power conditioners – Procedure for measuring efficiency</td></tr>
<tr><td>2</td><td>IEEE 1547/ IEC 61727/BDEW or Equivalent Standard</td><td>Photovoltaic (PV) System – Characteristics of Utility Interface</td></tr>
<tr><td>3</td><td>EN 50530</td><td>MPPT Efficiency of grid connected PV inverters</td></tr>
<tr><td>4</td><td>IEC 62109-1 & 2 / IEC 62103 or equivalent standard</td><td>Safety of power converters for use in photovoltaic power systems</td></tr>
<tr><td>5</td><td>IEC 61000-6-2</td><td>Electromagnetic compatibility (EMC) - Part 6-2: Generic standards-Immunity Standard for industrial environments</td></tr>
<tr><td>6</td><td>IEC 61000-6-4</td><td>Electromagnetic compatibility (EMC) - Part 6-4: Generic standards- Emission standard for industrial environments</td></tr>
<tr><td>7</td><td>IEC 62116/ IEEE 1547/ / UL 1741 / Equivalent EN/ BIS standard</td><td>Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures, Anti Islanding</td></tr>
<tr><td>8</td><td>IEEE 519</td><td>Recommended practices and requirements for Harmonic control in Electrical Power System.</td></tr>
<tr><td>9</td><td>IEC 60068-2/
IEC 62093</td><td>Environmental testing</td></tr>
<tr><td>10</td><td>IEC 60529</td><td>Ingress Protection Test</td></tr>
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		11 Grid Connectivity - CEA Technical Standards for Connectivity to the Grid Regulations 2007 with latest amendment **(including 2019)** and latest CERC /SERC Regulations and Grid Codes - including LVRT/HVRT requirement and any other latest statutory regulations/procedures.
	All the type test certificates as per the standards mentioned above shall be submitted for approval.	
4.1.3	Output transformer	PCU shall be of 'transformer-less' design.
4.1.4	Maximum Power Point Tracking (MPPT)	MPPT shall be integrated in the power conditioning unit to maximize energy drawn from the solar PV array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism of MPPT shall be submitted during the detailed engineering. The operating voltage range of PCU and the MPPT shall be large enough such that it satisfactorily operates for PV modules exposed to the maximum ambient temperature of 50 deg C. The MPPT unit shall confirm to IEC 62093 for design qualification.
4.1.5	AC-DC conversion	3-phase Inverter stack. *IGBT make shall be reputed and field proven in Indian conditions for at least 2 years from commissioning.*
4.1.6	Built-in support systems	PCU shall be provided with protection circuits, monitoring circuits, data logging & storage system, provisions to download data to PC/Laptop, MODBUS communication outputs for SCADA interface etc as per Cl. 4.7 of this specification.
4.1.7	Heat exchangers	Vendor shall submit HVAC calculations during detailed engineering (If applicable).
4.1.8	DC input and AC output terminations	Input and output terminations together with cable glands, lugs, hardware shall be provided to match the connections using BHEL cables as specified under related clauses of this specification. Terminals should be shrouded.
4.1.9	Environment protection	All PCB cards shall be provided with suitable coating (epoxy etc) for protection.
4.1.10	Provision of all necessary support/software files required for obtaining RLDC/CEA clearances:	Development of solar plant model in PSS/E and PSCAD software as per CTU/STU (as applicable) are in the scope of BHEL. All studies, approvals, modeling, simulation including equipment, system etc. required in relation to grid interconnection, line charging feasibility etc. are in the scope of BHEL. To achieve the same, bidder shall provide necessary PCU modelling documents /software files. In this regard, bidders are requested to refer all the regulations, clarifications, report, advisory, OM and any other document of CEA, MNRE, CERC, SERC**,** STU, CTU, Grid code, Load Dispatch Centers including committee/ working group formed by these bodies etc in relation to compliance by RE Generators so that dispute at a later stage may be avoided.

