



TECHNICAL SPECIFICATIONS FOR BALANCE OF SYSTEM
PACKAGE FOR DEVELOPMENT OF 1250 MW GRID
CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR
PARK IN BIKANER, RAJASTHAN

PS-439-1437

Rev No: 01

Date: 28.05.2025

**TECHNICAL
SPECIFICATIONS
FOR
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FOR
DEVELOPMENT OF 1250 MW
- CONNECTED SOLAR PV
PROJECTS
AT
RVUNL'S SOLAR PARK IN
BIKANER, RAJASTHAN**

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PM

Approved
MS

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PART-A
SUBSECTION – 1

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1.0	1-A PROJECT DETAILS																					
	INTRODUCTION																					
	<p>Bharat Heavy Electricals Limited (BHEL) is a Central Public Sector Enterprise under ministry of Heavy Industry and Public Enterprises, Government of India.</p> <p>It is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing companies of its kind in India and is a company listed in stock exchanges of India.</p> <p>Solar Business Division (SBD) is a Unit of BHEL located in Bengaluru, Karnataka State and engaged in execution of Solar PV project. BHEL SBD is one of the leading EPC Player in Solar PV market having a Portfolio of more than 1.2 GW comprising ground-mounted, canal-top, rooftop and floating solar.</p> <p>The project of 1500MW is being developed by a Joint Venture of NTPC Green Energy Limited and Rajasthan Rajya Vidyut Utpadan Nigam at RVUNL’s Solar Park in Pugal Tehsil, Bikaner district, Rajasthan . In which BHEL SBD intends to bid for a tender to develop 1250MW grid connected solar PV projects in Bandarewala (3 x 250 MW) and Barala (2 x 250 MW) in Rajasthan.</p> <p>Block wise details for which tender is invited is as below-</p>																					
	<table><tr><th>Block No.</th><th>Location</th><th>Capacity</th></tr><tr><td>BLOCK 2</td><td>BANDAREWALA</td><td>250 MW</td></tr><tr><td>BLOCK 3</td><td>BANDAREWALA</td><td>250 MW</td></tr><tr><td>BLOCK 4</td><td>BANDAREWALA</td><td>250 MW</td></tr><tr><td>BLOCK 5</td><td>BARALA</td><td>250 MW</td></tr><tr><td>BLOCK 6</td><td>BARALA</td><td>250 MW</td></tr><tr><td colspan="2">Total number of Blocks=5</td><td>Total Capacity=1250MW</td></tr></table>	Block No.	Location	Capacity	BLOCK 2	BANDAREWALA	250 MW	BLOCK 3	BANDAREWALA	250 MW	BLOCK 4	BANDAREWALA	250 MW	BLOCK 5	BARALA	250 MW	BLOCK 6	BARALA	250 MW	Total number of Blocks=5		Total Capacity=1250MW
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<p>Accordingly, this specification is for Balance of System (BOS) package for the development of 1250MW (5x250MW) Solar projects.</p> <p>The RVUNL Solar park land spans across three villages- Ramsar Chhota, Bandarewala and Barala. In the subject package, four Solar Project Blocks of 250MW are envisaged in Bandarewala village and two Solar Project Blocks of 250MW are envisaged in Barala Village. Separate Pooling Substations shall be constructed by the SPPD (RVUNL) in the two villages for interconnection of the solar projects. Bidders shall bid for the one or more of the 250MW blocks (BLOCK 2 TO 6) and the award shall be in line with the award criteria specified in the commercial portion of bidding documents.</p>																						

1.1 BRIEF SCOPE OF WORK

The scope includes the following:

1. The scope of work under this contract shall include Design, Engineering, Manufacturing, Supply, Packing and Forwarding, Transportation, Unloading, Storage, Installation, Testing, and Commissioning of the complete Solar Photovoltaic (SPV) Plant, **except for the supply of Solar PV Modules and Module Mounting Structure (MMS)**. The Supply of Solar PV Modules shall be in the End Customer's scope. The Supply of Module Mounting Structure (MMS) including Fasteners for MMS shall be in BHEL's scope.
2. Site - Grading & Clearing of Vegetation, Topographical Survey, Geotechnical Investigation.
3. Construction of foundation & erection of Module Mounting Structure for SPV panels, including fixing of PV Modules on MMS and PV Modules interconnection through fasteners.
4. Arranging power supply and water supply for construction purposes.
5. Construction of Pre-Engineered type Inverter room (if applicable) with Power conditioning unit associated LT and HT switchgear. In case of String Inverter, Construction of Pre-Engineered type HT Switchgear room.
6. All associated electrical and civil works required for interfacing with grid (i.e., transformers, panels, protection system, cables, metering at 33kV level, grid compliance study as per regulation, CMCS buildings etc.). Power evacuation in scope of the package shall be up to 33kV Pooling Switchgear/Switchyard at Park pooling substation of SPPD. 33kV Park Pooling switchgear/switchyard is not in the scope of the contract, **however supply and installation of metering infrastructure at each 33KV incoming feeders for solar projects interconnection at SPPD's PSS shall be in the scope of the bidder**
7. Laying and termination of HT Cables (including supply) from solar blocks to 33kV interconnection point of Park Pooling substation as per specification.
8. Module cleaning system including supply and installation of all accessories.
9. Construction of internal roads, pathways, construction of internal drainage system as per General Layout and Topography, any internal / temporary fencing, security cabin etc.
10. SCADA system for remote monitoring and control of Inverters with all hardware & software and complete set of Weather Monitoring Station including cloud cover.
11. Power Plant Controller(s) (PPC) with associated equipment for the solar project(s) including Power Quality meters.

2.0

12. Dynamic reactive power compensation equipment and Harmonic filters to comply with the requirements of dynamic reactive power capability at ISTS POI as per the "Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022".
13. CCTVs along with remote monitoring system with coverage of 100% periphery, entry/exit gates of the solar blocks, WMS, inverter stations
14. Comprehensive Operation & maintenance of SPV Plant along with electrical equipment, consumables and spare parts for a period of Three years from the date of commissioning of full Project capacity.
15. Supply of Mandatory spares.
16. Establishment for Site office (with accessories like printer, paper, PC, Internet etc.) for BHEL Officials for entire duration of execution and O&M Period.
17. Accommodation of BHEL Officials at Bikaner and transportation facility from Bikaner to site office.
18. Unloading, Storage, handling and installation at Site of all the components including PV modules and Module Mounting structure .

PROJECT CAPACITY

Name of the Project	BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1250 MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN
Plant Capacity	250MW for each of the Five blocks/projects at STU Point of Interconnection. Bidders shall bid for one or more of the 250MW blocks. Selection of bidders shall be as per award criteria mentioned elsewhere in the Bidding documents.
Termination Point	SPPD's 33kV Main Pooling switchgear at 400kV/33kV substation switchyard. (Number of 33kV feeders available for interconnection shall be as per Tender SLD)
Metering Point	SPPD's 33kV Main Pooling switchgear at 400kV/33kV substation switchyard.

	<p>(Solar Project shall be terminated at SPPD's 33kV Main Pooling Switchgear. Thereafter, voltage will be stepped up through Power Transformer (s) and the 400kV side will finally be connected to STU substation through 400kV Transmission Line(s))</p>
Power transformer details	<p>33-33/400KV transformers at Pooling substations to be executed by SPPD.</p> <p>Rating of transformers: 250MVA, Z=14.5% @ 250 MVA (Tentative).</p>
400kV transmission line details (for loss calculation)	
Point of Interconnection (STU)	<p>400 kV of STU substation (RVPNL) in Pugal Tehsil, Bikaner</p>
System Study	<p>400KV Transmission line data has been furnished for system study and setting up SVG. System study is under bidder scope.</p>

LOCATION AND APPROACH

Location of Site	Bandarewala and Barala, Pugal, Bikaner, Rajasthan
Nearest Town	Bikaner (55 kms)
Nearest Highway/Major Road	Suratgarh - Chattargarh - Bikaner Road
Nearest Railways Station	Bikaner Junction (55 km)

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	Nearest Commercial Airport	Bikaner Airport, Bikaner -- 45 kms Jodhpur International Airport – 280 kms		
	Indicative Coordinate	Bandarewala: 28°16'14.71"N, 73° 4'20.54"E Barala: 28°19'4.50"N, 73° 7'15.36"E		
4.0	AREA AVAILABILITY <table><tr><td>Land availability</td><td>As per Vicinity Map.</td></tr></table> <p><i>Land will be provided by END CUSTOMER on “as is where is basis”. Land being provided may or may not be on a contiguous basis.</i> Bidders are advised to carry out site visit for proper assessment of land and site conditions prior to submission of their bid. Entire land handover might be available in phases and bidders would be required to plan their activities accordingly. Once the land is handed over, further protection of soil would be in bidder’s scope.</p>		Land availability	As per Vicinity Map.
Land availability	As per Vicinity Map.			
5.0	TECHNOLOGY <p>In Solar Photo Voltaic Power Generation, the direct conversion of solar radiation into electricity is achieved by using semiconductor devices “Solar Cells”, which work on the principles of photo electric effect.</p>			
6.0	SITE SPECIFIC TECHNICAL DATA <p>Refer APPENDIX – 1</p>			
7.0	EVALUATION CRITERIA <p>Refer APPENDIX – 2.</p>			
8.0	STATUTORY COMPLIANCE, GRID CONNECTIVITY AND POWER EVACUATION <p>The scope of power evacuation system in the scope of the bidder is up to the terminal point as indicated in the tender SLD. The Bidder shall be responsible for terminating their 33kV evacuation feeder at 33kV Main Pooling Switchgear built by END CUSTOMER.</p> <p>Bidder shall comply all provisions and amendments thereafter of</p> <ul style="list-style-type: none">(i) Central Electricity Regulatory Commission (Connectivity and General Network Access to the inter-State Transmission System) Regulations, 2022.(ii) CERC ‘Detailed Procedure for Connectivity and GNA’ under the Central Electricity Regulatory Commission (Connectivity and General Network Access to the interState Transmission System) Regulations, 2022”.			

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	<ul style="list-style-type: none"> (iii) CERC (Grant of Connectivity, Long Term Access and Medium-term Access in Interstate Transmission and related matters) Regulation 2009 (if applicable as per extant connectivity regulations/procedures). (iv) CERC's revised procedure for "Grant of Connectivity to Projects based on renewable sources to inter-state transmission system" (if applicable as per extant connectivity regulations/procedures). (v) CEA (Technical Standards for Connectivity to Grid) Regulation, 2007 with all latest amendments including Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2019 and Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022. (vi) CEA (Technical Standards for construction of Electrical Plants and Electrical Lines) Regulation, 2022. (vii) CEA (Grid Standard) Regulation, 2010. (viii) CEA (safety requirements for construction, operation and maintenance of Electrical Plants and Electrical Lines) Regulations, 2011. (ix) CEA (Measures relating to Safety and Electrical Supply) Regulations, 2010 including amendment in 2023. (x) CEA (Installation and Operation of Meters) Regulations 2006. (xi) Indian Electricity Grid Code Regulation, 2023. (xii) CEA (Technical standards for communication system in Power system operations) Regulation 2020. (xiii) CERC (Communication System for Inter State Transmission of Electricity) Regulations 2017. (xiv) MOP Order dated 02.07.2020 stating measures to protect the security, integrity and reliability of the strategically important and critical Power Supply System and Network in the Country. (xv) CEA (Cyber Security in Power Sector) Guidelines, 2021. (xvi) Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022. (xvii) MNRE guidelines/OM/Advisory/Clarifications (xviii) Specifications for Next Generation Firewall (NGFW) issued by CTUIL including its subsequent amendments from time to time. (xix) Relevant state and STU/LDC guidelines. (xx) And any other applicable standards/ regulations/ Guidelines/ clarifications/ OMs/Advisories. <p>a) Solar Inverters shall be provided with Dual or Multi Master facility, whereas WMS shall be provided with Single or Dual Master facility. Bidder shall install and place its SCADA</p>

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	<p>system along with its terminals at the CMCS building(s) to be constructed by them for the respective blocks.</p> <p>b) Supply of hot standby redundant PLC/RTU/DCS based power plant controllers (PPC) for the solar block of the bidder along with associated independent equipment/accessories is in the scope of the Bidder. Detailed control logic and setting of the PPC shall be in line with latest CEA (Technical Standards for Connectivity to Grid) and as per SLDC/STU/CTU requirement. The solar plant PPC networks shall be suitably designed, so that PPC shall directly and independently be able to control/communicate the individual solar inverter (dual or multi-master) and WMS (single or multi-master) and redundant Power Quality Meters (IEC 61000-4-30 class A) at the STU Point of Interconnection and at suitable locations of SPPD's Pooling substation as per requirement of STU/LDC/CEA. The supply of Power Quality Meters at STU Pol as well as at necessary locations of SPPD's Pooling substation as per requirement of STU/CTU/LDC/CEA is in the scope of the bidder. PPC healthiness shall be monitored by SCADA which is in the scope of the bidder. Refer Technical specification Part B for detailed technical specifications of PPC, SCADA, PQM etc.</p> <p>c) Bidder shall also submit detailed Grid compliance study (steady state/Dynamic/Power Quality) with Power Plant Controller for solar project (in PSS/E and PSCAD platform) at various temperatures(minimum 2, to be finalized by END CUSTOMER during detailed engineering) as per CEA technical standard to grid connectivity/STU/CTU requirement/ Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid and latest guideline of LDC for first time energization and integration clearance. Bidder shall follow the "Report of the Working Group in respect of Data Submission Procedure And Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022".</p> <p>d) In this regard, Bidder shall submit the single inverter, aggregated and detailed RMS model of the plant in PSS/E along with PSCAD aggregated model in line with CEA Working Group report and/or applicable standard. Bidder to submit Generic model data of Inverters and PPC suitable for use in PSS/E software available at LDC/Park Developer and Encrypted user-defined model (UDM) of Inverter and PPC in PSS/E software (*.dll files) as applicable. In case any site testing is required for grid compliance as per LDC, it shall also be conducted.</p> <p>e) Bidder shall submit preliminary CEA grid compliance study as per timeline set by STU/CTU/LDC in line with "Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators" and timeline mentioned in the bidding documents. Based on their comments received on the submitted report, the study and Model shall be updated and resubmitted again within stipulated timeline, with solar plant latest parameters for final acceptance. Availability of PSSE and PSCAD model of Inverter and PPC shall be ensured by Bidder during selection of respective Manufacturer.</p> <p>f) Bidder shall provide all data for performing applicable study/simulation reports as per 'Procedure for Integration of solar plant those are regional entities" for submission to RLDC for first time charging clearances (as required by regulatory/statutory body).</p>

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	<p>Some information/documents from the above procedure and Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022 are mentioned below. However, bidder shall refer the applicable documents in detailed on their own for compliance.</p> <p>Dynamic Model</p> <ol style="list-style-type: none"> 1). Copy of dynamic model as per the connectivity 2). Updated dynamic model three months ahead of the proposed date of first-time charging. 3). Following Reports also to be included along with the dynamic model: <ol style="list-style-type: none"> (i) Parameters of Inverter in .dyr file to be validated with the test report results from the LVRT/HVRT certification and the validation report to be submitted. (ii) Simulation Report of plant model confirming CEA compliance for Dynamic reactive support /LVRT/ HVRT/Frequency control. (iii) Simulation Report of Reactive Capability Curve of Plant measured at POI to STU system/metering point (as applicable) for compliance of CEA technical standard (for Voltage 0.95/1/1.05 pu with pf ranging from 0.95 lag to 0.95 lead) and short circuit study/Load flow study/harmonics analysis results. 4). Inclusion of EMTP model of plant (in PSCAD platform), benchmarking report of model along with the dynamic model. 5). Harmonic study (Voltage and current harmonics) flicker study at Inverter level, Pooling Switchgear Level and POI. Impedance vs Frequency plot of the plant. g) Bidder shall update themselves latest requirement for technical data requirement/PSSE/PSCAD Model as per RLDC/STU/CTU. The minimum data required is attached in Appendix-5 for IBR (Inverter Based Resources) to be submitted to END CUSTOMER as a part of Grid study in the scope of the bidder. Bidder shall submit above documents within 3 months from LoA. However, the final requirement or any other requirement shall be intimated during detail engineering in due course of interaction with RLDC. The simulation study has to be carried out as per POI data (like SCR, X/R etc.) shared by END CUSTOMER/LDC/STU/CTU. h) Bidder shall facilitate END CUSTOMER in addressing all the queries of STU/CTU/LDC with respect to reports and models are answered to their satisfaction. i) Bidder shall provide the PSSE and PSCAD model and related study report at least 12 months before the schedule commissioning date of the project and Final Updated dynamic model after COD of the entire station (within one month of COD declaration) after site verification and site testing. j) Bidder shall install only Static Var Generators (SVG) for additional dynamic reactive power compensation beyond the dynamic reactive power compensation

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11.0	2	Power Requirement during construction	To be arranged by bidder
	3	MOEF Clearance	To be facilitated by bidder. (If applicable)
	4	SPCB Clearance	
	5	MNRE Clearance	To be facilitated by bidder (if applicable)
	6	ROW clearance	To be facilitated by bidder (except the specific ROW corridors earmarked by SPPD for cables as per tender drawing)
	7	Chief Electrical Inspector Clearance	To be facilitated by bidder
	8	Tree Cutting Permission	To be arranged by bidder
	12.0	Bidder shall apply for necessary approvals, permits and clearances not more than 90 days from the issuance of LOA, which shall be complete in all respects, incorporating the clarifications/changes as required by the concerned authorities.	
13.0	<p>All the statutory fees for approvals till the completion of O&M period shall be in the scope of bidder (unless otherwise specifically mentioned in document).</p> <p>LIQUDATED DAMAGES FOR GENERATION SHORTFALL DURING O&M</p> <p>Refer APPENDIX – 3A.</p> <p>COMPREHENSIVE AMC REQUIREMENTS</p> <p>Refer APPENDIX – 3B. FACILITIES</p> <p>FROM SPPD</p> <p>Refer APPENDIX – 4.</p>		

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																										
A.	<div>APPENDIX – 1</div> <div>SITE SPECIFIC TECHNICAL DATA</div> <div>Solar Insolation Data for Proposed Site</div> <table><tr><th>Month</th><th>Solar Insolation (kWhr/m²)</th><th>Albedo</th></tr><tr><td>January</td><td>114.7</td><td>0.25</td></tr><tr><td>February</td><td>135.1</td><td>0.26</td></tr><tr><td>March</td><td>184.9</td><td>0.27</td></tr><tr><td>April</td><td>201.4</td><td>0.27</td></tr><tr><td>May</td><td>204</td><td>0.27</td></tr><tr><td>June</td><td>181.5</td><td>0.27</td></tr><tr><td>July</td><td>168.1</td><td>0.27</td></tr><tr><td>August</td><td>173.3</td><td>0.27</td></tr><tr><td>September</td><td>174.3</td><td>0.26</td></tr><tr><td>October</td><td>164.9</td><td>0.27</td></tr><tr><td>November</td><td>123.6</td><td>0.27</td></tr><tr><td>December</td><td>112.8</td><td>0.25</td></tr><tr><td>Year</td><td>1938.5</td><td>0.27</td></tr></table>	Month	Solar Insolation (kWhr/m²)	Albedo	January	114.7	0.25	February	135.1	0.26	March	184.9	0.27	April	201.4	0.27	May	204	0.27	June	181.5	0.27	July	168.1	0.27	August	173.3	0.27	September	174.3	0.26	October	164.9	0.27	November	123.6	0.27	December	112.8	0.25	Year	1938.5	0.27
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B.	<div>MODULE MOUNTING – i) Fixed Tilt MMS to be adopted for this project.</div> <div>The minimum design clearance (at the highest tilt angle) between the lower edge of the modules and the developed ground level shall be 500mm for Fixed Tilt MMS system.*</div> <div>Clauses pertaining to Tracker system elsewhere in the NIT shall be ignored</div>																																										
C.	<div>CABL LAYING METHODOLOGY</div> <div>Bidder can also propose suitable cable laying methodology, keeping in view of the site conditions, which shall be reviewed during the detail design engineering.</div>																																										
D.	<div>PROJECT LOCATION CLASSIFICATION (CORROSION PROTECTION)</div> <table><tr><th>Parameter</th><th>Coastal/Non-Coastal</th><th>Corrosive Category (as per ISO12944-2)</th></tr><tr><td>Corrosive category</td><td>Non-coastal</td><td>Minimum C3</td></tr></table> <div>However, for sub-structures, the chemical aggressiveness of sub soil & ground water shall be as per approved geotechnical investigation report and IS: 456; based on which measures against corrosion shall be adopted.</div> <div>Pollution from industries/factory /mines etc shall also be considered while deciding the corrosion category depending on the level of pollution to which location is exposed.</div> <div>Corrosive category (for Paints)</div>	Parameter	Coastal/Non-Coastal	Corrosive Category (as per ISO12944-2)	Corrosive category	Non-coastal	Minimum C3																																				
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<p>E.</p> <p>F.</p> <p>G.</p>	<p>Classification of environments for Corrosive category shall be in accordance with ISO12944-2, the applicable atmospheric corrosivity categories are C3 (medium); C4 (high); C5-I (very high-industrial); C5-M (very high-marine). ISO12944-5 shall be used related to paint systems in combination with guidance for the selection of different types of protective paint system.</p> <p>Wherever specification allows LT electrical panels, UPS, SCADA panel, Fire protection panel etc. associated with Inverter station to be placed outdoor, the enclosure of the same should be well engineered product having proper ventilation system and must be protected from harsh environment & direct sunlight/rainfall. Radiation and absorption effects of outdoor environment must be considered for temperature rise calculations. The temperature rise should not be more than working temperature of components. Requirement of suitable shed/canopy shall be reviewed based on the offered solution during detailed engineering stage.</p> <p>For metal enclosed outdoor HT switchgear/RMU, pooling switchgear on the LT side (if applicable) from string inverter to inverter transformer, suitable shed shall be provided considering the O&M space.</p> <p>Painting of outdoor metallic enclosed electrical panels including HT switchgear/RMU shall be as per ISO 12944-5, corresponding to corrosive category mentioned in the above table.</p> <p>For outdoor inverter including containerized solution, painting corresponding to site condition shall be provided.</p> <p>RAINFALL – Heaviest rainfall in one hour (in mm): 48.8mm Or As per Nearest city / town (as mentioned in Appendix-A of IRC:SP:13-2004.)</p> <p>SEISMIC DATA & DESIGN CRITERIA – Provisions of IS 1893 (Part 1) shall be followed.</p> <p>WIND DATA & DESIGN CRITERIA</p> <p>Basic wind speed shall be as per IS 875 (Part-3) (Based on survey of India Political map printed in 2002).</p> <p>The minimum design wind pressure (Pd) to be considered for design of MMS, Equipment Fixing, Buildings, Rooms, etc. as below:</p> <table border="1"> <tr> <th>BASIC WIND SPEED, m/s</th><th>Design Wind Pressure, min, Pd (N/m²)</th></tr> <tr> <td>47</td><td>890</td></tr> </table> <p>For the solar project, the minimum design wind pressure (Pd) = 890 N/m² The complete peripheral boundary wall made of pre-stressed pre-cast boundary wall (Refer Tender Drawing) shall be executed by bidder.</p>	BASIC WIND SPEED, m/s	Design Wind Pressure, min, Pd (N/m ²)	47	890
BASIC WIND SPEED, m/s	Design Wind Pressure, min, Pd (N/m ²)				
47	890				

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																				
	<p>Alternatively, Bidder may provide Chain Link Fencing as per tender drawing in place of Boundary Wall. However, responsibility of safety of Project against damage / theft in said fencing or otherwise would remain with bidder until handover.</p>																																				
H.	<p>Bidder shall propose Dry Robotic cleaning system only for cleaning of Solar PV modules. The cleaning Array layout shall be designed considering Robotic Dry-cleaning system from reputed manufacturers/suppliers. The continuous length of solar array table (or MMS) for Robotic cleaning system, the distance between two modules of two different Array tables, required levelling and grading shall be done by the bidder.</p>																																				
I.	<p>System Unavailability of minimum 1% in terms of energy shall be considered in PVSyst for estimation of annual generation. This includes the loss due to data inaccuracy /data variability also. Additionally, Soiling loss of minimum 1.5% in terms of energy shall be considered by bidder in PVSyst for estimation of annual generation.</p>																																				
J.	<p>A CMCS Building shall be constructed in each of the 250MW blocks. The SCADA, PPC and other such equipment of each 250MW block shall be installed in the respective block CMCS building.</p> <p>The minimum area requirement of CMCS building rooms/facilities is as follows:</p> <table><tr><th>SI No:</th><th>Room</th><th>Minimum Area</th></tr><tr><td>1</td><td>SCADA & PPC ROOM</td><td>80 sqm, Min. 6.5m width</td></tr><tr><td>2</td><td>Store room</td><td>25 sq m with minimum 5m width</td></tr><tr><td>3</td><td>Toilets (Male and female)</td><td>20 sqm</td></tr><tr><td>3</td><td>Pantry</td><td>10 Sqm. Minimum 2m width</td></tr><tr><td>4</td><td>Owner Room</td><td>24 sqm Minimum 5m width</td></tr><tr><td>5</td><td>Conference Room</td><td>40 sqm</td></tr><tr><td>6</td><td>Transit room (2 nos.)</td><td>45 sqm with toilet</td></tr><tr><td>7</td><td>ACDB/DCDB Room</td><td>As per OEM Recommendation</td></tr><tr><td>8</td><td>Lobby</td><td>Min. 2m Width</td></tr><tr><td>9</td><td>Switchgear Room/UPS Room</td><td>As per requirement and OEM recommendation</td></tr><tr><td>10</td><td>Battery Room</td><td>As per requirement and OEM recommendation</td></tr></table>	SI No:	Room	Minimum Area	1	SCADA & PPC ROOM	80 sqm, Min. 6.5m width	2	Store room	25 sq m with minimum 5m width	3	Toilets (Male and female)	20 sqm	3	Pantry	10 Sqm. Minimum 2m width	4	Owner Room	24 sqm Minimum 5m width	5	Conference Room	40 sqm	6	Transit room (2 nos.)	45 sqm with toilet	7	ACDB/DCDB Room	As per OEM Recommendation	8	Lobby	Min. 2m Width	9	Switchgear Room/UPS Room	As per requirement and OEM recommendation	10	Battery Room	As per requirement and OEM recommendation
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	<p>Note:</p> <p>1. Clear Usable Area would mean the Internal Area excluding Wall thickness.</p>																																				

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>2. Aesthetic details will be as per Detailed Engg. drawings by the Bidder in mutual discussion with the concerned RE Project Team.</p> <p>As SCADA, PPC Panels, etc. are proposed to be kept inside the control room/CMCS building, sufficient space with air conditioning (as applicable) in addition to above minimum area shall be provided considering the equipment size, OEM recommendations and maintenance access. Space for future panels shall be provided in CMCS building which shall be finalized during detailed engineering stage. The above facilities are not exhaustive, and any additional room or space required for the CMCS as proposed by the bidder shall be in the scope of the bidder.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">APPENDIX – 2 EVALUATION CRITERIA</p> <ol style="list-style-type: none"> 1. Evaluation of Price Bids: Separate bid evaluation shall be carried out for each Block 2. Bidders shall ensure submission of ‘Bid Price’ on “Total quoted cost in INR” (including GST and all other taxes & Duties) for each Block Separately. 3. Bidder has no option to Quote Block 1

CLAUSE NO.	TECHNICAL SPECIFICATIONS
1.0	<p style="text-align: center;">APPENDIX – 3A</p> <p>LIQUIDATED DAMAGES FOR SHORTFALL IN GENERATION DURING O&M</p> <p>Liquidated damages per unit (kWh) for shortfall in generation during O&M period on yearly basis would be considered as INR 2.89 / kWh.</p> <p>Additional applicable GST on LD amount is payable by the contractor.</p> <p>Methodology for calculation of LD on shortfall in stipulated generation shall be as follows:</p> <ul style="list-style-type: none"> • Generation finalized (evaluated) during detailed Engg. = G_Y • Reference Global Horizontal Insolation= H_1 • Measured Generation during the O&M period=G_2 • [#]Measured Global Horizontal Insolation during the O&M period= H_2 • Modified target Generation during the O&M period (G_2') <p>$G_2' = (H_2/H_1) \times G_Y \times MCF \times OTF$</p> <p>Where,</p> <p>MCF=Module correction factor for performance degradation = $(1 - (N-1) \times 0.006)$ N</p> <p>= Year of operation</p> <p>Thus, for second year of operation $MCF = (1 - 1 \times 0.006) = 0.994$</p> <p>OTF=O&M Target Generation Factor: Ratio of achieved generation during OTGT Period to Corrected Target generation for OTGT period</p> <p>It shall be more than or equal to 1(one). Its minimum value shall be 1 if generation achieved during OTGT is equal to the corrected target generation for OTGT.</p> <p>Therefore, Liquidated Damages for shortfall in generation= $\Delta G \times (\text{Energy Charges})$</p> <p>Then ΔG= Shortfall in generation = $G_2' - G_2$</p> <p>In case $G_2' < \text{or} = G_2$ then no liquidated damages for the corresponding O&M period.</p> <p>The maximum Liquidated Damages for the shortfall of generation during each year of O&M period shall be limited to generation revenue corresponding to 5 % of the generation at ceiling tariff mentioned above.</p> <p>Tariff for computing Liquidated damage for O&M Period as per clause mentioned in Sub Part 1-A & 2-A, relevant clause.</p> <p>[#]In case, the GHI is not available because of instrumentation or SCADA problem, the corresponding insolation and generation shall be excluded from the time block for estimation of loss of generation.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Generation loss due to the grid outage not attributed to the contractor shall also be excluded for arriving loss of generation.</p> <p>One day shall be equally divided into 96 blocks of 15 minutes each starting from 00:00 Hrs, i.e. 42nd time block shall be from 10:15-10:30 Hrs.</p> <p>In case of shortfall in generation, recovery of LD shall be first deducted from payment towards O&M contract value Upto limiting level of 25% of the Annual Contract Value. The adjustment of LD amount shall be done in the 4th Quarter.</p> <p>In case the LD recovery amount exceeds above limiting value, balance amount shall be recovered through Bank Guarantee submitted by EPC Contractor. The value of amount encashed from above BG shall have to be replenished by EPC contractor within three months.</p> <p>.</p> <p>CALCULATION OF LD AND PROPOSAL FOR 50 MW SAMPLE PROJECT</p> <ul style="list-style-type: none"> Value of the Annual O&M Contract = Say Rs. Y per Year O&M Charges payable to the contractor on Quarterly basis= Rs. Y / 4 per Quarter • <p>Maximum LD deductible from O&M contract = 25 % of Annual O&M Contract value in Q4 =Rs. (Y / 4)</p> <p>The complete LD amount shall be adjusted in the 4th Quarter.</p> <p>Sample procedure for determining LD for shortfall in generation during O&M period as follows:</p> <ul style="list-style-type: none"> O&M Period being considered- 2nd Year i.e. MCF=0.994 • OTF=1.03 if during the OTGT, the excess generation is 3%. Evaluated Annual Generation by the Bidder (G_Y in Million Unit) = 100 MU <p>Reference Global Horizontal Insolation (H_1) = 1960 kWh/m²-year (Actual reference GHI for the site shall be as per Appendix – 1 to Part 1-A)</p> <ul style="list-style-type: none"> Measured Generation by the Bidder (G₂ in Million Units) = 100.8 MU (say) ✦ Measured Global Horizontal Insolation during the O&M period(H_2)=1965 kWh/m²year (say) Modified target Generation during the 2nd year of the O&M period(G₂') = $G_Y \times (H_2/H_1) \times MCF \times OTF$ = $100 \times (1965/1960) \times 0.994 \times 1.03 = 102.64$ MU <p>$\Delta G = G_2' - G_2 = 102.64 - 100.8$ MU = 1.84 MU</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Since $G_2' > G_2$, LD applicability = Yes</p> <p>Value of LD in INR = Shortfall in Generation (MU) x Tariff</p> <p>= INR ΔG x R</p> <p>Maximum Value of LD towards shortfall in generation during O&M period = Energy charges for 5% of Evaluated generation</p> <p>= $0.05 \times G_Y \times R$ INR</p> <p>Where R is the applicable tariff for LD i.e. INR 2.89/kWh. G_Y is the evaluated 1st Year Generation by the bidder.</p> <p><i>Further details and conditions regarding OTGT, O&M, Commissioning, etc. refer Part-B, General Systems.</i></p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS												
	<p style="text-align: center;">APPENDIX – 3B COMPREHENSIVE AMC REQUIREMENT</p> <p>Contractor shall carry out regular predictive maintenance during entire AMC period through OEM or <i>OEM authorized service provider</i>.</p> <p>The requirement of Comprehensive AMC of Critical Equipment is as follows:</p> <table> <tr> <th>Equipment/System</th><th>Comprehensive AMC*</th></tr> <tr> <td>Inverter</td><td>10 Years</td></tr> <tr> <td>SCADA</td><td>10 Years</td></tr> <tr> <td>Power Plant Controller (PPC) System</td><td>10 Years</td></tr> <tr> <td>Robotic Cleaning System</td><td>10 Years</td></tr> <tr> <td>Dynamic Reactive Power Compensation Equipment other than inverter</td><td>10 years</td></tr> </table> <p style="text-align: center;">* <i>Starts from date of commissioning of full capacity</i></p> <p>The AMC document has to be submitted before commissioning of full capacity. Joint undertaking document (as per Proforma provided along with bidding documents) is to be furnished by EPC contractor before completion of O&M contract.</p>	Equipment/System	Comprehensive AMC*	Inverter	10 Years	SCADA	10 Years	Power Plant Controller (PPC) System	10 Years	Robotic Cleaning System	10 Years	Dynamic Reactive Power Compensation Equipment other than inverter	10 years
Equipment/System	Comprehensive AMC*												
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">APPENDIX – 4</p> <p style="text-align: center;">FACILITIES FROM END CUSTOMER/SPPD FOR THE PROJECT</p> <ol style="list-style-type: none"> 1. Main Road connectivity up to periphery of all 250MW blocks. 2. Main Pooling 33kV Switchgear and associated equipment. 3. 33kV/400kV Substation Switchyard including Power Transformers for the block(s) and Substation Automation System. 4. 400kV Transmission line and ROW from 33 kV/400 kV Park Pooling Substation to STU substation. 5. Refer Tender Drawings, Annexures and Notes mentioned for more clarity w.r.t Site Specific Considerations. <p>Note - All <u>temporary arrangements</u> w.r.t approach roads, drainage, office set up etc., as necessary to take up the project construction work, would be in bidder's scope.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">APPENDIX – 5</p> <p>Requirement of Single IBR unit Simulation model & Benchmarking report</p> <p><u>Requirement of Single IBR unit Simulation model & Benchmarking report-</u></p> <ul style="list-style-type: none"> • Single SoC (Statement of Conformity) and Evaluation Report for Type test report as per CEA Connectivity standard mentioning all Hardware/software/Firmware version • Fault current characteristics (voltage -current) of Inverter during fault condition. The Reactive power response of the Inverter in case of fault condition, should be faster to support Grid or as per Grid operator. • Current and voltage Waveform capture facility during LVRT/HVRT at Inverter output terminal during event and accessible to END CUSTOMER in PPC. Availability of high-resolution data with pre fault/post fault time and automatic extraction of the above data into PPC subsequent to fault avoiding manual/OEM intervention. • During LVRT and HVRT, the Inverter shall distribute its active and reactive capacity in such a way that first priority will be reactive power support as per voltage dip. The active current and overall current shall be limited as per the transient rated current limit of inverter. Inverters should be capable to support reactive current in case of asymmetrical (1 ph/2 ph) fault condition. Active and reactive power response shall be oscillation free. • Inverter controller Setting facility from local as per CEA Regulation. The Inverter and its PSS/e and PSCAD model should have the tuneable parameters: FRT Voltage threshold, K factor, Proportional Gain, Integral Gain and Active and reactive power recovery gain during fault recovery duration etc as recommended by grid Operator. • Time synchronization facility of Inverter with PPC/SCADA • Single IBR Controller Setting in compliance with CEA grid connectivity regulation. • Single IBR model shall be prepared or get from OEM (for PSS/E and PSCAD) and benchmark it with the lab/factory/field test measurements taken during certification process. Benchmarking report shall include model validation against all the clauses mentioned in B1 & B2 of CEA Technical Standards for Connectivity to the Grid (Amendment) Regulation, 2019. • A separate benchmarking report /simulation comparison is required for SCR=5 and 3 for PSS/E and PSCAD software and furnishing the Parameters for the same. Provision to change setting in inverter according to various operating condition at site is to be provided. <p>Following shall be part of submission-</p> <ol style="list-style-type: none"> 1. Comparison of field test measurement with simulation results numerical values & as well as graphical values for following points.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<ol style="list-style-type: none"> a. Power Quality (only in EMT). b. Active power set change (RMS & EMT) c. Reactive power control- V control, pf & Q control (RMS & EMT) d. IBR capability demonstration (RMS & EMT) e. LVRT (RMS & EMT) f. HVRT (RMS & EMT) g. Frequency response (RMS & EMT) <ol style="list-style-type: none"> 2. Final simulation model parameters like Generator model, Electrical control model, drive train model etc. shall be included in benchmarking report. (RMS & EMT) 3. Firmware version of IBR unit controller for which IBR unit got certified shall also be included in this report. 4. Field test report documents shall be referenced in the benchmarking report. 5. Ensure the setting kept in IBR while field testing & actual IBR installed at site are same, if any alteration kindly include justification for the same. 6. IBR simulation model flat run results for 100 seconds with simulation time step of 1ms shall be included for electrical parameters (P, Q, V, f) and speed to be included (RMS) 7. EMT model of IBR unit- flat run results for 100 seconds with simulation time step of 10us or greater shall be included for electrical parameters (P, Q, V, f) and speed. Further, model shall get initialised within 3 seconds & shall have snapshot capability. 8. Model compatibility: EMT models provided to shall be compatible with PSCAD version 4.6 and above and Intel Visual FORTRAN version 15 or higher and RMS model for PSS/E version 34.4 and above. Same shall be included in the report. The models which is compatible with PSCAD V5 (latest version) with GNU Fortran compiler and with intel Fortran compiler need to be provided. If the model compiled in one compiler is not compatible with other compiler, it is requested to provide both models 9. Include a table having IBR controller setting, RMS & EMT model parameter for different control parameters as specified. (RMS & EMT) 10. IBR unit model for PSS/E shall include .sav, .dvr, .py, .idv, .sld, .out files and PSCAD .pscx and other supporting files. 11. Conclusion part include table for which models are benchmarked & whether the model replicates the actual. Error in simulation vs. actual shall be minimum to the extent possible, however it shall not be more than 5%.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
1.0	<p style="text-align: center;">1-B INTENT OF SPECIFICATION</p> <p>INTENT OF SPECIFICATION</p> <p>The scope of the proposal shall be Design, Engineering, Supply, Construction, Erection, Testing, and Commissioning of Solar PV plant in Bikaner, Rajasthan along with power evacuation system up to the terminal point excluding supply of PV modules. The scope also includes three (03) years Operation and Maintenance (O&M) of the solar PV plant as well as Comprehensive Annual Maintenance Contract (AMC) of critical equipment for a period of ten (10) years. The scope of work covers the following activities and services in respect of all the equipment & works specified and covered under the specifications and read in conjunction with “Scope of Supply & Services” elaborated elsewhere.</p> <p>All equipment, materials and services whether explicitly stated or otherwise and that are necessary for the satisfactory operation of the Solar PV system and its integration with the existing AC Systems as described in the specification shall be deemed to be included in the scope of work of the Contractor and shall not be limited to the following:</p> <ol style="list-style-type: none"> 1) Basic Engineering of the plant and systems. 2) Topographical survey, Geo-Technical investigation and all other necessary investigations. 3) Detailed design of all the equipment and equipment system(s) including civil works. 4) Providing, Review and approval of engineering drawings, data, process Calculations, test procedures, Structural Design Calculations, Equipment Layout, Drawings / Data sheets of bought out items, Civil Structural / Architectural Drawings, PG Test etc. 5) Providing Operation & Maintenance/ instruction manuals, as built drawings and other information 6) Providing training of Employer’s personnel 7) Finalization of sub-vendors, manufacturing quality plans and Field quality plans. 8) Complete manufacturing including conducting all type, routine and acceptance tests; Civil, Structural and Architectural works to the extent applicable, including construction facilities and construction power distribution. 9) Packing and transportation from the manufacturer’s works to the site including customs clearance & port clearance, port charges, (if any). 10) Receipt, storage, preservation and conservation of equipment including Owner supply equipment at the site; Fabrication, pre-assembly, (if any), erection, testing, pre-

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>1.1</p> <p>1.2</p> <p>1.3</p>	<p>commissioning and commissioning and putting into satisfactory operation all the equipment including successful completion of initial operation</p> <p>11) successful commissioning of full capacity.</p> <p>12) Supply of Spares.</p> <p>13) Satisfactory completion of the contract.</p> <p>14) Special tools and tackles if any required for maintenance of the plant.</p> <p>15) All equipment, materials and services that are necessary for implementation of the reactive power compensations system/harmonic filters etc. as per the grid study with satisfactory operation of the Solar PV system and its integration with the existing AC Systems.</p> <p>16) Comprehensive Operation and maintenance of the solar plant.</p> <p>17) Forecasting and scheduling during the 3-year O&M period as per guidelines/procedures of CERC/RLDC/Other nodal agencies.</p> <p>18) Aerial Drone survey of the complete project site shall be done by the bidder once a month and videos, photos depicting the physical progress of construction shall be submitted along with the monthly progress report for review of EIC/Site HOP/CEO, NRGEL.</p> <p>The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices etc. given in Technical Specifications (Section-VI) together with those stated in other Sections / Sub-sections of Bid Documents which shall be considered as a part of this volumes completely as if bound herewith. It is not the intent to specify herein all aspects of design and construction nevertheless, the equipment and civil works shall conforming all aspects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Employer, who will interpret the meaning of the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable Indian / International standards mentioned elsewhere in this specification.</p> <p>Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Such clarifications should be sought within the time period . Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. However, if the bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.</p> <p>The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to fulfill the intent of specification and ensuring operability, maintainability and the reliability of the complete work covered under this specification.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
1.4	<p>Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies and supplying the equipment that meet the requirement.</p>
1.5	<p>Before submitting his bid, the bidder should inspect and examine the site and its surroundings and should satisfy himself as to the nature of the ground and subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the Employer.</p>
	<p>SCOPE OF WORK</p>
2.0	
2.1	<p>Detailed design of Grid Interactive Solar PV Plant, civil, electrical & mechanical auxiliary systems including preparation of foundation drawings, single line diagrams, installation drawings, electrical layouts, design calculations etc. Design memorandum and other relevant drawings and documents required for engineering of all facilities within the scope to be provided under this contract, are covered under contractor's scope of work.</p>
2.2	<p>Bidder shall monitor the PV module performance data before the PV Module becomes operational using PV Analyzer of reputed make. This data has to be stored at site and shared with END CUSTOMER during the commissioning period. Bidder shall also carry out PV Module performance data review and storage using PV analyzer during O&M period.</p>
2.3	<p>Works related to site clearance including removal of bushes, trees, levelling, grading, finishing and other additional works in the scope of bidder. Mandatory permission/ licenses/ statutory clearances from Competent Authorities for undertaking blasting related works, disposal of cutting material, etc. shall be carried out by the Bidder.</p>
2.4	<p>Detailed system wise scope is elaborated in 2-A (Electrical Equipment & Works), 2-B (Civil Works) & 2-C (Miscellaneous Works) of Part-A, Section-VI.</p>
2.5	<p>Detailed system wise Technical Specification is elaborated in Part-B, Section-VI.</p>
2.6	<p>ALLOCATION FOR 1500MW (6x250MW) SOLAR PROJECTS AT RVUNL SOLAR PARK, BIKANER, RAJASTHAN:</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>3.0</p>	<p>TENDER DRAWINGS</p> <p>The list of drawings listed in Part-I of the Technical Specification shall form part of the specification and shall supplement the requirements specified in these technical specifications. These drawings are preliminary drawings for bidding purpose only and subject to changes that may be necessary during the detailed engineering keeping the basic parameters as specified. Various parameters for building and other equipment specified in the tender drawing are the minimum required & any increase in these parameters if required to meet the system requirement shall be made by the Bidder without any additional cost implication to Employer.</p>

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3.0	<p>transformers of 10 MVA or above capacity (consisting of one or more) were supplied, must have been in successful operation for at least six (6) months prior to the following reference date:</p> <p>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</p> <p style="text-align: center;">And</p> <p>b) Bidder/its sub-vendor should have its own facilities for conducting all routine tests for transformers as per IS: 2026/IEC 60076.</p> <p style="text-align: center;">And</p> <p>c) 2.5 MVA, 33kV or higher rated inverter transformer manufactured by Bidder/ its sub-vendor should have been successfully short circuit tested.</p> <p>Solar Inverter</p> <p>(a) The Bidder/its Sub-vendor should have designed, manufactured and supplied grid connected solar Inverters of cumulative capacity of 40 MW or above, out of which at least one such supply order for a single plant should be of 10 MW or above capacity. The reference plant in which 10 MW or above capacity solar Inverters (consisting of one or more) were supplied, must have been in successful operation for atleast six (6) months prior to the following reference date:</p> <p>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</p> <p style="text-align: center;">And</p> <p>(b) The Bidder/sub-vendor should have in-house solar Inverters routine testing facility as per relevant standard of solar Inverter.</p> <p style="text-align: center;">And</p> <p>(c) The offered solar Inverter model or any of its product family Inverter model or similar Inverter topology model with same make solid state power switching device must have been in successful operation for at least six (6) months the reference date mentioned above. The Inverter product family model or similar Inverter topology model power rating should not be less than 50% of the offered Inverter model rating. The similar Inverter topology model must have identical power circuit configuration and same maximum DC input voltage rating as compared with the offered Inverter model. The Inverter product family model or similar Inverter topology model shall be further technically assessed to establish the similarity with the offered Inverter model and same shall be subjected to END CUSTOMERacceptance.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
4.0	<p>Note: - (i) The individual Inverter capacity of 1.0 MW or above (for central Inverter) and 40kW or above (for string Inverter) shall only be considered for capacity determination. (ii) In case the inverter manufacturer is not meeting the requirement as mentioned in Clause 5.0 (a) & (c) above, they can utilize the credentials of its principal/ holding or subsidiary company/ associate/ collaborator (a solar inverter manufacturer) through technology tie-up for meeting the criteria as stipulated in clauses 5.0(a) & (c).</p> <p>HT Power cables (3.3kV or above but below 33kV)</p> <p>The Bidder/ Sub Vendor should have manufactured and supplied following cables, prior to the following reference date:</p> <p><i>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</i></p> <p>(a) At least 100kms of XLPE insulated power cables of 1.9/3.3 kV or higher voltage grade, executed in one or more limited to maximum of three orders.</p> <p>(b) At least one (1) km of flame retardant low smoke cables of any voltage level.</p> <p>(c) The plant for which cable have been supplied should have completed at least six months of successful operation prior to the date the reference date mentioned above.</p>
5.0	<p>HT Power cables (33kV)</p> <p>The Bidder/ Sub Vendor should have manufactured and supplied following cables, prior to the following reference date:</p> <p><i>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</i></p> <p>(a) At least 20kms of XLPE insulated power cables of 19/33 kV or higher voltage grade, executed in one or more limited to maximum of three orders.</p> <p>(b) At least one (1) km of flame retardant low smoke cables of any voltage level.</p> <p>(c) The plant for which cable have been supplied should have completed at least six months of successful operation prior to the reference date mentioned above.</p>
6.0	<p>DC Solar cables</p> <p>The Bidder/ Sub Vendor should have manufactured and supplied following cables, prior to the following reference date:</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
7.0	<p><i>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</i></p> <p>(a) At least 150 kms of XLPO insulated DC Solar cables of 0.63/1.1 kV or higher voltage grade of minimum 4 sq mm size executed in one or more limited to maximum of three orders.</p> <p>(b) The plant for which cable have been supplied should have completed at least six months of successful operation prior to the reference date mentioned above.</p> <p>Note: In case the DC solar cable manufacturer is not meeting the requirement as mentioned in Clause 8.0 (a) and/or 8.0(b) above, they can utilize the credentials of its principal/ holding or subsidiary company/ associate/ collaborator (a solar DC cable manufacturer) through technology tie-up for meeting these criteria as stipulated in clauses 9.0(a) and (b) above.</p> <p>Cable Laying Agency</p> <p>The bidder/ Subcontractor should have executed cabling works in which it has installed Power cables of 1.1 kV or higher-grade cables along with associated accessories for an industrial installation which should have been in successful operation for a period of at least two (2) years prior to the following reference date. The total quantity of Power cables (HT cables, LT cables, DC cables etc.) laid should be 100 kms or more in maximum two contracts/works</p> <p><i>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</i></p> <p>Robotic Dry-Cleaning System</p> <p>The Bidder/its Sub-vendor should have designed, manufactured, supplied, erected/supervised erection, and commissioned/supervised commissioned Robotic Dry Cleaning System for at least two (2) Nos. of projects of min. 100 MWp capacity each worldwide, OR at least one (1) No. of project of min 50MWp capacity in India.</p> <p>The reference plant in which 100 MWp / 50MWp respectively or above capacity is executed, must have been in successful operation for at least one (1) year prior to the following reference date:</p> <p><i>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</i></p> <p>The bidder/ its sub-vendor may use the credentials of its Parent/ Group/ Holding company for meeting the requirement.</p>
8.0	

CLAUSE NO.	TECHNICAL SPECIFICATIONS
9.0	<p>Reactive Power Compensating Equipment (SVG):-</p> <p>The bidder/ Subcontractor should have manufactured and supplied Static Var compensator/generator of cumulative capacity of 40 MVAR or above, out of which at least one such supply order for a single installation at Renewable project should be of 10 MVAR or above capacity. The reference installation in which 10 MVAR or above capacity were supplied, must have been in successful operation for at least six (6) months prior to the following reference date:</p> <p><i>Date of submission of proveness documents to END CUSTOMERor (LOA date + 6 months), whichever is earlier.</i></p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<div style="text-align: center; background-color: #f2f2f2;">Annexure-A to Chapter 1-C</div> <div style="text-align: center;">Undertaking from Main Contractor</div> <p style="text-align: center;">(On letter head signed by a duly authorized person along with company/firm's seal on behalf of the Main Contractor)</p> <p style="text-align: right;">Date:</p> <p>To CUSTOMER Rajasthan Green Energy Limited, Engineering Deptt/ EIC (as applicable)</p> <p>Subject: Authentication of veracity of documents submitted by M/sin support of meeting the proveness requirements mentioned in technical specifications.</p> <p>Name of Item/work for which proveness documents are submitted:</p> <p>Dear Sir,</p> <p>We (Main contractor name) hereby propose M/s. having Registered office at..... as sub vendor for the aforementioned item/work in referred tender of CUSTOMER Rajasthan Green Energy Limited.</p> <p>The tender condition stipulates that the main contractor shall duly verify, certify for its authenticity & correctness, and submit the credential documents of sub vendor pertaining to proveness criteria.</p> <p>In this regard, it is hereby confirmed that we have examined the following documents, which are also attached with this letter. The same has been verified from the Original Documents and/ or Client for authenticity and correctness.</p> <p>We hereby confirm that the following documents are found to be genuine and authentic.</p> <ol style="list-style-type: none"> 1. Doc ref. no. dated (name of Documents) 2. Doc ref. no. dated (name of Documents) 3. <p>All the aforesaid documents have been signed by us as a certificate of authenticity.</p> <p>Thanking you,</p> <p>(Name and details) (Company Seal)</p> <p><i>* Strike off, whichever is not applicable.</i></p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>PART-A SUBSECTION – 2</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS																														
1.0	2-A ELECTRICAL SCOPE OF SUPPLY & SERVICES																														
	BASIC ENGINEERING DESIGN PARAMETER OF SOLAR PV PLANT																														
	a) Plant Capacity at POI: 1500MW (6x250MW)																														
	<table><tr><th colspan="6">AC Capacity</th></tr><tr><th colspan="4">Bandarewala</th><th colspan="2">Barala</th></tr><tr><th>Block 1</th><th>Block 2</th><th>Block 3</th><th>Block 4</th><th>Block 1</th><th>Block 2</th></tr><tr><td>250MW</td><td>250MW</td><td>250MW</td><td>250MW</td><td>250MW</td><td>250MW</td></tr><tr><td>Min. Pitch = 6.5 m</td><td>Min. Pitch = 6.5 m</td><td>Min. Pitch = 6.5 m</td><td>Min. Pitch = 6.5 m</td><td>Min. Pitch = 6.5 m</td><td>Min. Pitch = 6.5 m</td></tr></table>	AC Capacity						Bandarewala				Barala		Block 1	Block 2	Block 3	Block 4	Block 1	Block 2	250MW	250MW	250MW	250MW	250MW	250MW	Min. Pitch = 6.5 m	Min. Pitch = 6.5 m	Min. Pitch = 6.5 m	Min. Pitch = 6.5 m	Min. Pitch = 6.5 m	Min. Pitch = 6.5 m
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	(* Refer tender drawing for Block details)																														
<p>Bidder must LIMIT the active power output of the Solar PV Plant at the Pol (STU) to Project Capacity (MWAC) so that the Power injected into the grid NEVER exceeds the threshold of Project Capacity. Reactive power capability at POI shall comply as per requirement of latest CEA (Technical standard for connectivity to Grid) Regulation.</p>																															
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<p><i>*Above Block DC capacity is considering DC:AC ratio 1.45 and nominal module Wp of 570 Wp. Number of modules for the solar PV project calculated based on 570 Wp (at DC:AC ratio of 1.45) shall be supplied to the BOS vendor. Even in case of change in nominal Wp of supplied PV module, the number of PV modules for erection shall remain same as calculated above and the DC capacity of the project shall be revised accordingly.</i></p>																															
<p>(END CUSTOMERshall provide Modules only as free issue items – However, Unloading, Storage, handling and installation at Site is in BOS Bidder Scope).</p>																															
c) Designed System Voltage: 1500 V DC																															
d) Design Philosophy: Bidder is free to propose his design of the solar plant including solar plant layout, solar block sizing, inverter sizing, inverter transformer sizing etc. subject to meeting the boundary conditions/design parameters as specified in the table below and other requirements as per this technical specification document. Bidder would be required to submit design details for 570Wp Modules as well as actual Wp that would be supplied by Owner, during detailed engineering. However, for the purpose of bidding consideration, the design for 570Wp is to be considered.																															