4.2 Technical parameters

#	Technical parameter	BHEL specification
4.2.1	Output power rating	As per Cl. 1.1. Vendor to specify ratings being offered. No derating upto 50degC
4.2.2	AC grid connection	3-phase
4.2.3	Output frequency	50 Hz +/- 5%
4.2.4	Nominal output voltage	Value to be indicated by vendor
4.2.5	Maximum DC input voltage (Max open circuit PV voltage)	1500 V DC
4.2.6	MPPT Range of control system	Range to be indicated by vendor.
4.2.7	DC side peak power	Vendor shall confirm that PCU is suitable for overloading of DC input power. Vendor to indicate the value in %. Minimum requirement is 40%
4.2.8	Max DC operating current	Value to be indicated by vendor.
4.2.9	Max AC output current	Value to be indicated by vendor corresponding to the rated output power of the PCU.
4.2.10	Power factor	Designed operation close to unity PF. Adjustable window 0.8 lead to 0.8 lag
4.2.11	Ambient temperature	0 to 60 deg C.
4.2.12	Relative Humidity	Upto 95% non-condensing
4.2.13	Protection class	As per Cl. 1.1
4.2.14	Grid Frequency tolerance	+/- 3 Hz
4.2.15	Grid Voltage tolerance	- 10% and +10%
4.2.17	AC output THD limits	Less than 4 % at nominal load / as per IEEE 519 / CEA norms whichever is more stringent, latest
4.2.18	Maximum noise level	Value to be indicated by vendor. * Inverter rooms max. 85 dB (A) at any place 1 m distant from operating equipment
4.2.19	DC injection (as % of nominal load current)	DC injection shall be limited to 0.5% of the rated current of the inverter
4.2.20	Flicker	Shall be as per IEC 61000/IEEE 519

4.2.21	Set point pre-selection for active power and VAR control	PCU shall be provided with all necessary features that will enable set point selection through SCADA. For this PCU vendor shall furnish the Modbus mapping for the set points or suggest the possible method for selecting VAR control. Operator shall be able to limit the total power (Active and Reactive) injected in the grid through manual intervention as and when required in view of grid security.
4.2.22	Re-synchronization time	In case of grid failure, the PCU shall be re-synchronized with grid after revival of power supply. Vendor shall indicate the time taken by PCU to be re-synchronized after restoration of grid supply.
4.2.23	European efficiency	≥ 98%, measured as per IEC 61683 standard for measuring efficiency
4.2.24	Peak Efficiency	Inverter No Load / Full Load Loss Calculation must be submitted by the bidder during detailed engineering.
4.2.25	PCU availability	The up-time of Inverters should be of 99% in a year, in case of failing to achieve this due to failure of any component of inverter the vendor shall either replace the inverter or the component at their own cost
4.2.26	No load loss	No load loss shall be < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%.
4.2.27	Voltage Ride Through	The PCU shall remain connected to the grid during temporary dip or rise in grid voltage as per the LVRT/HVRT requirements of CEA Technical Standards for Connectivity to the Grid Regulations. Inverter shall be equipped with Voltage Ride-Through (VRT) capabilities to stay online during grid disturbance as per CEA technical standard for grid connectivity. The PCU shall also be able to inject reactive power during the period of voltage dip.
4.2.28	Active power regulation	The PCU shall be able to limit the active power exported to the grid based on the set point provided through PCU front control panel. The PCU shall also be able to automatically the limit the active power after an increase in grid frequency above a pre-set value. The ramp rate shall be adjustable during operation and start-up after fault. The applicability of the requirement shall be as per CEA regulation and compliance.
4.2.29	Reactive power control	The PCU shall be able to inject /absorb reactive power to/ from the grid based on the set point provided through PCU front control panel. The same shall be performed automatically with adjustable ramp rate based on dynamic changes in grid voltage or reactive power reference. Night time VAR compensation as per CEA regulation and compliance. PCU shall offer the possibility to set a constant reactive power mode to absorb or inject reactive power during night time. The night time reactive power compensation capability of the inverters must be adequate to