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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p><i>*PV Module Wattage is tentative. The actual module supplied by the owner may vary. However, the total number of modules to be installed by the bidder shall remain the same as mentioned at Sl. No. b) above. Based on the actual Module panel size, the parameters may be modified suitably as per site conditions. Module data sheets / data would be provided during detailed Engg. Stage.</i></p> <p>Bidder shall submit PV Syst report complying with the design parameters specified above and the actual Module PAN file supplied by END CUSTOMER to arrive at the Target Generation for first year O&M at 33kV Metering point.</p> <p>However, this target generation figure for first year O&M shall be revised as per the outcome of O&M Target Generation Test (OTGT), on the basis of following variations in the</p> <ul style="list-style-type: none"> (i) Actual PV Module characteristics. (ii) Actual Loss Parameters. (iii) Results of O&M Target Generation Test. (iv) Any other factors considered reasonable by the Employer. <p>This revised generation to be called as MODIFIED TARGET GENERATION shall be Generation Target for the first year of the O&M period.</p> <p>e) Inverter Capacity/rating: The continuous combined MW rating of all PCUs/inverters at unity power factor and at 0.95 p.u. voltage at Inverter terminal at ambient temperature of 51 deg C shall not be less than Plant MW capacity.</p> <p>The reticulation system (kVA rating of cable, transformer etc.) shall be designed to withstand maximum generated Inverter apparent power at that ambient condition.</p> <p>Same size of Inverter is recommended for the whole plant and same size of Inverter Transformer is also preferred considering Mandatory spare management. Foundation design of Inverter and Inverter transformer shall be of one type as per highest size.</p> <p>f) Reactive Power requirement for each 250MW Block: - Bidder shall install only Static Var Generators (SVG) for additional dynamic reactive power compensation beyond the dynamic reactive power compensation capability of inverters (as per the minimum inverter rating mentioned at clause e) above) for each of the 250MW blocks to ensure compliance of dynamic reactive power compensation at rated capacity at POI, i.e., STU Substation under CEA technical standard of connectivity to Grid and “Report of the Working Group in respect of Data Submission Procedure And Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022”. SVGs shall be installed near to the respective Pooling Substation. Bidder to lay</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS				
	<p>control/communication cables up to PPC/CMCS as well as HT cables up to Main pooling switchgear and integrate it in all respect. Development of Auxiliary supply for SVG is also included in Bidder's scope. The details of evacuation for the projects, offered by SPPD is as follows:</p> <table border="1"> <tr> <td>Power Transformers at PSS 315 MVA, 400kV/33kV-33kV Yn0yn0yn0</td><td>250MVA, Z=14.5% @ 250 MVA <i>Other loss figures may be tentatively considered as per "Standard Technical Specifications of Power Transformers for Solar Park Pooling Station" published by CEA. (Above data is tentative).</i></td></tr> <tr> <td>Transmission Line</td><td>For Bandarewala (For 1000MW): Approximate length of 400 KV quad MOOSE conductor from SPPD's Bandarewala Pooling substation up to STU Substation is approximately 30 KM. For Barala (For 500MW): Approximate length of 400kV quad MOOSE conductor from SPPD's Barala Pooling substation up to STU substation is approximately 40 KM. Apart from the 500MW project capacity under the subject package, additional 300MW from owner's solar projects will be evacuated through the line. <i>(Above data is tentative).</i></td></tr> </table> <p>g) 33 kV Local Pooling Switchgear</p> <ol style="list-style-type: none"> 1) Bus Bar rating of HT Switchgear: As per Tender SLD. 2) System Fault Current Rating: As per Tender SLD. 3) Dynamic withstand Current rating: 2.5 times of system fault current. 4) DC Supply shall be used for control and protection system of switchgear. In case UPS AC supply is considered for auxiliary control and protection supply for switchgear (except CMCS), then suitably rated AC/DC converter/power pack shall be used to meet the DC control supply requirement of switchgear panels. 5) The 33kV switchgears (both indoor and outdoor type wherever allowed as per TS) shall have an internal Arc Classification corresponding to system fault current. 6) The switchgear shall be cooled by natural air flow. Forced cooling shall be considered in case current rating is 2000 A or above. <p>h) Construction of Store Room – 01 No. per block</p>	Power Transformers at PSS 315 MVA, 400kV/33kV-33kV Yn0yn0yn0	250MVA, Z=14.5% @ 250 MVA <i>Other loss figures may be tentatively considered as per "Standard Technical Specifications of Power Transformers for Solar Park Pooling Station" published by CEA. (Above data is tentative).</i>	Transmission Line	For Bandarewala (For 1000MW): Approximate length of 400 KV quad MOOSE conductor from SPPD's Bandarewala Pooling substation up to STU Substation is approximately 30 KM. For Barala (For 500MW): Approximate length of 400kV quad MOOSE conductor from SPPD's Barala Pooling substation up to STU substation is approximately 40 KM. Apart from the 500MW project capacity under the subject package, additional 300MW from owner's solar projects will be evacuated through the line. <i>(Above data is tentative).</i>
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Construction of 1 No. of store room for each block with minimum built-up size of 250 sqm (width not less than 7Mtr).</p> <p>i) Outdoor containerized solution/compact substation with inverter, inverter transformer & HT switchgear as inverter station are acceptable. However, technical specification of inverter, HT switchgear and inverter transformer as per relevant chapter of technical specification shall be applicable.</p> <p>j) Earth Pit for DC System: 1 Nos. per 1.50 MWp in each of the 250MW blocks. Nos. of earth pit indicated is valid if all the earth pits are interconnected in single mesh of earth pits.</p> <p>k) Metering: As per SLD. The metering for OTGT test and O&M period generation measurement shall be in the scope of the bidder. Further, Power quality meters shall be installed by the bidder at STU POI as well as necessary locations at Park pooling substation level for the 250MW project as per relevant guidelines/requirements of STU/CTU/LDC. These Power quality meters shall be integrated with the PPC system to be installed by the bidder. All necessary hardware and software for integration of the Power quality meters with the PPC system shall be in the scope of the bidder. The Bidder may utilize any available existing infrastructure at SPPD's Pooling substations and STU ends like OPGW, FOTE panels of SPPD for communication of PPC with the PQ meters at POI with the permission of SPPD. Additional redundant ABT compliant 0.2S class tariff meters shall be installed by the bidder for each 33kV incomer feeder in SPPD's Pooling switchgear to which the solar blocks, harmonic filters and reactive power compensation equipment of bidder's projects are connected. Bidder may utilize the available CT/PT in SPPD's pooling switchgear. However, necessary wiring shall be in bidder's scope. A separate metering panel may be provided for these meters or the meter may be installed in SPPD's HT Switchgear feeders subject to approval of SPPD and STU/buying entity. For interconnection with grid and metering, the SPDs shall abide by the relevant CERC/SERC Regulations, Grid Code and Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006 as amended and revised from time to time.</p> <p>l) Module Cleaning System: Provision for module cleaning shall be as mentioned in chapter D-3 of the technical specification.</p> <p>m) Cable sizing criteria: Only Single Core 19/33kV HT Cables shall be offered for the project where armour acts as the metallic screen. For these cables the conductor and armour shall withstand system fault current. The minimum size of cable (Conductor and armour individually) based on 33kV voltage level power application shall be as per protection time grading requirement subject to min. of 0.5 sec. For any cable feeder the minimum time for cable size calculation shall be the immediate one upstream breaker (towards grid) relay time setting plus 100 msec or 0.5 sec whichever is higher. For final power evacuation to power transformer, the time for cable size calculation shall be minimum 1.0 sec.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS														
	<p>n) SCADA: Licenses for Remote Monitoring of SCADA - 2 Nos with provision of Concurrent viewing for all users. Solar Plant SCADA shall also communicate with the SPPD's Substation SCADA, placed in Switchyard Control Room of Pooling Substation, in a server client methodology on Modbus TCP/IP or any industry standard communication protocol for full monitoring and control (if necessary) of entire plant from CCR (Central control room) SCADA of SPPD situated at substation. All necessary hardware/software for communication of SCADA/PPC with Substation SCADA is in the scope of the bidder.</p> <p>o) DC and LT Power cable voltage drop criteria: From Module to Inverter Transformer Maximum voltage drop shall be limited to 3% of rated voltage. For all other LT cables, Maximum Voltage drop shall be limited to 3% of rated voltage. 1.9/3.3kV grade LT cable shall be used for connection between Inverter and Inverter Transformer.</p> <p>p) DC system voltage of 125V/250V shall be considered for design of equipment rating, which has auxiliary voltage fed from 110V/220V battery.</p> <p>q) Closed Circuit Television (CCTV) and Monitoring System: CCTV system shall have 100% coverage for periphery and entry/exit gates of the solar block(s). Additionally, CCTV system shall have 100% coverage of all inverter stations, CMCS building, store room and security room. For detailed specifications of CCTV system, refer to the relevant chapter of Technical Specifications.</p> <p>r) Bidder shall follow forecasting and scheduling norms as per CERC/SERC/RLDC/Other nodal agencies during the contract period. As per CERC/SERC/LDC/Other nodal agencies, if required, bidder shall appoint a QCA (Qualified certified agency) to carry out forecasting, scheduling, deviation settlement and related matters.</p> <p>The detailed scope of work in accordance with this specification is elaborated below. The scope of the contractor shall be deemed to include all such items which although are not specifically mentioned in the bid documents and/or in contractor's proposal but are needed to make the system complete in all respects for its safe, reliable, efficient and trouble-free operation and the same shall be furnished and erected unless otherwise specifically excluded as per Section Terminal Points & Exclusions.</p>														
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<p>3.2</p>	<p>POWER EVACUATION SYSTEM, TELEMETRY & SCADA.</p> <p>Power Evacuation System: The Bidder shall terminate each 33kV export feeder at 33kV Indoor Switchgear of 33/400kV Park Pooling Substation switchyard of SPPD as per Block Single Line Diagram (SLD). All hardware (including but not limited to Cables, Cable jointing kits, end termination kits etc.) required for 33kV cable laying up to and termination at 33kV Switchgear of 33/400kV Park Pooling Substation switchyard of SPPD, including support structure and civil works required for the same, shall be under scope of bidder.</p> <p>Telemetry System: The arrangement to transmit data required by the Load Dispatch Centre (LDC) from Solar plant to NLDC/RLDC/SLDC as per extant regulations and procedures for grid management up to STU POI is in contractor's scope. The necessary details of connecting substations, availability of systems at STU substations/SLDC/ RLDC has to be ascertained by bidder for ensuring the Telemetry/data communication till final control centers. Necessary software and hardware, including laying of Communication cable/ Fibre Optic cable to SPPD's 33/400kV Project Pooling Substation required for communication of Solar plant data is included in the contractor's scope. Communication link and communication controller/Gateway used for data communication to LDC shall be redundant (one for normal operation and other as hot standby). If any upgradation/ modification required at existing infrastructure SPPD's Pooling substations and STU substation for establishing telemetry, it shall be done by the bidder.</p>																																														

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3.3	<p>Bidders are advised to update themselves with State SLDC/STU/RLDC requirement for compliance related to Automatic Meter Reading (AMR), telemetry data, channel and procedures for engineering of telemetry solution accordingly.</p> <p>The above real time data communication facility with REMC/RLDC shall comply CERC (Communication System for Interstate Transmission of electricity) Regulation 2017, Procedure for Implementation of the Framework on Forecasting and Scheduling for Renewable Energy (RE) Generating Stations, CEA (Technical Standards for Communication System in Power Systems Operations) Regulations,2020 and amendments thereof.</p> <p>Provision of SCADA HMIS/SERVER Operator Work-Station (OWS) at Owners’ Control Room at CMCS Building</p> <p>SCADA, PPC & other associated electrical system for each block shall be placed in the CMCS Building to be constructed by the bidder for the respective block.</p> <table><tr><th>SI No</th><th>Description</th><th>Quantity</th></tr><tr><td>1</td><td>Engineering cum Operator work station (EWS+OWS) (Desktop & Monitor)</td><td>01 Set</td></tr><tr><td>2</td><td>Operator work station (OWS) (Desktop & Monitor)</td><td>01 Set</td></tr><tr><td>3</td><td>Portable (laptop based) EWS</td><td>01 No</td></tr><tr><td>4</td><td>Historian (Desktop)</td><td>01 No</td></tr><tr><td>5</td><td>55 Inch LED display</td><td>01 No</td></tr><tr><td>6</td><td>Time Synchronization equipment*</td><td>01 No</td></tr><tr><td>7</td><td>Control Desk</td><td>01 Set</td></tr><tr><td>8</td><td>Chairs for Control Desk</td><td>02 No</td></tr><tr><td>9</td><td>Laser Printer</td><td>01 No</td></tr></table> <p>*The SCADA/ all other related system shall have facility to synchronize time on Network Time Protocol with Time Synchronization Equipment to be supplied under the package.</p>	SI No	Description	Quantity	1	Engineering cum Operator work station (EWS+OWS) (Desktop & Monitor)	01 Set	2	Operator work station (OWS) (Desktop & Monitor)	01 Set	3	Portable (laptop based) EWS	01 No	4	Historian (Desktop)	01 No	5	55 Inch LED display	01 No	6	Time Synchronization equipment*	01 No	7	Control Desk	01 Set	8	Chairs for Control Desk	02 No	9	Laser Printer	01 No
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4.0	<p>OPERATION AND MAINTENANCE (O&M) Target Generation test:</p> <p>The supply of PV modules is not in the scope of BOS vendor, therefore there shall be no Performance Guarantee (PG) Test. However, to ensure proper O&M during O&M Period, there shall be an O&M Target Generation Test for THREE months instead of a PG test. During O&M Target Generation Test, bidder shall be responsible for operation and maintenance of the plant so that the plant is running in the most optimum operation and generating in line with the designed parameters. The target generation for O&M shall be determined after the completion of O&M Target Generation test. Details of this test are mentioned elsewhere in the Specification.</p> <p>OPERATION AND MAINTENANCE (O&M)</p>																														

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5.0	<p>Comprehensive O&M of the entire facilities located in the solar plant upto 33kV Main Pooling Switchgear (excluding) of 33/400kV pooling sub-station for a period of three (03) years from successful commission of full capacity is in the scope of the bidder. Additionally, bidder to refer relevant section of bidding documents for details regarding O&M of part capacity commissioned.</p> <p>SOLAR PV MODULE – Performance Determination Methodology</p> <p>I. The procurement of Solar PV modules is NOT the Scope of the BoS Bidder. However, any shortfall in generation during OTGT and during O&M Period resulting from the non-performance of the PV Modules (Defective Modules*) shall be intimated by the BoS Bidder to the Owner at the earliest.</p> <p>II. The determination of Defective Modules, for initial troubleshooting and preliminary assessment at site, shall be done jointly by the Engineer in-charge and the bidder. In such a scenario, the Defective Modules shall be replaced with the healthy ones from Mandatory Spares by the contractor to reduce the downtime of the Solar PV Plant.</p> <p>* Defective Module is one whose either Isc (Short Circuit Current) or Voc (Open Circuit Voltage) or their combination thereof is less than 10% of average of 5-7 healthy modules of identical rating. The selection of healthy modules shall be done by Engineer-In-Charge (in consultation with the Module Manufacturer and as per the Approved Technical Documents) and bidder. Module shall also be declared as defective, if its output power is derated more than it's deemed Wp capacity taking consideration of yearly degradation. However, the responsibility for measuring the PV module performance output through the use of reputed make PV Analyzer etc, shall lie with the bidder.</p> <p>SOLAR PV MODULE- INPUT DETAILS</p> <p>6.0 END CUSTOMER will try to provide the exact PV Module characteristics including datasheet and other documents by 7 to 9 months after the award of LOA to BOS Bidder. There might be slight changes in the dimensions, weight and Isc as per the actual PV Module compared to the inputs provided by END CUSTOMER at clause 1.0(d) of chapter 2-A. BOS bidder shall suitably design the BOS system to consider such minor changes.</p> <p>BHEL will try to supply Module Mounting structure by 3 to 8 months after the award of LOA to bidder. Any minor re-work in MMS due to PV Module changes shall be in the scope of bidder.</p>

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1.0	2-B CIVIL SCOPE OF SUPPLY & SERVICES																											
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	The broad scope of work under this package shall include Civil, Structural and Architectural Works related to but not limited to the following areas, System, Structures / Substructures, Buildings and Facilities:																											
	A. Design & Construction of Permanent Facilities																											
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		<p>Toilet Container or Mobile toilet with water tank.</p>	<p>Room with all necessary facilities and minimum one for Office with necessary facilities shall be provided by the bidder for Owner's use.</p> <p>The porta cabins shall be equipped with AC, Furniture, Fan, Tube light, plug sockets and other equipment for comfortable working at construction site for use as Office & conference room. The conference room shall have an LED Screen of 50 inches with arrangement for connecting it with the portable devices like Laptop/Tablet etc. The Porta Cabin(s) for office shall also have a LaserJet A4 printer of reputed make.</p> <p>A separate environmentally friendly Toilet Container or Mobile toilet with water tank shall be provided. Complete electrical works, civil works and water pipe connection is in the scope of bidder.</p> <p>The porta cabins shall be electrified by green construction power (specified elsewhere in the subject document). Alternatively, Individual Green micro-grids may be installed for each porta cabins.</p> <p>Prior to supply, the Bidder shall submit the Office Porta Cabin layout proposal to END CUSTOMERSite HOP/ Engineer in Charge for approval.</p> <p>Porta Cabins, with the above facilities, shall be the property of the bidder only and the bidder is free to take back from the plant after commissioning of entire project capacity.</p>
	Any other misc. requirement necessary for completion of commissioning & operation in line with Bidder's technical proposal / detailed Engineering.		

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	<p>B. Site Preparation (as required for installation of panels / equipment, etc. during construction, erection and commissioning activities).</p> <ol style="list-style-type: none"> 1. Cutting, Clearing, transporting and disposal of plants, bushes, other vegetation, roots, stubs etc. 2. Site grading including slope protection, ground preparation/ filling/ levelling (if required) of the identified area for solar plant. 3. Any temporary drainage including any dewatering, site approach & service roads. 4. All temporary work in bidder scope i.e. Fencing, Parking Shed, Road, Porta cabin and other infrastructures etc. 5. Flood level calculation with 25 Years Return Period – For maintaining Plinth level of the building and equipment foundation level. 6. Swatch Bharat Yojana policy for cleaning and disposal of sewage. 7. The construction power shall be in the scope of contractor and the same shall be mandatorily through green power by means of Green Micro-grid which shall comprise of Solar PV System along with AC/DC coupled Battery Energy Storage System. Use of DG sets for construction power is not permitted under the contract (except for first time battery charging/exigencies/failure of microgrid). The Construction power Microgrid equipment shall be the property of the contractor and the contractor shall be responsible to maintain the same in working condition all through the construction period of the project. The contractor is free to take back the Micro-grid equipment post successful completion of facilities of the contract as per contract conditions. 8. Adequate no. and size of temporary Sheds with basic facilities shall be provided at sufficient locations within the project by the contractor which shall be used as resting place for contractor's workmen deployed during the construction period of the project. Environment friendly Male/female Toilet containers or Mobile Male/female Toilets with water supply and storage provision shall be provided besides the sheds. Safe Drinking water facilities shall be provided at each shed location. The contractor shall be responsible for maintaining all these facilities during construction stage and dismantling of all these temporary sheds and associated facilities as per the instruction of END CUSTOMERSite HOP. The contractor is free to take back the Material/Scrap/waste etc. from these facilities. <p>Note – Bidders are also advised to visit site location to appraise themselves with local conditions.</p> <p>C. O&M Related Facilities to be developed by Contractor</p> <ol style="list-style-type: none"> 1. Rainwater Harvesting for Buildings 2. Design, Supply & Installation of Module cleaning system including any requisite Construction works. <p>D. Site Investigations</p> <ol style="list-style-type: none"> 1. Topographical survey 2. Geo-Technical investigation (Refer Annexure-1 for enlisted agencies)

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	<p>The onus of correct assessment/interpretation and understanding of the existing sub soil conditions/data, including ground water table, permeability, expansiveness of soil etc. is on the Bidder.</p> <p><u>NOTES</u></p> <p><i>A. In case, any study / investigation report / design carried out by END CUSTOMER, has been shared with bidder, then it is solely for the purpose of guidance of the bidder. Bidder may cross verify the data / design system on its own without any financial / time implications to END CUSTOMER.</i></p>

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	<p style="text-align: center;">ANNEXURE – 1</p> <p style="text-align: center;">ENLISTED AGENCIES FOR GEO-TECHNICAL INVESTIGATION</p> <p>Geotechnical investigation work shall be got executed by the Contractor through the Enlisted agencies for Renewable Energy (RE) Projects as mentioned below:</p> <ol style="list-style-type: none"> 1. M/s Arun Soil Lab Pvt. Ltd 2. M/s Highway Engineering Magnitude Consortium (HEMC) 3. M/s Velciti Consulting Engineers (P) Ltd (VELCITI) 4. M/s Soigne Engineering Consultants (SOIGNE) 5. M/s Unique Engineering Services (UNIQUE) 6. M/s The Designers Consortium (DC) 7. M/s National Engineering Consultants & Testing Laboratory (NECTL) 8. M/s Idax Consulting & Research Pvt. Ltd. (IDAX) 9. M/s KCT Consultancy Services (KCT) 10. M/s Cengrs Geotechnica Pvt. Ltd. (CENGRS) 11. M/s CEG Test House And Research Centre Pvt. Ltd. (CEG) 13. M/s Vishwas Geotech Pvt Ltd (VISHWAS) 14. M/s M K Soil Testing Laboratory Private Limited (M K SOIL) 15. M/s Genstru Consultants Pvt Ltd. (GENSTRU) <p><i>*Refer detailed technical specification in Sub Part “Civil works”, Part-B of Section-IV</i></p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">2-C MISCELLANEOUS</p> <p>CODES AND STANDARDS</p> <p>1.0 All works shall be carried out as per the standards/codes (IEC, IS etc.) referred in the specification. All standards, specifications and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those codes/standards referred the former shall prevail.</p> <p>Equipment complying with other internationally accepted standards such as BS, UL, DIN, VDE etc. will also be considered, if they ensure performance and constructional features equivalent or superior to standards listed in the specification. In such case the Bidder shall clearly indicate the standards adopted, furnish a copy in the English of the latest revisions in force as on date of opening of bid and shall clearly bring out salient features for comparison.</p> <p>APPROVALS</p> <p>2.0 The scope of the bidder includes complete design and engineering, technical coordination (including participation and arranging technical co-ordination meetings), finalization of drawings/ documents, submission of engineering drawing / documents and processing of their approvals by the Employer as per relevant clauses of Section VI (Technical Specifications) and other relevant clauses given elsewhere in the Technical Specifications. Further, the scope shall also include submission, in proper shape & format, of all types of manuals, handbooks & documents in requisite numbers to the Employer at different phases of the project as per the requirement of Employer. The contractor shall have to arrange technical coordination meetings and ensure participation.</p> <p>Makes of all Bought Out Items shall be subject to approval of CUSTOMER QA Dept.. Approval of Engineering drawings shall not be treated as approval of makes of bought out items.</p> <p>PAINTING</p> <p>3.0 The bidder's scope of work includes painting of all equipment and structures as per the Employer's standard color-coding scheme. The painting shall include required application of finish paint indicated elsewhere in the Technical Specification. The quality and finish of paints shall be as per standards of BIS or approved equivalent, suitable for coastal (corrosive) conditions of site. Employer's Color-Coding scheme shall be furnished during detailed engineering stage.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>4.0</p>	<p>TESTING</p> <p>During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification. Unless specified, the type test should have conducted within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p> <p>However, if the contractor is not able to submit report of the type test(s) conducted within applicable period or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.</p> <p>All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.</p> <p>5.0 SPARES</p> <p>The Bidder shall include in his scope of supply all the necessary Mandatory spares as described elsewhere in the Bid documents.</p> <p>6.0 TRAINING OF EMPLOYERS PERSONNEL</p> <p>The bidder shall provide training (free of cost) to the personnel of END CUSTOMER for 15 mandays at his works and at site for erection, testing, commissioning and O&M. Expenses towards travel, lodging, and boarding and other expenses for the personnel shall be borne by END CUSTOMER.</p> <p>7.0 O&M TARGET GENERATION TEST (OTGT)</p> <p>The O&M Target Generation Tests shall be carried out as per the procedure specified elsewhere in the Technical Specification. All special equipment, tools and tackles instruments, measuring devices required for the successful conductance of the OTGT shall be provided by the bidder, free of cost. All costs associated with the tests shall be included in bid price.</p> <p>8.0 OPERATION AND MAINTENANCE (O&M)</p> <p>Comprehensive O&M of the complete solar PV plant (s) including the power evacuation system up to terminal point and equipment/systems installed under subject package in SPPD's Pooling substation, for a period of Three (3) years from the date of commissioning of full project capacity is in the scope of the bidder. Additionally, bidder to refer commercial portion of bidding document for details regarding O&M of part capacity commissioned.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>PART-A SUBSECTION – 3</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">3-A TERMINAL POINT AND EXCLUSIONS</p> <p>ELECTRICAL INTERFACES</p> <p>1.0 TERMINAL POINT</p> <p>1.01 The Bidder shall terminate each export feeder of 33kV voltage at SPPD's 33kV Main Pooling Switchgear of 33/400kV Pooling Substation switchyard of Bikaner Solar Project developed by END CUSTOMER as indicated in Tender SLD. All hardware required for 33kV cable laying and termination at 33kV Main Pooling Switchgear including additional support arrangements (if any required) inside SPPD's switchgear room shall be under scope of bidder.</p> <p>EXCLUSION</p> <p>1.02 The following are excluded from the scope of Contractor under this contract:</p> <ul style="list-style-type: none"> a. Main Pooling 33kV Switchgear and associated equipment. b. 33/400kV Switchyard for evacuation of power from each 250MW block including Power Transformer and Substation Automation System. c. LT Switchgear (ACDB/Lighting Boards) inside SPPD's Park Pooling Substation control room building, DCDB, Battery and Battery Chargers inside SPPD's Switchyard control room building for SPPD's Switchyard equipment. d. 400kV Transmission line from 33/400kV SPPD's Pooling Substation(s) to STU substation. <p>CIVIL INTERFACES</p> <p>2.0 TERMINAL POINT</p> <p>2.01 All Project Roads and all Drains (Refer Vicinity Map / Layout – Tender Drawing) within the plot are in Bidder Scope and shall be constructed and connected suitably with Main Approach Road and External drainage (if any) by the Bidder.</p> <p>Any temporary arrangement for safety and security of the project as well as any storage arrangement, etc. during construction would be in Bidder Scope. All temporary arrangements w.r.t approach roads, drainage, office set up etc. as necessary to take up the project construction work, would be in bidder's scope.</p> <p>EXCLUSION</p> <p>2.02 The following Civil works are excluded from the scope of Contractor under this contract:</p> <ul style="list-style-type: none"> a. Main external approach road for each 250MW project. However, necessary interconnections of internal roads (to be constructed by the bidder) with the main approach roads is in bidder scope.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>PART-B A – DC SYSTEMS</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>A-1 SOLAR PHOTOVOLTAIC (SPV) MODULES NOT APPLICABLE</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
1.0	<p style="text-align: center;">A-2 Module Mounting Structure (MMS)</p> <p>(MMS-Fixed tilt type material supply is under BHEL's scope; MMS pile concreting works, MMS erection and PV Module assembly by the bidder)</p> <p>GENERAL</p> <p>The PV modules shall be mounted on metallic structures called Module Mounting Structures (MMS) having adequate strength and appropriate design, which can withstand the load of the modules and design wind pressure.</p> <p>a) Modules shall be mounted on Non-corrosive support structures. b) Module mounting structures shall be designed to withstand the extreme weather conditions in the area. The site design wind speed factors k1, k2, k3 and k4 and pressure coefficient shall conform to IS 875 (Part-3): 2015 or as per a Wind Tunnel Study from a reputed national/international facility, for the design of MMS. However, design wind pressure to be considered for design, shall not be taken less than the minimum wind pressure “pd” as mentioned in the Technical Specification.</p> <p>If the Bidder is going for wind tunnel test for the design and analysis of complete MMS and solar tracking system following shall be ensured.</p> <p>i. It must be done from an institute of repute (IITs / SERC or equivalent) in India)/ international facility. ii. Deleted iii. Test results and design must comply with relevant Indian/ International codes. iv. The design shall be shown in STAAD pro or similar commercially available software for further checking of END CUSTOMERs and when required. v. Refer Appendix-1 (General design data for Solar PV Site) for site specific design parameters.</p> <p>c) The structural material, corrosion protection and design, shall be as per Design Criteria for Module Mounting Structures (MMS) described elsewhere in this specification. Material Yield Strength and Minimum Design Thickness can be as per “Proprietary Design” but in case Yield Strength / Minimum thickness are different than specified in Technical Specifications (MMS), same should be certified for successful performance of MMS for its design life of 25 Years after COD.</p> <p>d) The design and the calculations for the MMS and the foundation system shall be submitted for prior approval of END CUSTOMER before the commencement of construction and shall be based on the soil Geotechnical Investigation Report.</p>

CLAUSE NO.		TECHNICAL SPECIFICATIONS																
1.1		<p>e) Further details related to structures and foundations have been mentioned in the chapter on civil works of these specifications.</p> <p>f) The Structure shall be designed and analyzed in accordance with finite element method, the fundamental principles of Engineering using commercially available software (such as STAAD pro or similar), with dead load and wind load considered as per IS: 875 (Part 1& 3, respectively) or as per Wind Tunnel study done from a reputed national/international facility. Analysis shall be done as per appropriate load combinations preferably as per IS codes.</p> <p>g) All nuts and bolts shall be of SS type for a module to structure connection and other structural bolts shall be of grade HDG 5.6 or 8.8 which should suffice the design life for 25 years and more for Corrosive Category proposed for Lalitpur and Chitrakoot Solar Project and confirm to Indian / international codal provision.</p> <p>PROTECTION AGAINST CORROSION & UV</p> <p>Appropriate measures shall be considered, as required, to protect the structure, foundation, and all components against corrosion during the expected lifetime of the Plant. Structural steel shall be hot dip galvanized as per ISO 1461 (or BS 729), EN 10346, ISO 14713, IS 4759, ISO 9223 and as per Corrosive Category of proposed Solar PV Site. Non-metallic materials placed outdoors shall be UV and sand resistant and shall withstand high ambient temperature operation regimes as per the climatic conditions over the whole Plant design lifetime, and where materials are specified in any part of this Specifications, those characteristics are to be considered as a minimum requirement. Metallic materials are not explicitly required to be UV resistant but in case protective coating is required, this shall be UV and sand resistant. All materials used for concrete, reinforced concrete structures, steel structures, aluminum structures or structural elements or any other building material shall be of high quality, free from defects likely to undermine the strength and duration of service of the Plant.</p> <p>CODES AND STANDARDS</p> <p>The applicable codes and standards are as mentioned below.</p>																
	2.0		<table><tr><td>1</td><td>IS 875: Part 1 & 2</td><td>Code of practice for the design loads for buildings and structures.</td></tr><tr><td>2</td><td>IS 875: Part 3</td><td>Code of practice for the design loads for buildings and structures-Wind Loads.</td></tr><tr><td>3</td><td>IS 800: 2007</td><td>Code of practice for use of structural steel in general building construction</td></tr><tr><td>4</td><td>IS 4759</td><td>Hot-dip zinc coatings on structural steel and other allied products.</td></tr><tr><td>5</td><td>IS 1868</td><td>Anodic Coatings on Aluminium and its Alloys.</td></tr></table>	1	IS 875: Part 1 & 2	Code of practice for the design loads for buildings and structures.	2	IS 875: Part 3	Code of practice for the design loads for buildings and structures-Wind Loads.	3	IS 800: 2007	Code of practice for use of structural steel in general building construction	4	IS 4759	Hot-dip zinc coatings on structural steel and other allied products.	5	IS 1868	Anodic Coatings on Aluminium and its Alloys.
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>**</p> <p>Equivalent National and International standard/code would also be acceptable for Module Mounting structures (MMS).</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
1.0	<p style="text-align: center;">A-3 DC CABLES</p> <p>The DC Cables in a solar PV plant are used in the following areas</p> <ol style="list-style-type: none"> i. Interconnecting SPV modules ii. From SPV Modules upto SCB iii. From SCB upto the Inverter. <p>DC CABLES (Interconnecting SPV MODULES and from SPV Modules TO SCB)</p> <p>Each PV module, provided by Employer, shall have two 4 sq.mm stranded UV resistant cables and terminated with DC plug-in connector directly. The positive (+) terminal shall have a male connector while the negative (-) terminal a female connector. All the modules in the PV plant shall be arranged in a way so as to minimize the mismatch losses.</p> <p>It is to be ensured by the contractor that the Modules installed on a MMS, should be connected to each other so as to minimize the shading effect. Bidder can propose suitable scheme during detailed engineering subject to engineering review and acceptance.</p> <p>Cables used for inter-connecting SPV modules as well as Modules to SCB's shall conform to the requirements of EN 50618:2014/IS17293:2020 applicable for DC cable for photovoltaic system. The connectors used for interconnecting the modules and connectors used for connecting the strings and/or to the String combiner Box, i.e. field connectors to be mated shall be of same make and model otherwise they shall be tested for Inter-compatibility as per detailed Specification of Field Connectors given elsewhere in this specification).</p> <p>These cables shall also meet the fire resistance requirement as per the above standard and shall be electron beam cured.</p> <p>All cables except module cable used for (+) ve and (-)ve shall have distinct color identification.</p> <p>In addition to manufacturer's identification on cables as per EN50618/IS 17293, following marking shall also be provided over outer sheath.</p> <ol style="list-style-type: none"> (a.) Cable size, voltage grade and code designation "PV" (b.) Word 'HALOGAN FREE LOW SMOKE' (c.) Sequential marking of length of the cable <p>The distance between two consecutive printing, identification or embossing shall not be more than 550 mm. The Printing shall be progressive, automatic, in line and marking shall be legible and indelible.</p> <p>Type test, routine, acceptance tests requirements for these cables shall be as per EN50618:2014/IS 17293:2020. All test charges shall be deemed to be included in the cable price. Sampling for acceptance tests will be as per IS 7098.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>1.1</p> <p>2.0</p> <p>2.1</p> <p>3.0</p> <p>4.0</p>	<p>A maximum of 8 Cables (4 Circuits) shall be laid in one HDPE Pipe for DC Cable from Module to string monitoring box (if applicable). The fill factor of the pipe should not be more than 40%.</p> <p>However, in case of necessity to lay more than 8 cables (4 circuits) in one pipe, the same shall be allowed during detailed engineering and as per the derating factors recommended by the cable manufacturer. Fill factor criterion is still to be maintained.</p> <p>Bidder to ensure that there is no gap and proper packing at the junction of two pipes, in which DC cable is laid, using proper method and accessories, like bell mouth.</p> <p>Bidder can propose DC Cables (Interconnecting SPV Modules and from SPV Modules to SCB) with Nylon 12 sheath/other suitable material between Insulation and outer sheath of the DC Cable. Such cables can be laid without DWC/HDPE pipes. Such cable should be type tested. The proposal to accept such cable and such laying methodology shall be reviewed during detailed engineering.</p> <p>DC CABLES (STRING COMBINER BOX TO INVERTER)</p> <p>Cables used between SCBs and Inverters shall be of 3.3kV (E) grade. These Power cables shall have compacted Aluminium/copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), Armoured/ Unarmoured, FRLS PVC outer sheathed conforming to IS: 7098 (Part-II). These cables shall confirm to the requirements of the standards & codes specified in the relevant chapter.</p> <p>For other details refer chapter –LT Cables</p> <p>Bidder can propose DC Power Cables (SCB to Inverter) with armour of HDPE/other suitable material instead of Steel or Aluminium Armour. Such cable should be type tested. The proposal to accept such cable shall be reviewed during detailed engineering. DC CABLES SIZING CRITERIA</p> <p>As per relevant clause in Chapter 2-A</p> <p>CABLE DRUM</p> <p>For details refer clause 10.0 of Chapter -LT Cables</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS																					
1.0	<div>A-4 STRING COMBINER BOX</div> <div>GENERAL</div> <p>String Combiner Box (SCB) is used in multi-string photovoltaic systems to combine the individual strings electrically and connect them to the Inverters. It shall have protection devices to protect the PV modules from current/voltage surges. Nos. of input to each SCB shall be decided during detail engineering based on approved SLD and the temperature rise calculations.</p> <p>Vendor to note that DC system 1500-Volt rating only is acceptable. Accordingly, component/assembly shall comply with 1500 V rating as applicable.</p> <p>Voltage rating of the selected component shall be 1500V (Min.) as per system requirement during detail engineering. SCB offered for 1500V Application shall have already been type tested and in satisfactory operation in Solar plant with 1500 V DC system.</p>																					
	<div>2.0</div> <div>CODES AND STANDARDS</div> <table><tr><th>S NO.</th><th>CODES</th><th>DESCRIPTION</th></tr><tr><td>1</td><td>UL 94V</td><td>Fire Resistant/ flammability for Enclosure</td></tr><tr><td>2</td><td>UL 746C</td><td>UV Resistant for Enclosure</td></tr><tr><td>3</td><td>IEC 62262/EN 50102</td><td>Mechanical Impact Resistance for Enclosure</td></tr><tr><td>4</td><td>IS 2147/IEC 60529</td><td>Degrees of protection provided by enclosures (IP Code)</td></tr><tr><td>5</td><td>IEC 61643-12</td><td>Surge Protection</td></tr><tr><td>6</td><td>IEC 62208</td><td>Enclosure for low voltage Switchgear and control gear assemblies</td></tr></table> <p>Vendor shall submit the suitable Test Certificate/Report from accredited lab(s) indicating compliance of mentioned codes and standard if asked for the offered component or assembly.</p>	S NO.	CODES	DESCRIPTION	1	UL 94V	Fire Resistant/ flammability for Enclosure	2	UL 746C	UV Resistant for Enclosure	3	IEC 62262/EN 50102	Mechanical Impact Resistance for Enclosure	4	IS 2147/IEC 60529	Degrees of protection provided by enclosures (IP Code)	5	IEC 61643-12	Surge Protection	6	IEC 62208	Enclosure for low voltage Switchgear and control gear assemblies
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3.0	<div>GENERAL REQUIREMENT</div> <p>SCB shall be equipped (but not limited to) with the following.</p> <div><div>i.</div><div>DC Disconnector /Breaker to disconnect the PV strings from the Inverter for maintenance purpose as per specification mentioned in this chapter.</div></div> <div><div>ii.</div><div>All component in the SCB shall be suitable for operation within temperature range of 0-65 Deg C.</div></div> <div><div>iii.</div><div>Fuse in each SCB input (both positive and negative) shall be provided to prevent the reverse short circuit current flow. However, in case of</div></div>																					

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>negative string fuse is not required as per recommendation of inverter manufacturer, string cable shall preferably be terminated with field connector with SCB.</p> <ul style="list-style-type: none"> iv. Surge Protection Devices for protection against surge currents and voltages as per specification given in separate clause. Other associated items like cable glands, lugs, vents and items required for the protection and completeness of the system shall be provided v. The common collection bus bars should be made up of zinc/tin coated copper and shall be suitably sized to limit temperature rise within safe operating limits. vi. Vendor shall ensure adequate clearance with suitable insulated separator between positive bus and negative bus if it is in same enclosure. Positive and Negative section shall be orientated horizontally (Landscape orientation) on the either side of separator. Separate compartment for negative section and positive section for termination of positive and negative string input shall be preferred. <p>4.0 DC SURGE PROTECTION DEVICES (SPD) for PV Solar Application:</p> <p>DC output SPD shall consist of three Metal Oxide Varistors (MOV) type surge arrestors which shall be connected from positive and negative bus to earth. The discharge capability of the SPD shall be at least 12.5kA at 8/20 micro second wave as per IEC 61643-12 and shall be rated for MCOV 1500 Volt DC. During fault and failure of MOV, the SPD shall safely disconnect the healthy system. SPD shall have thermal disconnect to interrupt the surge current arising from internal and external faults. In order to avoid the fire hazard due to possible DC arcing in the SPD due to operation of thermal disconnect, the SPD shall be able to extinguish the arc. SPD shall have local visual indication and potential free contact for remote indication.</p> <p>5.0 STRING FUSES</p> <p>In order to provide protection to all cables and modules, string fuses shall be provided with strings. String fuses shall be of gPV category and dedicated to solar applications and conform to IEC 60269-6 or UL-2579 standards and fuse base shall comply with IEC 60269-1. String fuses should be so designed that it should protect the modules from reverse current overload. Fuses or Isolation Link shall be mounted in pull out type fuse holders. Fuse holders shall be suitable for DIN rail mounting. PCB mounted fuses are not acceptable. Fuse rating for single and combined input (limited to two) shall be calculated and finalized as per the current rating (Isc) of the PV module installed and the same be finalized during detailed engineering which shall be suitable for 1500 Volt for crystalline module.. For Thin film modules, fuse rating shall be decided during detail engineering. In case of negative grounded system, requirement of string fuses as well as inverter input fuses on negative side shall be decided based on the recommendation of Inverter (PCU) manufacturer. There should be minimum 10 mm gap between two fuses (fuse holders).</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
6.0	<p>SCB ENCLOSURE AND ASSEMBLY</p> <p>SCB shall satisfy the following requirement.</p> <ol style="list-style-type: none"> <li>i. The enclosure shall be made of UV Protected, Halogen Free, and Fireretardant GRP/FRP/Polycarbonate material with self-extinguishing property. <li>ii. Degree of protection for enclosure shall be at least IP 65. All the part shall be corrosion resistant and enclosure surface shall be free from crazing, blistering, wrinkling, color blots/striations. There should not be any mending or repair of surface. <li>iii. The mechanical impact resistance of enclosure shall be IK 07 or better. <li>iv. The size of the enclosure and general arrangement of the component shall be designed in such a way that the average temperature of enclosure shall not exceed 62 degree C and operating temperature of the components used in the enclosure shall not exceed 72 deg C or OEM recommended temperature limit at ambient temperature of 50 deg C for rated load conditions along with spare. The components mounted inside the SCB shall have higher temperature withstand capability and operation/performance of should not be affected due to derating by temperature. <li>v. Complete assembled SCB shall be subject to heat run type test to be witnessed by owner after manufacturing. The heat run test to be carried out at 1.25 times the rated current i.e. $1.25 \times (I_{mp} \text{ of PV Modules}) \times (\text{no. of string inputs} + \text{spare})$. In case it is found that the temperature rise is beyond the acceptable limits, bidder shall redesign the assembly and perform the test free of cost to verify that temperature rise is within acceptable limit. <li>vi. In each SCB 5 % spare terminals along with cable glands and fuse rounded off to next higher integer shall be provided to connect the PV strings. <li>vii. All terminals blocks shall be rated for min 1000V/1500 V and rated continuously to carry maximum expected current. <li>viii. SCB shall be mounted under the PV module or under proper shed with minimum 150mm extension at all sides of SCB for protection from direct radiation. Design and dimensions of SCB structure must be such that minimum 400 mm (bending of DC cable also to be considered) of ground clearance is available below SCB at site for repair and maintenance. All the erection hardware and mounting accessories shall be galvanized steel.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>7.0</p> <p>8.0</p>	<div> <ul style="list-style-type: none"> <li>ix. All internal wiring shall be carried out with stranded copper wires with voltage rating mentioned elsewhere in the specification. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on wires and shall not fall off when the wire is disconnected from terminal blocks. <li>x. If metallic hinge is being used with enclosure cover, it shall be made of SS 304 and shall be rust proof. Enclosure shall be provided with captive screws so that it screw don't fall off when cover is opened. Screw shall be made of corrosion free material. Suitable non-conducting protection cover shall be provided for any metallic hinge/screw/fastener to avoid contact with live part of the assembly. <li>xi. Mounting plate inside the SCB for mounting/fixing of devices shall be made of FRP/GRP or equivalent non-conducting material. <li>xii. Offered enclosure shall have adequate space to fix one String Monitoring card, One Modbus SPD and One DC-DC converter for internal power supply with suitable terminal block for retrofitting of enclosure to convert the offered combiner box as String Monitoring Box in future by END CUSTOMER. Vendor shall submit a sample Internal GA drawing with aforementioned components for future use of END CUSTOMER in addition to the drawing/document(s) for inspection and dispatch of offered assembly for END CUSTOMER approval. </div> <div> <p>DC On-load Isolator</p> <p>Solar PV On-load Isolator shall be suitable for 1500Vdc operational voltage having minimum Insulation voltage of 1500 V dc, in true 2 pole or 3 pole construction with 500Vdc per pole breaking. Any multipolar device achieving this configuration with shorting link (with less than 500Vdc per pole), will not be acceptable. The Isolators shall be type tested to carry the nominal current at rated Voltage till ambient Temperature of 60 Deg C without any de-rating, inside the String Junction box. The Switching part shall necessarily contain reinforced break with an integrated magnetic arc-extinguishing system for the PV arc. The PV isolator need to positive break indication given through a position indication window. The PV Isolator terminals need to be silver plated, and shall comply with IEC 60947-3 and tested for PV application. These shall withstand any PV current and should have no critical current.</p> </div> <div> <p>TYPE TEST</p> <p>Vendor shall submit the following Type Test/ Product Certification from any National/International accredited lab for approval.</p> </div>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
9.3	<p>TYPE TEST FOR DC PLUG-IN CONNECTORS</p> <ul style="list-style-type: none">a. Protection Degree (IP)b. Operating Temperaturec. Inflammabilityd. Pollution Degreee. Voltage Withstand (Rated Voltage/Test Voltage)f. Salt mist, cyclic (sodium chloride solution) as per IEC 60068-2-52g. Product Certification

CLAUSE NO.	TECHNICAL SPECIFICATIONS	
<p>1.00</p> <p>A-5 POWER CONDITIONING UNIT</p> <p>The Power Conditioning Unit (PCU) is Solar Inverter designed to convert solar PV DC power to 3-phase AC power and fed into utility grid. The PCU shall consist of solid-state electronic switch along with all associated control & protection, filtering, measuring instruments and data logging devices. Power conditioning unit shall be capable of capturing high resolution data (less than or equal to 10ms accuracy) for at least 10 seconds period during disturbances. Data shall be provided as per the format specified in Annexure-I (E)(c) of "NLDC Detailed Procedure covering modalities for First Time Energization and Integration of new or modified power system element" (Wind speed capturing is not required in case of solar inverter). The PCU shall have suitable maximum power point tracker (MPPT) for operating the input PV Array at its maximum power point. The PCU output shall always follow the grid voltage & frequency by sensing the grid voltage and phase and the PCU shall always remain synchronized with the grid. The PCU shall use only self-commutated device which shall be adequately rated. The continuous combined rating of all PCUs shall be as per Chapter 2-A, Part A.</p> <p>2.00</p> <p>CODES AND STANDARDS</p> <p>The PCU shall conform to all applicable IEC standard. Where an applicable IEC standard is not available, IS/ any applicable international standard shall be referred to as best practice.</p>		
	IEC-61683	Energy efficiency requirements
	IEC 61000	Emission/ Immunity requirement
	IEEE 519	Recommended practices and requirements for harmonic control in electrical power systems.
	IEC 60068	Environmental testing
	IEC 62116	Testing procedure—Islanding prevention measures for power conditioners used in gridconnected photovoltaic (PV) power generation systems
	IEC 62109-1 & 2	Safety of power converters for use in photovoltaic power systems.
	EN 50530	Overall efficiency of grid connected photovoltaic inverters.
	IEEE 1547/IEC 61727/	Standard for interfacing solar PV plant with utility

CLAUSe NO.	TECHNICAL SPECIFICATIONS											
3.00	<table><tr><td>BDEW</td><td colspan="2">grid.</td></tr><tr><td>IEC 60529</td><td colspan="2">Ingress protection test</td></tr><tr><td>Grid Connectivity</td><td colspan="2">Relevant CEA regulations and Indian grid code as amended and revised from time to time.</td></tr></table>			BDEW	grid.		IEC 60529	Ingress protection test		Grid Connectivity	Relevant CEA regulations and Indian grid code as amended and revised from time to time.	
	BDEW	grid.										
IEC 60529	Ingress protection test											
Grid Connectivity	Relevant CEA regulations and Indian grid code as amended and revised from time to time.											
3.01	GENERAL REQUIREMENTS											
	Applicable both for Central and String Inverter											
	PCU shall meet the following technical parameter											
	1.	Maximum Input voltage DC	1500V									
	2.	Nominal output voltage frequency	50Hz									
	3.	Continuous operating frequency range	47.5 Hz to 52 Hz									
	4.	AC Voltage Range	± 10% of rated AC voltage									
	5.	Euro efficiency	Minimum 97% (as per IEC 61683)									
	6.	Number of MPPT	Single MPPT or Multi-MPPT									
	7.	Surge Protection Device (SPD)	Type-I & II DC side Type-II AC side									
	8.	Euro efficiency	Minimum 97% (as per IEC 61683)									
	9.	Operating power factor range	0.8 Lead to 0.8 Lag (adjustable)									
	10.	Night SVG (Q at Night)	Required.									
	11.	Current harmonics	As per CEA regulation requirement									
	12.	Current THD value	< 3% at nominal power									
	13.	DC Injection	<0.5 % at rated current									
	14.	Operating ambient temperature	0 to 60 ° C									
	15.	Humidity	95 % non-condensing									
	16.	Maximum Noise level	75 dBA (for indoor application)									
17.	Flicker	As per CEA regulation requirement										
18.	Remote start and stop facility from SCADA	Required.										
19.	Active power limit control, reactive power, and power factor control features.	Required. Possible both from PPC and SCADA.										

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	20.	PCU designed DC fault current level	Maximum short circuit current of PV array connected to PCU and duration continuous.
	21.	PCU designed AC fault current level	Maximum short circuit current of LV side of Inverter Duty transformer and duration one sec.
	22.	(i) AC & DC overcurrent protection. (ii) Synchronization loss protection. (iii) Over temperature protection. (iv) DC & AC under and over voltage protection. (v) Under & over frequency protection. (vi) Cooling system failure protection (vii) PV array ground fault monitoring & detection (viii) PV array insulation monitoring (ix) LVRT protection (x) Anti-islanding protection (xi) Grid monitoring	Required.
3.02			
3.03	The PCU shall comply with the Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments.		
3.04	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.		
3.05	The PCU shall have protection against any sustained fault in the feeder line and against lightning discharge in the feeder line.		
3.10	The Contractor shall ensure by carrying out all necessary studies that the PCU will not excite any resonant conditions in the system that may result in the islanded operation of PV plant and loss of generation. In case there is excitation of any resonant condition in the system during PV plant operation that may result in the islanding/tripping of the PV plant and affect the power transfer, it shall be the responsibility of contractor to rectify the design and carryout required modification in the equipment of his supply.		
3.11	The PCU must be self-managing and stable in operation.		
3.12	In case of grid failure, the PCU shall be re-synchronized with grid after revival of power supply. Bidder to furnish the time taken by PCU to be re-synchronized after restoration of grid supply during detailed engineering.		
	The PCU shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of PCU component		

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>failure or from parameters beyond the PCU's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices.</p>
3.13	<p>PCU shall have necessary limiters in build in the controller so as to ensure safe operation of the PCU within the designed operational parameters.</p>
3.14	<p>PCU shall have thermal overloading protection to prevent failure of switching devices (i.e. IGBT) and other components of Inverter. PCU controller shall automatically regulate/limit the power output to reduce the PCU cabinet and switching devices temperature. Bidder to submit the PCU power vs ambient temperature curve during details engineering stage. PCU shall be able to provide inverter inside cabinet (in soft analog value) to SCADA system for remote monitoring, storing and report generation purpose.</p>
3.15	<p>PCU shall be provided with Mobile user interface facility for monitoring of inverter by plant O&M personal for better O&M and highest yield from the PV plant. In case PCU does not have this facility, then Bidder can provide the same facility through plant SCADA system.</p>
3.16	<p>PCU shall have AC and DC side monitoring capability and reporting to SCADA system (measured analog and digital value measured within PCU). Any special software if required for this purpose shall be provided for local and remote monitoring and report generation.</p>
3.17	<p>All-important alarm and trip signals shall be configured in the PCU and their corresponding modbus address shall be provided for SCADA configuration. Signal shall necessarily be included such as LVRT in action and trip operated, HVRT trip, islanding protection operated, over current operated, Inverter cabinet temperature high alarm and all other important signals. Details shall be finalized during details engineering stage.</p>
3.18	<p>DC Overloading:- Maximum PCU DC overload loading shall be limited to its design PV Array Power to PCU nominal AC power ratio. Bidder needs to submit all the relevant technical document/test report from PCU manufacturer (OEM) during details engineering stage in support of declared PCU design DC overloading capacity.</p>
3.19	<p>EARTHING OF INVERTERS:- The PCU shall be earthed as per manufacturer recommendation. During detail engineering the Bidder needs to submit the details earthing arrangement of PCU and system earth pit requirement during detail engineering stage. The detail specification for panel earthing for safety has been mentioned elsewhere in this specification.</p>
3.20	<p>OPERATING MODES OF PCU</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>a)</p> <p>b)</p> <p>c)</p> <p>d)</p> <p>3.21</p> <p>3.22</p>	<p>Low Power Mode:- The PCU shall be able to wake-up automatically when PV array open circuit voltage value is equal/more than preset value in the PCU program. Once its start generation the PCU shall automatically enter maximum power mode.</p> <p>Maximum Power Point Tracking (MPPT):- In order to maximize the energy collection from solar PV array, the PCU shall have inbuilt MPPT controller and same shall be able operate the PV array at its maximum power point by adjusting output voltage of PV array system according to atmospheric condition. PCU MPPT controller shall ensure that it operate the PV array system at its global maximum power point under all operating conditions of PV array including cloudy atmospheric condition.</p> <p>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.</p> <p>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 automatically start active power generation when the DC voltage rises above a pre-defined level.</p> <p>Standby Mode:- In standby mode the PCU DC & AC contactor are open, inverter is powered on condition and waiting for start command.</p> <p>In case auxiliary supply of PCU is met internally, then it should have sufficient power backup to meet the LVRT requirement.</p> <p>Bidder to submit third-party verified OND files of the inverter during detail engineering.</p>
<p>4.00</p> <p>4.01</p> <p>4.02</p>	<p>CENTRAL INVERTER</p> <p>PCS must have provision to be isolated from grid through Air Circuit Breaker/MCCB. The ACB/MCCB as required can be provided as a part of PCS/its Modules or separately based on standard design and configuration of PCS manufacturer. The ACB and MCCB shall be able to withstand the maximum fault current for minimum one sec duration. ACB/MCCB shall be able to isolate PCU from AC grid under all fault current condition. Any alternate provision other than ACB/MCCB which is recommended by OEM and meeting the requirement, shall be considered on case-to-case basis during detailed engineering stage.</p> <p>Suitable rated fuse shall be provided (at inverter end) in incoming DC cable from each string combiner box (SCB). One set spare terminal with fuse (as</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	applicable) and holder shall be provided for the future use. In addition, the PCU shall have suitable rated DC motorized isolator/MCCB or contactor for isolation of PV array from inverter.
4.03	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.
4.04	The PCU should be designed for parallel operation through galvanic isolation. Solid state electronic devices shall be protected to ensure smooth functioning as well as ensure long life of the inverter. Parallel operated PCU system are also accepted subjected to recommendation of PCU manufacturer. In such case, PCU design shall also ensure that no abnormal interaction shall take place among the PCU unit during any grid operating condition which may result in outages.
4.05	Deleted.
4.06	PCU shall have suitable communication card (Modbus TCP/IP) for networking and SCADA integration and same shall support dual master communication. 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. Details list of above such parameters shall be provided along with their Modbus address during detail engineering stage.
4.07	In case of modular design of PCU is offered, the Contractor shall ensure that no abnormal interaction shall take place among the various PCU modules during any grid operating condition which may result in outages. The PCU controller offered by the Contractor shall be such as to ensure stability, reliability, and a good dynamic performance. The Bidder shall indicate the control scheme adopted for modular PCU and its merits and the test which will check its performance.
4.08	Bidder may offer liquid cooling system subject to END CUSTOMER approval. In case Liquid cooled inverters are offered, Bidder to ensure that coolant is used in closed cycle. Complete inverter along with cooling system shall be of proven design.
4.09	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 more than safe operating limit.
4.11	Inverter shall have emergency stop push button for tripping of inverter with complete DC & AC electric isolation.
4.12	INDOOR CENTRL INVERTER

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>4.13</p> <p>5.00</p> <p>5.01</p>	<p>a) The PCU enclosure protection class shall be IP 20 or better protection.</p> <p>b) COOLING AND VENTILATION: - To prevent the maximum permissible temperature in the inverter room from being exceeded because of internal heat emission of inverters and other auxiliaries in the inverter room, the inverter room in the PV plant shall be adequately ventilated. The Ventilation plant capacity and air quality of inverter room shall be as per inverter and other auxiliary's system manufacturer's recommendations. Filter banks at the air inlet of the inverter room shall be provided to prevent dust ingress. Bidder shall furnish peak power consumption of cooling system (cooling fans, pumps etc.) of the PCU along with the data sheet.</p> <p>Ventilation shall be designed in such a way that the temperature rise of the inverter rooms does not exceed the maximum designed temperature of Inverters and other auxiliary equipment's placed inside the inverter room. Accordingly, the air velocity through the filter shall be suitably chosen to remove the heat from the inverter room. All exhaust and fresh air fans shall be provided with thermostat control.</p> <p>OUTDOOR CENTRL INVERTER</p> <p>a) Outdoor PCU enclosure must be suitable to withstand the harsh environmental conditions for complete life of plant.</p> <p>b) The PCU enclosure protection class shall IP 54 or better protection. For outdoor solution (Other than containerized), the electronic card compartment shall have IP 65 or better protection.</p> <p>c) Bidder to submit temperature endurance test report of complete assembly during detail engineering stage.</p> <p>d) For Outdoor PCU (without containerized solution) the complete assembly should be placed inside a shed made of structural steel section preferably tubular/hollow section and color coated metal sheets for roof with BMT 0.5 mm and at least 60cm projection in all side. For containerized solution separate shed is not required, however, the container shall have projection of at least 60cm wherever an opening in the inverter door exposes the inverter component to outside environment. Structural steel and paints for shed shall be as per ISO 12944-5.</p> <p>e) Outdoor inverter (including containerized solution) platform shall be raised Min 1250 mm from NGL. Cable bending radius and other relevant factors to be considered during platform design. This shall be reviewed during detailed engineering.</p> <p>STRING INVERTER</p> <p>The string inverter enclosure protection class shall be IP 65 or better protection.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
5.02	The string inverter should be placed inside a canopy shed with atleast 15 cm in all direction, if installed in open. Alternatively, the Bidder can also install the inverter on the column post of the module mounting structure, below the modules. In such case, the canopy is not required, and the column and foundation shall be designed accordingly.
5.03	String inverter shall have suitable communication port (TCP-IP/PLC) for SCADA integration. All necessary hardware, software and accessories used for communication with SCADA (including smart logger Data logger) at both the ends shall be provided by the bidder. String Inverters system shall support dual master communication.
5.04	String inverter shall have string monitoring (MPPT level) capability and reporting to SCADA system. Any special software if required for this purpose shall be provided for local and remote monitoring and report generation.
5.05	Anti-PID device along with all hardware and communication cable/device shall be provided in case negative grounding of PV string provision is not available in string inverter.
5.06	DC fuse requirement for PV string at string inverter end shall be as per string manufacturer/system requirement and same shall be finalized during detail engineering stage.
5.07	Provision for AC and DC electrical isolation device (such as MCB/MCCB/Isolator) inside string shall be as per string inverter manufacturer practice.
5.08	Local Display unit for viewing important parameters, configuration and troubleshooting purpose shall be provided as per string inverter manufacture practice. In case standard design of string inverter does not include display, then string inverter shall be provided with required software along with accessories (2 sets for complete plant) for interface with inverter or facility for mobile viewing and configuration with laptop.
5.09	LT Junction box, switchboard, and switchgear requirement for string inverter system as per chapter C-1 (LT Switchgear).
6.00	<p>TYPE TESTING</p> <p>Applicable both for Central and String Inverter</p> <p>During detailed engineering, the contractor shall submit all the type test reports including temperature rise test and surge withstand test carried out within last ten years from the date of techno-commercial bid opening for Owner's approval. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of techno-commercial bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>PART-B B – AC SYSTEMS</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS																						
1.0	B-1 LT SWITCHGEAR																						
	CODES AND STANDARDS																						
	The design, materials, and method of LT switchgear shall conform to the applicable IEC standard. All equipment shall be installed and all work shall be carried out in accordance with relevant IEC standards. Where an applicable IEC standard is not available, IS/ any applicable international standard shall be referred to as best practice. All standards, specifications and codes of practice shall be the latest editions including all applicable official amendments and revisions.																						
	As a minimum requirement, the following standards shall be complied with:																						
	<table><tr><td>IS</td><td>Details</td></tr><tr><td>IEC 60947/ IS13947</td><td>Low-voltage switchgear and control gear</td></tr><tr><td>IS 2705</td><td>Current Transformers</td></tr><tr><td>IS 3043</td><td>Code of practice for earthing.</td></tr><tr><td>IS 3072</td><td>Code of practice for installation and maintenance of Switchgear</td></tr><tr><td>IS 3156</td><td>Voltage Transformers</td></tr><tr><td>IS 3202</td><td>Code of practice for climate proofing of electrical equipment.</td></tr><tr><td>IS 3231</td><td>Electrical relays for power system protection.</td></tr><tr><td>IS 13703 / IEC 60269</td><td>HRC Cartridge fuses</td></tr><tr><td>IS 10118 (4 parts)</td><td>Code of practice for selection, installation and maintenance of switchgear and control gear.</td></tr><tr><td>IEC 60255</td><td>Electrical Relays</td></tr></table>	IS	Details	IEC 60947/ IS13947	Low-voltage switchgear and control gear	IS 2705	Current Transformers	IS 3043	Code of practice for earthing.	IS 3072	Code of practice for installation and maintenance of Switchgear	IS 3156	Voltage Transformers	IS 3202	Code of practice for climate proofing of electrical equipment.	IS 3231	Electrical relays for power system protection.	IS 13703 / IEC 60269	HRC Cartridge fuses	IS 10118 (4 parts)	Code of practice for selection, installation and maintenance of switchgear and control gear.	IEC 60255	Electrical Relays
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IEC 60255	Electrical Relays																						
TECHNICAL PARAMETERS																							
A. POWER SUPPLY (AC SYSTEM)																							
(i)	Voltage	415V ± 10%, 3 Phase, 4 wire, Neutral Solidly Earthed																					
(ii)	Frequency	50 Hz +/- 5%																					
(iii)	Minimum system fault level	As per system fault current (for 1 sec)																					
(iv)	Short time rating for bus bars, ckt. breakers, current transformers and swgr.	As per system fault current (for 1 sec)																					

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
		Assembly.	
	(v)	Maximum ambient air Temperature 50 deg. C	
	BUS BARS		
	(vi)	Continuous current rating at 50°C ambient: As Per Requirement	
	(vii)	Temperature Rise allowed above ambient 40°C for plain joints 55°C for Silver plated joints	
	B. MCCB		
	(i)	Rated voltage 415V	
	(ii)	Rated Insulation Level 690V	
	(iii)	Rated ultimate and service SC breaking capacity (As per system requirement) As per system fault current (for 1 sec)	
	(iv)	Rated making capacity 2.1 times of System fault current	
	(v)	Utilization category A	
	C. DIGITAL MFM		
	(i)	Accuracy class 0.5	
	(ii)	MFM shall be provided at LT incomer feeder. MFM shall have suitable communication port for integration with SCADA system.	
	D. CURRENT TRANSFORMERS		
	(i)	Type Cast Resin Bar Primary	
	(ii)	Voltage class and frequency 650V, 50HZ	
	(iii)	CT Secondary Current 1 A	
	(iv)	Class of insulation E or better	
	(v)	Accuracy class & burden	
		a) For Protection	5P20, 5VA
		b) For Metering	Class 1.0, 5VA (min)
	(vi)	Instrument Security Factor for metering CT 5	
	E. VOLTAGE TRANSFORMERS		
	(i)	Type Cast Resin	
	(ii)	Voltage Ratio 415 / 110V for line PT 415/√3 / 110/√3V for Bus PT	
	(iii)	Method of Construction Vee Vee	
	(iv)	Accuracy Class 0.5	

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
3.0	(v)	Rated Voltage factor	1.1 continuous, 1.5 for 30 sec.
	(vi)	Class of insulation	E or better
	(vii)	One minute power frequency withstand voltage	2.5 KV
	F. HRC FUSES		
	(i)	Voltage Class	650 Volts
	(ii)	Rupturing capacity	80kA (RMS) for AC circuits
	G. CONTACTORS		
	(i)	Type	Air break electro magnetic
	(ii)	Utilising Category	AC3 of IS/IEC 60947 for non reversible AC4 of IS/IEC 60947 for reversible drives
	H. SWGR. CUBICLE CONSTRUCTIONAL REQUIREMENTS		
	(i)	Colour finish	
		Exterior	RAL9002 (Main body) RAL 5012 (Extreme end covers) The paint thickness shall not be less than 50 microns
		Cable entry	
	(ii)	Power Cables	Bottom
		Control Cables	Bottom
3.0	The quantities/Nos. of the Feeders /MCCB shall be so as to meet the system requirements. 5% spare with minimum 01 No. to be provided on each board/switchgear having more than 5 MCCB. However, no spare Air circuit breaker panels are required.		
	DETAILS OF DISTRIBUTION BOARDS		
3.1	Applicable for Auxiliary Power Supply system and String Inverter distribution board of rating up to & including 400A.		
3.2	Switchboards in CMCS shall be of metal enclosed, indoor, floor-mounted, freestanding type. Distribution boards of small size can be of wall/channel mounted type. For inverter stations, if outdoor distribution boards/LT pooling switchgear is proposed, the same shall be of suitable IP class and shall be kept under shed.		
	All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material.		

CLAUSE NO.	TECHNICAL SPECIFICATIONS
3.3	All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that they do not permanently bulge/ bend by the weight of maintenance personnel working on it.
3.4	The switchboards shall be of bolted design. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cut outs shall be true in shape and devoid of sharp edges.
3.5	All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS/IEC 60947. All cutouts shall be provided with EPDM / Neoprene gaskets.
3.6	All switchboards shall be of uniform height not exceeding 2450 mm.
3.7	Switchboards shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates.
3.8	All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. Replacement /Maintenance of individual equipment/ component shall be possible without switching off or isolating the other equipments/components.
3.9	Each switchboard shall be provided with undrilled, removable type gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall be provided with gasket to ensure enclosure protection.
3.10	The minimum clearance in air between phases and between phases and earth for the entire busbars shall be 25mm. For all other components, the clearance between "two live parts", "a live part and an earthed part", shall be at least ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for busbars the clearances specified above should be maintained even when the busbars are sleeved or insulated. All connections from the busbars up to switch / fuses/MCCB shall be fully insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits. All busbars and jumper connections shall be of high conductivity aluminium alloy / copper of adequate size.
3.11	All switchboards shall be provided with three phase and neutral busbars. Entire busbar system shall be insulated with PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.
3.12	The cross-section of the busbars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars.
3.13	All busbars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength sheet molded compound or equivalent type polyester fiber glass molded insulator. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided, anti-tracking

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	<p>barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The busbar insulators shall be supported on the main structure.</p> <p>3.14 All busbar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the busbar. All copper to aluminium joints shall be provided with suitable bimetallic washers.</p> <p>3.15 All busbars shall be colour coded as per IS: 375.</p> <p>3.16 Wherever the busbars are painted with black Matt paint, the same should be suitable for temperature encountered in the switchboard under normal operating conditions.</p> <p>3.17 The Bidder shall furnish calculations establishing the adequacy of bus bar sizes for specified current ratings.</p> <p>3.18 Panel space heaters shall be provided and the supply for this shall be tapped from incomer, before the isolating switch/circuit breaker. Incoming circuit to space-heater shall have an isolating switch, HRC fuse and neutral link of suitable rating. Panel illumination and plug-socket shall also be tapped from the space heater supply.</p> <p>3.19 A galvanized steel / Copper / Aluminium earth bus shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar. Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus.</p> <p>3.20 The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth without exceeding the allowable temperature rise.</p> <p>3.21 All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting.</p> <p>3.22 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. All the equipment mounted on the door shall be earthed through flexible wire/braids. Insulation color code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors, soldering is not acceptable. Looping of earth connections, which would result in loss of earth connections to other devices, when a device is removed, is not acceptable. However, looping of earth connections between equipment to provide alternative paths to earth bus is acceptable.</p>

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3.23	VT and CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.
3.24	All hinged doors having potential carrying equipment mounted on it shall be earthed by flexible wire/ braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges/ hinge pins of proven design may also acceptable. The Contractor shall establish earth continuity at site also.
3.25	All switchboards shall be supplied completely wired internally upto the terminals, ready to receive external cables.
3.26	All auxiliary wiring shall be carried out with 650V grade, single core stranded copper conductor, colour coded, PVC insulated wires. Conductor size shall be 1.5 mm ² (min.) for control circuit wiring and 2.5 mm ² (min) for CT and space heater circuits.
3.27	Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped.
3.28	All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.
3.29	All internal wiring terminations shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible. Screw-less (spring loaded) / cage clamp type terminal shall also be provided with lugs.
3.30	Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.
3.31	Cable termination arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminium conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc., shall be provided by the contractor, to suit the final cable sizes.
3.32	All power cable terminals shall be of stud type and the power cable lugs shall be solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.
3.33	All Switchgears, MCCs, Distribution Boards, Fuse boards, all feeders, local pushbutton stations etc. shall be provided with prominent, engraved identification plates.
3.34	All name plates shall be of non-rusting metal or 3-ply Lamicoid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Employer's approval.

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3.35	
3.36	Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.
3.37	The gaskets, wherever specified, shall be of good quality EPDM / neoprene with good ageing, compression and oil resistance characteristics suitable for panel applications.
3.38	The bidder shall, ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per indian standards / specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.
3.39	ON/OFF status and protection trip status of incomers and bus coupler (if applicable as per SLD) be provided for SCADA system.
3.40	Suitable changeover and interlocking arrangement shall be provided for incomers and bus coupler (if applicable as per SLD).
3.41	It shall be the responsibility of the contractor to fully coordinate the overload and short circuit breakers/fuses with the upstream and downstream circuit breakers / fuses, to provide satisfactory discrimination. Further the various equipment supplied shall meet the requirements of type ii class of co-ordination as per IS: 8544.
4.0	<p>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 costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the employer. The paint thickness shall not be less than 50 microns.</p>
	<p>MCCB</p> <ol style="list-style-type: none"> 1. MCCB shall be fixed type module, air break type, having trip free mechanism with quick make and quick break type contacts. MCCB shall have current limiting feature. MCCB of identical ratings shall be physically and electrically interchangeable. MCCB shall be provided with 1 NO and 1NC auxiliary contacts. 2. MCCB shall have inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit also. The protection settings shall have suitable range to achieve the required time & current settings. LED indications shall also be provided for faults, MCCB status (on/off etc). 3. MCCB terminals shall be shrouded and designed to receive cable lugs for

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	<p>cable sizes relevant to circuit rating. Extended cable terminal arrangement for higher size cable may also be offered. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door can not be opened unless the MCCB is in OFF position. Means shall be provided for defeating this interlock at any time. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked. The MCCBs being offered shall have common/interchangeable accessories for all ratings like aux. switch, shunt trip, alarm switch etc. The MCCBs shall have the current discrimination up to full short circuit capacity and shall be selected as per manufacturer's discrimination table.</p> <p>5.0 FUSES</p> <p>5.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be rated for 80kA rms (prospective) breaking capacity at 415V AC and for DC circuits, 20kA rms breaking capacity at 240V DC.</p> <p>5.2 Fuse shall have visible operation indicators. Insulating barriers shall be provided between individual power fuses.</p> <p>5.3 Fuse shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchboard.</p> <p>5.4 The Neutral links shall be mounted on fuse carriers which shall be mounted on fuse bases.</p> <p>6.0 LT SWITCHGEAR FOR STRING INVERTER</p> <p>In addition to the above clauses (relevant), the following shall also be applicable for switchgear ratings more than 400A</p> <p>6.1 All switchboards shall be divided into distinct vertical sections (panels), each comprising of the following compartments</p> <p>(a) BUSBAR COMPARTMENT:- A completely enclosed bus bar compartment shall be provided for the horizontal and vertical busbars. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power busbars shall be in separate compartments.</p> <p>(b) SWITCHGEAR / FEEDER COMPARTMENT:- All equipment associated with an feeder of rating above 400A shall be housed in a separate compartment of the vertical section. ACB shall be provided for feeders of rating 1000A and above. The design of the vertical section for such an</p>

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	<p>arrangement shall ensure ease of termination of power cables of size & quantity as per system requirement. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. Insulating sheet at rear of the compartment is also acceptable. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure.</p> <p>(c) CABLE COMPARTMENT/CABLE ALLEY:- A full-height vertical cable alley of minimum 250mm width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations located in cable alley of capacity more than 400 A shall be designed to meet the Form IVb and for less than 400A A shall be designed to meet the Form 3b (as per IEC 61439) for safety purpose. Wherever cable alleys are not provided for distribution boards, segregated cable boxes for individual feeders shall be provided at the rear for direct termination of cables. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley. Cable alley door shall be hinged.</p> <p>(d) CONTROL COMPARTMENT:- A separate compartment shall be provided for relays and other control devices associated with a circuit breaker. All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 4X as per IS/IEC 60947 (for indoor panels). All cutouts shall be provided with EPDM / Neoprene gaskets. However, the control / relay compartments shall have degree of protection not less than IP 5X. If outdoor LT switchgear is proposed at inverter stations, the same shall be of suitable IP class and shall be kept under shed.</p> <p>6.2</p> <p>6.3 Provision of louvers on switchboards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating is 1600 A and above.</p> <p>6.4 Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. EPDM / Neoprene gasket shall be provided between the panel sections to avoid ingress of dust into panels.</p> <p>6.5 The minimum clearance in air between phases and between phases and earth for the entire busbars. and bus-link connections at circuit-breaker shall be 25mm. All busbars and jumper connections shall be of high conductivity aluminum alloy / copper of adequate size.</p> <p>6.6 After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section insulating barriers and shrouds shall be provided in the rear cable compartment to</p>

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	<p>avoid accidental touch with the live parts of one circuit when working on the other circuit.</p>
6.7	<p>All switchgear (circuit-breaker) panels shall be of single-front type. The covers shall be provided with "DANGER" labels. All panel doors shall open by 90 deg or more.</p>
6.8	<p>All circuit-breaker modules shall be of fully draw out type having distinct 'Service' and 'Test' positions. Suitable arrangement with cradle / rollers, guides along with tool / lever operated racking in / out mechanism shall be provided for smooth and effortless movement of the chassis.</p>
6.9	<p>All switchboards shall be provided with three phase and neutral busbars. Two separate sets of vertical busbars shall be provided in each panel of double front DBs. Interleaving arrangement for busbars shall be adopted for switchboards with a rating of more than 1600A. Entire busbar system shall be insulated with PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.</p>
6.10	<p>ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door cannot be opened unless the MCCB is in OFF position. Means shall be provided for defeating this interlock at any time. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked.</p>
6.11	<p>The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear switchgear also.</p>
6.12	<p>Temperature raise test of LT switchgear of rating more than 400A:- The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current.</p>
6.13	<p>The carriage and breaker frame shall get earthed while being inserted in the panel and positive earthing of the breaker frame shall be maintained in all positions, i.e. SERVICE & ISOLATED, as well as throughout the intermediate travel.</p> <p>Electrically controlled circuit breaker boards shall be provided with DC control supply.</p>
6.14	

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<p>7.0</p> <p>7.1</p> <p>7.2</p> <p>7.3</p> <p>7.4</p> <p>7.5</p> <p>7.6</p> <p>7.7</p> <p>7.8</p> <p>7.9</p> <p>7.10</p>	<p>CIRCUIT BREAKERS</p> <p>Circuit breakers shall be three pole, air break, horizontal draw out type, and shall have fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameters of continuous current rating and fault making / breaking capacity only after provision of cooling fans or special device shall not be acceptable.</p> <p>Circuit breakers along with its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker.</p> <p>There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "Test" position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLY WITHDRAWN" position. Circuit Breaker rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa shall be possible only in the compartment door closed condition.</p> <p>Separate limit switches, each having required numbers of contacts shall be provided in both "SERVICE" and "TEST" position of the breaker. All contacts shall be rated for making, continuously carrying and breaking 10 Amp at 240 V AC and 1 Amp (Inductive) at 240 V DC respectively.</p> <p>Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE", "TEST" AND "SPRING CHARGED" positions.</p> <p>Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half a cycle of rated frequency.</p> <p>Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably not trip the circuit breaker. In case the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exists between the fixed and drawout contact at the time of breaker trip so that no arcing takes place even with the breaker carrying its full rated current.</p> <p>Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position.</p> <p>Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.</p> <p>Breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.</p>

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7.11	Circuit breakers shall be provided with coded key / electrical interlocking devices, as per requirements.
7.12	Circuit breaker shall be provided with anti-pumping feature and trip free feature, even if mechanical anti-pumping feature is provided.
7.13	Mechanical tripping shall be possible by means of front mounted Red "trip" pushbutton. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.
7.14	Complete shrouding / segregation shall be provided between incoming and outgoing bus links of breakers. In case of bus coupler breaker panels the busbar connection to and from the breaker terminals shall be segregated such that each connection can be approached and maintained independently with the other bus section live. Dummy panels if required to achieve the above feature shall be included in the Bidder's scope of supply.
7.15	Circuit breaker open/close shall be possible from SCADA and open/close status and all other important signal status shall be provided for SCADA monitoring.
7.16	Power operated mechanism shall be provided with a Universal motor suitable for operation on DC Control supply. In case of DC supply motor should satisfactorily operate with voltage variation between 85% to 110% nominal control supply voltage. Motor insulation shall be class "E" or better.
7.17	The motor shall be such that it requires not more than 30 Seconds for fully charging the closing spring at minimum available control voltage.
7.18	Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.
7.19	The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.
7.20	Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
7.21	All circuit breakers shall be provided with closing and trip coils. The closing coil shall operate correctly at all values of voltage between 85% to 110% nominal control supply voltage. The trip coil shall operate satisfactorily at all values of voltage between 70% to 110% nominal control supply voltage.
7.22	Provision for mechanical closing of the breaker only in "Test" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds.
7.23	The ACB Panel door shall not be possible to open in breaker closed condition. Further, the racking mechanism shall be accessible only after opening the breaker panel door.

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7.24	Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit-breaker module in a cubicle at each location. The trolley shall be such that the top most breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. The telescopic trolley shall be such that all type, size and rating of breaker can be withdrawn /inserted of particular switchgear.		
7.25	Electrical Parameter of Circuit Breaker		
	1)	Type	Air break spring charged stored energy type
	2)	Operating duty	O-3 MIN-CO-3 MIN-OC
	3)	Symmetrical interrupting	As per system fault current (for one sec)
	4)	Short circuit rating	2.1 times of System fault current (peak)
	5)	Short Circuit Breaking current	
		a) AC Component	As per system fault current (for one sec)
		b) DC Component	As per IS:13947
	6)	Short time withstand	As per system fault current
8.0	AC JUNCTION BOXES (for use with string inverters)		
8.1	Separate AC Junction box shall be used for string inverters AC output connection. Protection class for AC junction box shall be IP 54 or better protection. All components of junction box shall be suitable for rated output voltage (with + 10% variation) of string inverter, grid frequency of 50 Hz +/- 5%, ambient temperature 50 deg. C and system fault current for 1 sec.		
8.2	AC junction box shall be of metal enclosed type. All frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / coldrolled sheet steel and 4.0 mm for non-magnetic material. The minimum clearance in air between phases and between phases and earth shall be at least twenty five (25) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers.		
8.3	All power cable terminals shall be of stud type and the power cable lugs shall be of tinned copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.		
8.4	EPDM / Neoprene gasket shall be used to prevent ingress of dust into panels.		
8.5	All non-current carrying metal work of the junction box shall be effectively connected to the system earth bus.		

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8.6	<p>Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns.</p>
9.0	<p>TEMPERATURE-RISE (For LT Switch-gear having capacity more than 400A)</p> <p>The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current.</p>
10.0	<p>DERATING OF COMPONENTS</p> <p>The Bidder shall, ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per Indian Standards / Specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.</p> <p>The Bidder shall indicate clearly the derating factors if any employed for each component and furnish the basis for arriving at these derating factors duly considering the specified current ratings and amb. temperature of 50 deg C.</p>

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1.0	B-2 HT SWITCHGEAR																																																																								
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	c)	IS: 1248	Direct Acting indicating analogue electrical measuring instruments and Accessories.																																																																						
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	e)	IS: 2544	Porcelain post insulators for systems with nominal voltages greater than 1000 Volts.																																																																						
f)	IS: 2705	Current transformers.																																																																							
g)	IS: 3156	Voltage Transformers																																																																							
h)	IS: 6005	Code of practice for phosphating of iron and steel.																																																																							
i)	IS: 5082	Specification for wrought aluminium and aluminium alloy bars, rods, tubes and selections for electrical purposes.																																																																							
j)	IEC: 61850	Communication Standard for Numerical relays																																																																							
k)	IEC: 61131-3	Automation Standard for Numerical relays																																																																							
l)	IS: 9046	AC contactors for voltages above 1000 volts and upto and including 11000 Volts.																																																																							
m)	IS: 13703	Low voltage fuses																																																																							
n)	IS: 9385	HV fuses																																																																							
o)	IS: 9431	Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 volts upto and including 300 kV																																																																							
p)	IS: 9921	A.C. disconnectors (isolators) and Earthing switches for voltages above 1000 V																																																																							
q)	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.																																																																							
r)	IS: 13118	Specification for high voltage AC circuit breakers.																																																																							
s)	IEC: 60099-4	Metal oxide surge arrester without gap for AC system																																																																							
t)	IS/IEC: 62271100	High voltage alternating current circuit breakers.																																																																							
u)	IS/IEC: 62271200	High voltage metal enclosed switchgear and control gear.																																																																							
v)	IEC: 60947-7-1	Terminal blocks for copper conductors																																																																							
w)	IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips																																																																							

CLAUSe NO.	TECHNICAL SPECIFICATIONS		
2.0	TECHNICAL PARAMETERS		
	A. SYSTEM PARAMETERS		
	a)	Nominal System voltage	33kV
	b)	Highest System voltage	36kV
	c)	Rated Frequency	50Hz
	d)	Number of phases/ poles	Three
	e)	System neutral earthing	Solidly Earthed
	f)	One minute power frequency withstand voltage	
		- for Type tests	70kV
		- for Routine tests	70kV
	g)	1.2/50 microsecond Impulse withstand voltage	170kV (peak)
	h)	Minimum system fault level	As per System Fault current (Refer Cl. 1.0 of Chapter 2-A, Part A)
	i)	Short time rating for bus bars, circuit breakers, current transformers and switchgear assembly.	
	j)	Dynamic withstand rating	2.5 times of system fault current
	k)	- Space heaters	240 V AC single phase with neutral solidly earthed
	l)	Maximum ambient air temperature	50 deg. C
	m)	Internal Arc testing	As per system fault current (for Min 1 sec)
	B. BUS BARS		
	a)	Continuous current rating at 50°C ambient:	As Per Requirement
	b)	Temper Rise allowed above ambient	As per IEC 62271-1, 2017
	C. SWGR. CUBICLE CONSTRUCTIONAL REQUIREMENTS		
	a)	Colour finish	
		Exterior	RAL9002 (Main body) RAL 5012 (Extreme end covers)
	b)	Cable entry	
		Power Cables	Bottom
	Control Cables	Bottom	

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	c)	Earthing conductor	Galvanized steel strip
	d)	Service Continuity of swgrs (LSC2B-PM)	as per IS/IEC 62271-200
	D. CIRCUIT BREAKERS		
	a)	The circuit breakers current rating shall be selected from the load current at an ambient of 50 deg. C.	
		Short circuit breaker Current	
	b)	a) A.C. component	As per Clause 1.0 of Chapter 2A (Part A)
		b) D.C. component	As per IS: 13118 or IEC-62271
	c)	Short Circuit making current	2.5 times of system fault current (peak)
	d)	Operating Duty	O-3 min-CO-3 min-CO
	e)	Total break time	Not more than 4 cycles
	f)	Total make time	Not more than 5 cycles
	g)	Operating Mechanism	Motor wound spring charged stored energy type as per IEC62271
	E. CURRENT TRANSFORMER		
	a)	Secondary Current	1A
	b)	Class of Insulation	Class E or better
	c)	Rated output of each	Adequate for the relays and devices connected, but not less than five (5) VA.
	d)	Accuracy class	
		Protection	5P20/PS as per requirement
		Measurement	0.5 class or better as per requirement
	e)	Instrument Security Factor for Measurement CTs	5
	f)	CT Ratio	CT ratio shall be finalized during details engineering stage. Minimum CT primary side current shall be 110% of rated current.
	F. VOLTAGE TRANSFORMERS		
	a)	Rated Voltage Factor	1.2 continuous for all VTs, and 1.9 for 8 Hours for star connected VTs.
	b)	Class of insulation	Class E or better

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3.0	c)	Other parameters	0.5 Class or better as per requirement. VA requirement shall be based on application/ requirement. Additional open delta core with damping resistor shall be provided in all VT's to prevent damage on account of Ferro-Resonance conditions
	d)	At pooling switchgear, Bus VTs panels and line VTs in outgoing feeders shall be provided. All other switchgear location, at outgoing feeder cable charge indication shall be provided based on voltage sensing or use of voltage transformer.	
	G. DIGITAL MFM		
	a)	Accuracy Class	0.5 or better
	b)	Digital MFM shall be provided for VCB panels as per requirement/SLD.	
	SWITCHGEAR PANEL		
3.1	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 bus bar 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 inter panel barriers in busbar compartment may also be considered.		
3.2	The circuit breakers and bus VTs 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. Testing of the breaker shall be possible in isolated position by keeping the control plug connected.		
3.3	The trucks shall have distinct SERVICE and ISOLATED positions. It shall be possible to close the breaker compartment door in isolated position also, so that the switchgear retains its specified degree of protection. Circuit Breaker rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa shall be possible only in the compartment door closed condition. While switchboard designs with doors for breaker compartments would be preferred, standard designs of reputed switchgear manufacturers where the truck front serves as the compartment cover may also be considered provided the breaker compartment is completely sealed from all other compartments and retains the IP-4X degree of		

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	<p>protection in the Isolated position. In case the latter arrangement is offered, the Bidder shall explain how this sealing is achieved and shall include blanking covers one for each size of panel per switchboard in his total Techno commercial bid price.</p> <p>3.4 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.</p> <p>3.5 The control / relay compartments shall have degree of protection not less than IP 5X in accordance with IS/IEC 60947. However, remaining compartments can have a degree of protection of IP 4X. 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 fully Flush mounted on the switchgear panels at a suitable height.</p> <p>3.6 The Switchgear shall have an internal Arc Classification of IAC FLR corresponding to system fault current. 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 Contractor shall submit a type test report in line with IEC 62271-200 Annex – A for each high voltage chamber. 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.</p> <p>3.7 Enclosure shall be constructed with rolled steel / Aluzinc sections. The doors and covers shall be constructed from cold rolled steel sheets of 2.0 mm or higher thickness. Gland plates shall be 2.5 mm thick made out of hot rolled or cold rolled steel sheets and for non-magnetic material it shall be 3.0 mm.</p> <p>3.8 The switchgear shall be cooled by natural air flow. Forced cooling shall be considered in case current rating is above 2000 A or above.</p> <p>3.9 The height of switches, pushbuttons and other hand operated devices shall not exceed 1800mm and shall not be less than 700mm.</p> <p>3.10 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> <p>3.11 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</p>

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	<p>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 energized from other end.</p> <p>3.12 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.</p> <p>3.13 The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors. Standard and proven designs of switchgear manufacturers (other than above) shall be reviewed during detailed engineering stage. 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 MV equipment, in case the supply is ON.</p> <p>3.14 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.</p> <p>3.15 Suitable base frames made out of steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and leveled when the flooring is being done, welding of base frame to the insert plates as per approved installation drawings shall be in Bidder's scope.</p> <p>3.16 Alternatively, Outdoor HT switchgear can be offered for ICOG configuration. The outdoor switchgear shall have minimum IP 55 or better protection with painting and shed requirement as mentioned in Appendix-1 of Part-A, Sub section-1. The bidder shall submit the relevant details of the switchgear including the datasheets, drawings and applicable type test reports during the detailed engineering for Employers approval. Internal Arc requirement for metal enclosed outdoor HT switchgear shall be same as indoor type switchgear. The main pooling/final pooling switchgear shall be indoor only.</p> <p>4.0 CIRCUIT BREAKERS</p> <p>4.1 The circuit breakers shall be of Vacuum type.</p> <p>4.2 They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism.</p>

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4.3	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 antipumping features. An arrangement of two breakers in parallel to meet a specified current rating shall not be acceptable.
4.4	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.
4.5	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.
4.6	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.
4.7	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.
4.8	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.
4.9	The rated control supply voltage shall be as mentioned elsewhere under Technical parameters. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between 85% to 110% rated DC 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 70% to 110% of rated DC voltage. The trip coil shall be so designed that it does not get energized when its healthiness is monitored by two indicating lamps (Red) and one trip coil supervision relay.
4.10	The time taken for charging of closing spring shall not exceed 30 seconds. The spring charging shall take place automatically preferably after a closing operation. Breaker operation shall be independent of the spring charging motor which shall only charge the closing spring. Opening spring shall get charged automatically during closing operation. As long as power supply is available to the charging motor a continuous sequence of closing and opening operations shall be possible. One open-close- open operation of the circuit breaker shall be possible after failure of power supply to the motor. Spring charging motors shall be capable of starting and charging the closing spring twice in quick succession

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4.11	<p>without exceeding acceptable winding temperature when the control supply voltage is anywhere between 85% to 110% rated DC voltage. The initial temperature shall be as prevalent in the switchgear panel during full load operation with 50 deg. C ambient air temperature. The motor shall be provided with short circuit protection.</p> <p>Motor windings shall be provided with class E insulation or better. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in a hot, humid and tropical climate.</p>
4.12	<p>Circuit breaker shall be provided with inter pole barriers of insulating materials. The use of inflammable materials like Hylam shall not be acceptable.</p>
5.0	CONTROLS AND INTERLOCKS
5.1	<p>Rotary type Control switches shall be provided in each switchgear panel. The circuit breaker will normally be controlled from remote control panels through closing and shunt trip coils. The control switch and 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.</p>
5.2	<p>The basic control scheme shall be developed in the numerical relay using programmable (soft) logics. Tripping of breaker shall be done either through numerical relay or Master Trip Relay.</p>
5.3	<p>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.</p>
5.4	<p>Each panel shall have two separate limit switches, one for the Service position and the other for isolated position.</p>
5.5	<p>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.</p>
5.6	<p>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 Employer'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 least 2 NO and 2 NC breaker/contactors original Auxiliary contacts made available for the of the Employer's use.</p>
5.7	<p>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.</p>

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5.8	
5.9	<p>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.</p>
5.10	<p>Closing of the breaker shall be possible only when truck is either in TEST/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.</p>
5.11	<p>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.</p>
5.12	<p>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.</p>
5.13	<p>Reverse blocking and Inter tripping shall be implemented in switchgear boards level. Detailed scheme for the same shall be finalized during detailed engineering stage.</p>
6.0	<p>All required interlock shall be provided for safe operation of switchgears. Capacitive voltage detection or other alternative suitable arrangement (VT shall not be used) shall be used for outgoing feeder backdoor (cable chamber) open interlock.</p>
6.1	<p>NUMERICAL RELAYS AND NETWORKING</p>
	<p>Circuit breaker feeders (with protection function as per requirement) shall be provided with communicable numerical relays (IED, i.e. Intelligent Electronic Device) complying with IEC-61850, having protection, control, 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 Employer's approval. Numerical relays shall have appropriate setting ranges, accuracy, resetting ratio and other characteristics to provide required sensitivity. All equipments shall have necessary protections.</p>
6.2	<p>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 / for analog / digital values.</p>
6.3	<p>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</p>

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	<p>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.</p> <p>6.4 One minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms).</p> <p>6.5 Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.</p> <p>6.6 Disturbance Record waveforms, event records & alarms shall be stored in Nonvolatile memory and failure of control supply shall not result in deletion of any of these data.</p> <p>6.7 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. The quantities of such input / outputs shall be finalized during detailed engineering.</p> <p>6.8 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. Laptop provided with PCU/SCADA shall be used to facilitate numerical relay configuration, DR and event/fault records downloading from relay locally. Latest version of hardware and Software for interfacing the numerical relays with laptop shall be provided. At least two sets of communication cable for Laptop to relay communication shall be provided.</p> <p>6.9 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. Numerical relays shall have inrush detection feature for blocking of user selectable protection functions.</p> <p>6.10 Numerical relays shall have feature of current measurement. Relay shall be able to provide the same in soft to solar SCADA system.</p> <p>6.11 Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.</p> <p>6.12 Master trip (86) and non-86 trips shall be software configurable to output contacts.</p> <p>6.13 Numerical relays used at main pooling switchgear shall have provision of both current and voltage inputs. Number of CT inputs for numerical relays at all switchgear panels shall be as per actual protections requirement but not less than 4 sets, 3 nos. for phase fault & 1 no. for earth fault. Relays shall be suitable for CT secondary current of 1A. All 33kV feeders shall be provided with nondirectional EF and OC protection. Numerical relays used at main pooling switchgear shall have voltage protection and measurement feature.</p>

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6.14	<p>Relay setting shall be based on time grading principle with minimum 100mSec shall be the grading margin. Least time setting at inverter transformer feeders and shall be increased towards the evacuation point (towards grid). Relay time setting shall be minimum 100 ms. However, relay current and time setting including time grading margin shall be as per Bidder offered system (with minimum as per above) considering smooth plant operation and proper protection integration/coordination with grid. Bidder can use same relay time setting for tie feeder panels between two switchgears. Relay setting of solar plant feeders shall be done in coordination with 33kV main pooling switch (grid side) relay setting. Any special/other protections, control interlocks etc as per requirement shall be provided by the Bidder. Details shall be finalized during detailed engineering stage.</p>
6.15	<p>For relay setting calculation grid side shall be taken upstream and inverter side shall be taken downstream. For any switchgear outgoing feeder shall be towards grid and incoming feeders shall be towards inverter to be considered.</p>
6.16	<p>All CT & VT terminals on the relays shall be of fixed type suitable for connection of ring-type lugs to avoid any hazard due to loose connection leading to CT opencircuit. In no circumstances Plug In type connectors shall be used for CT / VT connections.</p>
6.17	<p>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.</p>
6.18	<p>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.</p>
6.19	<p>Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC / ANSI programmable characteristics.</p>
6.20	<p>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.</p>
6.21	<p>All cards / hardware of numerical relays shall be suitable for operation in Harsh Environmental conditions with respect to high temperature, humidity & dust.</p>
6.22	<p>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.</p>
6.23	<p>All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.</p>
6.24	<p>Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc.</p>

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6.25	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.
6.26	Ethernet switches shall be suitable to accept both AC & DC supplies with range of 70 % to 120 % of rated voltage.
6.27	Disturbance Record waveforms, event records & alarms shall be stored in Nonvolatile memory and failure of control supply shall not result in deletion of any of these data.
6.28	Bidder to depute relay OEM protection engineer at END CUSTOMER office for finalization of relay setting and configuration during detail engineering stage. All numerical protection relay configuration and setting shall be done as per approved setting and configuration at switchgear manufacturer work by relay OEM or his authorized representative. All numerical relay testing and logic/interlock checking during commissioning stage at site shall be done under the supervision of Relay OEM or his authorized representative.
7.0	OTHER PROTECTIONS AND CONTROL FUNCTIONS IN THE RELAYS
7.1	Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker trip circuit both in pre trip and post trip conditions.
7.2	Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer function for protection function shall be as required. Timer functions shall be programmable for on/off delays.
7.3	The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis.
7.4	The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.
7.5	At least 200 time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault.
7.6	Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be shall be available on the user interface.
7.7	The alarm/status of each individual protection function and trip operation shall be communicated to solar SCADA.
7.8	Sequence of events shall have 1 ms resolution at device level.