		take care of the plant reactive power requirements for cables, transformers, etc. at night.
4.2.30	Enclosure	Suitable for Outdoor duty and IP class as per Cl. 1.1.
4.2.31	Night SVG (Q at Night)	Night SVG (Q at Night) Required The PCU shall be capable of supplying reactive power as per grid requirement during solar and non-solar hours. PCU shall have Static VAR Generation (SVG) function (Q at night) PCU shall have in built necessary limiters in the control so as to ensure its safe operation within the designed operational parameters. MAXIMUM VAR SUPPLYABLE BY EACH PCU UNIT SHALL BE MENTIONED.
4.2.32	Active Power Limit Control, Reactive Power and Power Factor Control Feature	Required. Possible from both PPC (if applicable) and SCADA
4.2.33	PCU designed DC Fault Current Level	Maximum Short Circuit Current of PV Array connected to PCU and duration continuous
4.2.34	PCU designed AC Fault Current Level	Maximum Short Circuit Current of LV side of IDT and duration 1 Sec
4.2.35	Emergency Stop	Inverter shall offer provision for both local and remote emergency stop push button for tripping of inverter with complete AC electric isolation.

4.3 Protection systems

4.3.1	Protection systems for current, voltage, temperature, surges, ground faults, fan failure etc. Fault indication shall be communicated to SCADA system	AC & DC over current
4.3.2		AC & DC short circuit
4.3.3		DC reverse polarity
4.3.4		Over temperature protection: Heat sink, Cabinet
4.3.5		Synchronization loss
4.3.6		Anti-islanding protection
4.3.7		EMI and RFI
4.3.8		Grid monitoring Protection against any sustained fault (lightning effect etc.) in grid / feeder line.
4.3.9		Ground fault protection
4.3.10		PCU inside ambient temperature and IGBT stack temperature (PCU shall be able to soft analogue values of above parameters to SCADA)

4.3.11		Power regulation in the event of thermal overloading. Vendor to submit inverter power vs ambient temperature curve during detail Engineering.
4.3.13		SPD-based overvoltage and under voltage protection on both DC and AC sides. It shall consist of Metal Oxide Varistors (MOV) type surge arrestors. The discharge capability of the SPD shall be at least 12.5kA at 8/20 micro second wave as per IEC 61643- 12. It shall have thermal disconnectors to interrupt surge current arising from internal / external faults. Following type surge protective device (SPD) conforming to IEC 61643- /12, shall be connected between positive/ negative bus and earth. • For DC side SPD-Type I & II • For AC side SPD-Type-II
4.3.14		Fan failure – Alarm contact shall be provided for air flow loss / rise of temperature of cooling fan
4.3.15		LVRT&HVRT
4.3.16		Over & Under frequency

4.4 DC, AC side load break disconnecting switch / breaker provisions

4.4.1	DC side	Suitable rated fuse shall be provided for each incoming DC cable. In addition, the PCU shall have suitable rated DC motorized isolator/MCCB or contactor for isolation of PV array from inverter. DC current shall be communicated to SCADA. (ALL SMB/SCB CURRENTs SHALL BE MEASURED & DISPLAYED INDEPENDENTLY)
4.4.2	AC side	(a) ACBs / MCCBs shall be provided on the AC output side. (b) Remote operating and controlling facility for PCU from SCADA Panel in Main Control Room shall be provided.
		(c) Surge protection device (3P) with suitable rating shall be provided at the input of the ACB.
		(d) Indication for grid side supply ON / OFF status shall be available on the Door Interface.
		(e) Interconnection between the ACB Panel and PCU supply/provision of cables / busbars as applicable shall be in the scope of the vendor.

4.5 Front panel display and control

4.5.1	PCU should have local display with touch screen/keypad for viewing important parameters, configuration, troubleshooting, control including start & stop, monitoring instantaneous system data, event logs, and data logs with date & time and configuration settings. Control and read-out should be provided on an indicating panel integral to the inverter. Display should be simple and self-explanatory to show all the relevant parameters relating to PCU operational	Instantaneous DC power input DC input voltage DC Current of each SMB (All SMB current shall be measured & displayed independently) Total DC Current
4.5.2		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) Frequency Power Factor Energy (kWh) produced during entire day Total Energy (kWh) produced during its life
4.5.3		Faults
4.5.4		Other event logs
4.5.5		Other features as may be necessary for supervisory control and operation of the PCUs shall be provided.