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7.9	Measurement accuracy shall be 1 % for RMS Current and voltage.
8.0	BUSBARS AND INSULATORS
8.1	All Busbar and jumper connections shall be of high conductivity aluminium alloy. They shall be adequately supported on insulators as per manufacturer's standard proven design to withstand electrical and mechanical stresses due to specified short circuit currents.
8.2	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.
8.3	Contact surfaces at all joints shall be silver plated or properly cleaned and nonoxide 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 aluminium to copper connections.
8.4	Busbar insulators shall be of arc and track resistant, high strength, nonhygroscopic, 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 \sqrt{S} limited to 100pico coulomb at rated voltage x 1.1 /. Use of insulators and barriers of in-flammable material such as Hylam shall not be accepted.
8.5	Successful Bidder shall furnish calculation establishing adequacy of busbar sizes for the specified continuous and short time current ratings.
8.6	All busbars shall be color coded.
8.7	The temperature of the busbar and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of IEC 62271-1,2017, duly considering the specified ambient temperature (50 deg. C).
9.0	EARTHING AND EARTHING DEVICES
9.1	10.01 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.
9.2	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.
9.3	The earth bus shall have sufficient cross section to carry the momentary shortcircuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise.

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9.4	Suitable arrangement shall be provided at each end of the earth bus for bolting to Employer's earthing conductors. All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.
9.5	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.
9.6	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.
9.7	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.
9.8	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.
9.9	Separate earthing trucks shall be provided by the Contractor 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 interlock to prevent earthing of any live connection.
9.10	As an alternative to separate earthing trucks the Bidder may also offer built-in earthing facilities for the busbars and outgoing / incoming connections, in case such facilities are available in their standard proven switchgear design. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have facility for padlocking in the earthed condition.
9.11	<p>Interlocks shall be provided to prevent :</p> <ol style="list-style-type: none"> Closing of the earthing switch if the associated circuit breaker truck is in Service position. Insertion of the breaker truck to Service position if earthing switch is in closed position. Closing of the earth switch on a live connection. Energizing an earthed Section: Complete details of arrangement offered shall be provided during detailed engineering, describing the safety features and interlocks.

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9.12	<p>The earthing device (truck / switch) shall have the short circuit withstand capability equal to that of associated switchgear panel.</p> <p>All hinged doors shall be earthed through flexible earthing braid</p>
10.0	<p>PAINTING (INDOOR SWITCHGEAR)</p> <p>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). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall be 50 microns or more as per the ambient conditions of installation area. 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.</p>
11.0	<p>INSTRUMENT TRANSFORMERS</p>
11.1	<p>All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.</p>
11.2	<p>All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly. The current transformer shall further have the dynamic and short time ratings at least equal to those specified for the associated switchgear and shall safely withstand the thermal and mechanical stress produced by maximum fault currents specified when mounted inside the switchgear for circuit breaker modules.</p>
11.3	<p>The parameters of instrument transformers specified in this specification are tentative and shall be finalized by the Employer in due course duly considering the actual burden of various relays and other devices finally selected. In case the Bidder finds that the specified ratings are not adequate for the relays and other devices offered by him, he shall offer instrument transformer of adequate ratings and shall bring out this fact clearly in his Techno commercial bid.</p>
11.4	<p>All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block.</p>
11.5	<p>Current transformers may be multi or single core and shall be located in the cable termination compartment. All voltage transformers shall be single phase</p>

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	<p>type. The bus VTs shall be housed in a separate panel on a truck so as to be fully withdrawable.</p>
11.6	<p>All voltage transformers shall have suitable current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted on the withdrawable portion. Replacement of the primary fuses shall be possible with VT truck in isolated position. The secondary fuses shall be mounted on the fixed portion and the fuse replacement shall be possible without drawing out the VT truck from service position.</p>
11.7	<p>All voltage transformers shall be designed and manufactured for 0.8 Tesla operating point on B-H curve. VT shall be fully insulated type (i.e. double pole construction and neutral side fully insulated to rated BIL). VT shall be manufactured without any joint in secondary winding.</p>
	<p>SURGE ARRESTOR</p>
12.0	<p>The surge arrestors shall be provided as per tender SLD/ as per system requirement and shall be of metal oxide, gapless type generally in accordance with IEC 60099-4 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment. Surge arrestor selected shall be suitable for un-earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear.</p>
	<p>CONTROL SUPPLY AND SPACE HEATER SUPPLY</p>
13.0	<p>Each switchboard shall be provided at least two (02) Nos of DC feeders for the control supply.</p>
13.1	<p>In case two DC sources are provided, then suitable rated blocking diodes in both circuit has to be provided. Alternately Bidder can provide source selection switch.</p>
13.2	<p>One suitable rated 240V single phase AC supply feeder per switchboard / Switchboard section for space heater supply. Bidder shall provide necessary switch and fuse to receive, isolate and distribute to each panel.</p>
13.3	<p>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.</p>
13.4	<p>Potential circuits for protection and metering shall also be protected by separate fuse.</p>
13.5	<p>All fuses shall be of 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.</p>
13.6	<p>All DC circuits shall be fused on both poles. Single phase AC circuits shall have fuses on line and link on neutral.</p>

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13.7	DC and AC supply monitoring relay shall be provided and alarm shall be generated in SCADA system in case of failure of supply.
	SPACE HEATER
14.0	
14.1	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.
14.2	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.
	TERMINAL BLOCKS
15.0	
15.1	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 nonferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design.
15.2	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.
15.3	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.
15.4	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.
15.5	All panel wiring 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.
	SWITCHGEAR WIRING
16.0	
16.1	All Switchgear panels shall be supplied completely wired internally upto the terminal block ready to receive Employer's external cabling. All inter cubicle wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided / done by the Contractor.

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16.2	All internal wiring shall be carried out with 650 V grade, single core, 1.5 sq. mm. stranded copper wires having minimum of seven strands per conductor and color coded, PVC insulation. CT circuits shall be wired with 2.5 sq. mm. wires which otherwise are similar to the above. Extra flexible wires shall be used for wiring between fixed and moving parts such as hinged doors.
16.3	All wiring shall be properly supported neatly arranged, readily accessible and securely connected to equipment, terminals and terminal blocks. Wiring troughs or gutters be used for this purpose.
16.4	Internal wire terminals shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor. Insulation sleeves shall be provided over the exposed parts of lugs.
16.5	Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.
16.6	Interconnection to adjacent panels shall be brought out to a separate set of terminal blocks located near the slots or holes, meant for the interconnecting wires. Arrangement shall permit neat layout and easy interconnections to adjacent panels at site and wires for this purpose shall be provided by Contractor looped and bunched properly inside the panels.
16.7	Contractor shall be fully responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.
16.8	The Contractor shall provide the necessary clamps wiring troughs etc. for all wiring in side the switchgear enclosed including the Employer's power and control cables.
	POWER CABLE TERMINATION
17.0	Cable termination compartment shall receive the stranded Aluminium conductor, XLPE insulated, shielded, armored / unarmored, PVC jacketed, single core / three
17.1	core, unearthed / earthed grade power cable(s).
17.2	A minimum clearance of about 600 mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnection of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTs, gland plates etc. and the electrical clearances available shall be submitted for Employer's approval during detail engineering.
17.3	Cable termination compartment shall have provision for termination of power cables of sizes as indicated during detailed engineering with removable undrilled gland plates. For all single core cables gland plates shall be of nonmagnetic material. Cable entry shall be from bottom. Any change will be intimated later

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																
18.0	NAME PLATES AND LABELS																																
18.1	Each switch board shall have a name plate for its identification. All enclosure mounted equipment shall be provided with individual engraved name plates for clear equipment identification. 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.																																
18.2	Name plate shall be of non-rusting metal or 3-ply lamicaid with white engraved letterings, on black background or as per manufacturer's proven standards. Inscriptions and lettering shall be subjected to Employer's approval.																																
18.3	Suitable stenciled paint mark shall be provided for identification of all equipment, located inside the enclosure, as well as for door mounted equipment, from the back side in addition to plastic sticker labels, if provided. These labels shall be located directly by the side of the respective equipment, shall be clearly visible and shall not be hidden by equipment wiring. Labels shall have device number as mentioned in wiring drawings. Type of labels and fixing of labels shall be such that they are not likely to peel off / fall off during prolonged use.																																
19.0	MODULE DESCRIPTION (Typical) <table><tr><th>SI No</th><th>Panel Type</th><th>Application</th><th>Applicability</th></tr><tr><td>1</td><td>DB</td><td>Transformer Feeder</td><td>Transformer Feeder</td></tr><tr><td>2</td><td>DC</td><td>Incomer Feeder</td><td>Incomer Feeder</td></tr><tr><td>3</td><td>DD</td><td>Bus Coupler Feeder</td><td>Bus Coupler Panel for MV Boards</td></tr><tr><td>4</td><td>DE-IC</td><td>Tie Feeder</td><td>Tie Incomer Panel</td></tr><tr><td>5</td><td>DE-OG</td><td>Tie Feeder</td><td>Tie Outgoing Panel</td></tr><tr><td>6</td><td>G</td><td>Bus PT</td><td>Bus PT Panel</td></tr><tr><td>7</td><td>ICOG</td><td>Standalone Transformer feeder</td><td>Standalone panel with both incoming & outgoing cables</td></tr></table>	SI No	Panel Type	Application	Applicability	1	DB	Transformer Feeder	Transformer Feeder	2	DC	Incomer Feeder	Incomer Feeder	3	DD	Bus Coupler Feeder	Bus Coupler Panel for MV Boards	4	DE-IC	Tie Feeder	Tie Incomer Panel	5	DE-OG	Tie Feeder	Tie Outgoing Panel	6	G	Bus PT	Bus PT Panel	7	ICOG	Standalone Transformer feeder	Standalone panel with both incoming & outgoing cables
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<p>20.0</p> <p>20.1</p>	<p>TEST</p> <p>TYPE TESTS</p> <p>All equipment to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the following type tests carried out not earlier ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p> <table border="1"> <tr> <td>A)</td><td>Reports of the following type tests carried out on circuit breaker / circuit breaker panels, of each voltage class and current rating shall be submitted.</td></tr> <tr> <td>i)</td><td>Short circuit duty test on circuit breaker, mounted inside the panel offered along with CTs , bushing and seperators</td></tr> <tr> <td>ii)</td><td>Short time withstand test on circuit breaker, mounted inside panel offered together with CTs, bushings and separators.</td></tr> <tr> <td>iii)</td><td>Power frequency withstand test on breaker mounted in side panel.</td></tr> <tr> <td>iv)</td><td>Lightning impulse withstand test on breaker mounted in side panel.</td></tr> <tr> <td>v)</td><td>Temperature rise test on breaker and panel together. 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	<p>free of at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p> <ul style="list-style-type: none">• All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.• The type test reports once approved for any projects shall be treated as reference. For subsequent projects of END CUSTOMER, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet. <table><tr><td colspan="3">D) Type test reports for the following tests on the model of the Numerical relays, Ethernet switches shall be submitted for employer’s review</td></tr><tr><th>Sl. No.</th><th>TEST ITEMS</th><th>Standard</th></tr><tr><td>i)</td><td>Dimensions of structure and visual inspection</td><td>IEC 60297-3-101</td></tr><tr><td rowspan="3">ii)</td><td>Functional requirements:</td><td rowspan="3">Relevant IEC 60255-100 series</td></tr><tr><td>– Steady-state simulation</td></tr><tr><td>– Dynamic simulation</td></tr><tr><td rowspan="2">iii)</td><td>Product safety requirements (including the dielectric tests and thermal short time rating)</td><td rowspan="2">IEC 60255-27</td></tr><tr><td></td></tr><tr><td rowspan="3">iv)</td><td>EMC requirements:</td><td rowspan="3">IEC 60255-26</td></tr><tr><td>– Emission</td></tr><tr><td>– Immunity</td></tr><tr><td rowspan="3">v)</td><td>Energizing quantities:</td><td></td></tr><tr><td>– Burden</td><td>N/A</td></tr><tr><td>– Change of auxiliary energizing quantity</td><td>IEC 60255-11</td></tr><tr><td>vi)</td><td>Contact performance</td><td>N/A</td></tr><tr><td>vii)</td><td>Communication requirements</td><td>IEC 61850</td></tr><tr><td rowspan="5">viii)</td><td>Climatic environmental requirements:</td><td rowspan="5">IEC 60068-2-14, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-78, IEC 60068-2-30, IEC 60255-27</td></tr><tr><td>– Cold</td></tr><tr><td>– Dry heat</td></tr><tr><td>– Change of temperature</td></tr><tr><td>– Damp heat</td></tr><tr><td rowspan="4">ix)</td><td>Mechanical requirements: – Shock</td><td rowspan="4">IEC 60255-21-1, IEC 60255-21-2, IEC 60255-21-3</td></tr><tr><td>– Vibration</td></tr><tr><td>– Bump</td></tr><tr><td>– Seismic</td></tr><tr><td>x)</td><td>Enclosure protection</td><td>IEC 60529, IEC 60255-27</td></tr></table> <p>Two (2) protected soft copies on CD-ROM of the approved test results shall be furnished with the equipment. These shall include complete reports and results of the routine tests and type tests (if the latter is carried out) on equipment. If the type tests are not conducted, the CDs shall contain copies of the results of type tests carried out on identical equipment earlier.</p>	D) Type test reports for the following tests on the model of the Numerical relays, Ethernet switches shall be submitted for employer’s review			Sl. No.	TEST ITEMS	Standard	i)	Dimensions of structure and visual inspection	IEC 60297-3-101	ii)	Functional requirements:	Relevant IEC 60255-100 series	– Steady-state simulation	– Dynamic simulation	iii)	Product safety requirements (including the dielectric tests and thermal short time rating)	IEC 60255-27		iv)	EMC requirements:	IEC 60255-26	– Emission	– Immunity	v)	Energizing quantities:		– Burden	N/A	– Change of auxiliary energizing quantity	IEC 60255-11	vi)	Contact performance	N/A	vii)	Communication requirements	IEC 61850	viii)	Climatic environmental requirements:	IEC 60068-2-14, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-78, IEC 60068-2-30, IEC 60255-27	– Cold	– Dry heat	– Change of temperature	– Damp heat	ix)	Mechanical requirements: – Shock	IEC 60255-21-1, IEC 60255-21-2, IEC 60255-21-3	– Vibration	– Bump	– Seismic	x)	Enclosure protection	IEC 60529, IEC 60255-27
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
20.2	<p>ROUTINE TESTS</p> <p>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</p> <p>An indicative lists of tests / checks is mentioned as QA chapter on HT switchgear. However, the manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.</p>
20.3	<p>COMMISSIONING CHECKS / TESTS</p> <p>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 the Contractor shall carry out all other checks and tests recommended by the manufacturers.</p> <p>General</p> <ul style="list-style-type: none"> (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 <p>Circuit Breakers</p> <ul style="list-style-type: none"> (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.

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<p>21.0</p> <p>21.1</p>	<ul style="list-style-type: none"> (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. <p>Current Transformers</p> <ul style="list-style-type: none"> (a) IR value 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. <p>Voltage Transformers</p> <ul style="list-style-type: none"> (a) Insulation resistance test. (b) Ratio test on all cores. (c) Polarity test. (d) Line connections as per connection diagram. <p>Cubicle Wiring</p> <ul style="list-style-type: none"> (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 checked for IR value. (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 <p>SPECIFICATION FOR 33KV RING MAIN UNIT (If applicable)</p> <p>33kV RING MAIN UNIT</p> <p>Each Ring Main Unit shall have all the following major components in addition to the other items required for satisfactory performance of equipment:</p> <ul style="list-style-type: none"> a. Painted MS enclosure with steel base frame for Ring Main Unit.

CLAUSE NO.	TECHNICAL SPECIFICATIONS																											
21.2	<div><div><div>b. 33 KV Ring Main Units, Non-extensible type along with requisite number of electrically operated breakers and manually operated Load break switches and earth switches as per Single line Diagram</div><div>c. Control protection and metering requirements as per system requirement and single line Diagram</div><div>d. Internal cabling for connections between the equipments of Ring Main Unit, lighting & earthing system along with required hardware, gaskets, gland plates etc as required.</div></div></div>																											
	Technical requirements for RMU																											
	CODES AND STANDARDS: IS: 13118, IEC: 62271-200																											
	The equipment shall have the following features:																											
	<table><tr><th colspan="3">1. ELECTRICAL SYSTEM PARAMETERS</th></tr><tr><td>i</td><td>Nominal system voltage</td><td>33 KV</td></tr><tr><td>ii</td><td>Highest system voltage</td><td>36 KV</td></tr><tr><td>iii</td><td>Rated insulation level i) Impulse with stand voltage with 1.2 / 50 Micro second wave ii) One minute power frequency with stand voltage</td><td>170 KV(Peak) 70 KV (RMS)</td></tr><tr><td>iv</td><td>Rated short circuit breaking capacity at specified site conditions (Minimum)</td><td>As per system fault current (Refer Cl. 1.0 of Chapter 2-A, Part A) with %age of DC component as per IEC-62271-100 corresponding to minimum operating time with operating conditions specified.</td></tr><tr><td>v</td><td>Rated short circuit making current (Minimum)</td><td>2.5 Times of system fault current.</td></tr><tr><td>vi</td><td>Rated short time withstand capacity (Minimum)</td><td>As per system fault current</td></tr><tr><td>vii</td><td>Rated operating duty cycle</td><td>O-3 minute-CO-3 minute – CO</td></tr><tr><td>viii</td><td>Maximum temperature rise over and ambient temperature of 50 deg.C</td><td>As per IEC : 62271-100</td></tr></table>	1. ELECTRICAL SYSTEM PARAMETERS			i	Nominal system voltage	33 KV	ii	Highest system voltage	36 KV	iii	Rated insulation level i) Impulse with stand voltage with 1.2 / 50 Micro second wave ii) One minute power frequency with stand voltage	170 KV(Peak) 70 KV (RMS)	iv	Rated short circuit breaking capacity at specified site conditions (Minimum)	As per system fault current (Refer Cl. 1.0 of Chapter 2-A, Part A) with %age of DC component as per IEC-62271-100 corresponding to minimum operating time with operating conditions specified.	v	Rated short circuit making current (Minimum)	2.5 Times of system fault current.	vi	Rated short time withstand capacity (Minimum)	As per system fault current	vii	Rated operating duty cycle	O-3 minute-CO-3 minute – CO	viii	Maximum temperature rise over and ambient temperature of 50 deg.C	As per IEC : 62271-100
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<table><tr><th colspan="3">2. RMU CONFIGURATION</th></tr><tr><td>i</td><td>RMU Configuration</td><td>Two Nos. Load break switches (LBS) and transformer circuit breaker as per system requirement.</td></tr><tr><td>ii</td><td>Extensibility</td><td>Non extensible type</td></tr><tr><td>iii</td><td>Load break switch, Circuit breaker& earth switch in RMU panel</td><td>All shall be fixed (Non draw out) type</td></tr><tr><td>iv</td><td>Insulation medium for panel/ bus bar</td><td>SF6 gas or Dry air in sealed metallic tank</td></tr><tr><td>v</td><td>Breakers & load break switches</td><td>SF6 gas or Vacuum type (with disconnecter & earth switch)</td></tr></table>	2. RMU CONFIGURATION			i	RMU Configuration	Two Nos. Load break switches (LBS) and transformer circuit breaker as per system requirement.	ii	Extensibility	Non extensible type	iii	Load break switch, Circuit breaker& earth switch in RMU panel	All shall be fixed (Non draw out) type	iv	Insulation medium for panel/ bus bar	SF6 gas or Dry air in sealed metallic tank	v	Breakers & load break switches	SF6 gas or Vacuum type (with disconnecter & earth switch)										
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	vi	Internal Arc classified FLR	As per system fault current (for Min 1 sec)
	3. RMU CONSTRUCTIONAL FEATURES		
	i	RMU Panel type	Metal enclosed panel construction
	ii	Service Location	Indoor/Outdoor
	iii	Mounting	Free Standing
	iv	Overall enclosure protection	IP54 minimum for MV Switchgear Compartments, Vermin proof
	v	Doors	Front access with anti-theft hinge
	vi	Covers	Bolted for rear access, with handles. All the accessible bolts / screws shall be vandal proof. One set of required Special tools per RMU shall be in the scope of supply.
	vii	Construction	Sheet metal 2 mm thick CRCA/Aluzinc/Stainless Steel (minimum) suitable for outdoor application.
	viii	Base frame made of steel for RMU	Raised frame of 300 mm height
	ix	Lifting lugs	Four numbers
	x	Cable entry	Bottom
	xi	Bus bar continuous rated current at designed 50 deg.C ambient temperature	As per system requirement.
	xii	Bus bar short time withstand capacity	As per system fault current (Minimum)
	xiii	Maximum temperature rise above reference ambient 50 deg C	As per IEC reference standard
	xiv	Earth bus bar	Aluminum sized for rated fault duty for 1 sec
	xv	Cooling arrangement	By natural air (without fan)
	xvi	Panel internal wiring	Stranded flexible color coded PVC insulated copper wire 1.5 sq mm.(min.), 1100 volt grade
	xvii	Gasket	Neoprene rubber
	xviii	Marshalling terminal blocks	1.5 Sq mm ₂ Nylon 66 material, screw type + 20% spare in each row of TB.
	xix	Padlock facility	Required for all earth switches & all handles
	xx	Explosion vents	To ensure operator's safety, design should ensure that gases / flames generated during flash over / blast in

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			any of the compartment, must not come out from the front of RMU. Cable compartment & other compartments of the RMU should withstand Internal arc test for the indicated system fault current.
	4. Requirements of sealed housing live parts (RMU SF6 gas chamber)		
	i	Enclosure	Stainless steel enclosure, IP67 class
	ii	SF6 gas pressure low alarm	To be given
	iii	Provision for SF6 gas filling	To be given (For 'sealed for life' design of RMU, this is not applicable)
	iv	Provision for SF6 gas pressure measurement	Manometer with non-return valve indication
	v	Arc interruption method for SF6 breaker / Load break switch	Puffer type / rotating arc type
	vi	Potential free contacts for SF6 gas 1NO +1NC pressure low	1NO +1NC
	vii	Electrical Bushing	Preferably, bushing should be suitable for replacement at site.
	5. LOAD BREAK SWITCH (LOAD BREAK ISOLATOR)		
	i	Type	Three poles operated simultaneously by a common shaft
	ii	Arc interruption in dielectric medium	SF6 or vacuum
	iii	Operating mechanism for close/open	Electrically operated through SCADA.
	iv	Continuous current rating of LBS at design ambient temperature of 50 deg C	100 Amps minimum or as per system requirement
	6. CIRCUIT BREAKER		
	i	Type	Three poles operated simultaneously by a common shaft
	ii	Arc interruption in dielectric medium	SF6 or vacuum
	iii	Operating mechanism	Electrically Operated
	iv	Emergency trip / open push button	On panel Front
	v	Continuous current rating of Breaker at design ambient temp of 50 deg.C	100 Amps minimum or as per system requirement
	vi	Short time withstand capacity	As per system fault current
	vii	Breaker status auxiliary contact	2NO + 2NC wired to terminal block
	viii	Current transformer Ratio	Suggestive rating: 100/1 A or as per requirement

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			<p>Other ratings as per manufacturer's standard may also be adopted.</p> <p>Sufficient space must be provided both in horizontal & vertical directions for mounting of CT's. Additionally, some CAUTION marking (by sticker/ paint) should be there to avoid CT's installation above the screen of cable (i.e. earth potential point.)</p>
	ix	CT accuracy class	Protection : 5P20 Metering : 0.5
	x	Potential Transformer (PT) ratio and Accuracy Class	<p>33000/ □3 /110/ □3</p> <p>Accuracy class : 0.5 suitable for converter duty application as mentioned elsewhere in the specification</p>
	xi	Protections	<p>Numerical relay as per requirements mentioned elsewhere in the specification. In addition to above Transformer protections like OTI, WTI, Buchholz, and Pressure Relief Valve (PRV) operated shall be suitably integrated in the protection circuit. Any AC/DC auxiliary supply requirement for the RMU shall be arranged as per requirement mentioned elsewhere in the specification.</p>
	xii	Relay aux contacts for remote indication	1NO+1NC Potential free wired to TB
	xiii	Shunt trip (for door limit switch of enclosure or transformer) as per the adopted voltage	To be wired to terminal blocks
	7. EARTH SWITCH		
	i	Type	Three poles operated simultaneously by a common shaft
	ii	Switching in dielectric medium	Dry air in sealed medium or SF6
	iii	Operating mechanism for Close/Open	Manual
	iv	Short time withstand capacity	As per system fault current
	v	Aux contacts	1NO+1NC free wired to TB
	vi	LBS Earth Switch close / open	Potential free contacts wired to terminal block.
	vii	CB Earth Switch close /open	Potential free contacts wired to terminal block.
	8. INDICATION		
	i	Cable charge status indication for all Load Break Switches & Circuit	Circuit breaker capacitor type voltage indicators with LED on all the phases

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		Breaker	(Shall be clearly visible in day light)
	ii	Spring charge status indication	On front for breaker
	iii	Earth switch closed indication (For Each LBS)	front
	iv	Load break switch ON/OFF indication	Green for OFF / Red for ON
	v	Circuit breaker ON/OFF indication	Green for OFF / Red for ON
	vi	Cable Fault Direction	Cable fault passage indicator.
	vii	CB close / open	Potential free contacts wired to terminal block.
	viii	Protection relay operated	Potential free contacts wired to terminal block.
	ix	SF6 gas pressure low	Potential free contacts wired to terminal block.
	9. RMU OPERATIONAL INTERLOCK		
	i	Interlock type	Mechanical
	ii	Load break switch & respective earth switch	Only one in 'close' condition at a time
	iii	Circuit breaker & respective earth switch	Only one in 'close' condition at a time
	iv	Prevent the removal of respective cable covers if load break switch or circuit breaker is 'ON'	Electrical / Mechanical
	v	Prevent the closure of load break switch or circuit breaker if respective cable cover is open	Electrical / Mechanical
	vi	Cable test plug for LBS/CB accessible only if Earth switch connected to earth	Mechanical
	10. MIMIC DIAGRAM, LABEL AND FINISH		
	i	On panel front with description of function & direction of operation of handles/buttons	
	ii	Mimic diagram (Shall not be preferred with Stickers)	
	iii	Operating instruction chart and Do's & Don'ts to be displayed on left / front side of panel enclosure on Al Sheet, duly affixed on panel.	
	iv	Name plate on panel front	Fixing by rivet only
	v	Material	Anodized aluminum 16SWG / SS
	vi	Background	Satin Silver
	vii	Letters, diagram & border	Black
	viii	Process	Etching
	ix	Name plate details	Month & year of manufacture, equipment type, input & output rating, purchaser name & order

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21.3			Number, guarantee period.
	x	Labels for meters & indications	Anodized aluminum with white character on black background OR 3 Ply lamicoid.
	xi	Danger plate on front & rear side	Anodized aluminum with white letters on red background
	xii	Painting surface preparation	As per Appendix-1 of Part-A (For outdoor)
	xiii	Painting external finish	As per Appendix-1 of Part-A (For outdoor) Shade-RAL 7032
	xiv	Painting internal finish	As per Appendix-1 of Part-A (For outdoor) Shade-White
	TESTS OF RMU		
<p>33 kV Switchgear/Ring Mains Unit shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p> <p>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p> <p>All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.</p> <p>The type test reports once approved for any projects shall be treated as reference. For subsequent projects of END CUSTOMER, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet.</p>			

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
1.0	B-3(A) INVERTER TRANSFORMER		
	TECHNICAL REQUIRMENTS (OIL FILLED TRANSFORMER)		
	Sr. No.	TRANSFORMER	INVERTER TRANSFORMER
	i)	VA Rating & Quantity	As per system requirement
	ii)	Voltage Ratio (KV)	As per system requirement
	iii)	Duty, Service & Application	Continuous Solar Inverter application and converter duty (Outdoor)
	iv)	Winding	AS per system requirement (Only 1/2/4 LV winding)
	v)	Frequency	50 Hz
	vi)	Nos. of Phase	THREE
	vii)	Vector Group & Neutral earthing	As per system requirement/ Inverter Manufacturer recommendation
	viii)	Cooling	ONAN
	ix)	Tap Changer	As per system requirement OCTC +/- 5% (min.)
	x)	Impedance at75 ⁰ C	
		a) Principal Tap	As per system requirement and SLD* & as per Inverter manufacturer recommendation.
		b) Other Taps	
	xi)	Permissible Temperature rise over an ambient of 50 deg C (irrespective of tap)	
		a) Top Oil	50 deg.C
		b) Each Individual Winding	55 deg.C
	xii)	SC withstand time (thermal)	2 sec.
	xiii)	Fault Level & Bushing CT	As per system requirement
	xiv)	Termination	As per system requirement(LV bushing shall be located on Tank Top)
	xv)	Bushing rating, Insulation class (Winding & bushing)	As per relevant IS/IEC (However Inverter Transformer LV side winding & bushing insulation class shall be of at least 3.6 kV) Creepage distance : 31 mm/kV
	xvi)	Noise level	AS PER NEMA TR-1
xvii)	Loading Capability	Continuous operation at rated MVA on any tap with voltage variation of +/-10%, also transformer shall be capable of being loaded in accordance with IS: 6600/ IEC60076-7.	
xviii)	Flux density	Not to exceed 1.7 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency	

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			fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds. Bidder shall furnish over fluxing char. up to 150%
	xix)	Air Clearance	As per CBIP
	xx)	Foundation	All the foundation shall be designed as per highest rating Transformer in case different capacity transformer are offered.
	xxi)	Transformer losses	Total Transformer losses (KW) shall be within 1% of the rated MVA capacity of the transformer. Total Transformer losses (KW) = NLL (KW) + LL(KW) LL: Load Loss (at rated current and temperature of 75 Deg. Celsius @ principal tap) NLL: No Load loss (at rated voltage and frequency)
	<u>Note (common for Oil filled and dry type transformer):</u>		
	<ul style="list-style-type: none">Inverter Transformer shall have copper/Aluminum Shield winding between LV & HV windings. Each LV winding must be capable of handling non-sinusoidal voltage with voltage gradient as per relevant applicable standards and Inverter manufacturer recommendation. Also each shield winding shall be taken out to tank with two separate connection from shield to bushing with proper support with 2 nos. 3.6 kV shield bushings and same shall be brought down along with support insulator from tank & copper flat up to the bottom of the tank for independent grounding.If Inverter transformer is provided indoor, it shall be necessarily dry type.Harmonic Factor as per Inverter manufacturer recommendation must be taken into account while designing the transformer. The extra no load loss due to voltage harmonics and load and stray load loss due to current harmonics (as applicable) and must be taken into consideration in transformer design. In addition, the dc bias component of 0.5% of rated Inverter output current is to be accounted for its effect on the transformer design.The adverse effect on life of transformer due to cloud intermittency and solar generation loading cycle must be compensated through suitable design (as applicable).		

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<p>2.0</p> <p>2.1</p>	<ul style="list-style-type: none"> • The thermal design of Inverter Transformer needs to consider the temperature dependent performance of the Inverter. It is to in accordance with Inverter output and under worst condition it should not limit Inverter output. • The multi-winding transformer needs to be designed for long term operating conditions with asymmetrical load on LV side i.e., in case three winding design, the transformer needs to operate reliable with only one Inverter supplying power to only one LV winding. • For multi winding transformer, it is recommended to have close coupling and equal impedances on each of LV winding to HV winding and to have high enough impedance (8% min. based on one LV winding rating) between two LV windings in order to decouple these windings. • In case of inverter transformer, it shall be proven and of successfully type tested design • Contacts from Inverter transformer fittings/protection devices shall be wired for tripping of Inverter transformer Circuit Breaker. Detailed scheme regarding same shall be finalized during detailed engineering. • Single Line Diagram (SLD) will be finalized during detailed engineering. However, the kVA rating of each LV winding (s) of each inverter transformer shall not be less than maximum kVA capacity of respective Inverters connected to it. <p>CODES AND STANDARDS</p> <table border="1"> <tr> <td>Transformers</td><td>IS:2026, IS:6600, IEC:60076</td></tr> <tr> <td>Bushings</td><td>IS:2099, IEC:60137,IS 3347 ,IS 12676</td></tr> <tr> <td>Insulating oil</td><td>IEC 60296 ,IEC 61099/IS16081</td></tr> <tr> <td>Bushing CTs</td><td>IS:2705, IEC 60185</td></tr> <tr> <td colspan="2">Indian Electricity Act 2003, BEE Guideline & CEA notifications</td></tr> </table> <p>General Construction</p> <p>Transformer shall be constructed in accordance to IS: 2026 and IS: 3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect and shall be in scope of supplier. The other important construction particulars shall be as below.</p> <p>a. The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane.</p>	Transformers	IS:2026, IS:6600, IEC:60076	Bushings	IS:2099, IEC:60137,IS 3347 ,IS 12676	Insulating oil	IEC 60296 ,IEC 61099/IS16081	Bushing CTs	IS:2705, IEC 60185	Indian Electricity Act 2003, BEE Guideline & CEA notifications	
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<p>2.2</p> <p>2.3</p>	<p> b. A double float type Buchholz relay conforming to IS: 3637 shall be provided. c. Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc. d. All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at site e. The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel breather (in transparent enclosure). Silica gel shall be isolated from atmosphere by an oil seal. f. Transformer shall have adequate capacity Conservator tank to accommodate oil preservation system and volumetric expansion of total transformer oil. g. Transformer shall have Oil Temperature Indicator and Winding temperature Indicator with accuracy class of +/-2 deg. h. Radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/valve at the bottom and air release plug at the top. i. M. Box shall be of sheet steel, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Also Marshalling Box, shall be at least 450 mm above ground level. Wiring scheme (TB details) shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door. Windings </p> <p> a) The Bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere. b) The conductors shall be of electrolytic grade copper/electrolytic grade Aluminum free from scales & burrs. c) All windings of the transformers shall have uniform insulation. d) Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio. </p> <p>Core</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																																			
2.4	a) The core shall be constructed from non-ageing, cold rolled, super grain oriented silicon steel laminations equivalent to M4 grade steels or better. b) Core isolation level shall be 2 kV (rms.) for 1 minute in air. c) Adequate lifting lugs will be provided to enable the core & windings to be lifted.																																																			
	Insulating Mineral oil																																																			
	No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.																																																			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS				
2.5	i)	BDV	60 kV (min)	60 kV (min)	Applicable for all Transformers.
	ii)	Moisture content	10 ppm (max.)	10 ppm (max.)	
2.6	Bushings				
	<div><div>i.</div><div>Bushing below 52 kV shall be oil communicating type with porcelain insulator.</div><div>ii.</div><div>LV Bushing below 3.6 kV used within transformer cable box, epoxy type bushing confirming to IS 2099/IEC 60137 also allowed as alternate to porcelain type</div><div>iii.</div><div>No arcing horns to be provided on the bushings.</div><div>iv.</div><div>Inverter Transformer LV bushing palms shall be silver/tin plated.</div></div>				
2.7	Bushing CTs				
	<div>Shall be of adequate rating for protection (differential and others if any) as required, WTI etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.</div> <div>All CT terminals shall be provided as fixed type terminals on the M. Box to avoid any hazard due to loose connection leading to CT opening. In no circumstances Plug In type connectors shall be used for CT.</div>				
2.8	Valves				
	<div>All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies. Sampling & drain valves should have zero leakage rate.</div>				
	Gaskets				
	<div>a) Gasket shall be fitted with weather proof, hot oil resistant, nitrile rubber based gasket.</div> <div>b) If gasket is compressible, metallic stops shall be provided to prevent over compression.</div> <div>c) The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period,</div>				

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
2.9	the guaranteed period shall be extended until the performance is established.			
	PAINTING			
	PARTS NAME	TYPE OF PAINT	NO.OF COATS	TOTAL DFT
	Inside of tank and accessories (except M Box)	Oil & heat resistant fully glossy white	One coat	Atleast 30 micron
	External surface of transformer and accessories including M Box (except radiators)	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceous iron oxide) as intermediate paint followed by polyurethane finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)	One coat each	Atleast 100 micron
	External Radiator surface	Anticorrosive primary paint followed by high quality full glossy outer finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)	Two coats each	Atleast 100 micron
	Internal Radiator surface	Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil	---	---
	Internal surface of M Box	Chemical resistant epoxy zinc phosphate primer followed by chemical and heat resistant epoxy enamel white paint	Two coats each	Not less than 100 micron
2.10	Neutral Earthing Arrangement			
	Neutral earthing shall be done as per system requirement and SLD. In case of solidly earthed neutral of Transformers, it shall be brought through insulated support from tank to the ground level at a convenient point with 2 nos. copper flat, for connection to ground network (as applicable).Neutral of Transformer if not used should be taken out through bushing and covered by insulating cap.			
2.11	Cable boxes & disconnecting chamber (Disconnecting chamber applicable 3.3 kV and above & for Inverter Transformer both side)			
	(a) HV Cable boxes shall be of phase segregated air insulated type & shall be of sufficient size to accommodate Employer's cable & termination. Phase segregation shall be achieved by insulating barriers (for 3.3 kV and above side) (b) Cable boxes shall have bus bars / suitable terminal connectors of adequate size & bolt holes to receive cable lugs. The degree of protection of cable boxes shall be IP 55. (c) A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box			

CLAUSE NO.	TECHNICAL SPECIFICATIONS
2.12	(d) The support from base for the cable box (for 3.3 kV and above side) shall be of galvanized iron
	(e) The contractor shall provide earthing terminals on the cable box, to suit Employer's GI flat.
	(f) The minimum length provided for terminating 33 kV, 11KV & 3.3 KV XLPE cable shall be 1000 mm (for 33 kV) 650 mm (for 3.3 kV and 11 kV) from cable gland plate to the cable lug) for the cable boxes, for 433V side suitable length shall be provided (shall be discussed during detail engineering). The final cable size, number & length of terminating XLPE cable shall be furnished during detailed engineering.
	(g) Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).
	(h) Cable boxes shall have removable top cover (for transformer above 100 KVA) & ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.
	FITTINGS
	Following fittings shall be provided with Transformers covered under this sub section.
	a) - Air cell type Conservator for main tank shall be provided with MOG with Air cell rupture relay, low oil level alarm contact, drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.
	b) - Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement.
	c) - It shall be provided with minimum two numbers of spring operated PRD (with trip contacts) with suitable discharge arrangement for oil shall be provided.
	d) OTI & WTI shall be 150 mm dial type with alarm and trip contacts with max. reading pointer & resetting device (maximum height 1500 mm above ground level). For Inverter Transformers, WTI shall be provided at least for all LV windings.
	e) Top & bottom filter valves with threaded male adapters, bottom sampling valve, drain valve/sludge removal valve at the bottom most point of the tank.

f) Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings (as applicable).
g) Prismatic/toughened glass oil gauge for transformers.
h) Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Cooling equipment.
i) Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs, inspection cover, Bilingual R&D Plate, Terminal marking plates, two nos. earthing terminals etc.
j) Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.
k) Rain hoods to be provided on Buchholz, MOG & PRD. Entry points of wires shall be suitably sealed to protect from all directions.

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
3.0	The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformers are deemed to be included.		
	DRY TYPE INVERTER TRANSFORMER		
	Sr. No.	PARAMETERS	INVERTER TRANSFORMER
	i)	Type	Epoxy cast resin/resin encapsulated
	ii)	Duty, Service & Application	Continuous Solar Inverter application and converter duty (Indoor)
	iii)	MVA & Voltage ratio	As per system requirement and SLD.
	iv)	Vector group	
	v)	Termination & Bushing CT	
	vi)	Fault Level & Earthing	
	vii)	Tap changer type & range	As per system requirement and SLD. OCTC +/-5% (min.)
	viii)	Impedance	As per system requirement and SLD & as per Inverter manufacturer recommendation.
	ix)	Number of phases	Three (3)
	x)	Type of cooling	AN Transformer shall be provided with suitable ventilation system to ensure the temperature rise limits under most severe condition while in service however all tests and performance guarantee shall correspond to air natural (AN) cooling.
	xi)	Bushing rating, Insulation class (Winding & bushing)	As per relevant IS/IEC (However Inverter Transformer LV side winding & bushing insulation class shall be of at least 3.6 kV)
	xii)	Maximum Temperature rise of winding over 50 deg. C ambient. (by resistance method) with Air Natural (AN) cooling.	90 deg.C. (class F) 115 deg.C. (class H)
	xiii)	SC withstand time (thermal)	2 sec
	xiv)	Noise Level	Not to exceed values specified in NEMA TR-1.
	xv)	PD Level (max. Allowable)	10 pc
	xvi)	Loading Capability	Continuous operation at rated KVA on any tap with voltage variation of +/-10% corresponding to

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
3.1			the voltage of the tap as well as in accordance with IEC60076-12/IS: 6600.
	xvii)	Flux Density	Not to exceed 1.9 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds.
	CODES AND STANDARDS		
3.2	Dry type transformers		IS: 11171, IEC 60076-11
	Indian Electricity Act 2003 and Indian Electricity Rules, BEE notification & CEA guidelines		
DESIGN AND CONSTRUCTIONAL FEATURES			
3.2.1	The core shall be constructed from high grade non-ageing cold rolled grain oriented silicon steel laminations of M4 grade or better quality. The insulation of core to clamp-plates shall be able to withstand a power frequency voltage of 2 kV (rms) for one (1) minute.		
3.2.2	The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23. In case it is placed outdoor, IP for enclosure shall be minimum IP-42 or higher. Enclosure shall be of a tested quality sheet steel of minimum thickness 2mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting. Suitable bi-directional skids with pre-drilled holes shall be provided integral with the enclosure or bi-directional rollers shall be provided with suitable locking arrangement.		
3.2.3	Winding conductor shall be electrolytic grade Copper/ Aluminum. Windings shall be of class F insulation or better. All windings are to be uniformly insulated.		
3.2.4	Transformer HV bushings and LV bushings can be either solid porcelain or epoxy type. Bushing shall be suitable for satisfactory operation in the high ambient temperature inside Bus Duct enclosure (if applicable). LV flange area shall be of non-magnetic material.		
3.2.5	Bushing CTs shall be provided in the LV neutral side of adequate rating for REF protection, WTI, etc (as applicable).		
3.2.6	For Marshalling Box the sheet steel used shall be at least 1.6 mm thick cold rolled. The box shall be tank mounted type. The degree of protection shall be IP54 in accordance with IS-13947. Wiring Scheme shall be engraved in a stainless		

CLAUSE NO.	TECHNICAL SPECIFICATIONS						
<p>3.2.7</p> <p>3.3</p> <p>3.3.1</p> <p>3.4</p> <p>4.0</p>	<p>steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.</p> <p>Transformer shall be provided with suitable ventilation system to ensure the temperature rise limits under most severe condition while in service however all tests and performance shall correspond to air natural cooling.</p> <p>PAINTING</p> <p>The inside of enclosure and accessories (except M. Box) shall be painted with two coats of fully glossy white colour with total DFT of 25 to 60 microns. The external paint colour of transformer & accessories shall be blue corresponding to RAL 5012. The external surface of transformer & accessories shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of polyurethane finish paint with total DFT of 80 to 150 microns. The internal surface of M.Box shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of chemical & thermal resistant epoxy enamel white paint with total DFT of 80 to 150 microns.</p> <p>FITTING</p> <table border="1"> <tr> <td>Winding temperature indicator (WTI)</td><td> Shall be Platinum resistance type temperature detector in each limb. Single Indicating meter may be provided for display of temperature of all limbs. Accuracy class of Indicating meter shall be +/- 1% or better and it shall have least count of 0.1 °C or better. 1 no. 4-20 mA signal shall be provided for remote monitoring of winding Temperature. </td></tr> <tr> <td>RTD/Thermistors</td><td> 1 No. PT-RTD shall be embedded in each limb with alarm and trip contacts for remote annunciation. Additional 1 No. thermistor/RTD shall be embedded in each limb. </td></tr> <tr> <td colspan="2"> Fittings which are generally required for satisfactory operation of the transformers are deemed to be included, in the scope of supply of the Contractor. </td></tr> </table> <p>TESTS AND INSPECTION</p> <p>In case the bidder/contractor has conducted type test(s) within last ten years, he may submit the type test reports to the owner for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p> <p>In case the Bidder is not able to submit report of the type test(s) conducted within last ten years from the date LOA by END CUSTOMER, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract at no additional cost to the Employer and submit the reports for approval</p>	Winding temperature indicator (WTI)	Shall be Platinum resistance type temperature detector in each limb. Single Indicating meter may be provided for display of temperature of all limbs. Accuracy class of Indicating meter shall be +/- 1% or better and it shall have least count of 0.1 °C or better. 1 no. 4-20 mA signal shall be provided for remote monitoring of winding Temperature.	RTD/Thermistors	1 No. PT-RTD shall be embedded in each limb with alarm and trip contacts for remote annunciation. Additional 1 No. thermistor/RTD shall be embedded in each limb.	Fittings which are generally required for satisfactory operation of the transformers are deemed to be included, in the scope of supply of the Contractor.	
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	<p>Short Circuit Test:- In case short circuit test has not been conducted or the test report not meeting the specification requirement for the offered transformer manufacturer, Bidder /Sub-vendor shall establish" Ability to withstand the dynamic effects of short circuit "for the offered transformer as per latest IEC 60076-5.The ability to withstand the dynamic effects of short circuit can be established either by performing actual short circuit test or by method of calculation with reference to short circuit tested reference transformer as per IEC-60076-5/Annexure-A&B. Bidder shall choose any one the two options mentioned below;</p> <p>Option-1:- Performing actual short circuit test as Type Test. In order to meet project schedule, Bidder/Sub vendor shall take suitable steps quite in advance to ensure successful conduction of short circuit test within three months time from date of LOA failing which the offered make of the transformer shall not be considered.</p> <p>Option-2: By theoretical evaluation of the ability to withstand dynamic effect of short circuit based on 'Calculation and Design and Manufacture Consideration'. In this regard the guidelines given in Annexure-A with applicable tables of the IEC 60076-5 is to be followed. <u>The reference transformer chosen shall be of same application, winding configuration, conductor current density and as per Annexure-B of latest IEC-60076-5.</u> Necessary Design document and reference test reports related to theoretical comparative evaluation must be submitted by Manufacturer/Bidder as required by Employer in this case.</p>																																													
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4.1	S.N.	ROUTINE TESTS	
		radiators (as per relevant clause of this sub section)	
	15.	Jacking test followed by D.P. test	√
	16.	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	√
	17.	IR measurement on wiring of Marshalling Box.	√
	S. N.	TYPE TESTS * (To be carried out on one transformer of each rating)	
	1.	Lightning impulse(Full and chopped wave) test on windings(as per IEC 60076-3) (Not applicable for LV)	√
	2.	Short circuit test (special test) as per IEC 60076-5 (if applicable).	√
	3.	Temperature Rise test at a tap corresponding to maximum losses as per IEC 60076. Gas Chromatography shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599).	√
	4.	Measurement of harmonics of no load current (special test)	√
	5.	Measurement of acoustic noise level as per NEMA TR-1 (special test)	√
	6.	Tank Vacuum & Pressure Test (as per CBIP norms)	√
	(#) NOTE:- i) All the type and special tests shall be conducted after performing Short Circuit Test. If Tank Vacuum & Pressure Test is to be carried out then it shall be conducted before SC test. ii) Inverter Transformer LV winding Di-electric tests (except for lightning impulse test for LV winding) shall be carried out corresponding to levels (as per IEC 60076) for 3.6 kV class. iii) All Type tests should be done as per Employer's approved procedure.		
	Leakage test on assembled Oil filled Transformer (ROUTINE TEST) All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur. Bidder can perform this test at site depending upon urgency subject to END CUSTOMER approval. Statutory requirement- Suitable Fire Fighting arrangements for Oil filled Transformers shall be provided if applicable as per CEA safety regulation /statutory requirements. In case Nitrogen based fire protection system is used, CBIP manual/BIS standard shall be followed for compliance. Firewall & soak pit		

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4.2	as applicable (as per statutory requirement/IS 10028 / IS 1646) shall be provided of minimum 230 mm thickness of RCC wall or 355 mm thick fire resisting brick wall subject to END CUSTOMER approval. However, for all oil filled outdoor transformers, a pit shall be provided all around at a distance of 1.0 meter (min.) from transformer outer edge including sump pit. Transformer efficiency shall be as per Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electrical Lines) regulation, 2010.																																																			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS		
1.0	B-3(B) AUXILIARY TRANSFORMER TECHNICAL REQUIRMENTS (OIL FILLED TRANSFORMER)		
	Sr. No.	DESCRIPTION	AUXILIARY TRANSFORMER (AT)
	i)	VA Rating & Quantity	As per system requirement and /or SLD*
	ii)	Voltage Ratio (KV)	As per system requirement and / or SLD*
	iii)	Duty, Service & Application	Continuous application (Outdoor)
	iv)	Winding	TWO
	v)	Frequency	50 Hz
	vi)	Nos. of Phase	THREE
	vii)	Vector Group & Neutral earthing	As per system requirement and /or SLD*
	viii)	Cooling	KNAN
	ix)	Tap Changer	As per system requirement and /or SLD*
	x)	Impedance at 75°C	
		a) Principal Tap	As per system requirement and /or SLD*.
		b) Other Taps	
	xi)	Permissible Temperature rise over an ambient of 50 deg C (irrespective of tap)	
		a) Top Oil	35 deg.C
		b) Winding	40 deg.C
	xii)	SC withstand time (thermal)	2 sec.
	xiii)	Fault Level & Bushing CT	As per system requirement and SLD*
	xiv)	Termination	As per system requirement /cable box
	xv)	Bushings rating, Insulation class (Winding & bushing)	As per relevant IS/IEC Creepage distance : 31 mm/kV
	xvi)	Noise level	AS PER NEMA TR-1
	xvii)	Loading Capability	Continuous operation at rated MVA on any tap with voltage variation of +/-10%, also transformer shall be capable of being loaded in accordance with IS: 6600.
	xviii)	Flux density	Not to exceed 1.7 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds. Bidder shall furnish over fluxing char. up to 150%
	xix)	Air Clearance	As per CBIP

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2.0	<p><u>Note (common for Oil filled and dry type transformer):</u></p> <ul style="list-style-type: none">Auxiliary transformers shall be suitable for 3 phase, 4 wire system with additional LVN bushing for equipment earthing.Auxiliary Transformer can be either Oil Natural/Synthetic Ester oil) filled or Dry Type (refer relevant specification).In case Ester Oil filled Transformers are offered, then 50% quantity shall be Natural ester filled and balance 50% quantity shall be of Synthetic Ester oil filled.									
	<p>CODES AND STANDARDS</p> <table><tr><td>Transformers</td><td>IS:2026, IS:6600</td></tr><tr><td>Bushings</td><td>IS:2099,IS 3347</td></tr><tr><td>Insulating oil</td><td>IS 16659 / IS 16081</td></tr><tr><td>Bushing CTs</td><td>IS:2705</td></tr><tr><td colspan="2">Indian Electricity Act 2003, BEE Guideline & CEA notifications</td></tr></table>	Transformers	IS:2026, IS:6600	Bushings	IS:2099,IS 3347	Insulating oil	IS 16659 / IS 16081	Bushing CTs	IS:2705	Indian Electricity Act 2003, BEE Guideline & CEA notifications
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2.1	<p>General Construction</p> <p>Transformer shall be constructed in accordance to IS: 2026 and IS: 3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect and shall be in scope of supplier.</p> <p>The other important construction particulars shall be as below.</p> <ul style="list-style-type: none">a. The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane.b. A double float type Buchholz relay conforming to IS: 3637 shall be provided.c. Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.d. All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at sitee. The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel breather (in transparent enclosure). Silica gel shall be isolated from atmosphere by an oil seal.f. Transformer shall have adequate capacity Conservator tank to accommodate oil preservation system and volumetric expansion of total transformer oil.									

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2.2	<p>g. Transformer shall have Oil Temperature Indicator and Winding temperature Indicator (WTI applicable for transformer above 50 KVA) with accuracy class of +/-2 deg.</p> <p>h. For Transformers above 100KVA, radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/valve at the bottom and air release plug at the top.</p> <p>i. M. Box shall be of sheet steel, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Also Marshalling Box, shall be at least 450 mm above ground level (for transformer above 100 KVA). For transformer above 100 KVA, wiring scheme (TB details) shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.</p> <p>j. In case Natural Ester oil (IS 16659) filled transformer, the Transformer should be hermetically sealed and corrugated tank design. It should fitted with monitoring equipment like DGPT etc. for accessing the healthiness of Natural ester oil. As transformer becomes hermetically sealed, fitting, valves and accessories shall be decided during detail engineering but all other part of tender specification related to design of transformer active part and testing requirement shall remain same. HV/LV Bushing shall be fitted vertically on tank cover and all necessary measures to be taken to make the transformer leakage proof. Suitable nitrogen capping system shall be provided for preserving Natural ester oil for O&M.</p> <p>Windings</p> <p>a) The bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.</p> <p>b) The conductors shall be of electrolytic grade copper free from scales & burrs.</p> <p>c) All windings of the transformers shall have uniform insulation.</p> <p>d) Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.</p> <p>2.3</p> <p>Core</p> <p>a) The core shall be constructed from non-ageing, cold rolled, super grain oriented silicon steel laminations equivalent to M4 grade steels or better.</p> <p>b) Core isolation level shall be 2 kV (rms.) for 1 minute in air.</p> <p>c) Adequate lifting lugs will be provided to enable the core & windings to be lifted.</p>

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2.4	<p>Insulating Mineral oil</p> <p>No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.</p> <table><tr><th>S.No.</th><th>Property</th><th>Permissible values</th></tr><tr><td>1.</td><td>Kinematic Viscosity, mm²/s</td><td>□ 12 at 40 □ C □ 1800.0 at (-)30 □ C</td></tr><tr><td>2.</td><td>Flash Point, □ C</td><td>□ 140□ C</td></tr><tr><td>3.</td><td>Pour point, □ C</td><td>□ (-)40 □ C</td></tr><tr><td>4.</td><td>Appearance</td><td>Clear , free from sediment and suspended matter</td></tr><tr><td>5.</td><td>Density kg/dm³ at 20 □ C</td><td>□ 0.895</td></tr><tr><td>6.</td><td>Interfacial Tension N/m at 25□ C</td><td>□ 0.04</td></tr><tr><td>7.</td><td>Neutralisation value, mgKOH/g</td><td>□ 0.01</td></tr><tr><td>8.</td><td>Corrosive sulphur</td><td>Non Corrosive</td></tr><tr><td>9.</td><td>Water content mg/kg</td><td>□ 30 in bulk supply □ 40 in drum supply</td></tr><tr><td>10.</td><td>Anti-oxidants additives</td><td>Not detectable</td></tr><tr><td>11.</td><td>Oxidation Stability -Neutralization value, mgKOH/g -Sludge, % by mass</td><td>□ 1.2 □ 0.8</td></tr><tr><td>12.</td><td>Breakdown voltage As delivered, kV After treatment, kV</td><td>□ 30 □ 70</td></tr><tr><td>13.</td><td>Dissipation factor, at 90□ C And 40 Hz to 60 Hz</td><td>□ 0.005</td></tr><tr><td>14.</td><td>PCA content</td><td>□ 1%</td></tr><tr><td>15.</td><td>Impulse withstand Level, kVp</td><td>□ 145</td></tr><tr><td>16.</td><td>Gassing tendency at 50 Hz after 120 min, mm³/min</td><td>□ 5</td></tr></table> <p>Subsequently oil samples shall be drawn at:</p> <table><tr><th>Sr. No.</th><th>Parameters</th><th>Before filling in main tank & tested for</th><th>Prior to energization for following properties & acceptance norms:</th><th>Applicability</th></tr><tr><td>i)</td><td>BDV</td><td>60 kV (min)</td><td>60 kV (min)</td><td rowspan="2">Applicable for all Transformers.</td></tr><tr><td>ii)</td><td>Moisture content</td><td>10 ppm (max.)</td><td>10 ppm (max.)</td></tr></table> <p>For ester filled oil, relevant IS/IEC shall be followed for relevant oil parameters for type/routine test.</p>	S.No.	Property	Permissible values	1.	Kinematic Viscosity, mm ² /s	□ 12 at 40 □ C □ 1800.0 at (-)30 □ C	2.	Flash Point, □ C	□ 140□ C	3.	Pour point, □ C	□ (-)40 □ C	4.	Appearance	Clear , free from sediment and suspended matter	5.	Density kg/dm ³ at 20 □ C	□ 0.895	6.	Interfacial Tension N/m at 25□ C	□ 0.04	7.	Neutralisation value, mgKOH/g	□ 0.01	8.	Corrosive sulphur	Non Corrosive	9.	Water content mg/kg	□ 30 in bulk supply □ 40 in drum supply	10.	Anti-oxidants additives	Not detectable	11.	Oxidation Stability -Neutralization value, mgKOH/g -Sludge, % by mass	□ 1.2 □ 0.8	12.	Breakdown voltage As delivered, kV After treatment, kV	□ 30 □ 70	13.	Dissipation factor, at 90□ C And 40 Hz to 60 Hz	□ 0.005	14.	PCA content	□ 1%	15.	Impulse withstand Level, kVp	□ 145	16.	Gassing tendency at 50 Hz after 120 min, mm ³ /min	□ 5	Sr. No.	Parameters	Before filling in main tank & tested for	Prior to energization for following properties & acceptance norms:	Applicability	i)	BDV	60 kV (min)	60 kV (min)	Applicable for all Transformers.	ii)	Moisture content	10 ppm (max.)	10 ppm (max.)
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2.5	Bushings			
	a) Bushing below 52 kV shall be oil communicating type with porcelain insulator. b) No arcing horns to be provided on the bushings.			
2.6	Bushing CTs			
	Shall be of adequate rating for protection as required, WTI (WTI CT applicable for transformer above 50 KVA) etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted. All CT terminals shall be provided as fixed type terminals on the M. Box to avoid any hazard due to loose connection leading to CT opening. In no circumstances Plug In type connectors shall be used for CT.			
2.7	Valves			
	All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies. Sampling & drain valves should have zero leakage rate.			
2.8	Gaskets			
	a) Gasket shall be fitted with weather proof, hot oil resistant, rubberized cork gasket. b) If gasket is compressible, metallic stops shall be provided to prevent over compression. c) The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.			
2.9	PAINTING			
	PARTS NAME	TYPE OF PAINT	NO.OF COATS	TOTAL DFT
	Inside of tank and accessories (except M Box)	Oil & heat resistant fully glossy white	One coat	Atleast 30 micron
	External surface of transformer and accessories	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceous iron oxide) as intermediate paint	One coat each	Atleast 100 micron

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2.10	<table><tr><th>PARTS NAME</th><th>TYPE OF PAINT</th><th>NO.OF COATS</th><th>TOTAL DFT</th></tr><tr><td>including M Box (except radiators)</td><td>followed by polyurethane finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)</td><td></td><td></td></tr><tr><td>External Radiator surface</td><td>Anticorrosive primary paint followed by high quality full glossy outer finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)</td><td>Two coats each</td><td>Atleast 100 micron</td></tr><tr><td>Internal Radiator surface</td><td>Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil</td><td>---</td><td>---</td></tr><tr><td>Internal surface of M Box</td><td>Chemical resistant epoxy zinc phosphate primer followed by chemical and heat resistant epoxy enamel white paint</td><td>Two coats each</td><td>Not less than 100 micron</td></tr></table>				PARTS NAME	TYPE OF PAINT	NO.OF COATS	TOTAL DFT	including M Box (except radiators)	followed by polyurethane finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)			External Radiator surface	Anticorrosive primary paint followed by high quality full glossy outer finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)	Two coats each	Atleast 100 micron	Internal Radiator surface	Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil	---	---	Internal surface of M Box	Chemical resistant epoxy zinc phosphate primer followed by chemical and heat resistant epoxy enamel white paint	Two coats each	Not less than 100 micron
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2.11	Neutral Earthing Arrangement																							
	<p>Neutral earthing shall be done as per system requirement and SLD. In case of solidly earthed neutral of Transformers, it shall be brought through insulated support from tank to the ground level at a convenient point with 2 nos. copper flat, for connection to ground network (as applicable).Neutral of Transformer if not used should be taken out through bushing and covered by insulating cap.</p>																							
	Cable boxes & disconnecting chamber (Disconnecting chamber applicable 3.3 kV and above)																							
	<p>(a) HV Cable boxes shall be of phase segregated air insulated type & shall be of sufficient size to accommodate Employer's cable & termination. Phase segregation shall be achieved by insulating barriers (for 3.3 kV and above side)</p> <p>(b) Cable boxes shall have bus bars / suitable terminal connectors of adequate size & bolt holes to receive cable lugs. The degree of protection of cable boxes shall be IP 55.</p> <p>(c) A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box</p> <p>(d) The support from base for the cable box (for 3.3 kV and above side) shall be of galvanized iron</p> <p>(e) The contractor shall provide earthing terminals on the cable box, to suit Employer's GI flat.</p> <p>(f) The minimum length provided for terminating 33 kV, 11KV & 3.3 KV XLPE cable shall be 1000 mm (for 33 kV) 650 mm (for 3.3 kV and 11 kV) from cable gland plate to the cable lug) for the cable boxes, for 433V side suitable length shall be provided (shall be discussed during detail engineering). The final cable size, number & length of terminating XLPE cable shall be furnished during detailed engineering.</p>																							

CLAUSE NO.	TECHNICAL SPECIFICATIONS																								
2.12	<p>(g) Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).</p> <p>(h) Cable boxes shall have removable top cover (for transformer above 100 KVA) & ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.</p> <p>FITTINGS</p> <p>Following fittings shall be provided with Transformers covered under this sub section.</p> <table border="1"> <tr> <td>a)</td><td>-Conservator for main tank (transformer above 100 KVA shall be provided with MOG with low oil level alarm contact), drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.</td></tr> <tr> <td>b)</td><td>- Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement (Gas collecting arrangement applicable for transformer above 100 KVA).</td></tr> <tr> <td>c)</td><td>- For Auxiliary transformers below 2 MVA, diaphragm type explosion vent shall be provided.</td></tr> <tr> <td>d)</td><td>OTI & WTI shall be 150 mm dial type with alarm (WTI only for transformer above 50 kVA) and trip contacts with max. reading pointer & resetting device (maximum height 1500 mm above ground level).</td></tr> <tr> <td>e)</td><td>For transformer above 100 KVA: Top & bottom filter valves with threaded male adapters, bottom sampling valve, and drain valve/sludge removal valve at the bottom most point of the tank. For Transformer upto 100 KVA: common drain cum sampling cum bottom filter cum sludge removal valve and top filter valve can be provided.</td></tr> <tr> <td>f)</td><td>Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings (as applicable).</td></tr> <tr> <td>g)</td><td>Prismatic/toughened glass oil gauge for transformers.</td></tr> <tr> <td>h)</td><td>Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Cooling equipment.</td></tr> <tr> <td>i)</td><td>Cover lifting eyes, transformer lifting lugs, jacking pads(jacking pad applicable for transformer above 100 KVA), towing holes and core and winding lifting lugs, inspection cover, Bilingual R&D Plate, Terminal marking plates, two nos. earthing terminals etc.</td></tr> <tr> <td>j)</td><td>Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.</td></tr> <tr> <td>k)</td><td>Rain hoods to be provided on Buchholz, MOG & PRD. Entry points of wires shall be suitably sealed.</td></tr> <tr> <td colspan="2">The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformers are deemed to be included.</td></tr> </table>	a)	-Conservator for main tank (transformer above 100 KVA shall be provided with MOG with low oil level alarm contact), drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.	b)	- Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement (Gas collecting arrangement applicable for transformer above 100 KVA).	c)	- For Auxiliary transformers below 2 MVA, diaphragm type explosion vent shall be provided.	d)	OTI & WTI shall be 150 mm dial type with alarm (WTI only for transformer above 50 kVA) and trip contacts with max. reading pointer & resetting device (maximum height 1500 mm above ground level).	e)	For transformer above 100 KVA: Top & bottom filter valves with threaded male adapters, bottom sampling valve, and drain valve/sludge removal valve at the bottom most point of the tank. For Transformer upto 100 KVA: common drain cum sampling cum bottom filter cum sludge removal valve and top filter valve can be provided.	f)	Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings (as applicable).	g)	Prismatic/toughened glass oil gauge for transformers.	h)	Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Cooling equipment.	i)	Cover lifting eyes, transformer lifting lugs, jacking pads(jacking pad applicable for transformer above 100 KVA), towing holes and core and winding lifting lugs, inspection cover, Bilingual R&D Plate, Terminal marking plates, two nos. earthing terminals etc.	j)	Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.	k)	Rain hoods to be provided on Buchholz, MOG & PRD. Entry points of wires shall be suitably sealed.	The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformers are deemed to be included.	
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
2.13	Tests and Inspection			
	S.N.	ROUTINE TESTS		
	1.	All routine test shall be carried out in accordance with IEC 60076.	√	
	2.	Measurement of Voltage Ratio & phase displacement	√	
	3.	Measurement of winding resistance on all the taps (as per IEC 60076-1)	√	
	4.	Vector group and Polarity Check	√	
	5.	Magnetic Balance and Magnetising Current Test	√	
	6.	Measurement of no load current with 415 V, 50 Hz AC supply	√	
	7.	Measurement of no load losses and current at 90%, 100% & 110% of rated voltage	√	
	8.	Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps	√	
	9.	IR measurement (As per IEC 60076-1)	√	
	10.	Separate Source Voltage Withstand Test /Applied voltage test.	√	
	11.	Induced overvoltage test/Induced voltage withstand (IVW) test .	√	
	12.	Repeat no load current/loss & IR after completion of all electrical test	√	
	13.	Oil leakage test on completely assembled transformer along with radiators (as per relevant clause of this sub section)	√	
	14.	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	√	
	15.	IR measurement on wiring of Marshalling Box.	√	
		S.N.	TYPE TESTS#	
	1.	Temperature Rise test at a tap corresponding to maximum losses as per IS 2026.	√	
	2.	Tank Vacuum & Pressure Test (as per CBIP norms)	√	
2.14	Leakage test on assembled Oil filled Transformer (ROUTINE TEST)			
	All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur. Bidder can perform this test at site depending upon urgency subject to END CUSTOMERapproval.			
2.15	Fire Fighting			
	Firewall & soak pit as applicable (as per statutory requirement/TAC/IS 10028 / IS 1646) shall be provided of minimum 230 mm thickness of RCC wall or 355 mm thick fire resisting brick wall subject to END CUSTOMERapproval. However for all outdoor transformer at a distance of 1.0 m (min.) from transformer outer edge. A sump pit shall be provided for each pit. Transformer efficiency shall be as per Central			

CLAUSE NO.	TECHNICAL SPECIFICATIONS
3.0	<p>Electricity Authority (Technical Standards for Construction of Electrical Plants and Electrical Lines) regulation, 2010.</p> <p>DRY TYPE AUXILIARY TRANSFORMERS:</p> <p>Dry Type Transformer shall be constructed in accordance to IS: 2026, IS: 11171 or equivalent to any other international standard, Indian Electricity Act 2003, BEE Guideline & CEA notifications. Transformer rating and all related technical parameters including tap changer (if applicable) shall be as per system requirement/SLD and relevant standards. Transformer shall be suitable for continuous indoor duty application. Transformer shall be complete & functional in all respect. The other important construction particulars shall be as below.</p> <ul style="list-style-type: none"> a) The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23. The enclosure shall be provided with suitable hardware (as required). b) The conductors shall be of electrolytic grade copper free from scales & burrs. c) Dry Type Transformer windings shall be of class F insulation or better. Cooling shall be AN. d) The core shall be constructed from non-ageing, cold rolled, grain oriented silicon steel laminations (M4 or better). <p>The fittings/accessories including protection/monitoring device (temperature scanner) generally required for satisfactory operation of the transformer, are to be provided.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>B-3(C) TIE TRANSFORMER DELETED</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS																														
1.0	<p style="text-align: center;">B-4 AC CABLES</p> <p>All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:</p> <table border="1"> <tr> <td>IS:7098 (Part -I)</td><td>Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.</td></tr> <tr> <td>IS:7098 (Part -II)</td><td>Cross linked polyethylene insulated PVC sheathed cable for (Part -II) working voltage from 3.3 KV upto & including 33 KV</td></tr> <tr> <td>IS :1554 - I</td><td>PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.</td></tr> <tr> <td>IS : 3961</td><td>Recommended current ratings for cables</td></tr> <tr> <td>IS : 3975</td><td>Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.</td></tr> <tr> <td>IS : 5831</td><td>PVC insulation and sheath of electrical cables.</td></tr> <tr> <td>IS : 8130</td><td>Conductors for insulated electrical cables and flexible cords.</td></tr> <tr> <td>IS : 10810</td><td>Methods of tests for cables.</td></tr> <tr> <td>ASTM-D -2843</td><td>Standard test method for density of smoke from the burning or decomposition of plastics.</td></tr> <tr> <td>ASTM-D-2863</td><td>Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.</td></tr> <tr> <td>IEC-754 (Part-I)</td><td>Tests on gases evolved during combustion of electric cables.</td></tr> <tr> <td>IEC-332 Part-3:</td><td>Tests on electric cables under fire conditions. Tests on bunched wires or cables (Category-B).</td></tr> <tr> <td>IEEE-383</td><td>Standard for type test of Class IE Electric Cables</td></tr> <tr> <td>IS : 4905</td><td>Methods for random sampling.</td></tr> <tr> <td>IS : 10418</td><td>Specification for drums for electric cables.</td></tr> </table> <p>General Requirements:</p> <p>The cables shall be suitable for laying on racks, in ducts, trenches, conduits, overground cabling and underground (buried) installation with chances of flooding by water.</p>	IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.	IS:7098 (Part -II)	Cross linked polyethylene insulated PVC sheathed cable for (Part -II) working voltage from 3.3 KV upto & including 33 KV	IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.	IS : 3961	Recommended current ratings for cables	IS : 3975	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.	IS : 5831	PVC insulation and sheath of electrical cables.	IS : 8130	Conductors for insulated electrical cables and flexible cords.	IS : 10810	Methods of tests for cables.	ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.	ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.	IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.	IEC-332 Part-3:	Tests on electric cables under fire conditions. Tests on bunched wires or cables (Category-B).	IEEE-383	Standard for type test of Class IE Electric Cables	IS : 4905	Methods for random sampling.	IS : 10418	Specification for drums for electric cables.
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1.1. 1.2. 1.3. 1.4.	<p>All cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.</p> <p>Cables shall be armored type if laid in switchyard area or directly buried.</p> <p>Cable lengths shall be considered in such ways that straight through cable joints are avoided.</p> <p>If cables are to be laid underground, laying shall be as per latest relevant IS code.</p> <p>If cables are to be laid overground (eg on RCC/concrete pedestals etc), the cables shall be UV-resistant supported by test reports.</p> <p>CONDUCTOR</p> <p>Copper/aluminium conductor used in power cables shall have tensile strength as per relevant standards. Conductors shall be stranded.</p> <p>INSULATION</p> <p>XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.</p> <p>The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.</p> <p>ARMOUR</p> <p>For single core armoured cables, armouring shall be of copper/aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanised steel as follows:</p> <table border="1"> <thead> <tr> <th>Calculated nominal dia.of cable under armour</th><th>Size and Type of armour</th></tr> </thead> <tbody> <tr> <td>Upto 13 mm</td><td>1.4mm dia GS wire</td></tr> <tr> <td>Above 13 & upto 25mm</td><td>0.8 mm thick GS formed wire / 1.6 mm dia GS wire</td></tr> <tr> <td>Above 25 & upto 40 mm</td><td>0.8mm thick GS formed wire / 2.0mm dia GS wire</td></tr> <tr> <td>Above 40 & upto 55mm</td><td>1.4 mm thick GS formed wire /2.5mm dia GS wire</td></tr> <tr> <td>Above 55 & upto 70 mm</td><td>1.4mm thick GS formed wire / 3.15mm dia GS wire</td></tr> <tr> <td>Above 70mm</td><td>1.4mm thick GS formed wire / 4.0 mm dia GS wire</td></tr> </tbody> </table>	Calculated nominal dia.of cable under armour	Size and Type of armour	Upto 13 mm	1.4mm dia GS wire	Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire	Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire	Above 40 & upto 55mm	1.4 mm thick GS formed wire /2.5mm dia GS wire	Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire	Above 70mm	1.4mm thick GS formed wire / 4.0 mm dia GS wire
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2.0	<p>The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel. The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wire / formed wire.</p> <p>OUTERSHEATH</p> <p>Outer sheath shall be of PVC as per IS: 5831 & black in colour for power cables. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.</p> <p>Oxygen index of min. 29 (as per IS 10810 Part-58).</p> <p>Acid gas emission of max. 20% (as per IEC-754-I).</p> <p>Smoke density rating shall not be more than 60 % (as per ASTM-D-2843).</p> <p>In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.</p> <p>Cable size and voltage grade - To be embossed</p> <p>Word 'FRLS' at every 5 metre - To be embossed</p> <p>Screen Fault current __ _KA for __ _ Sec. (Value of current & time shall be indicated) (If applicable)</p> <p>Sequential marking of length of the cable in metres at every one metre -To be embossed / printed</p> <p>The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.</p> <p>All cables shall meet the fire resistance requirement as per IEEE - 383 with cable installations made in accordance with 'Flammability Test' and as per Category-B of IEC 332 Part -3.</p> <p>Allowable tolerances on the overall diameter of the cables shall be +\2 mm maximum, over the declared value in the technical data sheets.</p> <p>Repaired cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.</p> <p>CABLE SELECTION & SIZING</p> <p>Cables shall be sized based on the following considerations:</p> <p>Rated current of the equipment</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>3.0</p> <p>4.0</p>	<p>The Maximum Overall Voltage Drop: As per relevant clause in chapter 2-A,Part-A,Subsection 2. Short circuit withstand capability Fault current- As per system fault current. Time-As per protection time grading requirement subject to the minimum value mentioned at Cl 1.0 (I) Cable sizing criteria of Chapter 2-A.</p> <p>DERATING FACTORS</p> <p>De rating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:</p> <ol style="list-style-type: none"> Variation in ambient temperature for cables laid in air Grouping of cables Variation in ground temperature and soil thermal resistivity for buried cables. <p>HT POWER CABLES</p> <p>For single-core armoured cables, the armouring may constitute the metallic part of insulation screening</p> <p>In case of single core cables where there are both metallic screening and armouring, there shall be extruded inner sheath between them.</p> <p>Distinct extruded PVC inner sheath of black colour as per IS:5831 shall be provided for the cables as follows: a) For all multicore cables. b) For single core armoured cables, where armouring is not being used as metallic screen</p> <p>Cores of the cables of upto 3 cores shall be identified by colouring of insulation or by providing coloured tapes helically over the cores with Red, Yellow & Blue colours.</p> <p>The cross-sectional area of the metallic screen strip/tape shall be considered in design calculations.</p> <p>The eccentricity shall be calculated as</p>

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5.0	<table border="1"> <tr> <td>Eccentricity</td><td>Ovality</td></tr> <tr> <td> $\frac{t_{\max} - t_{\min}}{\max} \times 100$ </td><td> $\frac{d_{\max} - d_{\min}}{d_{\max}} \times 100$ </td></tr> <tr> <td>T</td><td></td></tr> <tr> <td colspan="2">hWhere t-max/t-min is the maximum/minimum thickness of insulation and demax/d-min is the maximum / minimum diameter of the core</td></tr> <tr> <td colspan="2">eccentricity of the core shall not exceed 10% and ovality not to exceed 2%</td></tr> </table> <p>Cables shall conform to IS: 7098 Part - II. These cables shall have mutli-stranded, compacted circular, aluminium conductors, XLPE insulated, metallic screened suitable for carrying the system earth fault current, PVC outer sheathed. The conductor screen and insulation screen shall both be of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for cables shall be “dry curing / gas curing”.</p> <p>The metallic screen of each core shall consist of copper tape with minimum overlap of 20%. However for single core armoured cables, the armouring shall constitute the metallic part of the screening.</p> <p>The standard length for HT power cables shall be 1000 meter for all single core cables and 750 meters for 3 core cables. The length per drum shall be subjected to a maximum tolerance of +/- 5% of the standard drum length. The Employer shall have the option of rejecting cable drum with shorter lengths. One drum length of each cable size can be of non standard length (not less than 250 meter) so as to match the ordered quantity. For each size, the variance of total quantity, adding all the supplied drum lengths, from the ordered quantity, shall not exceed +/-2% and the payment shall be made based on the actual cable length supplied within this limit.</p> <p>LT POWER CABLES</p> <p>LT Power & control cables shall be of minimum 1100 volts grade XLPE /PVC insulated conforming to IS 1554 / IS 7098 (Part-I) for utilization voltages less than equal to 415 V.</p> <p>For cable connecting central inverter and inverter transformer, no. of runs and interconnecting trench, bus bar terminations, lugs shall be provided in such a manner so that no overheating of contacts & terminals encountered. Sufficient space for cabling & termination shall be kept.</p> <p>The sizing of the cable will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.</p>	Eccentricity	Ovality	$\frac{t_{\max} - t_{\min}}{\max} \times 100$	$\frac{d_{\max} - d_{\min}}{d_{\max}} \times 100$	T		hWhere t-max/t-min is the maximum/minimum thickness of insulation and demax/d-min is the maximum / minimum diameter of the core		eccentricity of the core shall not exceed 10% and ovality not to exceed 2%	
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CLAUSE NO.	TECHNICAL SPECIFICATIONS				
6.0	<p>Single core cables shall have no Inner sheath as per IS: 7098 Part-I All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated. 1.1 KV grade XLPE power cables shall have compacted aluminium/ copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), armoured/ unarmoured, PVC outer-sheathed conforming to IS:7098. (Part-I). Cables which are directly buried shall be armoured. 1.1KV grade PVC power cables shall have aluminium/copper conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) armoured/ unarmoured, PVC outer-sheathed conforming to IS:1554 (Part-I).</p> <p>LT CONTROL CABLES</p> <p>Conductor of control cables shall be made of stranded, plain annealed copper. Outer sheath shall be of PVC as per IS: 5831 & grey in colour for control cables. Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:</p> <ul style="list-style-type: none"> 1 core - Red, Black, Yellow or Blue 2 core- Red & Black 3 core-Red, Yellow & Blue 4 core-Red, Yellow, Blue and Black <p>For control cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.</p> <p>CABLE SELECTION & SIZING: Control cables shall be sized based on the following considerations:</p> <ul style="list-style-type: none"> (a) The minimum conductor cross-section shall be 1.5 sq.mm. (b) The minimum number of spare cores in control cables shall be as follows: <table border="1"> <tr> <th>No. of cores in cable</th><th>Min. No. of spare cores</th></tr> <tr> <td>2C, 3C</td><td>NIL</td></tr> </table>	No. of cores in cable	Min. No. of spare cores	2C, 3C	NIL
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2C, 3C	NIL				

CLAUSE NO.	TECHNICAL SPECIFICATIONS											
7.0	<table><tr><td>5C</td><td>1</td></tr><tr><td>7C-12C</td><td>2</td></tr><tr><td>14C & above</td><td>3</td></tr></table>	5C	1	7C-12C	2	14C & above	3					
	5C	1										
	7C-12C	2										
	14C & above	3										
	<p>1.1 KV Grade Control Cables shall have stranded copper conductor and shall be multicore PVC or XLPE insulated, PVC inner sheathed, armoured / unarmoured, FRLS PVC outer sheathed conforming to IS: 1554. (Part-I).</p>											
	<p>TESTS</p>											
	<p>Indicative list of tests/checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of power and control cables enclosed at relevant section.</p>											
	<p>All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price. All cables to be supplied shall be of type tested design.</p>											
	<p>During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p>											
	<p>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.</p>											
<p>The type test reports once approved for any projects shall be treated as reference. For subsequent projects of END CUSTOMER, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.</p>												
<p>The reports for following type tests shall be furnished:</p>												
<table><tr><td>Sl</td><td>Type Test</td><td>Remarks</td></tr><tr><td></td><td>Conductor</td><td></td></tr><tr><td>1.</td><td>Resistance test</td><td></td></tr><tr><td></td><td>For Armour Wires / Formed Wires</td><td></td></tr></table>	Sl	Type Test	Remarks		Conductor		1.	Resistance test			For Armour Wires / Formed Wires	
Sl	Type Test	Remarks										
	Conductor											
1.	Resistance test											
	For Armour Wires / Formed Wires											

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	Sl	Type Test	Remarks
	2.	Measurement of Dimensions	
	3.	Tensile Test	
	4.	Resistance test	
	5.	Wrapping test	
	6.	Torsion test	For GS round wires only
	7.	Elongation test	For GS wire only
	8(a)	Mass& uniformity of Zinc Coating tests	For GS wires/formed wires only.
	8(b)	Adhesion test	For GS wires/formed wires only
		For XLPE insulation & PVC Sheath	
	9.	Test for thickness	
	10.	Tensile strength and elongation test before ageing and after ageing	
	11.	Ageing in air oven	
	12.	Shrinkage test	
	13	Hot set test	For XLPE insulation only
	14	Water absorption test	For XLPE insulation only
	15.	Loss of mass test	For PVC outer sheath only.
	16.	Hot deformation test	For PVC outer sheath only.
	17.	Heat shock test	For PVC outer sheath only
	18.	Thermal stability test	For PVC outer sheath only
	19.	Oxygen index test	For PVC outer sheath only
	20.	Smoke density test	For PVC outer sheath only
	21.	Acid gas generation test	For PVC outer sheath only
	22	Flammability test as per IEC-332 Part-3 (Category -B)	For completed cable only
	23	Insulation resistance test (Volume Resistivity method)	
	24	High voltage test	
	25. *	Partial discharge test	For HT cables only
	26. *	Bending test	
	27. *	Dielectric power factor test	
	a) As a function of voltage		
	b) As a function of temperature		
28. *	Heating cycle test		
29. *	Impulse withstand test		
* Not applicable for 3.3/3.3kV grade cables.			

CLAUSE NO.	TECHNICAL SPECIFICATIONS
8.0	<p>CABLE DRUMS</p> <p>(a) Cables shall be supplied in wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. However, For Single core cables upto 6 Sq. mm size, supplier can do alternative packaging of whole Drum/Spool to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.</p> <p>Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stenciled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
1.0	<p style="text-align: center;">B-5 CABLE INSTALLATION METHODOLOGY</p> <p>CODES AND STANDARDS</p> <p>All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.</p> <p>IS:513 Cold rolled low carbon steel sheets and strips.</p> <p>IS:802 Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.</p> <p>IS:1079 Hot Rolled carbon steel sheet & strips</p> <p>IS:1239 Mild steel tubes, tubulars and other wrought steel fittings</p> <p>IS:1255 Code of practice for installation and maintenance of power cables upto and including 33 KV rating</p> <p>IS:1367 Part-13 Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).</p> <p>IS:2147 Degree of protection provided by enclosures for low voltage switchgear and control gear</p> <p>IS:2309 Code of Practice for the protection of building and allied structures against lightning.</p> <p>IS:2629 Recommended practice for hot dip galvanising of iron & steel</p> <p>IS:2633 Method for testing uniformity of coating on zinc coated articles.</p> <p>IS:3043 Code of practice for Earthing</p> <p>IS:3063 Fasteners single coil rectangular section spring washers.</p> <p>IS:6745 Methods for determination of mass of zinc coating on zinc coated iron & steel articles.</p> <p>IS:8308 Compression type tubular in- line connectors for aluminium conductors of insulated cables</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
2.0	<p>IS:8309 Compression type tubular terminal ends for aluminium conductors of insulated cables.</p> <p>IS:9537 Conduits for electrical installation.</p> <p>IS:9595 Metal - arc welding of carbon and carbon manganese steels - recommendations.</p> <p>IS:13573 Joints and terminations for polymeric cables for working voltages from 6.6kv upto and including 33kv performance requirements and type tests.</p> <p>BS:476 Fire tests on building materials and structures</p> <p>IEEE:80 IEEE guide for safety in AC substation grounding</p> <p>IEEE:142 Grounding of Industrial & commercial power systems</p> <p>DIN 46267 (Part-II) Non tension proof compression joints for Aluminium conductors.</p> <p>DIN 46329 Cable lugs for compression connections, ring type ,for Aluminium conductors</p> <p>VDE 0278 Tests on cable terminations and straight through joints</p> <p>BS:6121 Specification for mechanical Cable glands for elastomers and plastic insulated cables.</p> <p>Indian Electricity Act.</p> <p>Indian Electricity Rules.</p> <p>Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.</p> <p>DESIGN AND CONSTRUCTIONAL FEATURE</p> <p>Inter Plant Cabling</p> <p>Interplant cabling for main routes shall be laid in Cable trenches/cable trays/buried/duct banks. In case of Duct banks, pull-pits shall be filled with sand</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
3.0	<p>and provided with a PCC covering. All buried cables shall be of armoured type. Bidder can propose overground cabling methodology (e.g. on RCC/concrete pedestals etc.). In such cases, the cables shall be UV-resistant supported by test reports.</p> <p>Cable Sizing Conditions All cables shall be suitably derated as per the laying conditions for carrying the required load current and fault current. For derating, the ambient temperature for directly buried cables shall be taken as 40° C and 50° C for cables laid in air. All XLPE cables shall be rated at 90° C conductor temperature for AC Voltage drop calculation and 80° C for DC Voltage calculation. However, for Voltage drop calculation in DC Cable, actual conductor temperature as per loading can be used</p> <p>Trenches PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.</p> <p>General The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.</p> <p>Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.</p> <p>Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:</p> <ul style="list-style-type: none"> • Meet all safety requirements • Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc <p>EQUIPMENT DESCRIPTION</p> <p>Cable trays, Fittings & Accessories Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.</p> <p>Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.</p> <p>Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm</p> <p>Support System for Cable Trays</p> <p>Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".</p> <p>Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:</p> <ol style="list-style-type: none"> a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc. b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fittings and accessories shall be prefabricated factory galvanized. c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
e.	<p>Support system shall be able to withstand</p> <ul style="list-style-type: none"> • weight of the cable trays • weight of the cables (75 Kg/Meter run of each cable tray) • Concentrated load of 75 Kg between every support span. • Factor of safety of minimum 1.5 shall be considered. <p>Pipes, Fittings & Accessories</p> <p>Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria</p> <p>GI Pipes shall be of medium duty as per IS:1239</p> <p>Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.</p> <p>Hume pipes shall be NP3 type as per IS 458</p> <p>Junction Boxes</p> <p>Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanized as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.</p> <p>Terminal blocks shall be 1100V 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 nonferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded copper conductors of size upto 2.5 sq mm each. All internal wiring shall be of minimum 1.5 sq. mm cu. Conductor PVC wire.</p> <p>Terminations & Straight through Joints</p> <p>Termination and jointing kits for 33kV, 11kV, 6.6 kV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be premoulded type, taped type or heat shrinkable type. 33kV, 11kV and 6.6 kV grade joints and terminations shall be type tested as per IS:13573. 3.3kV grade joints</p>

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	<p>and terminations shall be type tested as per VDE0278. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solderless crimping type cable lugs & ferrule as per DIN standard.</p> <p>Straight through joint and termination shall be capable of withstanding the fault level for the system.</p> <p>1.1 KV grade Straight Through Joint shall be of proven design. Cable glands</p> <p>Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS:6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.</p> <p>Cable lugs/ferrules</p> <p>Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipment. Cable lugs and ferrule shall conform to relevant standard</p> <p>Trefoil clamps</p> <p>Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.</p> <p>Cable Clamps & Straps</p> <p>The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment</p>

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4.0	<p>Receptacles</p> <p>Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped galvanized or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break, AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable mA sensitivity.</p> <p>Galvanizing</p> <p>Galvanizing of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots.</p> <p>The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified</p> <p>Welding</p> <p>The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595</p> <p>INSTALLATION</p> <p>Cable tray and Support System Installation</p> <p>Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.</p> <p>Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000</p>

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	<p>mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with relevant standard.</p> <p>The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.</p> <p>The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval.</p> <p>All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.</p> <p>In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.</p> <p>Conduits/Pipes/Ducts Installation</p> <p>The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/ roof/ wall/ cable tunnel/ cable trenches made for conduit installation shall be sealed and made water proof by the Contractor either with any proven fire sealing system rated for one hour or Modular multi-diameter cable sealing system consisting of frames, blocks, Compression wedge and its accessories. The Cable sealing system should have been tested for fire insulation for min. 1 hr as per BS 476 and shall also provide water sealing. System shall be anti- rodent and anti- termite.</p> <p>GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.</p>

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	<p>Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material</p> <p>Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise</p> <table border="0"> <thead> <tr> <th>Conduit /pipe size (dia).</th><th>Spacing</th></tr> </thead> <tbody> <tr> <td>Upto 40 mm</td><td>1 M</td></tr> <tr> <td>50 mm</td><td>2.0 M</td></tr> <tr> <td>65-85 mm</td><td>2.5 M</td></tr> <tr> <td>100 mm and above</td><td>3.0 M</td></tr> </tbody> </table> <p>For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.</p> <p>Junction Boxes Installation</p> <p>Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.</p> <p>Cable Installation</p> <p>Cable installation shall be carried out as per IS:1255 and other applicable standards.</p> <p>For Cable unloading, pulling etc following guidelines shall be followed in general :</p> <ul style="list-style-type: none"> • Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be 	Conduit /pipe size (dia).	Spacing	Upto 40 mm	1 M	50 mm	2.0 M	65-85 mm	2.5 M	100 mm and above	3.0 M
Conduit /pipe size (dia).	Spacing										
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100 mm and above	3.0 M										

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	<p>rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.</p> <ul style="list-style-type: none"> • While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager. <p>Cables shall be laid on cable trays strictly in line with cable schedule</p> <p>Power and control cables shall be laid on separate tiers in line with approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two meter. All multi core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with self-locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multi core power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multi core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.</p> <p>Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.</p> <p>Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.</p> <p>No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.</p> <p>In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have</p>

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★	<p>sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.</p> <p>Wherever few cables are branching out from main trunk route troughs shall be used.</p> <p>Wind loading shall be considered for designing support as well Cable trays wherever required.</p> <p>Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.</p> <p>The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.</p> <p>Separation</p> <p>At least 300mm clearance shall be provided between :</p> <ul style="list-style-type: none"> - HT power & LT power cables, - LT power & LT control/instrumentation cables, <p>Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:</p> <table> <thead> <tr> <th>No. of cores in cable</th><th>No. of spare cores</th></tr> </thead> <tbody> <tr> <td>2C,3C</td><td>NIL</td></tr> <tr> <td>5C</td><td>1</td></tr> <tr> <td>7C-10C</td><td>2</td></tr> <tr> <td>14C and above</td><td>3</td></tr> </tbody> </table> <p>Directly Buried Cables</p> <p>Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255.</p>	No. of cores in cable	No. of spare cores	2C,3C	NIL	5C	1	7C-10C	2	14C and above	3
No. of cores in cable	No. of spare cores										
2C,3C	NIL										
5C	1										
7C-10C	2										
14C and above	3										

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✦	<p>RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.</p> <p>Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags</p> <p>While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.</p> <p>Cable Terminations & Connections</p> <p>The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.</p> <p>Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.</p> <p>The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.</p>

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	<p>Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self-locking type nylon cable ties with de interlocking facility to keep them in position.</p> <p>All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.</p> <p>All cable terminations shall be appropriately tightened to ensure secure and reliable connections</p>

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	<p style="text-align: center;">B-6 SCADA</p> <p>1.0 GENERAL</p> <p>1.1 Contractor shall provide complete SCADA system with all accessories, auxiliaries and associated equipment and cables for the safe, efficient and reliable operation of entire solar plant and its auxiliary systems.</p> <p>1.2 Bidder shall include in his proposal all the Hardware, Software, Panels, Power Supply, HMI, Laser Printer, Gateway, Networking equipment and associated Cable etc. needed for the completeness even if the same are not specifically appearing in this specifications.</p> <p>1.3 SCADA System shall have the provision to perform the following functions:</p> <ul style="list-style-type: none"> i) Remote control of all the HT Breakers either in hard or soft signal. ii) Remote control of Inverter active and reactive power as per requirement mentioned in respective chapter. iii) SCADA shall also be able to acquire, display and store real time data, status and alarm signal from following equipment included but not limited to as required or offered under the scope of this specification: <ul style="list-style-type: none"> a) All the HT Switchgear/RMU equipment b) Incomer and bus coupler breaker of LT Panel. c) Power conditioning unit (PCU) d) UPS and Battery charger as per requirement mentioned in respective chapter e) Weather Monitoring Equipment f) TEM/ABT/MFM meter, numerical relay, fire alarm panel, GPS time synchronization unit and transformer. g) SCADA Hardware, Accessories and Communication link h) Any other equipment required as per specification. iv) Display of status of major equipment in Single Line/Mimic Diagram. Mimic Diagram color shall comply to IS 11954: Guide for color coding of electrical mimic diagrams. v) Display and storage of derived/calculated/integrated values. vi) Generate, store and retrieve user configurable periodic reports. SCADA shall have facility to generate report in MS Excel file type. vii) Remote monitoring of essential parameters of plant on the web using popular web browser without requirement of additional software. Same shall be authorised with user id and password using standard modem. User ID and password for remote view can only be changed by SCADA Administrator. Internet connection for transferring data to web shall be taken by Contractor in the name of END CUSTOMERSite for O & M period.