4.6 Data logging, storage, retrieval, downloading, uploading

4.6.1	Provision of built-in systems for data logging, storage, retrieval, downloading, uploading etc.	Date-cum-time stamped logging of DC and AC side parameters (current, voltage, frequency, phase, power factor, power, export energy etc), faults and other events.
4.6.2		Data storage with retrieval features.
4.6.3		Provision of all necessary built-in systems, ports etc for downloading the data into a PC / Laptop etc that will be required for reporting, data analysis and trouble-shooting purposes.
4.6.4		Provision of all necessary built-in systems, ports etc for uploading of software etc that will be required for replacing, revising, upgrading the system.
4.6.5	**Supply of Laptop**	One number of laptop PC shall be supplied for PCU configuration and troubleshooting purpose. Laptop shall be supplied with complete set of hardware & software accessories. Laptop detailed configuration must ensure suitability for the required applications. Supplied Laptop shall be

		protected with the latest anti-virus software and shall be provided 5 Years onsite warranty including its battery. At least two sets of communication cable for Laptop to PCU communication shall be provided

4.7 Provisions for SCADA interface

4.7.1	SCADA interface requirement	Solar PV power plant will have an integrated SCADA, which is within BHEL scope, whereby all the PCUs will be integrated with other data systems such as solar array string monitoring, weather monitoring, HT side transformers / breakers monitoring, etc. Accordingly, PCU shall have necessary communication protocol and output ports to facilitate SCADA interface as per Clause 4.7.2. SCADA shall be OPC server based.
4.7.2	Communication protocol	PCU shall have suitable communication card (Modbus/Ethernet) for networking and SCADA integration and same shall support dual master communication. Communication port shall be preferably TCP/IP protocol. PCU shall include all important measured & internal calculated analog values and alarm & trip signals for remote monitoring, storing and report generation purpose in SCADA system
4.7.4	Parameters for SCADA	All DC and AC parameters (current, voltage, frequency, phase, power factor, power, export energy etc), grid data, temperature, faults, other event logs, date/time logs etc from each PCU will be required at SCADA control desk. PCU shall provide for this requirement. (All SMB current shall be measured & displayed independently)
4.7.5	Remote monitoring features	PCU shall have features to facilitate remote monitoring via telephone modem or mini web server.

4.8 DC Inputs and termination details.

Vendor shall supply the PCU with the termination features on DC side as tabulated below. Detailed drawings of termination arrangements with bus bar particulars such as positions, dimensions, hole sizes, spacing between holes, support to bus bar, etc shall be submitted for BHEL approval.

4.8.1	DC input terminals	Each SMB output: 360 to 400kW Total no. of DC inputs shall be designed to be suitable for a) SMB kW mentioned above (which includes 36.7% DC Overload) + 1 no. spare input b) Vendor to indicate the no. of DC inputs provided for each rating of PCU to meet the requirement as per (a) above in offer.
4.8.2	Fuses / DC Ckt Breaker on DC input side	Suitable rated fuse shall be provided for each incoming DC cable. In addition, the PCU shall have suitable rated DC motorized isolator/MCCB or contactor for isolation of PV array from inverter.
4.8.3	Max DC input current rating of PCU	Vendor shall indicate the rating. In addition, max rating of each individual DC input shall be indicated
4.8.4	DC cable entry into panel	Bottom entry. Cable supply is within BHEL scope. Details shall be provided during detail Engineering. 1Cx*** sq-mm Aluminium, multi-strand, Al, Un- Armored, XLPE insulation, PVC sheath cable will be used for each DC input. Exact size shall be provided during detailed engg. DC termination shall be suitable for the above cable.
4.8.5	Gland plates	Drilled Gland plates shall be provided with holes to accommodate the cable glands.
4.8.6	Cable glands	Nickel plated brass, double compression type cable glands of reputed make (Make: Comet or any other reputed make) shall be provided by the vendor. To enable right selection of glands, final cable O.D will be provided by BHEL at the time of manufacturing. Approval of make and type/size shall be taken from BHEL before procurement of glands. Part no. and qty shall be indicated in the BOM. PCUs shall be supplied with all the glands fixed on the gland plates.
4.8.7	Cable lugs, plain washers, spring washers, bolts and nuts	Similarly, cable lugs, bolts, nuts & plain washers, Zinc coated spring washers shall be provided by the BHEL.
4.8.8	Bus bar design	Tinned Copper /Aluminium shall be provided.
4.8.9	In case of separate DC termination panel	(a) General arrangement showing views and details of termination panel, with cable entry particulars, shall be submitted as part of technical bid. (b) Interconnecting the add-on DC termination panel with the main panel, including supply of cables for this purpose, shall be within the scope of vendor.