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	<p>Please refer Chapter-2-A for Nos. of Web Client Licenses for remote monitoring, Nos. of OWS/EWS/Historian with location.</p> <p>viii) Performing self-monitoring and diagnostic functions</p> <p>ix) SCB Monitoring and performance review features through SCADA: To enhance performance tracking and facilitate the identification of String Combiner Boxes (SCBs) with faulty strings, the SCADA system shall incorporate the following monitoring logic:</p> <p>a) The current flowing through each SCB associated with an inverter shall be displayed on the SCADA mimic. The current input for each SCB to be taken from corresponding Inverter.</p> <p>b) In real time, the current flowing through each SCB (say A) shall be compared with the maximum current (say B) among all SCBs connected to the same inverter. If the current A remains below a predefined percentage of B for a continuous, predefined time interval, an alarm along with visual indication shall be generated to indicate the underperforming SCB.</p> <p>c) Since all SCBs connected to an inverter may not have an equal number of strings, normalized current to be compared to avoid false indication.</p> <p>d) By integrating the normalized current value flowing through each SCB, the SCADA mimic should also display Best Performing and 3 worst performing SCB for each inverter for a day.</p> <p>e) The detailed logic and thresholds for this functionality shall be finalized during the detailed engineering stage and shall be witnessed during FAT.</p> <p>1.4 The contractor shall provide at least one GPS clock, which shall be synchronized with the SCADA system. All devices having real-time clock (RTC) with time synchronization facility and are communicating with plant SCADA shall be synchronized with GPS Clock through SCADA or directly with GPS Clock. The technical details of GPS have been specified elsewhere in the specification</p> <p>1.5 Type of signal from equipment (Hard wired or Soft) shall be as per specification of the equipment mentioned in the respective chapter and approved during detail engineering.</p> <p>1.6 SCADA shall provide real time performance monitoring according to IEC 61724 standard. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail.</p> <p>The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is affected. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit. On any of these failures the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalized during detailed engineering. System shall be designed such that there will be no upset when power is restored. This</p>

1.7	<p>operation shall be demonstrated by vendor during Factory Accepted Test (FAT) in the presence of END CUSTOMER Representative.</p> <p>Contractor shall provide a Package/Split AC of suitable capacity decided by load requirement in SCADA Main control/CMCS room. All the power supply module, Ethernet switches and network accessories for non-air-conditioned area shall be suitable for operating in ambient temperature of 55 Deg C minimum.</p> <p>Supply of hot standby redundant PLC/RTU/DCS based power plant controllers (PPC) and associated independent equipment/accessories is in the scope of the Bidder. Power plant controller (PPC) shall be provided with two processors (main processing unit and memories), one for normal operation and one as hot standby.</p>
1.8	<p>In case of failure of working PPC processor, there shall be an appropriate alarm and simultaneously the hot standby PPC processor shall take over the plant control function automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. It shall be possible to keep any of the PPC processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. The solar plant SCADA and PPC networks shall be suitably designed,</p>
1.9	<p>so that PPC shall directly and independently able to control the individual solar inverter. Detailed control logic in the PPC shall be finalized during detailed engineering stage. Detailed control logic and setting of the PPC shall be in line with latest CEA (Technical Standards for Connectivity to</p>

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	<p>Grid) and as per RLDC/SLDC requirement. The solar plant PPC networks shall be suitably designed, so that PPC shall directly and independently be able to control/communicate the individual solar inverter (dual or multi master), WMS (Single master). It shall also be able to communicate two ways with RLDC/SLDC on IEC 104 protocol for its various mode of control. PPC power supply healthiness shall be monitored in SCADA. Bidders to ensure that the offered PPC models is acceptable and proven at RLDC/SLDC end as applicable. The acceptability of the models as per the regulations applicable is mentioned elsewhere in the tender document. Bidder to provide HMI/Display for the PPC with all controls in the control room.</p>
1.10	<p>The SCADA system is designed to conform to industry-standard security practices, including Central Electricity Authority (Technical Standards for Communication System in Power System Operations) Regulations, 2020 and subsequently the CEA (Cyber Security in Power Sector) Guidelines, 2021 and latest amendments/Office memorandum/Office order/guidelines etc. thereof during execution of the SCADA and PPC works for the project.</p>
2.0	<p>SCADA CONTROLLER SYSTEM:</p>
2.1	<p>The SCADA at Main control /CMCS room shall be of PLC/RTU/DCS based as per specification given hereunder. For other locations such as Inverter Room, PLC/ IO modules/RTUs are acceptable.</p> <p>Main control /CMCS room SCADA shall have the following feature:</p> <ul style="list-style-type: none"> i) Facility for implementation of all logic functions for control, protection and annunciation of the equipment and systems. ii) Main control /CMCS room SCADA shall be provided with two processors (main processing unit and memories), one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete plant operation automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. iii) The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future. Programmed operating sequences and criteria shall be stored in non-volatile semiconductor memories like EPROM. All dynamic memories shall be provided with buffer battery backup for at least 360 hours. The batteries shall be lithium or Ni-Cd type. iv) A forcing facility shall be provided for changing the states of inputs and outputs, timers and flags to facilitate fault finding and other testing

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3.0	<p>requirements. It shall be possible to display the signal flow during operation of the program.</p> <p>DATA COMMUNICATION SYSTEM (DCS)</p> <p>The Data Communication System shall include a redundant Main System Bus with hot back-up. Other applicable bus systems like cubicle bus, local bus, I/O bus etc. shall be redundant except for backplane buses which can be non-redundant.</p> <p>The DCS shall have the following minimum features:</p> <ul style="list-style-type: none"> i) Redundant communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) and PLCs and between PLCs and operator workstation. ii) The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module. iii) If the system bus requires a master bus controller philosophy, it shall employ redundant master bus controller with automatic switchover facility iv) Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/logged. v) The design and installation of the system bus shall take care of the environmental conditions as applicable. vi) Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 25% spare capacity shall be available for future expansion. vii) Cat 6 UTP or fibre optic cables shall be employed. viii) The Contractor shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc. ix) Contractor shall setup Gigabit Ethernet based Plant Local Area Network (LAN) to connect to different communication nodes at Inverter /Switchgear location etc. with redundant backbone using ring or better topology. For plant capacity more than 100MW (AC), there shall be more than one ring for each 100MW or part connecting field node (controller/switches) and CMCS SCADA in manner that there are equal nodes in each ring as for as possible. Each Modbus cable shall be provided with Surge protection

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4.0	<p>device at SCADA Panel End. Specification of OFC and Modbus cable has been given elsewhere in this specification.</p> <p>HUMAN MACHINE INTERFACE SYSTEM (HMIS)</p> <ul style="list-style-type: none"> i) HMIS configured around latest state-of-the art servers/Workstations with open architecture supporting OPC /TCP/IP protocols, etc. ii) The SCADA shall be OPC version 2.05a compliant and implement a OPCDA 2.05a server as per the specification of OPC Foundation. All data should be accessible through this OPC server. iii) For communicating the generation data of plant in EMPLOYER, the SCADA system shall be interfaced/ connected with PI server of EMPLOYER on OPC Protocol. The details of EMPLOYER PI server shall be furnished during the detailed engineering. Bidder has to consider necessary Internet connectivity at solar plant end for interfacing the PI data. Updation of data at existing PI server of Owner shall be done by Owner. Any hardware /software required for the above at solar plant end shall be in bidders' scope however updation at Owner's end shall be in the Owners scope. Till the lease line is installed the provision of alternate arrangements like data transfer through FTP shall be in bidders' scope only. iv) Graphical Interface Unit (GIU) / Operator workstation (OWS) shall perform control, monitoring and operation (as applicable) for plant equipment's connected with SCADA system. v) Engineering workstation (EWS) shall work as a programming station both for controller and SCADA. It shall be possible to use same EWS as programming station and the Human Machine Interface System. vi) SCADA System shall also be provided with an OWS. Operator shall be able to access all control/information related data under all operating conditions including a single processor and computer failure/hardware failure at CMCS in the HMIS. vii) In addition to a desktop based EWS, vendor shall also provide dedicated portable (laptop) based EWS. viii) All frequently called important functions including major displays shall be assigned to dedicated function keys on a soft keyboard for the convenience of the operator for quick access to displays & other operator functions. ix) The mimic shall be configured on the HMI, and it shall be possible to control, monitor and operate the plant from the same. x) The SCADA System shall have ability to perform operator functions for each OWS / GIU as a minimum, include Control System operation (A/M

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	<p>selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local-remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.; printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering.</p> <p>xi) The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. There should be no limitation on number of such targets.</p> <p>xii) The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. There should be no limitation on number of such targets.</p> <p>xiii) The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions. Assignment of allowable functions and entry fields shall be on the basis of user profile. The system security shall contain various user levels with specific rights as finalized by the Employer during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).</p> <p>xiv) Wherever Graphical Interface Unit is envisaged, it shall meet the minimum functional requirements of monitoring, operating & controlling the process and displaying information related to process locally. GIU shall be provided with TFT active matrix or LED display and keypad for operation. GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.</p> <p>xv) In addition to GUI Display, one 55 Inch LED display shall be provided at SCADA Room.</p> <p>xvi) Bidder has to provide suitable hardware DMZ network firewall to restrict unauthorized access to HMI/ SCADA system. Details specification of hardware firewall is provided elsewhere in the specification.</p> <p>xvii) SCADA shall have facility to provide real time reporting of alarms and statistical data through SMS and e-mails.</p> <p>xviii) Programming of the PLC Processor/controller as well as programming of HMIS shall be user friendly with graphical user interface and shall not require knowledge of any specialized language.</p>

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<p>5.0</p>	<p>xix) The programming of HMIS (like development and modification of data base, mimics, logs / reports, HSR functionalities etc.) shall also be possible through user-friendly menus etc.</p> <p>xx) All programming functionalities shall be password protected to avoid unauthorized modification.</p> <p>PROGRAMMING FUNCTIONALITIES</p> <p>Programming of the PLC Processor/controller as well as programming of HMIS shall be user friendly with graphical user interface and shall not require knowledge of any specialized language. For example, the programming of PLC shall use either of the following:</p> <ul style="list-style-type: none"> - Flow-chart or block logic representing the instructions graphically - Ladder diagrams <p>The programming of HMIS (like development and modification of data base, mimics, logs / reports, HSR functionalities etc.) shall also be possible through user-friendly menus etc.</p> <p>All programming functionalities shall be password protected to avoid unauthorized modification.</p> <p>6.0</p> <p>SOFTWARE REQUIREMENT</p> <ul style="list-style-type: none"> i) All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The contractor shall provide sufficient documentation and program listing so that it is possible for the Employer to carry out modification at a later date. ii) The Contractor shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification. iii) Industry standard operating system like WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry. iv) SCADA system shall include the following standard protocols as a minimum: <ul style="list-style-type: none"> a) Modbus (TCP/IP, RTU, ASCII). b) Sub Station Protocol (IEC-61850 and IEC 60870 -5-101/104). Any other protocol on which the offered equipment (by Contractor) will communicate with SCADA. v) The system shall have user friendly programming language & graphic user interface.

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	<p>vi) All system related software including Real Time Operating System, File management software, screen editor, database management software, Online diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software, Antivirus software and latest WINDOWS based packages (MS Word, Excel and PowerPoint) etc. and any other standard language offered shall be furnished as a minimum. vii) All application software for SCADA system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.</p> <p>viii) The Contractor shall provide software locks and passwords to Employer's engineers at site for all operating & application software so that Employer's engineers can take backup of these software and are able to do modifications at site.</p> <p>ix) The Contractor shall provide software license for all software being used in Contractor's System. The software licenses shall be provided for the project (e.g., organization or site license) and shall not be hardware/machine specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good, and it shall not be necessary for Employer to seek a new license/renew license due to up gradation/change of hardware/machine in Contractor's System at site. All licenses shall be valid for the continuous service life of the plant.</p> <p>x) All the SCADA Software with license Key shall be handed over to END CUSTOMER on the DVD/CD media. All the hardware and software shall be licensed to END CUSTOMER.</p> <p>PARAMETRIC REQUIREMENTS</p> <p>7.0 The control system shall be designed such that under worst case loading conditions the response time shall not be worse than the following:-</p> <p>i) On/Off Command:- The response time for screen update after the execution of the control command from the time the command is issued shall be one second (excluding the drive actuation time).</p> <p>ii) Adjustment Command:- 0.5 to 1 second. iii) On screen Updating and All Control related displays:- 1 second.</p> <p>iv) Bar Chart displays, Plant Mimic displays, Group review displays, X-T Plot Displays and Plant Summary Displays :- 1 to 2 seconds.</p> <p>v) All the Analog data shall be scanned at the resolution of 1(one) second and refreshed on screen however, recording of data shall be as finalized during detail engineering.</p>

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8.0	<p>INPUT/OUTPUT MODULES</p> <ul style="list-style-type: none"> i) The SCADA system should be designed according to the location of the input/output cabinets as specified. ii) Input Output modules, as required in the Control System for all type of field input signals (4-20 mA, non-changeover/change over type of contact inputs etc.) and outputs from the control system (non-changeover/change over type of contact, output signals for energizing interface relays at suitable DC voltage as decided during detail engineering, 4-20 mA output etc.) are to be provided by the Contractor. iii) Electrical isolation of 1.5kV with optical couplers between the plant input/output and controller shall be provided on the I/O cards. The isolation shall ensure that any inadvertent voltage or voltage spikes (as may be encountered in a plant of this nature) shall not damage or maloperate the internal processing equipment. iv) The Input/output system shall facilitate modular expansion in fixed stages. The individual input/output cards shall incorporate indications on the module front panels for displaying individual signal status. v) Individually fused output circuits with the blower fuse indicator shall be provided. All input/output points shall be provided with status indicator. vi) The I/O Module shall have the following features: <ul style="list-style-type: none"> a) Power supply monitoring. b) Contact bounce filtering. c) Optical isolation between input and output signals with the internal circuits d) In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be finalized during detailed engineering. vii) Binary Output modules shall be rated to switch ON/OFF coupling relays of approx. 3 VA. Analog output modules shall be able to drive a load impedance of 500 Ohms minimum. viii) In case of loss of I/O communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be finalized during detailed engineering) with proper annunciation. ix) Requirement of Nos. of channel in each type of Module (Analog Input, Analog Output, Binary Input, Binary Output, RTD) and Modbus link at Inverter and main control room shall be calculated based on the Input/output signal list to be submitted by the contractor for approval during detail engineering.

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<p>9.0</p>	<p>SYSTEM SPARE CAPACITY</p> <p>Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, Control System shall have spare capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site:</p> <ul style="list-style-type: none"> i) 10 % spare channels in input/output modules fully wired up to cabinets TB. ii) Wired-in "usable" space for 10% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in system cabinets. iii) Empty slots between individual modules/group of modules, kept for ease in maintenance or for heat dissipation requirement as per standard practice of Contractor shall not be considered as wired-in "usable" space for I/O modules. iv) Terminal assemblies (if any in the offered system), corresponding to the I/O modules shall be provided for above mentioned 10 % blank space. v) Each processor / controller shall have 20% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops. Further, each processor / controller shall have spare capacity to handle minimum 20% additional inputs/ outputs of each type including above specified spare requirements, over and above implemented capacity. Each of the corresponding communication controllers shall also have same spare capacity as that of processor/controller. vi) The Data communication system shall have the capacity to handle the additions mentioned above. vii) Ten (10) percent spare relays of each type and rating mounted and wired in cabinets TB. All contacts of relays shall be terminated in terminal blocks of cabinets. viii) The spare capacity as specified above shall be uniformly distributed throughout all cubicles. The system design shall ensure that above mentioned additions shall not require any additional controller/processor/ peripheral drivers in the system delivered at site. Further, these additions shall not deteriorate the system response time / duty cycle, etc. from those stipulated under this specification.
<p>10.0</p>	<p>OPERATOR INTERFACE DISPLAYS/LOGS/REPORTS</p> <ul style="list-style-type: none"> i) Suitable Operator Interface Displays/Logs/Reports for control operation & monitoring shall be provided. The details shall be finalized during detailed Engineering stage. ii) Minimum quantities shall be as follows:-

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11.0	<p>Various displays on the OWS shall as a minimum include P&ID displays or mimic, bar chart displays, X-Y & X-T plot (trend) displays, operator guidance message displays, group displays, plant start-up/shutdown message displays, system status displays etc. Number of displays and the exact functionality shall be on as required basis and as finalized during detailed engineering subject to the minimum quantities as given in subsequent clauses. For X-T & X-Y plots, the facility of providing a background grid on operator request shall be variable with adequate no. of divisions in both co-ordinates.</p> <p>The minimum quantity of major types of displays per unit shall be as follows:</p>																												
	<table><tr><th>SI</th><th>Display</th><th>Minimum Qty for Plant capacity of 50 MW or Less</th><th>Additional Qty for each 10 MW or part above 50 MW</th></tr><tr><td>a)</td><td>Control displays (group/subgroup/sequence/loop)</td><td>(On as reqd. basis subject to 100 minimum)</td><td>(On as reqd. basis subject to 100 minimum)</td></tr><tr><td>b)</td><td>P&ID/ mimic display</td><td>25</td><td>5</td></tr><tr><td>c)</td><td>X-Y Plot (with superimposed operating curves + using user selectable stored data)</td><td>25+25</td><td>5+5</td></tr><tr><td>d)</td><td>Group displays</td><td>30</td><td>5</td></tr><tr><td>e)</td><td>Operator guidance message</td><td>20</td><td>NIL</td></tr><tr><td>f)</td><td>System status & other diagnostic display</td><td>on as required basis</td><td>on as required basis</td></tr></table>	SI	Display	Minimum Qty for Plant capacity of 50 MW or Less	Additional Qty for each 10 MW or part above 50 MW	a)	Control displays (group/subgroup/sequence/loop)	(On as reqd. basis subject to 100 minimum)	(On as reqd. basis subject to 100 minimum)	b)	P&ID/ mimic display	25	5	c)	X-Y Plot (with superimposed operating curves + using user selectable stored data)	25+25	5+5	d)	Group displays	30	5	e)	Operator guidance message	20	NIL	f)	System status & other diagnostic display	on as required basis	on as required basis
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	<p>The assignment for the above will be done by the contractor as per the requirement of operation of contractor's system as well as for maintenance. The balance displays shall be left as spare for future modification/addition.</p>																												
<p>HISTORICAL STORAGE AND RETRIEVAL SYSTEM (HSRS)</p>																													
<p>i) The HSRS shall collect, store and process system data from MMIPIS data base. The data shall be saved online on hard disk and automatically transferred to non-erasable long term storage media once in every 30 Days periodically for long term storage. Provision shall be made to notify the operator when hard disk is certain percentage full.</p>																													
<p>ii) The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs/reports.</p>																													

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12.0	<p>iii) The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same.</p> <p>iv) In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration on portable external long term storage media. Bidder shall provide two numbers of portable external hard drive of 2TB each.</p> <p>v) For long term plant performance analysis, the following plant data as a minimum with time stamping and interval as indicated in below table but not limited to shall be stored daily on historian.</p> <p><u>Important plant data for a very long duration (plant life) Storage on Historian</u></p> <table><tr><th>Sl.</th><th>Parameter</th><th>Time Interval</th></tr><tr><td>1</td><td>Weather Monitoring Stations data: Global Horizontal Irradiance, Global Inclined Irradiance and Diffuse Horizontal Irradiance, Ambient Temp, Wind Speed, Wind Direction, Rain Fall and Relative Humidity.</td><td>1 (One) Minute</td></tr><tr><td>2</td><td>Calculated Daily Global Horizontal Insolation, Global Inclined Insolation and Diffuse Horizontal Insolation.</td><td>24 (Twenty Four) Hours</td></tr><tr><td>3</td><td>Power Conditioning Unit (PCUs):- DC Voltage, DC Power, DC Current, SMB/SMU Current (PCU end), AC Active & Reactive Power, Power factor, AC Current & Voltage, Energy, Inverter room temp, Inverter Cabinet temp and Modules Temp</td><td>1 (One) Minute</td></tr><tr><td>6</td><td>MFM, Energy meter and Numerical Relay data:- Active & Reactive Power, Energy (day), Current and Voltage</td><td>1 (One) Minute</td></tr><tr><td>7</td><td>Export feeder/s Energy Meter Data:- Active & Reactive Power, Energy import and export, Current and Voltage and Grid Frequency.</td><td>1 (One) Minute</td></tr><tr><td>8</td><td>Daily energy export from each Inverter</td><td>24 (Twenty-Four) Hours</td></tr><tr><td>9</td><td>Total sum of daily energy export from all Inverter</td><td>24 (Twenty-Four) Hours</td></tr></table>	Sl.	Parameter	Time Interval	1	Weather Monitoring Stations data: Global Horizontal Irradiance, Global Inclined Irradiance and Diffuse Horizontal Irradiance, Ambient Temp, Wind Speed, Wind Direction, Rain Fall and Relative Humidity.	1 (One) Minute	2	Calculated Daily Global Horizontal Insolation, Global Inclined Insolation and Diffuse Horizontal Insolation.	24 (Twenty Four) Hours	3	Power Conditioning Unit (PCUs):- DC Voltage, DC Power, DC Current, SMB/SMU Current (PCU end), AC Active & Reactive Power, Power factor, AC Current & Voltage, Energy, Inverter room temp, Inverter Cabinet temp and Modules Temp	1 (One) Minute	6	MFM, Energy meter and Numerical Relay data:- Active & Reactive Power, Energy (day), Current and Voltage	1 (One) Minute	7	Export feeder/s Energy Meter Data:- Active & Reactive Power, Energy import and export, Current and Voltage and Grid Frequency.	1 (One) Minute	8	Daily energy export from each Inverter	24 (Twenty-Four) Hours	9	Total sum of daily energy export from all Inverter	24 (Twenty-Four) Hours
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		<p>SCADA PANEL/CABINET/CONTROL DESK/FURNITURE</p> <p>i) The SCADA cabinets shall be minimum IP-42 protection class for indoor and incase outdoor Panel is offered for Inverter control rooms only the bidder has to provide minimum Ip-55 protection class.</p> <p>ii) The Contractor shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design. The Contractor shall ensure that the</p>																							

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition and specification requirements for remote I/O cabinets. Ventilation blowers shall be furnished as required by the equipment design and shall be soundproof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper. Suitable louvers with wire mesh shall be provided on the cabinet.</p> <p>iii) The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables for Main control room.</p> <p>iv) The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the cabinet shall not higher than 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Employer and shall be furnished by the Contractor during detailed engineering. Wall mounted cabinet is acceptable for Inverter room/subpooling switchgear.</p> <p>v) Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided. vi) Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish color shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. The Preferable finish colors for exterior and interior surfaces shall conform to following shades:</p> <p style="padding-left: 40px;">a) Exterior:- As per RAL 9002 (End panel sides RAL 5012),</p> <p style="padding-left: 40px;">b) Interior:- Same as above</p> <p style="padding-left: 40px;">Paint films which show sags, checks or other imperfections shall not be acceptable.</p> <p style="padding-left: 40px;">As an alternative, single coat of anodic dipcoat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable.</p> <p>vii) Control desk shall be free standing tabletop type with doors at the back and shall be constructed of 2 mm thick CRCA steel plates. A 19 mm thick wooden top shall be provided on the desk to keep the monitors at top and computers inside. Control desk shall consist of vertical, horizontal and</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
13.0	<p>base supports with their coverings for work surface, keyboard trays, mouse pads, monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal and vertical directions. ASCII Keyboard shall be capable of being pulled out through a tray.</p> <ul style="list-style-type: none"> viii) Contractor shall provide the two power supply feeders (DC supply or UPS AC) and one raw supply feeder of suitable rating to cater all the load requirements of SCADA panel/cabinet/control desk. System remains in service in case of single power supply failure/power supply module failure. Suitable alarm shall be generated in case of any power supply failure. ix) The cabling / wiring between OWS & CPU'S, power supply cables etc. shall be aesthetically routed and concealed from view. x) Chairs – Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators and other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back. Arm-rests in one piece shall be of polyurethane and twin wheel castor of glass filled nylon. xi) One Printer Table made of Laminated Wood or Heavy Duty MDF shall be provided for printer. xii) All the furniture shall be of reputed make (Godrej or Equivalent). <p>HMIPIIS HARDWARE</p> <ul style="list-style-type: none"> i) The HMIPIIS as specified shall be based on latest state of the art Workstations and Servers and technology suitable for industrial application & power plant environment. ii) The Workstation/Servers employed for HMIPIIS implementation shall be redundant based on industry standard hardware and software which will ensure easy connectivity with other systems and portability of Employer developed and third-party software. iii) Redundant sets of communication controllers shall be provided to handle all the communication between the HMIPIIS and redundant system bus and to ensure specified system response time and parametric requirements. Each communication controller shall have message checking facility. Power Fail Auto Restart (PFAR) facility with automatic time update shall be provided. iv) All the peripherals shall conform to the following minimum requirement, but the exact make & model shall be as approved by Employer during detailed engineering. The LAN to be provided under HMIPIIS shall support TCP/IP protocol (Ethernet connectivity) with OPC RDI for interface with PLCs/other systems and shall have data communication speed of min. 100 MBPS. All network components of LAN and Workstations shall be compatible to the LAN, without degrading its performance.

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	Engineering Workstations/ Operator Workstations/ Historian/ Portable EWS		
	SI No.	Features	Industrial Grade Engineering Cum Operator Workstations/ Operator workstations/ Other workstations/ Documentation station (in case not part of prog. Stn.)
	1.	Processor	Engineering Cum Operator Workstations: 64-bit Server Grade (Xeon or Equivalent or Better), Octacore minimum For other Workstation: 64 bits. (i7 or Better)
	2.	Memory	Engineering Cum Operator Workstations: 16 GB RAM upgradable to 24 GB minimum For other Workstation: 8 GB RAM upgradable to 16 GB
	3.	Hard Disk	Engineering Cum Operator Workstations: 1 TB RAID1. For Historian: 5 TB ultra-wide RAID1. For other Workstation: 500 GB ultra-wide RAID1 for OWS/ 500 GB for Portable EWS.
		Communication port	Engineering Cum Operator Workstations: 2 Serial bus. Expansion slot=2 For other Workstation: 4 Serial bus, Expansion slot=2 Portable EWS: 2 Serial bus.
	4.	Monitor (color)	Min 80 cm display size, LED-backlit technology. IPS panel, Graphic Memory = 16 MB. Display to have sufficient number of input ports as required which includes HDMI, USB, Display port, LAN (RJ-45) etc as required.
	5.	Removable bulk storage drive	2 TB (minimum)

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	6	Network Connectivity	Engineering Cum Operator Workstations: 4 Nos. Built-in Ethernet Network Port For other Workstation: 2 Nos. Built-in Ethernet Network Port Portable EWS: 1 No. Built-in Ethernet Network Port and 1 No. Wi-Fi.
	7.	DVD R/W	16x or higher for EWS and OWS
	8.	Keyboard	ASCII
	9.	Pointing Device	Mouse
	10.	Additional general-purpose software (for using over network by servers/workstations/PCs)	Comprehensive disk maintenance utility for disk clean sweep/ crash guard/antivirus, etc.
	11.	Software	MS. Windows latest, MS Office Editor (EXCEL, WORD, POWER POINT), Adobe Acrobat, Anti-Virus, Network Security, etc.
	LED Display		
	1	LED Display	55 Inch LED Display, Display Resolution: 1920 x 1080, Wall Mounted, Reputed make (Samsung/Sony/LG or Equivalent)
	Printer		
	Sr	Features	Networked Color Laser Printer
	1	Paper Size	A3
	2	Printing Speed (min.)- in normal mode for A4 size paper	6 ppm (Color)
			24 ppm (B&W)

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
14.0	3	Type	Heavy duty, at least 50000 pages/month
	4	Resolution (black) (min.)	600 dpi
	5	First page out time (with full graphic display)	=<1 min for color,
			<45 sec for BW
	6	Paper input capacity (min.)	500 sheets
	7	Additional features	Automatic Duplex Printing
	8	Paper sheets (1 ream = 500 sheets) with printer (To be supplied with printer)	10 reams (A3)
			20 reams (A4)
15.0	ADDITIONAL CLAUSE		
Please refer to the Chapter 2-A, Part-A for additional clause, if any related to this section of specification.			
FACTORY ACCEPTANCE TEST (FAT)			
16.0	FAT procedure shall be submitted by bidder for END CUSTOMER approval and after approval of FAT procedure, FAT will be witnessed by END CUSTOMER Engineering or authorized representative of END CUSTOMER. SCADA shall communicate with all thirdparty devices which are part of Solar Plant and the same shall be demonstrated during the FAT. The FAT shall also be witnessed for PPC in similar fashion as for SCADA.		
TIME SYNCHRONISATION EQUIPMENT			
16.1	Time Synchronization equipment shall be provided and shall be located in the control Room. It shall receive Coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite (GPS) for time synchronization of all components of the SCADA.		
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CLAUSE NO.	TECHNICAL SPECIFICATIONS									
16.4	It shall be immune to hostile electrical environment. Suitable protections are to be provided against lightning surges and over-voltages in power supply systems and antenna feeders.									
16.5	The system shall be fully tested to the relevant international standards such as IEC: 801 and IEC: 255.									
16.6	All components of the SWYD SAS, including Substation Controllers, Workstations, Bay Control Units (BCU) and Bay Protection units (BPU) and all numeric protection relays as per requirement under this scope of technical specification or offered by bidder shall be synchronized with an accuracy of 1ms.									
16.7	The GPS shall be synchronized with the SCADA system to be supplied under this contract. Necessary software and Hardware (including laying of communication cable) required for time synchronization with SCADA and all other devises shall be in scope of contractor.									
16.8	The system should be able to track more than 1 satellite at a time to ensure no interruptions of synchronization signals.									
16.9	<p>The system shall have provisions for combination of any of the following output signals:</p> <ul style="list-style-type: none">• NTP (network time protocol) 100Mbits Ethernet port• IRIG-B00x (TTL, pulse width modulated signal)• 2 x Pulse per half-hour/ Pulse per minute/ Pulse per second outputs via potential free contacts• Any other output port as may be required for the offered system.• Alarm status contact indicating healthy status of system.									
16.10	<p>These output ports shall be compatible with the requirement of the equipment to be synchronized i.e., BCUs/ BPU's/Numerical Relays/IEDs etc as per scope of the specification. The master clock in control room shall also be synchronized with the time synchronization system. The actual port requirements (no./type) in line with the system offered shall be finalized during detailed engineering.</p>									
16.11	<p>The equipment should have a periodic time correction facility of one-sec. periodicity. The equipment shall also have real time display in hour, minute, second (24-hour mode) and have a separate time display, having display size of approx. 144mm height.</p>									
17.0	<p>TECHNICAL SPECIFICATION FOR NETWORK FIREWALL</p> <p>Offered firewall shall include but not limited to the following features-</p> <table><tr><th colspan="3">Technical Requirements for Network Firewall</th></tr><tr><th>S No</th><th>Feature</th><th>Required parameter</th></tr><tr><td>A</td><td colspan="2">General</td></tr></table>	Technical Requirements for Network Firewall			S No	Feature	Required parameter	A	General	
Technical Requirements for Network Firewall										
S No	Feature	Required parameter								
A	General									

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	A1	Common Criteria Certification.	The offered product series or its operating system series must have achieved EAL (Evaluation Assurance Level) Certification of EAL4 or higher in the Common Criteria for Information Technology Security Evaluation (ISO/IEC 15408) for computer security certification.
	A2	Architecture	The firewall should be a purpose-built hardware appliance based next generation firewall (NGFW) solution having application awareness & Intrusion prevention function.
	A3	End of sale	OEM End-of-sale declaration shall not have been released for the offered model at the time of the bid submission.
	B.	Hardware Specifications & Performance Parameters	
	B1	Firewall Interfaces	Minimum Four or AS REQUIRED Nos of gigabit 10/100 base T Ethernet ports to be provided.
			Provision of addition of at least Two Nos of gigabit Fiber SFP ports shall be available.
			Each Port must be configurable flexibly in any security zone as per the requirement without any fixed zone assignments.
			All the above specified interfaces shall be firewall interfaces. Internal Switch interfaces shall not be considered.
			The Firewall shall NOT have any wireless interfaces.
	B2	Security Zones	At least four Security zones must be supported.
	C	Firewall Inspection	
	C1	Application Support for Inspection	Should support standard protocols
			Internet based applications like Telnet, FTP, SMTP, http, DNS, ICMP etc. should be supported for filtering
			Internet web 2.0 applications & widgets.
	C2	NAT & PAT	Dynamic NAT as well as one-to-one NAT
			Port / IP Address Forwarding
			PAT
	C3	Resistance to Evasion	The firewall shall be able to detect and block evasion techniques including SYN flood, Address spoofing and TCP split handshake etc.
	D	Application awareness	

CLAUSE NO.	TECHNICAL SPECIFICATIONS		

CLAUSE NO.	TECHNICAL SPECIFICATIONS

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>1.0</p> <p>1.1</p> <p>2.0</p>	<p style="text-align: center;">B-7 INSTRUMENTATION AND COMMUNICATION CABLE</p> <p>COMMUNICATION CABLE (Optic Fibre Cable)</p> <p>Optic Fiber cable shall be 8/12 core, galvanized corrugated steel taped armored, fully water blocked with dielectric central member for outdoor /indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multimode fibers on as required basis so as to avoid the usage of any repeaters. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturing, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.</p> <p>The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central number, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum & crush resistance 4000 N minimum. The operating temperature shall be -20 deg. C to 70 deg. C.</p> <p>All testing of the optic fiber cable being supplied shall be as per the relevant IEC, EIA and other international standards.</p> <p>Bidder to ensure that minimum 50% (but not less 4) cores are kept as spare in all types of optical fiber cables</p> <p>Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground buried installation.</p> <p>Spliced/ Repaired cables are not acceptable.</p> <p>Penetration of water resistance and impact resistance shall be as per IEC standard.</p> <p>Communication Cable (Modbus)</p> <p>Data (Modbus) Cable to be used shall be shielded type with stranded copper conductor based on VDE 0881 . Cable shall have minimum 2 pair each with conductor size of 0.5 SQMM and core identification shall comply with DIN 47100. Cable shall be flame retardant according to IEC 60332-1-2. or equivalent Standard Surge protection device to be provided shall be approved from UL/CSA or any national/international approved lab.</p> <p>INSTRUMENTATION CABLES</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
2.1	Common Requirement		
	S No.	Property	Requirement
	1.	Voltage grade	225 V (peak value)
	2.	Codes and standard	All instrumentation cables shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS10810 (latest editions) and their amendments read along with this specification.
	3.	Continuous operation suitability	At 70 deg. C for all types of cables
	4.	Progressive automatic on-line sequential marking of length in meters	To be provided at every one meter on outer sheath.
	5.	Marking to read 'FRLS	To be provided at every 5 meters on outer sheath
	6.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
	7.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
	8.	Ovality at any cross-section	Not more than 1.0 mm
	9.	Others	a) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided. b) Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground-buried installation c) Repaired cables shall not be acceptable.
10.	Color	The outer sheath shall be of blue Blue	
2.2	Specific Requirement		
	S No.	Property	Requirement
		Type of Cable	F and G Type cables
	A. Conductors		
	1.	Cross section area	0.5 sq. mm
	2.	Conductormaterial	HighconductivityAnnealed bare copper
	3.	Colour code	As per VDE-815

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	4.	Conductor Grade	Electrolytic
	5.	No & dia of strands	7x0.3 mm (nom)
	6.	No. of Pairs	4,8,12,16,24,48
	7.	Max. conductor resistance per Km (in ohm) at 20 deg. C	73.4 (loop)
	8.	Reference Standard	VDE 0815
	B. Insulation		
	1.	Material	Extruded PVC type YI 3
	2.	Thickness in mm (Min/Nom/Max)	0.25/0.3/0.35
	3.	Volume Resistivity (Min) in ohm-cm	1 x 10 ¹⁴ at 20 deg. C & 1x10 ¹¹ at 70 deg. C.
	4.	Reference	VDE 0207 Part 4
	5.	Core diameter above insulation	Suitable for cage clamp connector
	C. Pairing & Twisting		
	1.	Single layer of binder tape on each pair provided	Yes
	2.	Bunch(Unit formation) for more than 4P	To be provided
	3.	Conductor /pair as per identification VDE081	To be provided
	D. Shielding		
	1.	Type of shielding	Al-Mylar tape
	2.	Individual pair shielding	To be provided for F-type cabl
	3.	Minimum thickness of Individual pair shielding	28 micron
	4.	Overall cable assembly shielding	To be provided
	5.	Minimum thickness of Overall cable assembly shielding	55 micron
	6.	Coverage Overlapping	100% coverage with 20% overlapping
	7.	Drain wire provided for individual shield	Yes (for F-type) Size=0.5 mm ² , No.of strands=7, Dia of strands =0.3 mm ,Annealed Tin coated copper
	8.	Drain wire provided for overall shield	Yes. Size=0.5 mm ² , No.of strands=7, Dia of strands=0.3mm Annealed Tin coated copper
	E. FILLERS		
	1.	Non-hygrosopic, flame retardant	To be provided
	F. Outer Sheath		
	1.	Material	Extruded PVC compound

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
				YM1 with FRLS properties
	2.		Minimum Thickness at any point	1.8 mm
	3.		Nominal Thick-ness at any point	>1.8 mm
	4.		Resistant to water, fungus, termite & rodent attack	Required
	5.		Minimum Oxygen index as per ASTMD-2863	29%
	6.		Minimum Temperature index as per ASTMD2863	250 deg.C
	7.		Maximum acid gas generation by weight as per IEC-60754-1	20%
	8.		Maximum Smoke Density Rating as per ASTMD2843	Maximum 60% To be provided (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843)
	9.		Reference standard	VDE207 Part 5,VDE-0816
	G. Electrical Parameters			
	1.		Mutual Capacitance Between Conductors At 0.8 Khz (Max.)	120 nF/km for F type 100 nF/km for G-type
	2.		Insulation Resistance(Min.)	100 M Ohm/Km
	3.		Cross Talk Figure (Min.) At 0.8 Khz	60 dB
	4.		Characteristic Impedance (Max) At 1 Khz	320 OHM FOR F-TYPE 340 OHM FOR G-TYPE
	5.		Attenuation Figure At 1 Khz (Max)	1.2 db/km
	H. Complete Cable			
	1.		Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.
	2.		Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	I. Tests			
	1.		Routine & Acceptance tests	Refer Type Test requirement of Specification for C & I System
	2.		Type tests	
	J Cable Drum			
	1.		Type	Wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum.
	2.		Outermost layer covered with waterproof paper	Yes
	3.		Painting	Entire surface to be painted
	4.		Length	1000 m + 5% for up to & including 12 pairs 500 m + 5% for above 12 pairs

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">B-8 EARTHING SYSTEM</p> <p>GENERAL REQUIRMENTS</p> <p>1.0</p> <p>This specification is intended to outline the requirement of earthing (grounding) for Solar array (DC) side and AC Power block side of Solar PV Project. It is not the intent of the specification to specify all details of design and construction since the bidder has full responsibility for engineering and implementation of earthing system meeting the intent of the specification and functional requirement. Any additional equipment, material, services which are not specifically mentioned herein but are required for successful installation, testing and commissioning of earthing system for safe and satisfactory operation of the plant shall be included under scope of the bidder.</p> <p>Earthing requirement for outdoor metering yard/Switchyard has been mentioned elsewhere in the specification and hence shall be excluded from scope of this chapter unless earthing requirement of metering yard/Switchyard is specifically mentioned in this chapter.</p> <p>Electrical Resistivity Test (ERT) of the soil is included in the scope of bidder.</p> <p>EARTHING DESIGN REQUIRMENT</p> <p>1.1</p> <p>The object of protective earthing system is to provide as nearly as possible a surface under and around a station which shall be at a uniform potential and as nearly zero or absolute earth potential as possible. The purpose of this is to ensure that, in general, all parts of apparatus other than live parts, shall be at earth potential, as well as to ensure that operators and attendants shall be at earth potential at all times. Also by providing such an earth surface of uniform potential under and surrounding the station, there can exist no difference of potential in a short distance big enough to shock or injure an attendant when short-circuits or other abnormal occurrences take place.</p> <p>Care must be taken for equipment with functional earthing that its service is not disrupted due to undesired disturbances in protective earthing system.</p> <p>CODES AND STANDARD</p> <p>1.2</p> <p>The equipment/product furnished for earthing system shall meet the requirements of all the applicable relevant National/International codes and standards or their latest amendment Codes and Standards. Product certification has to be CE/UL/BIS/TUV or equivalent. The relevant codes and standard for earthing system are tabulated below.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																						
2.0	<table border="1"> <tr><td>IS: 3043</td><td>Code of practice for Earthing.</td></tr> <tr><td>IEEE: 80</td><td>IEEE guide for safety in AC substation grounding</td></tr> <tr><td>IEEE: 837</td><td>Standard for qualifying permanent connections used in substation grounding</td></tr> <tr><td>IS: 2309</td><td>Code of Practice for the protection of building and allied structures against lightning.</td></tr> <tr><td>IS: 802</td><td>Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.</td></tr> <tr><td>IS: 2629</td><td>Recommended practice for hot dip galvanizing of iron & steel</td></tr> <tr><td>IS: 2633</td><td>Method for testing uniformity of coating on zinc coated articles</td></tr> <tr><td>IS: 513</td><td>Cold rolled low carbon steel sheets and strips</td></tr> <tr><td>IS: 6745</td><td>Methods for determination of mass of zinc coating on zinc coated iron & steel articles.</td></tr> <tr><td></td><td></td></tr> <tr><td>IS 2062</td><td>HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL — SPECIFICATION</td></tr> <tr><td></td><td></td></tr> <tr><td>IS: 4736</td><td>Hot-dip Zinc coating for MS Tubes.</td></tr> <tr><td></td><td></td></tr> <tr><td>IS: 458</td><td>Precast Concrete Pipes (With and Without Reinforcement)</td></tr> <tr><td>UL-467</td><td>Grounding and Bonding Equipment</td></tr> <tr><td>IEC 62561-7</td><td>Requirements for earthing enhancing compounds</td></tr> <tr><td></td><td>CEA regulations for electrical safety-2010</td></tr> <tr><td></td><td>Indian Electricity Rules/ Indian Electricity Act.</td></tr> </table> <p>All</p> <p>standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (codes and standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the above standards/ codes as applicable.</p> <p>The earthing system includes earth electrode, installation of earth electrode in suitable pit size, construction of earth pit with cover for the installation, connection of earth electrode with equipotential earth bus and connection of equipment to equipotential earth bus.</p> <p>Earth Electrode</p> <p>The earth electrode is in direct contact with the ground provides means for conducting earth current with ground. Earth Electrode material should have good electrical conductivity and mechanical strength and should not corrode in wide variety of soil conditions. For an effective earthing system, following type of vertical earth electrodes can be used.</p> <p>I. MS Rods Hot rolled, Medium or High Tensile Steel Rod as per IS 2062 of length not less than 3000 mm.</p>	IS: 3043	Code of practice for Earthing.	IEEE: 80	IEEE guide for safety in AC substation grounding	IEEE: 837	Standard for qualifying permanent connections used in substation grounding	IS: 2309	Code of Practice for the protection of building and allied structures against lightning.	IS: 802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.	IS: 2629	Recommended practice for hot dip galvanizing of iron & steel	IS: 2633	Method for testing uniformity of coating on zinc coated articles	IS: 513	Cold rolled low carbon steel sheets and strips	IS: 6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.			IS 2062	HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL — SPECIFICATION			IS: 4736	Hot-dip Zinc coating for MS Tubes.			IS: 458	Precast Concrete Pipes (With and Without Reinforcement)	UL-467	Grounding and Bonding Equipment	IEC 62561-7	Requirements for earthing enhancing compounds		CEA regulations for electrical safety-2010		Indian Electricity Rules/ Indian Electricity Act.
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
2.1	<p>II. Copper Bonded Rods</p> <p>High tensile-low carbon steel rod having diameter not less than 14/17 mm of Length 3000 mm to be selected based on earth fault current. The Rod shall comply with requirements of BS 4360 Grade 43A or EN10025:2-004 S275JR, molecularly bonded by 99.99% pure high conductivity copper on outer surface with copper coating thickness 250 micron or more in conformity to UL-467. Its surface shall be clean, free from mechanical defect and any visible oxide layer or foreign material.</p> <p>Earthing Enhancement Compound</p> <p>A low resistance earth electrode system is important to provide a low impedance path for the better dissipation of lightning/fault currents, and to protect personnel and equipment by minimizing and equalizing voltage potential differences. Earthing (ground) enhancement materials shall be used to improve the ground electrode resistance. Earth enhancement material shall be a superior conductive material which improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.). It shall be tested and should conform to the requirements of IEC 62561-7. It shall have the following characteristics:-</p> <ul style="list-style-type: none"> a) High conductivity, improves earth's absorbing power and humidity retention capability, non-corrosive in nature having low water solubility but highly hygroscopic. b) Carbon based with min 95% of fixed carbon content premixed with corrosion resistant cement to have set properties. Cement shall not mix separately & shall not have Bentonite. c) Resistivity of less than 0.2 ohms -meter. d) It shall not depend on the continuous presence of water to maintain its conductivity and shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time. e) It shall not dissolve, decompose or leach out with time and shall be environmental friendly, suitable for soils of different resistivity and any kind of earth electrode. <p>The Earth enhancement material shall be supplied in sealed, moisture proof bags, marked with Manufacturer's name or trade name, quantity etc. The minimum quantity of earth enhancement compound to be used with each earthen pit shall be 25 Kg.</p>
2.2	<p>Earthing conductor</p> <p>Earthing conductor is the conductor for buried below the ground at the depth of 600 mm connecting earth pits to make interconnection of earth pit. To interconnect earth pits, following type of conductor can be used. Application of specific conductor and its size has been mentioned in relevant clause:</p> <p>I. Galvanised Steel Flat (GS) Flat</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
2.3	<p>GS/GI Flat (Strip) conductor shall comply to IS 2026 with Galvanization of 85 Micron as per IS. Material shall be clean and free from mechanical defects.</p> <p>II. Copper Clad Steel (CCS) Earthing Conductor The Copper Bonded Steel Grounding Conductor shall be made of steel with the coating of 99.99% pure copper complying to ASTM B 869-96 and ASTM B 452-93 standards. Each strand of CCS shall have continuous, uniform coating and the conductor surface shall be smooth and free from mechanical defects.</p> <p>III. MS Rod Hot rolled, Medium or High Tensile Steel Rod as per IS 2062 of length not less than 3000 mm and diameter of 40 mm.</p> <p>Earthing Technical and Installation Requirement</p> <p>Careful consideration should be given to installing an earthing system that meet or exceed statutory requirements. Contractor shall select certified product and ensure good workmanship for installation for satisfactory performance to fulfill the designed parameters all the times. Following care shall be taken while installation of earthing.</p> <p>I. Metallic frame/ structure of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed as per requirement mentioned elsewhere in the specification. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable. Metallic column for Inverter/Switchgear shelter/E-house shall be earthed with two distinct connections at minimum two column. All the wall cladding section shall be earthed at minimum two location with flexible copper cable of not less than 50 sq. mm.</p> <p>II. Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>III. Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.</p> <p>IV. The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.</p> <p>V. Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti-corrosive paint/compound.</p> <p>VI. Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.</p> <p>VII. Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding. Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.</p> <p>VIII. Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.</p> <p>IX. Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.</p> <p>X. A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same. Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.</p> <p>XI. Earth pit shall be constructed as per IS:3043. Electrodes shall be embedded preferably below permanent moisture level. Minimum spacing between electrodes shall be 600mm.</p> <p>XII. Earth pits shall be treated with earth enhancement compound if resistivity is more than 20 ohm meter.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS																
3.0	XIII. On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.																
	XIV. Contractor shall obtain all necessary statutory approvals for the earthing system before charging of the plant and electrical equipment.																
	TECHNICAL DETAILS FOR AC EARTHING SYSTEM																
	This section outlines the requirements of protective and functional earthing system to discharge AC fault current to earth and provide equipotential bonding for Transformer, HT and LT Switchgear Panel and other similar electrical equipment, Transformer neutral and shield.																
	The Contractor shall furnish the detailed design and calculations as per IEEE 80/IS 3043 for Employer's approval for equipment earthing.																
	1. Conductors above ground level and in built up trenches -Galvanized steel																
	2. Conductors buried in earth -Mild steel rod of 40 mm dia (Any alternate proposal by bidder shall be reviewed and decided during detailed engineering based on requirement)																
	3. Earth electrodes - Mild steel rod of diameter 40mm or Copper bonded steel rod of dia not less than 17 mm																
	4. Life Expectancy - 25 years																
	5. Fault Level - Mentioned Elsewhere																
6. Min. Steel corrosion - As per IS 3043																	
7. Soil Restivity -Actual as per site condition																	
The sizes of earthing conductors for various electrical equipment shall be as below:																	
<table><tr><th>S No.</th><th>Equipment</th><th>Earth Conductor buried in Earth</th><th>Earth conductor above ground level and in built up in trenches</th></tr><tr><td>1</td><td>33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear</td><td>--</td><td>65 x 8mm GS flat</td></tr><tr><td>2</td><td>415 V MCC/ Distribution boards / Transformers</td><td>--</td><td>50 x 6mm GS flat</td></tr><tr><td>3</td><td>LT Motors above 125 KW</td><td>--</td><td>50 x 6mm GS flat</td></tr></table>		S No.	Equipment	Earth Conductor buried in Earth	Earth conductor above ground level and in built up in trenches	1	33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	--	65 x 8mm GS flat	2	415 V MCC/ Distribution boards / Transformers	--	50 x 6mm GS flat	3	LT Motors above 125 KW	--	50 x 6mm GS flat
S No.	Equipment	Earth Conductor buried in Earth	Earth conductor above ground level and in built up in trenches														
1	33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	--	65 x 8mm GS flat														
2	415 V MCC/ Distribution boards / Transformers	--	50 x 6mm GS flat														
3	LT Motors above 125 KW	--	50 x 6mm GS flat														

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
3.1	4	LT Motors 25 KW to 125 KW	--	25 x 6mm GS flat
	5	LT Motors 1 KW to 25 KW	--	25 x 3mm GS flat
	6	Fractional House power motor	--	8 SWG GS wire
	7	Control panel & control desk	--	25 x 3 mm GS flat/25 sq mm Cu cable
	8	Push button station/Junction Box	--	8 SWG GI wire
	9	Columns, structures, cable trays and bus ducts enclosures	--	50 x 6mm GS flat
	10	Crane, rails, rail tracks & Other non-current carrying metal parts	--	25 x 6mm GS flat
	Contractor shall ensure there at least two earth pits each dedicated for earthing of each Transformer, HT/LT Switchgear panel, transformer neutral, Battery Charger/UPS/Control Panel etc. shall be provided. Earth electrode shall be located near to the equipment and all earth electrodes shall be interconnected with parallel conductor buried in earth surrounding the equipment.			
	Earthing system of different locations such as Inverter room/Pooling Switchgear/Sub pooling switchgear/Inverter shelter etc. shall be interconnected in single network of earthing with buried conductor of the size 65X8 MS Flat laid at 600 mm depth (if specifically required to achieve the earth resistance value within the acceptable limit based on the soil property of site). Contractor shall submit the calculation based on the system of earth conductor and electrode connected in single network. Location and manner of interconnection shall be approved during detail engineering.			
	Bidder shall also interconnect the earthing system of Solar PV plant with Owner's existing earthing system wherever available (applicable for Solar Projects being setup inside existing Owner's Projects).			
3.4	For functional earthing of electronic component such as SCADA, contractor shall provide 1 no. (Min) isolated earth electrode near to the equipment connected with 2 run of copper cable of size not less than 25 sqmm. Contractor shall comply to the recommendation of OEM (Original Equipment Manufacturer) for electronic earthing and electrode can be connected with other earth electrode as per recommendation of OEM.			
	Each inverter duty transformer having shield between HV and LV winding shall be provided with 2 nos. Isolated earth electrode connected with each other for functional earthing of transformer shield. Each electrode shall be connected with transformer shield with separate 25X6 Cu flat.			

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<p>4.0</p>	<p>TECHNICAL DETAIL SOLAR ARRAY (DC) EARTHING</p> <p>This section outlines the earthing requirement for discharging DC fault current to earth of Solar PV plant and provide equipotential bonding for Module Mounting Structure (MMS), SMB Mounting structure, Module Frames etc.</p> <p>System Requirement for the solar array DC earthing:</p> <p>Conductors buried in earth -GS Flat or CCS</p> <p>Conductors above ground level -GS Flat or CCS</p> <p>Earth Electrode -32 mm or higher dia MS Rod or Copper bonded Steel rod of dia. not less than 14 mm</p> <p>Life Expectancy -25 Years</p> <p>System fault level -5 KA for 1 Sec.</p> <p>Soil resistivity -Actual as per site conditions Min.</p> <p>4.1 Steel corrosion -As per IS 3043</p> <p>Each Module mounting structure (MMS), SPV Module frames, mounting arrangement for String Monitoring Boxes, Metallic Junction Boxes, Metal frames/Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system for solar array shall consist interconnected earth pits electrodes connected by 25X6 GS flat (Min.) or Copper Clad Steel (CCS) earthing Conductor of size not less than 120 SQMM laid at the depth of 600 MM below the ground. Minimum size of riser conductor to connect the structures to buried earthing conductor and structure to structure in the solar farm shall be 25X3 GS Flat or CCS of Min. 70 SQ MM size.</p> <p>4.2 Periphery fencing wherever provided shall be earthed at every 100 meter interval with 25X3 GS flat connected with DC or AC side nearest buried earthing conductor.</p> <p>4.3 Earthing conductor for connection to structure and equipment may be kept on the ground below MMS. However, these conductor shall be laid 300 mm below the ground along the pathway and/or crossing the pathway.</p> <p>4.4 Equipment and structure in the solar farm shall be earthed in compliance to the IS: 3043 (Code of Practice for Earthing) and Indian Electricity Rules/Acts.</p> <p>4.5 The Contractor shall furnish the detailed design and calculations for Owner's approval as per IS 3043 to determine the number of earth pit and size of earth conductor. However the no. of earth pit electrodes for the DC earthing shall be as per Clause. 2.0 of Chapter A-2</p> <p>4.6 Buried earth conductor shall be laid all around periphery of solar array farm. GS flat above the ground for structure earthing shall be connected to the nearest buried conductor or electrode. All the earth electrodes shall be interconnected in single network/mesh and no electrode or group of electrodes shall be</p>

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	<p>isolated/islanded. These electrodes shall be uniformly distributed in the solar farm at maximum practical extent and location of earth electrode shall be approved during detail engineering. A continuous earth path is to be maintained throughout the PV array.</p> <p>4.7 Connection of DC earthing system and AC earthing system with location and manner of connection shall be approved during detail engineering. Contractor shall submit the design calculation of earthing system of AC and DC side as standalone (no interconnection) system.</p> <p>4.8 Connection of riser to the structures shall be bolted or welded type. Portion of galvanized structure which undergoes welding at site shall be coated with two coats of cold galvanizing and anti-corrosion paint afterwards.</p> <p>4.9 Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection, welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.</p> <p>4.10 Each PV Module frame shall be earthed in accordance with module manufacturer guidelines. In case module frame earthing is to be separately provided, it shall be earthed with minimum 2.5 SQMM flexible copper cables with lug at suitable location of module frame. Nos. of PV modules in single loop of earthing connection to module frame shall be as per Module manufacturer recommendation. Both ends of the loop of copper cable for earthing shall be connected with nearest earthed structure or earth conductor.</p> <p>4.11 Contractor shall seek owner's approval for connecting solar array earth mesh with any other earth mat/earth grid of the solar PV plant.</p> <p>4.12 Size of earth conductor, nos. of earth pits given in this clause is applicable for solar array earthing only. Relevant method and practice of laying of earthing conductor, earth pits and riser not mentioned herewith but given elsewhere in this specification is applicable to solar array earthing also.</p> <p>4.13 Inverter functional earthing (Negative earthing, Anti PID Earthing) shall be carried out as per guideline of OEM. Contractor shall submit complete detail of such earthing from OEM and implement the earthing accordingly</p>

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	<p style="text-align: center;">B-9 PLANT ILLUMINATION SYSTEM</p> <p>This chapter covers supply and installation of suitable illumination system along the approach roads to inverter room and inverter room(s), transformer yard and other facilities inside the plant.</p> <p>1.0</p> <p>DESIGN PHILOSOPHY</p> <p>A comprehensive illumination system shall be provided in the entire project. Each building shall be provided with adequate light fittings, 6A/16A socket, fans, etc. Exhaust fans shall also be provided in toilets, battery room, etc</p> <p>All outdoor lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.</p> <p>2.0</p> <p>LIGHTING SYSTEM DESCRIPTION for CMCS and inverter room</p> <p>Normal AC Lighting System: AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels Control Board (LPs) which in turn will be fed from the lighting distribution boards (LDBs) of AC Switch board MCC.</p> <p>Emergency AC Lightning System: The emergency lighting system consisting of 20% of the lights shall be fed from UPS DB or DCDB as per scheme adopted by the EPC bidder. Load of the same has to be considered for UPS/ Battery and charger sizing. Bidder shall provide indoor and outdoor emergency lighting at each inverter room, CMCS, security room and main gate.</p> <p>3.0</p> <p>Lighting Fixture, Lamps & Accessories</p> <ol style="list-style-type: none"> All lighting fixtures and accessories shall be designed for continuous operation for its life under atmospheric conditions existing at site. AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of +/-10%, frequency variation of +/- 5% and combined voltage and frequency variation (absolute sum) of 10% DC lighting fixtures and accessories shall be suitable for operation on 220 V, with variation between 190 V & 240 V. All lighting fixtures shall be complete with lamp(s), lamp holder(s), LED chip assembly, terminal blocks, clamps, locking arrangements, fixing brackets etc. Driver circuit/Control gears shall be provided as applicable / specified. The fixtures shall be fully wired upto terminal block. The internal wiring of the fixtures shall be done with suitable low smoke halogen free thermo-plastic or silicon rubber insulated or fire retardant PTFE copper conductor wires of suitable size and type. Further fuse protection of suitable rating in input side shall also be provided specifically for LED luminaires. However, the normal cross section of conductor shall be not less than 0.5 Sq. mm and minimum thickness of insulation shall be 0.6 mm. The wiring shall be capable of withstanding the maximum temperature to which it will be subjected under

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<p>4.0</p> <p>4.1</p>	<p>specified service conditions without deterioration and affecting the safety of the luminaire when installed and connected to the supply. All fixing /locking screws, washers, nuts, brackets, studs etc, shall be zinc plated and passivated.</p> <p>d. All lighting fixtures shall be provided with an external, brass/GI earthing terminal suitable for connecting 14 SWG, GI earthing wire. All metal or metal enclosed parts of the housing and accessories shall be bonded and connected to the earthing terminal as so to ensure satisfactory earthing continuity through out the fixture</p> <p>e. The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection</p> <p>f. The reflectors shall be manufactured from CRCA sheet steel or Aluminium as specified. The aluminium reflectors shall be made of high purity aluminium sheet, polished electrochemically brightened and anodized or proven alternate arrangement of anodizing</p> <p>g. Starters shall have bi-metal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without use of any tool. Starter shall have brass contacts and radio interference suppressing capacitor.</p> <p>h. LED luminaires body shall such designed that heat sink/heat dissipating housing shall be mounted outside the overall luminaires fixture housing, and shall be suitably clearing the driver circuit. Further for outdoor type LED luminaires, the exposed heat sink shall be suitably designed to avoid dust/foreign particles accumulation on the same.</p> <p>i. LED luminaires housing/body shall be pressure die cast aluminium or extruded Aluminium or CRCA as specified alongwith finished powder coating. Care shall be taken in the design that there is no water stagnation anywhere.</p> <p>LED Luminaires:</p> <p>CODES AND STANDARDS</p> <p>All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of technocommercial bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.</p> <table border="0"> <tr> <td>16101:2012</td><td>General Lighting. LEDs and LED modules Terms and definitions</td></tr> <tr> <td>16102(Part 1):2012</td><td>Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.</td></tr> <tr> <td>16102(Part 2):2012</td><td>Self Ballasted LED Lamps for General lighting Services.</td></tr> </table>	16101:2012	General Lighting. LEDs and LED modules Terms and definitions	16102(Part 1):2012	Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.	16102(Part 2):2012	Self Ballasted LED Lamps for General lighting Services.
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Part-2 Performance Requirements.</p> <p>16103(Part I):2012 LED modules for General lighting Safety Requirements.</p> <p>15885(Part 2/Sec. 13) :2012Lamp control gear Part 2 particular Requirements Section 13 d.c. or a.c. Supplied Electronic control gear for LED modules</p> <p>16104:2012 d.c. or a.c. Supplied Electronic control gear for LED modules - Performance Requirements.</p> <p>16105:2012 Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources.</p> <p>16106:2012 Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products</p> <p>16107:2012 Luminarie Performance</p> <p>16108:2012 Photobiological safety of Lamps and Lamp Systems</p> <p>IS 513 Cold rolled low carbon steel sheets and strips</p> <p>IS 12063 Classification of degree of protection provided by enclosures.</p> <p>IS 14700 Electro magnetic compatibility (EMC) – Limits (Part 3/Sec. 2) for Harmonic emission – THD < 15% (equipment, input current < 16 Amps. per phase.</p> <p>IS 9000 (Part 6) Environment testing: Test Z – AD: composite temperature/humidity cyclic test.</p> <p>IS 15885 Lamp control gear: particular requirements for (Part 2/Sec. 13) DC or AC supplied electronic control gear IS 16004 – 1 and 2) for LED modules.</p> <p>IS 4905 Method for random sampling IEC 60598 Ingress protection, luminaire performance and safety</p> <p>IEC 61000-3-2 Total Harmonic Distortion EC 61000-4-5 Surge Protection</p>

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4.2	<p>IES-LM 80 along with Lumen Depreciation and Rated life of LED chip TM 21/ IS 16105</p> <p>IES-LM 79 / IS 16106 Luminaire optics and color parameter and electrical parameter</p> <p>LED LIGHTING SYSTEM</p> <p>LED Luminaires shall be used for the lighting of all the indoor & outdoor areas. However for DC lighting & hazardous areas conventional type luminaires shall be used. In false ceiling area LED luminaires shall be recessed mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type.</p> <p>The individual lamp wattage for LED shall be upto 3 watt for outdoor type luminaires. However for indoor type luminaires fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall not be less than 80 Lm/W. Heat sink/heat dissipation arrangement shall be provided in the luminaires. The LED used in the luminaires shall have colour rendering index (CRI) of Min 70 and 80 for outdoor and indoor luminaires respectively.</p> <p>Colour designation of LED shall be “cool day light” (min 5700K) type for indoor type LED luminaires. Further for outdoor type luminaires, the colour designation shall be 5000K, except for well glass type LED luminaires, where the colour designation shall be 4000K. The LED luminaires shall have minimum life of 25,000 burning hours with 80% of lumen maintenance at the end of the life.</p> <p>The beam angle for LED chip for indoor type luminaires shall be 120 degrees. However for highbay & flood light type outdoor luminaires the LED chip with suitable beam angle shall be used to deliver better lumen-output. The maximum junction temperature of bare LED without heat sink shall be limited to 85 deg C, further the lumen maintenance at this temperature shall be min 90%. The THD of tube light based LED Luminaires shall be less than 20%. For other type of luminaries, it shall be minimum 10%.</p> <p>Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink/ heat dissipation arrangement, with proper thermal management shall be designed for the luminaires.</p> <p>Driver Circuit: LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED manufacturer.</p> <p>LED Drivers may have following control & protections:- • Suitable precision current control of LED.</p> <ul style="list-style-type: none"> • Open Circuit Protection • Short Circuit Protection • Over Temperature Protection • Overload Protection • Surge Protection

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5.0	<p>Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have IP55 degree of protection (for outdoor panels) and IP-4X for indoor panels (inside buildings).</p> <p>Wires of different phase shall normally run in separate conduit.</p> <p>Power supply shall be fed from 415 / 240 V normal AC supply through suitable number of conveniently located lighting distribution boards (LDB) and at least one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc.</p> <p>Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for welding purposes at one location.</p> <p>Incandescent lamps may be used only with DC Lighting.</p> <p>Electrification of all building shall be carried out as per IS 732-1989, IS 4648-1968 and other relevant standards.</p> <p>Indoor Lighting fixtures shall generally be controlled from switch boxes of each area not directly from lighting panel. Each switch shall control a maximum of three fixtures.</p> <p>All luminaires and their accessories and components shall be of type readily replaceable by available Indian makes.</p> <p>Following test reports to be submitted for LED chip/LED luminaires:</p> <p>a) LED parameters like Lumen per watt, CRI, Beam angle from manufacturer. b) LM 80/IS: 16105 report.</p> <p>c) LM 79/IS: 16106 report</p> <p>JUNCTION BOXES, CONDUITS, FITTING & ACCESSORIES</p> <p>Junction box for indoor lighting shall be made of fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type.</p> <p>Junction boxes for street lighting poles and lighting mast if applicable , shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55.</p> <p>All switches and receptacles upto 16A shall be modular type. These shall be provided with pre-galvanized/galvanized modular switchbox & plate.</p> <p>Conduits, Pipes and Accessories:</p> <p>Heavy duty PVC conduits conforming to IS: 9537 Part-III along with various accessories shall be used for indoor wiring in the buildings. These conduits shall be concealed in the wall/floor/roof. However, in PEB's, conduits can be fixed on surface.</p> <p>Pull out boxes shall be provided at suitable interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, etc. Pull-out boxes shall have cover with screw. Pull out boxes used outdoor shall be weather proof type suitable for IP: 55 degree of protection and those used indoor shall be suitable for IP: 4X degree of protection.</p>

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6.0	LIGHTING WIRES Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R,Y,B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper		
7.0	LIGHTING POLES The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. Height of the poles should be chosen so as not to affect working of Solar panels. The poles shall be hot-dip galvanized as per relevant IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole. The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB. Lighting shall be provided along boundary/periphery and at roads connecting Boundary Gate to strategic locations like CMCS/Switchyard (Avg 10 Lux). Hot dipped Galvanized hexagonal/Octagonal lighting pole with inbuilt JB shall also be acceptable		
8.0	EARTHING Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the ends.		
9.0	AVERAGE ILLUMINATION LEVEL		
	Location	Average Illumination Level (Lux)	Type of Fixture
	Control Room	per technically superior and p approval of 300	LED Luminaries
	Store Room	200	LED Luminaries
	Switchgear Room	150	LED Luminaries
	Inverter Room	150	LED Luminaries
	Street lighting-Roads Cl 7.0 above	10	LED Luminaries
	Yard/ Substation/MCS etc	20(general) 50(on strategic equipment)	LED Luminaries

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CLAUSE NO.	TECHNICAL SPECIFICATIONS																																																																																															
	<div><div>B-10 AUXILIARY POWER SUPPLY SYSTEM</div><div>GENERAL</div><div>1.00</div><div>1.01</div><div>1.02</div></div> <div><p>Auxiliary power supply arrangement shall be in line with tender SLD. Each Inverter Room/local pooling/sub-pooling/CMCS room shall have its own auxiliary power supply system comprising of AC distribution board (ACDB) which shall be fed from LV side of Inverter transformer through suitably rated auxiliary transformers. ACDB in CMCS room shall have two incomer (100% rated) fed from two different sources. At CMCS, auxiliary transformer directly feed from 33kV switchgear are also acceptable. Following consideration shall be taken while arriving kVA capacity of auxiliary transformer,</p><div><div>1. 20 % future load margin.</div><div>2. The minimum kVA capacity of auxiliary transformer for CMCS requirement shall be 50kVA.</div></div><p>All non-critical auxiliary loads shall be fed directly from ACDB. However, emergency, and important load shall be fed from suitable sized Uninterrupted Power Supply (UPS) or Battery system. Input AC supply for Uninterrupted Power Supply (UPS) and Battery Charger shall be fed from ACDB. Bidder shall consider the following one of the supply options for feeding different equipment loads:</p><table><tr><th>Sl No</th><th>Equipment Name</th><th>Option-1 ACDB</th><th>Option-2 UPS AC</th><th>Option-3 Battery DC supply</th></tr><tr><td>1.</td><td>SCADA including remote RTU/IO panel</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>2.</td><td>SCADA HMI</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>3.</td><td>Data logger</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>4.</td><td>Fire Detection /Alarm Panel</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>5.</td><td>Emergency Lighting</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>6.</td><td>CCTV (if applicable)</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>7.</td><td>HMI of SCADA</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>8.</td><td>Inverter's Auxiliary supply (if applicable)</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>9.</td><td>Energy Meter/MFM</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>10.</td><td>Sub and Local Pooling Switchgear control & protection</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>11.</td><td>Main Pooling Switchgear (CMCS) control & protection</td><td></td><td></td><td><input type="checkbox"/></td></tr><tr><td>12.</td><td>Switchgear spring charging motor</td><td></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>13.</td><td>switchgear space heater</td><td><input type="checkbox"/></td><td></td><td></td></tr><tr><td>14.</td><td>Illumination, Fan supply etc</td><td><input type="checkbox"/></td><td></td><td></td></tr><tr><td>15.</td><td>Module washing system</td><td><input type="checkbox"/></td><td></td><td></td></tr><tr><td>16.</td><td>Other non-critical auxiliary loads</td><td><input type="checkbox"/></td><td></td><td></td></tr><tr><td>17.</td><td>Switchyard control and protection</td><td></td><td></td><td><input type="checkbox"/></td></tr><tr><td>18.</td><td>Switchyard PLCC</td><td></td><td></td><td><input type="checkbox"/></td></tr></table></div>	Sl No	Equipment Name	Option-1 ACDB	Option-2 UPS AC	Option-3 Battery DC supply	1.	SCADA including remote RTU/IO panel		<input type="checkbox"/>	<input type="checkbox"/>	2.	SCADA HMI		<input type="checkbox"/>	<input type="checkbox"/>	3.	Data logger		<input type="checkbox"/>	<input type="checkbox"/>	4.	Fire Detection /Alarm Panel		<input type="checkbox"/>	<input type="checkbox"/>	5.	Emergency Lighting		<input type="checkbox"/>	<input type="checkbox"/>	6.	CCTV (if applicable)		<input type="checkbox"/>	<input type="checkbox"/>	7.	HMI of SCADA		<input type="checkbox"/>	<input type="checkbox"/>	8.	Inverter's Auxiliary supply (if applicable)		<input type="checkbox"/>	<input type="checkbox"/>	9.	Energy Meter/MFM		<input type="checkbox"/>	<input type="checkbox"/>	10.	Sub and Local Pooling Switchgear control & protection		<input type="checkbox"/>	<input type="checkbox"/>	11.	Main Pooling Switchgear (CMCS) control & protection			<input type="checkbox"/>	12.	Switchgear spring charging motor		<input type="checkbox"/>	<input type="checkbox"/>	13.	switchgear space heater	<input type="checkbox"/>			14.	Illumination, Fan supply etc	<input type="checkbox"/>			15.	Module washing system	<input type="checkbox"/>			16.	Other non-critical auxiliary loads	<input type="checkbox"/>			17.	Switchyard control and protection			<input type="checkbox"/>	18.	Switchyard PLCC			<input type="checkbox"/>
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
1.03	
1.04	<p>For inverter stations and sub-pooling systems, UPS system shall comprise of 1 x 100% UPS with 30 minutes backup. For CMCS, UPS system shall comprise of 2 x 100% UPS with 30 minutes backup for each. Each UPS shall consist of 1x100% charger and inverter, 1 x 100% Battery bank for providing required backup as above. Bypass Line static switch, manual bypass switch, 1 x 100% UPSDB, and other necessary Protective devices and accessories. In place of UPS, bidder can provide DC supply system (1 x 100% Battery with Charger system for inverter stations/sub-pooling systems and 2x 100% system for CMCS) with backup as indicated as above, if the auxiliary power supply requirement of the loads is in DC.</p>
1.05	<p>Each Battery with charger system shall consist of 1 x 100% charger and 1 x 100% Battery bank for required back up and 1 x 100% DCDB, and other necessary protective devices and accessories. DC supply system voltage shall be 12V or above upto 220V DC.</p>
1.06	<p>The rated AC output capacity shall be taken for UPS battery size calculation. However, the minimum UPS rating shall be 2KVA and the battery sizing shall be calculated on a minimum load of 1 KW (DC) for required backup. All UPS having rating 5KVA or more shall have three phase input.</p>
1.07	<p>The Bidder can provide alternate arrangement with suitable redundancies such as power pack with required backup for switchgears/RMUs located at local pooling/inverter station.</p>
1.08	<p>Solar Plant Main Pooling Switchgear shall be powered from 2X100% DC supply system. Each DC supply system shall consist of 1x100% charger, 1 x 100% station Battery bank rated 110V/220VDC (+10%,-20%) for providing minimum 30 minutes backup and DC switchgear. In case UPS fed from above DC supply system, in that case separate DC system for UPS is not required.</p>
1.09	<p>Requirements of DC supply system for switchyard is mentioned in switchyard chapter. Bidder can offer common DC system for both switchyard and CMCS, but their individual requirements must be met.</p>
1.010	<p>For CMCS, each UPSDB shall have two incomers fed from two separate UPS and one bus coupler. Similarly, each DCDB/DC switchgear shall have two incomers fed from two separate Battery-Charger and one bus-coupler.</p>
1.011	<p>DC system shall be design in such way that it is possible isolate the battery and charger for boost charging of batteries, while corresponding DC switchgear section shall be capable of being in service and continue to supply the DC load by closing of bus coupler.</p>
1.012	<p>Bidder shall submit configuration diagram, power supply distribution scheme, single line diagram and data sheets, all calculations such as Rectifier Modules/UPS Charger/Inverter rating calculations, battery sizing calculation etc. for UPS, Battery Charger & Battery system during detailed engineering stage for employer's review and approval.</p> <p>Size and rating of UPS, Battery Charger and Battery shall be finalized during details engineering stage. Following shall be considered for sizing calculation;</p>

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2.00	<p>i. UPS load power factor shall be taken as 0.8 lagging.</p> <p>ii. UPS efficiency shall be taken as per actual. iii. UPS and charger design margin shall be taken 10% at 50 deg C. iv. IEEE-485 standard shall be followed for sizing calculation of Lead Acid Batteries and IEEE-1115 standard shall be followed for sizing calculation of Nickel-Cadmium batteries.</p> <p>v. For Battery sizing calculation, lowest electrolyte temperature shall be taken as 5 deg C more than the minimum ambient temperature or 15 deg cel whichever is lower, with Temperature correction factors as per relevant standards. vi. Batteries aging factor shall be taken as 1.25 and design margin factor shall be taken as 1.10.</p>
2.01	<p>UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM</p>
2.02	<p>The UPS shall have an overload capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 seconds. The overall efficiency of UPS shall be at least 80% on full load.</p>
2.03	<p>The UPS system shall be capable of operating without D.C. battery in circuit under all conditions of load and the performance of various components of UPS like inverter, charger, static switch etc. shall be guaranteed without the battery in circuit.</p>
2.04	<p>For UPS capacity 5 kVA or more, in addition to indications/display on UPS panel, important alarms along with important analog signal shall also be provided for use in SCADA. For UPS capacity less than 5 kVA bidder shall provide status, common alarm, and trip DI (soft or hard) signal to SCADA</p>
2.05	<p>The UPS chargers shall be self-regulating, solid state silicon controlled, full-wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates. The charger should be capable to fully charge the required batteries as well as supply the full rated load through inverter. The charger shall be able to re-charge the fully discharge battery within 8 hours. The charger shall be design for input supply variation of $\pm 10\%$ and frequency variation of $\pm 5\%$. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. The detailed specification for the battery charger for UPS rating of 5kVA and above has been mentioned in the battery charger section below in this specification.</p>
2.06	<p>The UPS inverter shall be of continuous duty, solid state type using proven Pulse Width Modulation (PWM)/Quasi square wave/step wave technique. Ferroresonant types Inverters are not acceptable. The nominal voltage output shall be 230 Volts single phase, 50 Hz. The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, etc. The total harmonic content shall be 5% maximum and content of any single harmonic shall be 3% maximum.</p> <p>The static switch shall be provided to perform the function of transferring UPS loads automatically without any break from faulty inverter to standby AC source.</p>

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2.07	Manual bypass switch shall be employed for isolating the UPS during maintenance.
2.08	Contractor has the option of supplying either Nickel Cadmium type batteries or Lead Acid Plante type batteries. The detailed specification for the batteries has been mentioned in the battery and charger section below in this specification.
2.09	Equipment enclosures shall match and line up in assemblies of freestanding floor mounted cabinets designed for indoor service.
2.10	Individual enclosure shall be ventilated switchboard type fabricated from not less than 1.6-mm thick sheet steel. Enclosures shall be furnished with concealed hinges. Front and rear doors shall be designed to permit easy access to all components for maintenance or replacement. The enclosures shall be reinforced with formed steel members as required to form a rigid self-supporting structure. Doors shall have three point latches.
2.11	Adequate ventilating louvers and enclosure top panels shall be included. All vent openings shall be covered with corrosion resistant fine screen coverings.
2.12	The cabinets shall be IP-42 protection class for indoor application and IP55 or better for outdoor application.
2.13	The temperature rise inside all the cabinets/enclosures shall not exceed 10 deg.C above ambient temperature.
2.14	The Contractor shall also carry out the site tests on UPS as required to be conducted as a standard practice of the UPS manufacture or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer.
3.00	One set of tools shall be provided for maintenance and testing purposes.
	BATTERY CHARGER
3.01	The chargers shall be self-regulating, solid state silicon controlled, full-wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates, effective current limiting features and filters to minimize harmonics. The charger should be capable to fully charge the required batteries as well as supply the full rated load. Furthermore, the charger should be able to re-charge the fully discharged battery within 8 hours. The charger shall be current limited for charger circuit protection and protection of battery from overcharge shall also be provided. The current limit shall be continuously adjustable. The chargers shall have a slow walk-in circuit. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. The charger shall be design for input supply voltage variation of $\pm 10\%$ and frequency variation of $\pm 5\%$.
3.02	Battery Chargers shall have a selector switch for selecting the battery charging mode i.e. whether trickle or Boost charging.
3.03	All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or

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3.04	<p>manual. Means shall be provided to avoid current/ voltage surges of harmful magnitude/nature which may arise during changeover from Auto to Manual mode or vice-versa under normal operating condition.</p> <p>Soft start feature shall be provided to build up the voltage to the set value slowly. The chargers shall have load limiters which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall neither damage the Charger nor shall it cause blowing of any of the charger fuses. The Charger shall not trip on overload or external short circuit. After clearance of fault, the Charger voltage shall build up automatically when working in automatic mode.</p>
3.05	<p>When on automatic control mode during Trickle charging, the Charger output voltage shall remain within $\pm 1\%$ of the set value for AC input voltage variation of $\pm 10\%$, frequency variation of $\pm 3/5\%$, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from zero to full load. Uniform and step-less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire Trickle charging output range specified & shall be capable of matching the float voltage correction recommendations (w.r.t. temperature) as suggested by the respective battery manufacturer. Step-less adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Trickle charging mode.</p>
3.06	<p>During Boost charging, the Battery Chargers shall operate on constant current mode (When automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. The charger output voltage shall automatically go on rising, when it is operating on boost mode, as the battery charges up. For limiting the output voltage of the charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for boost charging mode. All voltage and current setting potentiometers shall be Vernier type.</p>
3.07	<p>Energizing the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilize, to within the specified limits as mentioned elsewhere, shall be less than fifteen seconds.</p>
3.08	<p>Momentary output voltage of the Charger, without the Battery connected shall be within 94% to 106% of the voltage setting during sudden load Change from 100% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified as mentioned elsewhere in less than 2 seconds after the above-mentioned change.</p>
3.09	<p>Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 1% irrespective of the DC load, even when they are not connected to a battery.</p>

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3.10	<p>The DC System shall be ungrounded and float with respect to the ground potential when healthy. An earth fault relay shall be provided by the bidder in the DC distribution board for remote annunciation.</p>
3.11	<p>Digital Outputs shall be configured for connection to the SCADA for real-time charger status updating. Outputs like charger output current, output voltage, float/boost mode, etc may be configured to provide the update to SCADA.</p>
3.12	<p>The Battery Chargers as well as their automatic regulators shall be of static type. The Chargers shall be designed to operate, as mentioned above, at an ambient air temperature of 50°C.</p>
3.13	<p>For Lead Acid plante battery:-Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC lead-acid Batteries while supplying the D.C. loads. The Batteries shall be Trickle charged at 2.25 Volts per cell. All chargers shall also be capable of Boost charging the associated D.C. Battery at 2.3 to 2.7 Volts per cell at the desired rate.</p>
3.14	<p>For Nickel-Cadmium battery:-Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC Nickel-Cadmium Batteries while supplying the D.C. loads. The Batteries shall be Trickle charged at 1.4 to 1.42 Volts per cell. All chargers shall be capable of Boost Charging the associated D.C. Battery at 1.54 to 1.7 Volts per cell at the desired rate.</p>
3.15	<p>All Battery Chargers shall have an AC contactor on the input side. It shall be of air break type and suitable for continuous duty. A thermal overload relay incorporating a distinct single phasing protection (using differential movement of bimetal strips) shall also be provided for the AC input. The relay shall trip the above contactor.</p>
3.16	<p>The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger.</p>
3.17	<p>Digital or analog indicating instruments shall indicate DC current, DC voltage & AC voltage.</p>
3.18	<p>The Chargers shall be indoor, floor mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Charger shall be fabricated using cold rolled sheet steel shall not be less than 1.6 mm and shall have folded type of construction. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. Removable undrilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be supplied by the Contractor. The Charger shall be tropicalized and vermin proof. Ventilation louvers shall be backed with fine brass wire mesh. All doors and covers shall be fitted with synthetic rubber gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals.</p> <p>All the Charger cubicle doors shall be properly earthed.</p>

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3.19	Treatment as per IS: 6005. Two coats of lead oxide primer followed by powder painting with final shade of RAL9002 for complete panel except end covers & RAL 5012 for end covers.		
3.20	All acceptance and routine tests as per the manufacture recommendations and relevant standards shall be carried out.		
3.21	The cabinets shall be IP-42 protection class for indoor application and IP55 or better for outdoor application.		
3.22	The Contractor shall also carry out the site tests on battery charger systems required to be conducted as a standard practice of the UPS manufacture or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer.		
4.00	BATTERY : NICKEL-CADMIUM BATTERY		
4.01	BATTERY PARAMETER		
	a)	Battery Voltage	To be decided during Detail Engineering
	b)	No. of Cells	To be decided during Detail Engineering
	c)	Battery type	Nickel-Cadmium
	d)	Nominal discharge voltage per Cell	1.2
	e)	Float voltage	1.42V/Cell
4.02	Batteries should be suitable for continuous operation for the maximum ambient temperature as defined in technical parameters.		
	CODES AND STANDARDS		
	All standards, specifications and codes of practice referred to herein, shall be the latest editions including all applicable official amendments and revisions as on date of opening of techno-commercial bid. In case of conflict between this specification and those (IS codes, Standards etc.) referred to herein, the former shall prevail. All works shall be carried out as per the following standards and codes:		
	IEC 60623/ IS 10918	Specification for vented type Nickel Cadmium Batteries.	
	IS 106	Quality tolerances for water for storage batteries	
	IEC 60993	Electrolyte for vented Nickel-Cadmium cells	
	Indian electricity rules		
	Indian electricity acts		

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	<p>Equipment complying with other internationally accepted standards such as IEC., BS, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of techno-commercial bid and shall clearly bring out the salient features for comparison.</p>
4.03	<p>DC Batteries shall be stationary Nickel Cadmium Pocket plate type conforming to IS:10918. The batteries shall be high/medium discharge performance type suitable for the backup time as specified. For the purpose of design an ambient temperature of 50 degree centigrade and relative humidity of 85% shall be considered.</p>
4.04	<p>DC batteries shall be suitable for standby duty. The batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies are lost. Batteries shall be suitable for a long life under continuous float operations and occasional discharges. The batteries shall be boost charged at about 1.54 to 1.7 volts per cell maximum and float charged at about 1.42 V/cell.</p>
4.05	<p>Construction Features:-</p> <p>Containers</p> <p>a) Containers shall be made of polypropylene plastic material. Containers shall be robust, heat resistance, leak proof, nonabsorbent, alkali resistant, non-bulging type and free from flaws, such as wrinkles, cracks, blisters, pin holes etc. Electrolyte level lines shall be marked on container in case of translucent containers.</p> <p>Vent Plugs</p> <p>b) Vent plugs shall be provided in each cells. They shall be antisplash type, having more than one exit hole shall allow the gases to escape freely but shall prevent alkali from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition, the ventilator shall be easily removed for topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into the vent to take electrolyte samples.</p> <p>Plates</p> <p>c) The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The construction of plates shall conform to latest revisions of IS:10918. The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion. The positive and negative terminal posts shall be clearly marked.</p>

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5.00 5.01	d)	Sediment Space Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells.					
	e)	Electrolyte The electrolyte shall be prepared from battery grade potassium hydroxide conforming to IEC 60993. The cells can be shipped either in charged condition or in dry condition. Necessary electrolyte for make-up shall be supplied separately.					
	f)	Connectors and Fasteners Nickel plated copper connectors shall be used for connecting adjacent cells and PVC insulated flexible copper cables shall be used for inter-row / inter-tier / interbank connections. Bolts, nuts and washers shall be Stainless Steel / Nickel coated steel to prevent corrosion. The thickness of Nickel coating of connectors should be not less than 0.02 mm. All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds.					
	g)	Battery racks Mild steel racks for all the batteries shall be provided. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators/High impact plastic insulators. Batteries shall preferably be located in the single tier arrangement. However, batteries having a complete cell weight of lower than 50 Kg could be located in the double tier arrangement. The batteries racks and supports for cable termination shall be coated with three (3) coats of anti-alkali paint of approved shade. Name plates, resistant to alkali, for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor. Test The Contractor shall submit for Owner's approval the reports of all the type tests carried out as per latest IS-1146(for all applicable tests for containers) / IS10918 (for NI-CD batteries).The complete type test reports shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier. Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of battery.					
	h)	BATTERY : LEAD –ACID PLANTE BATTERY BATTERY PARAMETER					
	a)	Battery Voltage	To	be	decide	during	Detail
	b)	No. of Cells	To	be	decide	during	Detail
	c)	Battery type	Stationary Lead Acid Plante				
	d)	Nominal discharge	2.0V				

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5.02		voltage per cell	
	e)	Float Voltage	2.25V/Cell
5.03	CODES AND STANDARDS		
	IEC 60896	Stationary Lead-Acid Batteries	
	IS : 266	Specification for sulphuric acid	
	IS : 1069	Specification for water for storage batteries	
	IS : 1146	Specification for rubber & plastic containers for lead acid storage batteries.	
	IS : 1652	Specification for stationary cells and batteries, lead acid type (with plante positive plates).	
	IS : 3116	Specification for sealing compound for lead acid batteries.	
	IS : 8320	General requirements and methods of tests for lead acid storage batteries.	
	IS : 6071	Specification for synthetic separators for lead acid batteries.	
		Indian Electricity Rules	
5.04		Indian Electricity Acts	
	Equipment complying with other internationally accepted standards such as IEC, BS, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of techno-commercial bid and shall clearly bring out the salient features for comparison.		
5.04	DC Batteries shall be stationary lead acid Plante positive plate type conforming to IS:1652. The batteries shall be high/medium discharge performance type suitable for the backup time as specified. For the purpose of design an ambient temperature of 50 degree centigrade and relative humidity of 85% shall be considered.		
	DC Batteries shall be suitable for standby duty. The Batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies are lost. Batteries shall be suitable for a long life under continuous float operations and occasional discharges. The batteries shall be boost charged at about 2.7 volts per cell maximum and float charged at about 2.25 V/cell.		

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5.05	<p>Construction Features:-</p> <p>a) Containers</p> <p>Containers shall be made of transparent glass, hard rubber, suitable robust, heat resistance, leak proof, non absorbent, acid resistant, non-bulging type and free from flaws, such as wrinkles, cracks, blisters, pin holes etc. Electrolyte level lines shall be marked on container in case of transparent containers. Float type level indicator shall be provided in case of opaque containers. The stem portion of the float should be long enough to prevent falling of the float inside the container even if there is no electrolyte in the container. The marking for the electrolyte level should be for the upper and lower limits. The material of level indicator shall be acid proof and oxidation proof. Container shall be closed/sealed lid type. Lid and sealing compound shall be non-cracking type. The container made of hard rubber and plastics shall be type tested as per IS: 1146. All type tests shall be carried out for sealing compound as per IS: 3116.</p> <p>The pole sealing arrangement should be such that no acid particle get entrapped due to acid creep as a result of capillary action and it should be possible to remove and refix the sealing to carry out the maintenance.</p> <p>b) Vent Plugs</p> <p>Vent plugs shall be provided in each cells. They shall be antisplash type, having more than one exit hole shall allow the gases to escape freely but shall prevent acid from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition the ventilator shall be easily removed for topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into the vent to take electrolyte sample.</p> <p>c) Plates</p> <p>The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The construction of plates shall conform to latest revisions of IS : 1652 as applicable.</p> <p>The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion. The positive and negative post shall be clearly marked.</p> <p>d) Sediment Space</p> <p>Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells.</p> <p>e) Cell Insulator</p> <p>Each cell shall be separately supported on PVC/porcelain/hard rubber insulators fixed on the racks with adequate clearance between adjacent cells. Minimum distance between adjacent cells shall be more than the bulge allowed for two cells in accordance with IS: 1146.</p>

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6.00	f)	Electrolyte The electrolyte shall be prepared from battery grade sulphuric acid conforming to IS: 266 and distilled water conforming to IS: 1069. The cells shall be shipped dry uncharged. The electrolyte shall be supplied separately.		
	g)	Connectors and Fasteners Lead or Lead coated copper connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively lead coated to prevent corrosion. The thickness of lead-coating of connectors should not be less than 0.025 mm. The lead coating thickness shall be measured in accordance with APPENDIX F of IS:6848 (latest edition). All the terminals and cells interconnectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded copper conductors and PVC insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied by the contractor.		
	h)	Battery racks Wooden racks for all the batteries shall be provided. These racks shall be made of good quality first class seasoned teak wood in line with CPWD specification. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators/High impact plastic insulators. Batteries shall preferably be located in the single tier arrangement. However, batteries having a complete cell weight of lower than 50 Kg could be located in the double tier arrangement. The batteries rack and wooden support for cable termination shall be coated with three (3) coats of anti-acid paint of approved shade. Numbering tags, resistant to acid, for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor. Wherever racks are transported in dismantled condition, suitable match markings shall be provided to facilitate easy assembly.		
	i)	Test The Contractor shall submit for Owner's approval the reports of all the type tests carried out as per latest IS-1146 (for rubber & plastic containers for lead-acid storage batteries)/IS 1652 (for lead-acid plante batteries). The complete type test reports shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier. Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of battery.		
	AUXILIARY EQUIPMENT Manual discharge resistance bank suitable for each type of battery bank of UPS/Battery Charger has to be provided by contractor.			
		Following shall be provided (as per applicability) for maintenance purpose		
		a	Hydrometers	2 Nos.