4.8.10	DC Side Negative Grounding	The Inverter shall have suitable arrangement for negative grounding of solar PV array system and the ground current shall be limited to safe limit. Ground current shall be measured continuously and alarm shall be generated in case ground current reaches to predefined set value. Inverter shall trip in case ground current is more than safe operating limit. The same shall be indicated in the GA/SLD/Schematics and BOM.
4.8.11	String Monitoring facility	PCU shall be provided with current monitoring transducer at incoming DC cables from each string combiner box (SCB) for PV array zone monitoring purpose. The current transducers used for this purpose shall have accuracy of 1.0 class or better. The PCU shall be able to provide the measured DC current value and calculated DC power and energy value of incoming SCB DC cable to SCADA system for remote monitoring, storing and report generation.

4.9 AC Output and termination details.

Vendor shall supply the PCU with the termination requirements on AC side as tabulated below. General arrangement showing views of termination shall be submitted as part of technical bid. Detailed drawings of termination arrangements with bus bar particulars such as positions, dimensions, hole sizes, spacing between holes, support to bus bar, etc shall be submitted within seven days after receipt of purchase order for BHEL approval.

4.9.1	Number of AC outputs	Three phases: R, Y, B terminals
4.9.2	AC cable entry into panel	Bottom entry. Cable supply is within BHEL scope. For each phase, 1Cx400 sq.mm or 1Cx630 sq.mm Aluminium, multi-strand, Un-armored, XLPE insulation, PVC sheath cable will be used. Final cable selected, cable O.D and no. of runs of cable shall be informed to vendor during detailed engineering for termination. In the offer, vendor to indicate for each type of PCU being offered, the maximum no. of inputs along with cable size which can be accommodated.
4.9.3	Gland plates	Drilled Gland plates shall be provided with holes to accommodate the cable glands.
4.9.4	Cable glands	Nickel plated brass, double compression type cable glands of reputed make (Make: Comet or any other reputed make) shall be provided by the vendor. Approval of make and type shall be taken from BHEL before procurement of glands. PCUs shall be supplied with all glands fixed on the gland plates.

		Minimum gap between ACB and gland plate terminals – Shall be provided by supplier
4.9.5	Cable lugs, plain washers, spring washers, bolts and nuts	Similarly, cable lugs, bolts, nuts & plain washers, Zinc coated spring washers shall be provided by the BHEL.
4.9.6	Bus bar design	Tinned Copper or Aluminium busbars shall be provided.
4.9.7	Aux. Transformer taping	Vendor should give provision for tapping Axillary transformer from AC SIDE BUS BAR xxxv/415 volt (where xxx is the PCU AC nominal voltage output). –with provision of MCCB for aux transformer requirement. Aux.Tf rating shall be provided during detail Engineering.

4.10 Panel related parameters

4.10.1	Structure sheets	Doors and frames - Type of enclosure and size/thickness details of the doors and frames shall be indicated by vendor, by maintaining following conditions. Doors: 2MM min thickness Side cover: 1.5MM min thickness Top and bottom covers: 2MM thickness Gland plate: Minimum 3mm thk min sheet steel or 4 mm thk non-magnetic material
4.10.2	Bus bars	Busbars shall be of appropriate size to match current rating, based on vertical / horizontal layouts and bus bar orientations. Insulation sleeves (PVC etc.) shall be used wherever necessary. Bus bars (both AC and DC) shall be suitably colour coded.
4.10.6	Fixing of PCU	PCU shall be suitable for fixing on the cable trench channels by the means of tack welding.
4.10.7	Earthing terminals as per relevant standards	Earthing terminals shall be provided using tinned copper bars of suitable cross section. Terminals shall be brought out to facilitate external connections. all cubicles and panels shall be provided with a ground bus with 40mm x 5mm or higher (as per requirement) copper bar extending throughout the length.
4.10.8	Insulation clearances	AC side: Phase to Phase / neutral: As per relevant standards DC side: As per relevant standards.
4.10.9	Painting	Epoxy based powder coating. Powder coating shall meet the requirement of IS 13871 Paint shade shall be RAL 1013 Pearl white. Same shall be re-confirmed during detailed engineering.

		Anti-moisture coating and corrosion free coating to be applied.
4.10.10	Overall dimensions	Width x Depth x Height in mm shall be indicated in the offer.
4.10.11	Weight	Panel weight shall be indicated in the offer.
4.10.12	Air Flow Requirement (m3/hr)	To be indicated by vendor for each PCU. - HVAC calculations shall be provided by vendor during detailed engg including CFD analysis for ventilation.

5.0. TESTING AND INSPECTION

5.1	Routine tests, as per relevant standards (IEC etc), shall be carried out on the PCUs and shall be witnessed by BHEL & Customer/ Customer authorized third party inspection agency). Vendor shall submit Manufacturing Quality Plan (MQP) and detailed Test Procedure along with drawings for formal approval by customer prior to inspection. Routine tests shall be carried out by vendor on all the PCUs as per customer approved MQP. Following are the minimum tests to be conducted but not limited to: (a) HV and IR tests on 100% PCUs. (b) Functional tests (c) Load testing of inverter on 1No. PCU: - Verification of inverter performance in its standalone operational mode with a defined power (up to 100% rated full load power) and DC input voltage (up to max value). All parameters: DC voltage, current, power, grid voltage / current of R,Y,B lines, line frequency, ac output power, ac output energy, power factor, line current, efficiency, THD, etc. to be measured at 25%, 50%, 75% and 100% of the rated nominal power and checked against specified acceptance norms. (d) Heat Run Test at rated full load on 1 no. panel (e) Protection tests (by direct method or simulation method) - Verification of automatic disconnecting and reconnecting of Inverter to the grid, based on rise and fall of heat sink and cabinet temperature with reference to set points. - DC Reverse Polarity protection test - DC Ground Fault - AC and DC Overvoltage - Abnormal voltage and frequency Test reports shall be submitted prior to dispatch of the system to the site.

6.0. DOCUMENTS TO BE SUBMITTED AFTER RECEIPT OF PURCHASE ORDER

6.1	Following documents shall be submitted for approval within seven days from date of purchase order. 1. GTP/Datasheet 2. General Arrangement of PCU and other auxiliary equipment, lighting, HVAC details etc. 3. BOM for complete PCU including all major components of PCU, AC and DC Combiner Panels 4. Type test reports 5. Manufacturing Quality Plan (MQP) Vendor shall proceed with Manufacturing only after final approval of all the listed documents.

7.0. DOCUMENTS TO BE SUBMITTED ALONG WITH CONSIGNMENT

7.1	Following documents shall be submitted at the time of dispatch: a. Test reports on individual PCUs b. Technical manual with system specifications, installation guidelines, commissioning guidelines, schematic drawings, circuit board overlays, system set points, calibration settings, hardware settings, cable schedule, general arrangement drawings, panel details. c. Operation and Maintenance manual including final As Built and tested drgs and datasheet, test reports, Catalogs of individual components, schematic drgs shall be provided (segregated section wise) in both hard copy and soft copy.