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7.00		b	Set of hydrometer syringes suitable for the vent holes in different cells	2 Nos.
		c	Thermometer for measuring electrolyte temperature	2 Nos.
		d	Specific gravity correction chart	2 Nos.
		e	Wall mounting type holder made of teak wood for hydrometer & thermometer	2 Nos.
		f	Cell testing voltmeter (3-0-3 V)	2 Nos.
		g	Alkali mixing jar	2 Nos.
		h	Rubber aprons	5 Nos.
		i	Pair of rubber gloves	
		j	Set of spanners	5 Nos.
		k	No smoking notice for each battery room	2 Nos.
		l	Goggles (industrial)	2 Nos.
		m	Instruction card	2 Nos.
		n	Temperature indicator	1 No. per room
		o	Cell lifting facility	1 Set per room
	Following shall be taken as minimum load value for sizing calculation of UPS/Battery Charger/Battery system. However, Bidder needs to provide the details auxiliary power rating of each individual equipment. & any other load apart from below required for completion of the system is also in the scope of the bidder.			
		Sl No	Description	Rated Power in Watt
		1	HT Switchgear VCB Panel	
		(i)	Closing Coil	Actual as per datasheet
		(ii)	Tripping Coil	Actual as per datasheet
		(iii)	Spring Charging Motor	Actual as per datasheet
		(iv)	Numerical Relay	20
		(v)	Auxiliary Relays	20 (total)
		(vi)	LED Indication Lamps	10 (total)
		(vii)	Misc. load	20 (total)
		2	Inverter (if applicable)	300
				Continuous load

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8.00	3	SCADA panel at CMCS	2000	Continuous load
	4	SCADA HMI including LED Display and Printer	500	Continuous load
	5	SCADA RTU panel at PEB	400	Continuous load
	6	Transformer N2 Injection unit at PEB (if applicable)	100	Continuous load
	7	Fire Alarm Panel at CMCS	300	Continuous load
	8	Fire Alarm Panel at PEB	200	Continuous load
	9	WMS	100	Continuous load
	10	Emergency Load (light + Fan) at CMCS	300	Continuous load
	11	Emergency Load at PEB	100	Continuous load
	<p>Following shall be considered for main pooling/final pooling HT switchgear as a minimum.</p> <p>(i) Per switchboard only one panel spring charging motor load shall be considered.</p> <p>(ii) All outgoing and tie feeder panel trip coil load (subject to Minimum 3 Nos) shall be considered.</p> <p>(iii) All outgoing feeders+ Aux transformer feeders+ 50% of incomer panel closing coil load shall be considered.</p> <p>Following shall be considered for inverter station HT switchgear/RMU. i)</p> <p>Per switchboard only one panel spring charging motor load shall be considered.</p> <p>(ii) All panel trip coil and close coil load shall be considered.</p>			
8.01	SITE TESTS			
	<p>The contractor shall carry out the following site tests as applicable on UPS, Battery Charger and Battery system. However, any other site test is required to be conducted as a standard practice of the OEM or deemed necessary by the employer and mutually agreed between the contractor and the employer, the same shall also be carried out.</p>			
	<p>Light Load Test</p> <p>This test is carried out to verify that the UPS/Battery Charger is correctly connected and all functions operate properly. The load applied is limited to some percent of rated value. The following points should be checked:</p> <p>a) Output voltage, frequency and the correct operation of meters;</p> <p>b) Operation of all control switches and other means to put units into operation.</p> <p>c) Functioning of protective and warning devices.</p>			
8.02	<p>A. C. Input Failure Test</p> <p>The test is performed in UPS/Battery Charger with a fully charged battery and is carried out by tripping input supply feeder or may be simulated by switching off all</p>			

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8.03	<p>rectifiers and bypass feeder as at the same time. Output voltage variations are to be checked for specified limits with an oscilloscope/Recorder.</p>
8.04	<p>A. C Input Return Test</p> <p>AC input return test is performed in UPS/Battery Charger by closing AC input supply feeder, or is simulated by energizing rectifiers. Proper operation of rectifier starting and voltage and frequency variations are to be observed. This test is normally performed with a fully or partially charged battery.</p>
8.05	<p>Auto changeover Test</p> <p>This test shall be carried out in UPS ACDB fed from two separate UPS system. Auto changeover of one UPS source to standby UPS to be check by tripping the active UPS manually or by simulation condition. This test shall be check as per approved auto changeover logic.</p>
8.06	<p>Transfer Test (for UPS)</p> <p>This test is applicable for UPS with bypass, particularly in the case of an electronic bypass switch. Transients shall be measured during load transfer to bypass caused by a simulated fault and load retransfer after clearing of the fault.</p>
8.07	<p>Full load test</p> <p>Load tests are performed by connecting the actual load to the UPS/Charger output. Load tests are necessary for testing output voltage and frequency, rated stored energy, recharge time, ventilation, and temperature.</p>
8.08	<p>Rated Stored Energy Time (Battery test)</p> <p>This test is a load test to prove the actual possible time of battery operation. If rated load is not available in the case of large UPS/Battery charger, it is possible to apply a partial load to check the actual battery discharge characteristics and compare these with characteristics specified by the battery manufacturer. Discharge time with rated load shall then be calculated. The test shall be performed with a fully charged battery and also may be done under other battery conditions to be specified, if so agreed. Active power output of the UPS/Battery Charger and the battery voltage shall be recorded during the test. Since new batteries often do not provide full capacity during a starting up period, the discharge test may be repeated after a reasonable recharge time if the original test has failed.</p>
8.09	<p>Rated Restored Energy Time</p> <p>Restored energy depends on the charging capacity of the rectifiers and the battery characteristics. If a certain recharging rate is specified, it shall be provided by repeating the discharge test after the specified charging period.</p>
	<p>Battery Ripple Current</p> <p>If battery ripple currents are specified, then the ripple current which depends on UPS operation shall be checked under normal operating conditions. Rough measuring methods are sufficient.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS										
	<p style="text-align: center;">B-11 LIGHTNING PROTECTION SYSTEM</p> <p>GENERAL REQUIRMENTS</p> <p>1.0</p> <p>This specification is intended to outline the requirement of external lightning protection (ELP/Lightning protection) for Solar array (DC) side and AC Power block side of Solar PV Project. It is not the intent of the specification to specify all details of design and construction since the bidder has full responsibility for engineering and implementation of external lightning protection system meeting the intent of the specification and functional requirement. Any additional equipment, material, services which are not specifically mentioned herein but are required for successful installation, testing and commissioning of earthing system for safe and satisfactory operation of the plant shall be included under scope of the bidder.</p> <p>Lightning protection requirement for outdoor metering yard/Switchyard has been mentioned elsewhere in the specification and hence shall be excluded from scope of this chapter unless Lightning protection requirement of metering yard/Switchyard is specifically mentioned in this chapter.</p> <p>LIGHTNING PROTECTION DESIGN REQUIRMENT</p> <p>1.1</p> <p>The object of a lightning protection system is to protect buildings/structure and equipment from direct lightning strikes, potential fire as well as the effects of injected lightning currents (non-incentive flash). It consists of termination systems for direct lightning, down conductors and an earth-termination system.</p> <p>Care must be taken for while designing the lightning protection that surges are prevented in the electrical system to reduce failure of electrical and electronic equipment.</p> <p>CODES AND STANDARD</p> <p>1.2</p> <p>The equipment/product furnished for earthing system shall meet the requirements of all the applicable relevant National/International codes and standards or their latest amendment Codes and Standards. Product certification has to be CE/UL/BIS/TUV or equivalent. The relevant codes and standard for earthing system are tabulated below.</p> <table> <tr> <td>IS/IEC 62305</td><td>PROTECTION AGAINST LIGHTNING</td></tr> <tr> <td>IEEE: 80</td><td>IEEE guide for safety in AC substation grounding</td></tr> <tr> <td>IEEE: 837</td><td>Standard for qualifying permanent connections used in substation grounding</td></tr> <tr> <td>IS: 2629</td><td>Recommended practice for hot dip galvanizing of iron & steel</td></tr> <tr> <td>IS: 2633</td><td>Method for testing uniformity of coating on zinc coated articles</td></tr> </table>	IS/IEC 62305	PROTECTION AGAINST LIGHTNING	IEEE: 80	IEEE guide for safety in AC substation grounding	IEEE: 837	Standard for qualifying permanent connections used in substation grounding	IS: 2629	Recommended practice for hot dip galvanizing of iron & steel	IS: 2633	Method for testing uniformity of coating on zinc coated articles
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CLAUSE NO.	TECHNICAL SPECIFICATIONS																		
2.0	<table border="1"> <tr> <td>IS: 513</td><td>Cold rolled low carbon steel sheets and strips</td></tr> <tr> <td>IS: 6745</td><td>Methods for determination of mass of zinc coating on zinc coated iron & steel articles.</td></tr> <tr> <td></td><td></td></tr> <tr> <td>IS 2062</td><td>HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL — SPECIFICATION</td></tr> <tr> <td>IS: 458</td><td>Precast Concrete Pipes (With and Without Reinforcement)</td></tr> <tr> <td>UL-467</td><td>Grounding and Bonding Equipment</td></tr> <tr> <td>IEC 62561-7</td><td>Requirements for earthing enhancing compounds</td></tr> <tr> <td>NFC 17 -102</td><td>Early streamer emission lightning protection systems</td></tr> <tr> <td colspan="2">CEA regulations for electrical safety-2010 Indian Electricity Rules/ Indian Electricity Act.</td></tr> </table> <p>All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (codes and standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the above standards/ codes as applicable.</p> <p>The lightning protection system includes lightning terminal, Down conductor, test link, earth electrode, installation of lightning terminal, down conductor and earth electrode in suitable pit size, construction of earth pit with cover for the installation, connection of earth electrode with lightning terminal.</p> <p>Detail specification of earthing system has been mentioned elsewhere in the specification.</p> <p>DOWN CONDUCTORS</p> <p>Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.</p> <p>Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.</p> <p>All joints in the down conductors shall be welded type.</p> <p>Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.</p> <p>Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.</p>	IS: 513	Cold rolled low carbon steel sheets and strips	IS: 6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.			IS 2062	HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL — SPECIFICATION	IS: 458	Precast Concrete Pipes (With and Without Reinforcement)	UL-467	Grounding and Bonding Equipment	IEC 62561-7	Requirements for earthing enhancing compounds	NFC 17 -102	Early streamer emission lightning protection systems	CEA regulations for electrical safety-2010 Indian Electricity Rules/ Indian Electricity Act.	
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>3.0</p> <p>3.1</p> <p>3.2</p> <p>3.3</p>	<p>All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.</p> <p>Lightning conductors shall not pass through or run inside GI Conduits.</p> <p>Testing link shall be made of galvanized steel of size 25x 6mm.</p> <p>Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths oxide layer or foreign material.</p> <p>LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY</p> <p>Codes and Standard</p> <p>IS/IEC 62305: PROTECTION AGAINST LIGHTNING</p> <p>NF C 17-102 : LIGHTNING PROTECTION WITH EARLY STREAMER AIR TERMINATION ROD</p> <p>Complete Solar Array with associated structure shall be protected from Direct Lightning Stroke. Lightning Protection for solar array shall be achieved with any or both of the following two systems as per specification provided in the following section.</p> <p>Single Rod Air Terminal (Faraday Rods)</p> <p>Early Streamer Emission (ESE) Air Terminal</p> <p>Suitable earthing and equipotential bonding shall be ensured for the lightning protection Air Terminal as per applicable standard/Equipment manufacturer guidelines.</p> <p>Current carrying parts and accessories such as clamps, fasteners, down conductor, Test links and earth termination etc. shall be preferably procured from OEM of Air Terminals if it is supplied by them as part of lightning protection system.</p> <p>LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY WITH E.S.E AIR TERMINAL</p> <p>Solar array shall be protected from direct lightning stroke with Early Streamer Emission air terminal in accordance to NF C 17-102 .</p> <p>Location and layout of ESE terminal shall be in such a manner that it cast no shadow on the PV Modules during 08:30 AM to 04:30 PM. Any minor changes in timings shall be reviewed during detailed engineering stage, provided the proposal is acceptable to PV Module manufacturer.</p> <p>Number and location of ESE air terminal shall be decided during detail engineering. For this purpose, design calculation considering protection level IV</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
4.0	<p>(minimum) and Autocad drawing of the layout of ESE terminal shall be submitted to END CUSTOMER for approval.</p> <p>ESE air terminal shall be type tested as per Annexure- C of NF C 17-102 (Latest Revision) in the manner as mentioned in the standard.</p> <p>ESE Air terminal shall be supplied with test link, counter, down-conductor, Two earth pits, support mast and accessories required for completeness for ESE Lightning protection system.</p> <p>Owner shall test ESE terminal (Each terminal/Sample basis) before installation with suitable instrument for functionality of terminal. Vendor shall replace the terminal free of cost if found defective.</p> <p>Support mast for ESE Air terminal shall be heavy duty hot dip galvanized material and shall be suitable to withstand dynamic and static forces acting on it without failure. Foundation for the mast shall be M20 Grade concrete or better with minimum depth of 1200 MM.</p> <p>LIGHTNING PROTECTION SYSTEM FOR BUILDING AND ENCLOSURE</p> <p>Contractor shall provide lightning protection for Inverter room/shed/shelter/enclosure, main control room, Switchgear Room/shed/shelter and similar housing per IS/IEC 62305.</p> <p>ESE Air Terminal shall not used for lightning protection of Metering yard/Switchyard .</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">B-12 METERING SYSTEM</p> <p>1.0 GENERAL</p> <p>1.1 Energy meter (0.2s accuracy class) suitable for ABT requirement with metering panel as required shall be conforming to STU/CTU/PGCIL requirement.</p> <p>1.2 For measurement of Auxiliary power consumption, MFM in ACDB incomer shall be provided by the bidder.</p> <p>1.3 Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment. Bidder shall synchronize the meter using GPS time synchronization equipment. All the hardware required for synchronization shall be in scope of bidder.</p> <p>1.4 The ABT meters supplied under this contract shall also meet the requirement of respective RLDC/State power Utilities.</p> <p>1.5 This metering system shall have following features:</p> <ul style="list-style-type: none"> I. Meters shall be microprocessor-based MWH meters having an accuracy class of 0.2S or better. MVARH meters shall have accuracy class of 0.5 or better. II. These meters shall have provision for downloading of data through an optical port and /or through RS 232/485 port. III. Even under absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters. <p>2.0 Technical Requirements of Energy Meters for ABT Requirement</p> <p>Contractor shall supply energy meters along with metering station, MRI as per the technical specification given below:</p> <ul style="list-style-type: none"> a) Shall be microprocessor-based conforming to IEC 62052-11, IEC 62053-22, IS 14697 b) Shall carry out measurement of active energy (both import and export) and reactive energy (both import and export) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load. c) Shall have an accuracy of energy measurement of at least Class 0.2S for active energy and at least Class 0.5 for reactive energy. d) The active and reactive energy shall be directly computed in CT & VT primary ratings. e) The reactive energy shall be recorded for each metering interval in four different registers as MVARh (lag) when active export, MVARh (Lag) when active import, MVARh (lead) when active export, MVARh (Lead) when active import. f) Two separate registers shall be provided to record MVARH when system voltage is $\geq 103\%$ and when system voltage is $\leq 97\%$.

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																				
g)	Shall compute the net MWh and MVARh during each successive 15-minute block metering interval along with a plus/minus sign, instantaneous MWh, instantaneous MVARh, average frequency of each 15 minutes, net active energy at midnight, , net reactive energy for voltage low and high conditions at each midnight.																																				
h)	Each energy meter shall have a display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MWh demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.																																				
i)	All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.																																				
j)	At least the following data shall be stored before being over-written for the following parameters. <table><tr><td></td><td>Parameters</td><td>Details</td><td>Min No of days</td></tr><tr><td>1.</td><td>Net MWH</td><td>15 min block</td><td>40days in meter</td></tr><tr><td>2.</td><td>Aver Freq</td><td>15 min block</td><td>40days in meter</td></tr><tr><td>3.</td><td>Net MVARH for V > 103%</td><td>15min block</td><td>40days in meter</td></tr><tr><td>4.</td><td>Net MVARH for V < 97%</td><td>15min block</td><td>40days in meter</td></tr><tr><td>5.</td><td>Cumulative Net MWH at every midnight</td><td></td><td>10 days in meter/ 40 days in PC</td></tr><tr><td>6.</td><td>Cumulative Net MVARH for V> 103% at every midnight</td><td></td><td>10 days in Meter/ 40 days in PC</td></tr><tr><td>7.</td><td>Cumulative Net MVARH for V < 97% At every midnight</td><td></td><td>10 days in Meter/ 40 days in PC</td></tr><tr><td>8.</td><td>Date and time blocks of VT failure on any phase.</td><td></td><td></td></tr></table>		Parameters	Details	Min No of days	1.	Net MWH	15 min block	40days in meter	2.	Aver Freq	15 min block	40days in meter	3.	Net MVARH for V > 103%	15min block	40days in meter	4.	Net MVARH for V < 97%	15min block	40days in meter	5.	Cumulative Net MWH at every midnight		10 days in meter/ 40 days in PC	6.	Cumulative Net MVARH for V> 103% at every midnight		10 days in Meter/ 40 days in PC	7.	Cumulative Net MVARH for V < 97% At every midnight		10 days in Meter/ 40 days in PC	8.	Date and time blocks of VT failure on any phase.		
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k)	Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.																																				
l)	Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment being supplied by the contractor.																																				
m)	The voltage monitoring of shall be inbuilt feature provided to signal failures to the Substation Automation System, The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be less than 2 VA.																																				
n)	The power supply to the meter shall be healthy even with a single-phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need																																				

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>replacement for at least 10 years with a continuous VT interruption of at least 2 years. Even under absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meter. In case data downloading is not possible in absence of VT supply, meter with provision of 220V DC auxiliary power shall be provided. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory.</p> <p>o) Shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software. The contractor shall supply the MRI and/or notebook complete with all optical interface unit required.</p> <p>p) The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.</p> <p>q) Each meter shall have a unique identification code provided by the Owner and shall be permanently marked on the front of the meter and stored in the nonvolatile memory of the meter.</p> <p>3.0 Type Test requirement for Energy Meter</p> <p>All Type Test Reports shall be provided as per IEC 62052-11, IEC 62053-22, IS 14697.</p> <p>4.0 Suitable PQ meters (0.2 accuracy class) shall be provided at plant output and at necessary locations (as per scope of work) for measurement of required electrical parameters such as active power, reactive power, power factor, voltage, current, frequency, power quality parameters, etc. PQ meter shall have TCP/IP port for SCADA and PPC communication. Selected PQ meters shall be able to measure grid frequency with minimum two digit after decimal point. CT and PT/CVT core used for PQ meters shall have accuracy class of 0.2S and 0.2 respectively. These PQ meters should have auto report generation facility of daily reports of Harmonics/Flicker and DC currents as per IEEE519/IEC61000 accessible from OWS of PPC system so that it can be submitted in relevant REMC/RLDC. Necessary software for visualization of online parameters and setting in PQM in OWS(PPC) must be supplied along with PQM.</p> <p>Additional Requirements of PQ meters:</p> <p>Standards: -</p> <ul style="list-style-type: none"> • IEEE Standards: Compliance with latest IEEE 519:2022, IEEE 1547.1:2020, IEEE 2800: 2022 • Grid Codes: Adhering to local grid interconnection standards which dictate power quality requirements. CEA (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2019 and its amendments. • International Standards: Following IEC standards for testing and performance of electrical components in solar power plants- IEC 61000-4-30:2015 Class A Power Quality meters.

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	<p>Salient Technical parameters of PQM: -</p> <ul style="list-style-type: none"> • Sample rate choice of 512 Samples/cycle or 1024 Samples/cycle • Storage memory options ensuring more than 90 days storage in the device as specified by CEA. • Historical Logs –8 no.s, providing robust computation capability. • Voltage Sag/swell, Flicker, Transient logs • Cyber Security. • Post event/fault capability to capture 10 sec as specified by CEA, and also exceeding the same if the need arises. • Able to capture LVRT/HVRT fault waveform signature as per CEA requirement.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>B-13 SWITCHYARD & TRANSMISSION SYSTEM DELETED</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>B-14 CONTROL AND PROTECTION DELETED</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>B-15 EHV CABLE AND ITS ASSOCIATED ACCESSORIES DELETED</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>B-16 33KV OUTDOOR YARD & OVERHEAD LINE DELETED</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>PART-B C – CIVIL WORKS</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">C-1 TOPOGRAPHY SURVEY AND SOIL INVESTIGATION</p> <p>TOPOGRAPHICAL SURVEY</p> <p>1.0 Bidder shall conduct the Topographical Survey for the allocated plot in the proposed solar project. The scope of work and technical specification for the same is as below:</p> <p>Scope of Work</p> <p>1.1 The Bidder shall carry out the Topographical Survey and prepare of Plans (Survey Maps) and report of the entire area for locating the Solar PV Power plant and its other systems.</p> <p>Carrying out the Benchmark (GTS) to site(s) under survey by parallel levelling, establishing and constructing benchmark, grid and reference pillars in the field and spot level survey of the entire area at specified intervals and development of the contours. Bidder can also use DGPS for establishing the coordinates.</p> <p>Carrying out cross-section of river/canal taking spot levels at an average 20 meters intervals or less depending upon the site conditions.</p> <p>Furnishing all field data & drawings with Longitude and Latitude of all corners and strategic points. Furnishing of the survey report as described in detail in the succeeding paragraphs is also included in the scope of this work.</p> <p>The work shall include construction of two permanent Benchmarks and reference pillars which shall be shown on the survey drawings.</p> <p>Latitude and Longitude: The work shall be carried out in UTM grids system.</p> <p>At least 50-meter width of the adjoining solar plots and area shall also be covered in the survey for correlation with adjoining plots. Presence of any well and/or tube well in the site or adjoining areas and water level in them shall be marked in the documents / Drawings.</p> <p>1.2 Topographical Survey and Mapping</p> <p>Positions, both in plan and elevation, of all natural and artificial features of the area like waterways, railway tracks, trees, cultivation, houses, fences, pucca and kutcha roads including culverts and crossings, foot tracks, other permanent objects like telephone posts and transmission towers etc. are to be established and subsequently shown on survey maps by means of conventional symbols (preferably, symbols used in Survey of India Maps), all hills and valleys within the area/areas is to be surveyed and plotted on maps by contours.</p> <p>Method of the survey, contour intervals etc. shall be decided by the bidder with prior approval of the Owner (END CUSTOMER), in case of steep slopes and dense jungle</p>

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	<p>etc. where grading is not possible. Any unusual condition or formations on the ground, locations of rock outcrops (if visible on the surface) and spring/falls, possible aggregate deposits etc. shall also be noted and plotted on the maps.</p> <p>The field work shall be done with Total Station Equipment in the following steps:</p> <p>Establishing horizontal and vertical controls and locating reference grids and benchmark in the area. Surveying for establishing spot levels and plotting contours. Surveying for locating the natural and manmade details as described earlier.</p> <p>The grids for the survey work shall be established in N-S & E-W direction (Corresponding to Magnetic North).</p> <p>1.3 Contouring</p> <p>Bidder shall carry out spot level surveying at an interval of average 50 meters for contouring the area. Levels shall also be taken on all traverse stations and on salient points located at random over the area (ground points). Contours are to be interpolated at 0.5 M intervals after the above points are plotted.</p> <p>1.4 Preparation & Submission of Survey Maps and Documents</p> <p>The Contractor shall submit survey maps of the site in 1:10,000 scale indicating grid lines and contour lines, demarcating all permanent features like roads, railways, waterways, buildings, power lines, natural streams, trees etc. All the maps should be prepared in digitized forms using computer software like AutoCAD – Release 2016 or latest.</p> <p>Bidder shall submit all data pertaining to the Survey and Array layout in original (.dwg & .pdf format) including all levels & co-ordinates in X-Y-Z format for the entire area in scale in Soft format and in hard copy (3 no's in A0 size).</p> <p>2.0 GEOTECHNICAL INVESTIGATION SCHEME</p> <p>2.0.1 The scheme for geotechnical investigation shall be as given at Clause 2.1 and shall be approved by Owner before execution. The Bidder shall carry out geotechnical investigation for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings.</p> <p>The Bidder shall obtain the approval for the field and laboratory testing scheme before undertaking the geotechnical investigation work.</p>

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2.0.2	The detailed Geotechnical Investigation has to be carried out by the bidder in line with the Technical Specification. Bidder shall carry out the design of foundation etc. based on the approved geotechnical report.
2.0.3	Field test shall include but not be limited to the following: Boreholes, Standard Penetration Test (SPT), collection of disturbed and undisturbed soil samples (UDS), Trial Pits (TP), collection of water samples, Electrical Resistivity Test (ERT) etc.
2.0.4	Bidder shall carry out his own Geotechnical Investigation, as per the requirements of Technical Specification provided at Cl. 2.1 below. No time extension would be admissible on account of this. Bidder shall carry out the design of foundation etc. based on the approved geotechnical investigation report.
2.1	Scheme of Geotechnical Investigation
2.1.1)	Minimum 1 No. of borehole of 5 m depth shall be carried out in every 12.5 acres of land. Minimum 1 number of ERT & 1 no. TP shall be carried out for every 100 acres or less area, as per layout. Depth of bore hole at Control Room Building shall be 10 m and that at Switchyard location shall be 12m or depth of borehole at these locations shall be as per approved geotechnical investigation scheme.
2.1.2)	SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery upto 20%, met within a borehole. This test shall be conducted at every 1.5 m interval or at change of strata. The starting depth of SPT shall be 0.5m from ground level. UDS shall be collected at every 1.5m interval or at change of strata. In case UDS is not possible to collect, then interval of SPT shall be reduced to 1m instead of 1.5m.
2.1.3)	The laboratory tests shall be conducted on soil, rock & water samples collected during field investigations in sufficient numbers. Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free Swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel. Laboratory tests on rock samples shall be carried out for Hardness, Specific Gravity, Unit Weight, Uniaxial Compressive Strength (in-situ & saturated), Slake Durability etc. On completion of all field and laboratory work, the Bidder shall submit a Geotechnical investigation report for approval. The Geotechnical

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<p>2.1.4)</p> <p>2.2</p> <p>2.2.1</p>	<p>investigation report shall contain field and laboratory observations/ data/ records, analysis of results and recommendations on type of foundation for different type of structures envisaged for all the areas of work.</p> <p>Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc. shall also be covered in the report, as applicable.</p> <p>Geotechnical investigation work shall preferably be got executed by the Contractor through the Enlisted agencies, refer Annexure-1 of Chapter 2-B, Sub-section -2.</p> <p>Foundation System</p> <p>Foundation system for various facilities shall be designed and adopted as per approved geotechnical investigation report and relevant IS standard. The general requirements for the foundation system to be adopted, are as given below.</p> <ol style="list-style-type: none"> 1) All structures/ equipment shall be supported either on suitable open foundation (isolated, combined, raft) or pile foundation depending on type of structures/ facilities, sub-strata, topography, etc. 2) If the encountered sub-strata is black cotton soil, the same shall be either replaced up to the full depth of black cotton soil or expansive soil shall be stabilized by suitable treatment. 3) Shallow foundation shall not rest in black cotton soil. 4) All foundation system shall be designed in accordance with the latest revisions of relevant Indian Standards. For short pile foundation, method by B. B. Broms shall be followed for calculating lateral resistance and lateral deflection of a pile. 5) Contractor shall furnish design of piles for approval. 6) Level of Ground water table for design purpose shall be considered as per the recommendation of geotechnical investigation report. 7) Minimum depth of foundation shall be 1.0m below ground level. 8) In desert areas where sand erosion is anticipated, depth of pile shall be increased beyond designed depth by minimum 300mm or envisaged depth of erosion, whichever is higher. 9) Testing of piles and interpretation of pile load test results shall be carried out as per the stipulations of IS: 2911 (Part-4). Contractor

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2.2.2	<p>shall obtain approval for the pile load test scheme before undertaking the pile load test.</p> <p>DELETED</p>

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	<p style="text-align: center;">C-2 SITE LEVELLING AND GRADING</p> <p>1.0 SITE LEVELLING AND GRADING:</p> <p>1.1 Site levelling works involves the following works:</p> <ol style="list-style-type: none"> 1) Site levelling works/scheme shall match with the specific functional requirement of Solar PV optimum generation considering the full utilization of the plot area for the desired capacity 2) Site grading level shall be fixed with due reference to site drainage of the whole area, existing drainage pattern and system requirements. 3) For Plant boundary wall and fencing. <p>1.2 Based on the spot level, contour survey done and meeting above requirements, bidder can propose different site grade levels. The site levelling may be carried in patches/blocks. Bidder may also propose the site leveling and grading matching with the natural topography of the land considering the optimized use of the land, however bidder shall ensure to meet the desired power generation capacity in the allotted plot area. Bidder shall also ensure that no water ponding and flooding occurs in the low lying areas & effective drainage is provided in the whole plot area, in all kind of site levelling and grading or plant at natural topography schemes, bidders has to provide proper and effective drainage system in line with "Drainage System" chapter. After performing the optimization of levels from the detailed site survey by the Bidder, the final formation level of the plot in various areas shall be finalized. The area shall be suitably cut and filled to suit the layout requirement. The site levelling and grading scheme incorporating the above aspects shall be submitted to END CUSTOMER for prior approval.</p> <p>1.3 Fill shall normally be made up of Cohesive Non swelling (C-Ø) material capable of being compacted up to 95% Standard Proctor density. If cohesionless soils (Sandy soils) are used as fill material, then the degree of compaction shall be 75% of relative density for site levelling and grading work.</p> <p>In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the Bidder. The slope at the edge of graded areas shall not be steeper than 1:1.5 (1 vertical to 1.5 horizontal) in cutting and 1:2 in filling.</p> <p>1.4 All buildings & switchyard area/sub-station area shall be constructed in levelled area. No foundation shall be allowed on back filled soil and in that case the depth of foundations shall reach up to NGL. Final Level will be approved in detail engineering.</p> <p>1.5 The slope protection measure shall be provided in case inter levelled patches level difference is more than 2.0m. Random rubble/boulder/stone pitching/concrete blocks etc. shall be provided for the slope protection for road side slope, storm water ditches/drainage, embankment slopes, inter levelled patches slopes etc. as per design requirements.</p>

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1.6	<p>Suitable sand erosion control measure shall be provided in case any sand dune or very loose soil areas fall inside the plot area. The same may be made with Random rubbles/boulders/stone pitching/concrete blocks/ murrum filling, etc. Bidder shall also provide sufficient grass/buses/trees covers on these dune / loose soil patches, as specified below for desert areas.</p>
1.7	<p>Bidder shall also provide suitable sand erosion protection measure around the foundation as mentioned above. In case murrum filling around foundation is adopted as sand erosion measure, then well compacted murrum filling around foundation/ pile may serve the purpose of control of sand erosion. However, diameter of extent of murrum layer shall be at least 1500mm beyond face of foundation and depth of filling shall extend at least 100mm beyond the maximum depth of erosion observed/ anticipated. In no case, it shall be less than 300mm.</p>
1.8	<p>For Solar Project in Desert areas:</p> <p>Bidder shall also provide suitable sand erosion protection measure within its allotted plot area by sowing Cassia angustifolia (Sonamukhi or senna) and cenchrus ciliaris. This shall be taken up when the majority of construction, MMS erection and fixing work has completed. A minimum of one bush shall be planted in each 5 sqm area of the plot. Cassia angustifolia (Sonamukhi or Senna) and cenchrus ciliaris to be sown to develop under canopy vegetation for effective control of sand drift. C. angustifolia is a perennial shrub considered as the perfect crop for restoring barren and infertile lands of dry region while the cenchrus ciliaris is an important grass of the Indian dry zone and used as fodder. Seeds of C. angustifolia usually germinate within five days of sowing. However, regeneration from naturally dispersed seeds occurs immediately after rain when sufficient soil water availability is there. Usually, it attains height of 70-80 cm and crown diameter of 50-60 cm within a period of 5-6 months, when sown.</p> <p>Bidders are also encouraged to plan additional suitable green belt with local shrubs and grasses in the plot area to control the sand flow in the plot area.</p> <p>Solar Plants proposed in areas lying towards the western margin of Aravali Hills, and the areas falling under the Great Indian Desert (Thar Desert) as per the Physiographic Division of Rajasthan, shall be classified as "Solar Project in desert areas", for providing additional suitable sand erosion protection measure as described above.</p> <p>The areas categorized as slight to very severe as per the Wind erosion map by CAZRI, shall be used for identifying "Solar Project in desert areas" in Rajasthan state for providing the additional scope of sand erosion protection measure.</p>

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3.0	<p>wall shall be at sufficient height from water level. The toe wall for fencing at water body area shall be made of RCC only. Alternatively, in place of Toe wall, Concertina Fencing at Ground can also be provided as per Tender Drawing.</p> <p>g) Boundary wall if provided, shall be executed in line with tender drawing Title: Pre-Stressed Precast Boundary Wall.</p> <p>h) Cutting of high strength cable, distressing and lifting shall be as per the standard IS: 1343. Pre-stressing tendons of high tensile steel / wire shall be as per IS: 6003-2010. For 4mm dia wires min Tensile strength shall be 1715 N/mm2. Pretension force should not exceed 80% of ultimate tensile strength of the tendon. The pre-stressing shall be released from the panels and poles only when 50% of the characteristic strength of concrete is achieved.</p> <p>i) Prestressed precast boundary wall members shall be designed as per IS1343</p> <p>Tolerances:</p> <table><tr><th>SL no</th><th>Item</th><th>Tolerance</th><th></th><th></th></tr><tr><td>1</td><td>Length</td><td>(+/-) 0.1%</td><td></td><td></td></tr><tr><td>2</td><td>Straightness or bow</td><td>1/750 of length</td><td></td><td></td></tr><tr><td>3</td><td>Cross section dimensions</td><td>(+/-)3 mm</td><td></td><td></td></tr><tr><td>4</td><td>Squareness</td><td>When considering the squareness of the corner, length of the two adjacent sides being checked shall be taken as base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.</td><td></td><td></td></tr><tr><td>5</td><td>Flatness</td><td>The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.</td><td></td><td></td></tr></table>					SL no	Item	Tolerance			1	Length	(+/-) 0.1%			2	Straightness or bow	1/750 of length			3	Cross section dimensions	(+/-)3 mm			4	Squareness	When considering the squareness of the corner, length of the two adjacent sides being checked shall be taken as base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.			5	Flatness	The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.		
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	<p>Chain Link Fencing:</p>																																		
	4.0	<p>as per Tender Drawing Title: Details of Chain-link Fencing</p>																																	
	<p>RCC Fencing Post with Barbed Wire:</p>																																		
<p>RCC fencing post shall be a straight type of total length of 1.8 meters. The height of RCC post shall min 1.2 meters from finished ground level.</p>																																			
<p>Hooks for fixing Barbed Wire</p>																																			
<p>Hooks shall be made of 6 mm dia MS bar. 9 Nos. Hooks shall be provided for fixing 'Steel Barbed Wire, A-3 or B-3 IS 278' at 1.8 meters post. The top hook should be provided 60 mm below the top of post and bottom hook should be</p>																																			

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5.0	<p>provided 140 mm above the bottom of the pole. The central distance between the top and bottom hooks shall be equally divided to fix remaining hooks. Diagonal steel barbed wire fixed with RCC fencing post shall also be provided.</p> <p>Inclined strut or stay post on either side shall be provided at every 15 meters c/c, corner and end. The maximum distance between two RCC, fencing post shall be 2.5 meters c/c.</p> <p>Reinforcement of RCC Post:</p> <table><tr><td rowspan="2">In Post</td><td>Vertical 6 Dia Bars 4 Nos.</td><td rowspan="2">In Strut</td><td>Vertical 6 Dia Bars 4 Nos.</td></tr><tr><td>Stirrups 6 Dia Bars 9 Nos.</td><td>Stirrups 6 Dia Bars 10 Nos.</td></tr></table> <p>Dimensions RCC Post</p> <p>1. Bottom: 165 mm x 165 mm square, and 2. Top: 100 mm x 100 mm square.</p> <p>Cement Concrete Mix and Manufacturing</p> <p>Cement concrete to be used having the nominal mix of ratio 1:2:4 with 12.5 mm nominal size coarse aggregate. RCC Post shall be embedded into PCC block made from Cement Concrete nominal mix 1:5:10 below ground level. Concrete Mix shall be conforming to Grade M-15 of IS 456 (2000). RCC Fencing post shall be manufacturer at the factory and In order to ensure desired compressive strength, RCC fencing poles should be compacted with the help of plate form vibrator. The surface shall be uniform and free from voids. The concrete cover over the reinforcement shall not be less than 15 mm.</p> <p>Tolerances for RCC Fencing Poles</p> <table><tr><td>SL no</td><td>Item</td><td>Tolerance</td></tr><tr><td>1</td><td>Length (+/-) 0.1%</td><td></td></tr><tr><td>2</td><td>Straightness or bow 1/750 of length</td><td></td></tr><tr><td>3</td><td>Cross section dimensions (+/-)3 mm</td><td></td></tr></table>				In Post	Vertical 6 Dia Bars 4 Nos.	In Strut	Vertical 6 Dia Bars 4 Nos.	Stirrups 6 Dia Bars 9 Nos.	Stirrups 6 Dia Bars 10 Nos.	SL no	Item	Tolerance	1	Length (+/-) 0.1%		2	Straightness or bow 1/750 of length		3	Cross section dimensions (+/-)3 mm	
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	<p>Chain Link Fencing for Yard (Transformer Yard, Metering Yard, etc.)</p> <p>As per Tender Drawing Title: CHAIN LINK FENCING FOR YARD AND COMMON FENCING (5779-004(B)-POC-A-003C)</p> <p>6.0 Main Gate - Mild Steel frame gate woven with chain linking having minimum span 4 m conform to IS: 2062 shall be provided. The gate shall be complete with the</p>																					

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7.0	<p>guide track, castor wheel, all fitting and fixture like hinges, aldrops, locking arrangement, posts, etc. The width of approach road shall cover the gate width at the main entrance with a suitable transition. All members used in gates shall be finished by cleaning of steel surfaces as per IS: 1477 (Part-II) and applying zinc chrome or zinc phosphate primer, followed by two coats of synthetic enamel paint. For finishing coat suitable colour pigment shall be added. All paints including primer shall be of reputed brand/manufacturer and as approved by the Engineer-In-charge. The method of application shall be as per the recommendations of the manufacturer.</p> <p>One man movement passage gate (minimum 1.2m width) shall also be provided at the main entry gate. 400 mm height concertina with all supporting members shall also be provided on a gate (gates other than main entry gate) for better security.</p> <p>The minimum size & requirements of the Gate's including all items shall be as per the fencing tender drawing title: "Details of Main Gate".</p> <p>The main gate shall be constructed inside the plant/plot boundary line to provide sufficient space for Heavy motor vehicle and light motor vehicle for inspection/check before entering the solar plant and vehicles shall not disturb the traffic in the main approach road.</p> <p>HT cable support</p> <p>As per detailed Engineering, if over ground cabling is envisaged to avoid submergence during flooding, following would be followed for over ground support.</p> <p>T-TYPE RCC Pedestals or Galvanized Steel Structure over Concrete Pedestals shall be constructed for laying of the HT cable from Transformer to 33kV switchgear. Height of such structures would be as per Electrical Cabling – Technical Requirement (System Design), w,r,t Flood Level Report.</p>

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<p>1.</p> <p>2.</p> <p>3.</p> <p>4.</p>	<p>C-4 DESIGN OF MODULE MOUNTING STRUCTURE (MMS design and material supply are under BHEL's scope; pile concreting works including design, execution , MMS erection, and PV Module erection by the bidder) & CIVIL WORKS</p> <p>Design criteria for module mounting structure (MMS)</p> <p>The design calculations and drawings for MMS shall be submitted for prior approval of BHEL before the commencement of construction. The construction methodology for MMS and its foundations shall be submitted for END CUSTOMER approval before the start of works.</p> <p>Scope:</p> <p>This section covers the loads and design requirement of the structures, racking, and all other items required to furnish and install a complete ground mounting structural system which constitutes a photovoltaic array(s).</p> <p>Design Loads:</p> <ul style="list-style-type: none"> A. Dead Load: The load obtained by summing up the weight of modules and self-weight of Structure including Purlins, rafter/beams, Bracings, struts, columns, necessary fittings, etc. to be added as a Dead load. B. Wind Load: The wind load (positive and negative) normal to surface on the modules and wind load on the structural members. C. Refer Appendix-1 / Part -A of Technical specification for site-specific design parameters. D. The concept of wind tunnel studies may be considered in the design philosophy for fixed module mounting structure . <p>If the Bidder is going for wind tunnel study for the design and analysis of complete MMS following has to be ensured.</p> <ul style="list-style-type: none"> i. It must be done from an institute of repute having suitable wind tunnel facility (IITs / SERC Chennai or equivalent level institute in India). ii. If the study is done by any reputed international facility, the study results must be vetted by the wind domain expert at any of the IITs / SERC like institutes in India. <p>Design Parameters:</p> <ul style="list-style-type: none"> A. MMS design & analysis to be done on computer software (preferably STAAD) and the Bidder shall submit a write-up on the computer program used and its input (soft format) and output data for review and approval.

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	B. An increase in allowable stresses of structural materials should not be considered during design and analysis.						
	C. Wind pressure for following loads shall be considered as follows:						
	(1) Dead Load of steel with all members, fittings & panels.						
	(2) Load due to fair wind direction on design tilt angles of solar mounting structural members.						
	(3) Load due to adverse wind direction on design tilt angles of solar mounting structural members.						
	(4) Load on the side face of mounting structural members.						
	D. Wind pressure coefficient, load and load combination shall be as per Indian standards (latest revision) such as IS: 875, IS: 800, IS 801.						
	E. Design analysis and the forces on MMS (Compressive force, uplift force, shear and moment) shall be used for the design of foundation system.						
	F. Seasonal Tilting MMS type (as applicable): Mechanized arrangement for lifting MMS during seasonal tilting shall be provided with MMS. The lifting forces shall be transferred only through rafter/beam for lifting the MMS during seasonal tilt with a suitable hook, clamp, etc. and fixed at rafter/beam.						
	5.	Vertical Deflection and Horizontal Sway Limits:					
Limiting Deflection: The limiting permissible vertical deflection for structural steel members shall be as per following:							
a) Maximum vertical deflection in purlin = $\text{Span} / 180$,							
b) Maximum vertical deflection in rafter (cantilever span) = $\text{Span} / 180$ and							
c) Maximum lateral deflection in column/vertical post = $\text{Height} / 240$							
d) All deflection limits can also be as per the serviceability limit defined by the module manufacturer & tracker/MMS manufacturer OR the proposed deflection limits duly approved by the module manufacturer during detailed engineering.							
6.	Materials Specification & Coating for Structural Steel Works:						

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				Referen ce	Thickne ss	Referenc e code	Thickness (mm)
	Column/ Vertical	IS	250	70 micron (IS 4759) (minimum)	2.0	110 micron (IS 4759) (minimum)	3.0
	Bracing/Raft er/	2062 / IS 1079			2.0		
	Steel Tubes in all sections	IS 1161	240		2.0		
	Hollow Steel in all sections	IS 4923	240		2.0		
	Coupler/Plate/Cl eat Splice/Sag	IS 2062	250		2.0		2.0
			Yield strengt h, MPa	Coating Class Designat io n			
	Rafter/ Beam/ Purlin (Pre-Galvanized steel sections)	ASTM A653 M/ IS 1079	255- 550	Z600 (ASTM A653M/ IS 277)	1.6		Not recommen ded in coastal
	NOTE:			1. Minimum elongation % shall be as per relevant Standard and Code. 2. Materials shall be fabricated in the shop. 3. Minimum coating requirement mentioned above in the table. 4. All structural calculations of cold formed steel section for checking the adequacy for strength and deflection criteria is to be done taking into consideration the maximum permissible negative tolerance over specified BMT i.e, the lower limit of BMT is to be considered.			
B. Hot-dip Aluminium-Zinc alloy metallic coated sheet steel strip and sheet sections:							
	Members	Refer enc e	Yield stren gth	Coating Class Designa tion	Min Thickn ess	Coastal Area	
	Rafter/ Beam	AS TM A792 M/ IS	250 - 550	AZM 165 (ASTM A792M)	1.2	Not recommen ded in coastal	
	Purlin	AS TM A792 M/ IS	250 - 550	AZM165 (ASTM A792M) / IS	0.9	Not recommen ded in coastal	
	NOTE: 1. Minimum elongation % shall be as per relevant Standard and Code. 2. Materials shall be fabricated in the shop. 3. Minimum coating requirement mentioned above in the table. 4. All structural calculations of cold formed steel section for checking the adequacy for strength and deflection criteria is to be done taking into consideration the maximum permissible negative tolerance over specified BMT i.e, the lower limit of						
Painting of Steel Surfaces embedded in Concrete : For the portion of Steel surfaces completely embedded in Concrete as reinforcement or otherwise for foundation systems, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).							

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7.	<p>C. Bidder shall also use principles governing design that shall prevent or reduce the risks of corrosion as per IS 9172 and other relevant IS codes.</p> <p>Connections: Supply of all connections for Module Mounting system as below shall be in the scope of Bidder:</p> <table><tr><th>Sr. No.</th><th>Connection</th><th>Grade</th></tr><tr><td>1</td><td>Solar PV module to purlin/structure connection</td><td>SS304, A2-70</td></tr><tr><td>2</td><td>Foundation Anchoring.</td><td>HDG 4.6</td></tr></table> <p>Note: Fastener shall conform to IS 1367</p> <p>A. SS304 Fasteners (nuts, bolts, washers and U-bolts) shall be of corrosion-resistant austenitic steel. SS 304 Fasteners shall have a good anti-seize finish with proper wax coating for better durability and firm resistance to all types of failure including seasonal removal and re-fixing of bolts.</p> <p>B. All fasteners shall be provided according to the connection design requirement. All bolts shall be tightened with designed torque mechanically immediately after the erection of MMS to avoid any possible damage due to any incidental storm during the erection stage.</p> <p>C. One set of fasteners shall consist of one hexagonal head nut, one hexagon shape bolt, and two washers. The bots and nuts with inbuilt washers may also be provided.</p>	Sr. No.	Connection	Grade	1	Solar PV module to purlin/structure connection	SS304, A2-70	2	Foundation Anchoring.	HDG 4.6
	Sr. No.	Connection	Grade							
	1	Solar PV module to purlin/structure connection	SS304, A2-70							
	2	Foundation Anchoring.	HDG 4.6							
8.	<p>Foundation System</p> <p>Top of concrete/ height of collar for MMS foundation shall be minimum 150 mm above Finish ground level. The proposed foundation system for MMS shall be based on findings/results of the approved geo technical investigation report. Following kind of foundation may be provided:</p> <ol style="list-style-type: none">Short pile foundation (Min. 300mm dia.)Rock anchor with concrete collar (Min. 700 sq.cm.)Isolated, strip or raft foundationConcrete ballast foundation									
	<p>List of applicable Indian standards</p> <p>IS 2062 - Hot Rolled Medium and High Tensile Structural Steel.</p>									

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	<p>IS 811 - Cold Formed Light Gauge Structural Steel Sections.</p> <p>IS 1161- Steel Tubes for Structural Purposes.</p> <p>IS 4923 - Hollow steel sections for structural use.</p> <p>IS 4759 - Hot-dip zinc coatings on structural steel and other allied products</p> <p>IS 4736 - Hot-dip zinc coatings on mild steel tubes</p> <p>IS 1868 - Anodic coatings on aluminium and its alloys.</p> <p>IS 2629 - Recommended practice for hot-dip galvanizing of iron and steel.</p> <p>IS 15961 - Hot dip aluminium-zinc alloy metallic coated steel strip and sheet (plain)</p> <p>IS 9172 -Recommended design practice for corrosion prevention of steel structures.</p>

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	<p style="text-align: center;">C-5 CIVIL & STRUCTURE WORKS - GENERAL DESIGN CRITERIA</p> <p>1.0 GENERAL</p> <p>The layout, design and drawings for Buildings, Structure and foundation system shall be approved from END CUSTOMER before the start of works. Design of RCC and Steel structures shall be carried out as per IS 456 and IS 800 respectively. Refer appendix-D1 for site specific design parameters.</p> <p>2.0 INVERTER ROOMS & SECURITY ROOM</p> <p>The following structures shall be designed and provided by the bidder:</p> <p>A. CMCS Buildings: For the operation and maintenance of SPV Plant one Central Monitoring and Control Station (CMCS) building shall be provided. The CMCS building shall consist of the following as minimum:</p> <ol style="list-style-type: none"> 1. SCADA & PPC Panel and Control Room. 2. LT Switchgear and UPS Room (As applicable) 3. UPS Battery Room 4. Store-room. 5. Owner's office. 6. Conference Room 7. Owner's Overnight stay/Transit rooms. 8. Toilets (Male and female). 9. Pantry. 10. Panoramic observation deck on terrace of CMCS building. <p>Bidder to adhere to the Tender Drawing and equipment's manufacturers requirements for development of layout. The CMCS shall be RCC framed structure with bricks/concrete blocks masonry walls. Steel Frame (instead of RCC) with Brick Walls is permitted as an additional option. It can be Prefab building also but Brick Work is compulsory to avoid issues of Insulation - Detailed Aesthetics & Functional requirements would be finalized as per detailed design - Roof will be with RCC Slab only. The CMCS shall have entry lobby and portico with a roof for vehicle stoppage. Parking shed to accommodate at least 2 cars and 5 bikes shall be provided near the CMCS building. The parking shed shall be made of structural steel conforming to IS 1079/2062 with permanently color coated roof sheets. The minimum size & requirements of the CMCS Building & all items shall be as tender drawing title: "Details of Central Monitoring & Control Station".</p>

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2.1	<p>B. Inverter Rooms: Inverter rooms consist of PCU's, LT panels, batteries, etc. shall be provided based on manufacturer recommendation, easy passage of O&M persons and cable trench layout required.</p> <p>The inverter rooms shall be made through any of the options as mentioned below:</p> <ul style="list-style-type: none"> a) RCC framed structure with bricks/concrete blocks masonry walls, b) Pre-Engineered Building in line with PEB Tender drawing & technical specification (IR PEB shall be provided only in non-coastal area), c) Steel Containerized solutions. d) On elevated RCC Platform with Mono Slope Roof/Dual Slope Roof <p>The battery and its associated equipment shall be suitably segregated inside the Inverter room with proper ventilation arrangement.</p> <p>The equipment inside the inverter room shall be placed to provide sufficient space for their maintenance.</p> <p>C. Security Room: Prefabricated security room or brick/stone masonry with RCC slab near the entry of the main gate. The toilet room shall be made of brick/stone masonry with water facility, drainage and sewage facility.</p> <p>D. Store Room (PEB): One store shed shall be constructed near CMCS Room for storage of Mandatory Spares during O&M Period by bidders and later on for END CUSTOMER after O&M period.</p> <p>The buildings and allied works shall be designed to meet NATIONAL BUILDING CODE (SP: 07 2016) requirements. Finish floor level of all building/rooms shall be minimum 450 mm above from Finish graded level.</p> <p>All railings in CMCS Building (if applicable), Inverter rooms and other buildings shall be made of Stainless steel.</p> <p>SPECIFICATION FOR (CENTRAL MONITORING AND CONTROLS STATION (CMCS) BUILDINGS AND OTHER RCC/MASONRY STRUCTURE.</p> <p>The CMCS building shall be made of RCC framed structure with bricks/concrete blocks masonry walls. Any building including CMCS if made of RCC framed structure with bricks/concrete blocks masonry walls will be made in line with provisions of IS 456. The thickness of outer masonry walls shall be minimum 230mm in case of bricks and minimum 200mm thick in case of concrete blocks. The roof shall be designed for a minimum superimposed load to 150 kg/m².</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>2.2</p>	<p>The bidder shall also provide rainwater harvesting system at all RCC building roofs (if provided).</p> <p>SPECIFICATION OF INVERTER ROOMS (PEB):</p> <p>The Inverter Rooms shall be made of Pre-Engineered Buildings (PEB). The architectural and civil works drawing of Pre Engineered - Inverter Rooms are provided in the technical specification, tender drawings. Bidder shall prepare the detailed fabrication and civil construction drawings based on tender drawing title: “Pre-Engineered Building- Store Shed/Inverter Room” and submit to END CUSTOMER for approval before the start of work. PEB shall be supplied and erected by the bidder/PEB agency. The PEB shall be made of structural steel construction with double skinned metal roofing and wall cladding of approved profile. PEB shall be complete with painting, metal fascia, metal gutter, rainwater down comers, sun-shades, openings, etc., along with associated structural steel, cladding and roofing work insulation, Trims & Flashings. Each item of PEB like panels, masonry, plastering, flooring, foundation, fittings etc. shall be suitable for the complete life of the solar plant. The construction methodology for PEB shall also be submitted for END approval before the start of works.</p> <p>The layout of the Inverter room shall be designed so as to divert the heat generated from each inverter outside the room. The inverter room shall be designed for a life of 25 years. The PEB shall have a robust water tightness at all joints and connections. The building shall have a high class durability and performance during the adverse weather conditions. The PEB supplied shall be complete in all respect meeting all the requirements of tender drawings and other technical and functional requirements like lighting, ventilation system etc. to ensure effective functioning.</p> <p>PEB length can be determined based on actual requirement, however, the grid spacing shall be maintained as per tender drawing title: “Pre-Engineered Building- Store Shed/Inverter Room”.</p> <p>2.2.1</p> <p>Structure and material specification:</p> <p>The PEB inverter room structural members shall meet the requirements of tender drawings. All hot rolled primary structural members and Rod/Angle/Pipe bracing etc. shall conform to IS: 2062, minimum Grade E250 Quality A. Secondary members for Purlins and Girts shall conform to the specification of IS 811 or ASTM A1003-12 made from steel sheets conforming to ASTM A1011-</p>

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	<p>12b Grade 50 having a minimum yield strength of 345 MPa. The minimum thickness of secondary members shall be 3mm. All other miscellaneous secondary members shall have the minimum yield strength of 250 MPa.</p> <p>Insulated wall cladding or roofing shall consist of double skin metal cladding with Poly Urethane Foam (PUF). PUF must be made of continuous method PU foam and must be CFC free, self-extinguishing, fire retardant type with density 40 +/-2 kg/m³ and thermal conductivity 0.019-0.023 W/(m.K) at 10°C. The PUF panels shall be a factory made item ready for installation at site.</p> <p>2.2.2 Fasteners & Connections:</p> <p>Special coated self-drilling screws/fastener shall be used conforming to class 3 as per AS 3566.1 and AS 3566.2. Steel bolts, nuts and washers complying with AS 1112:2000. High Strength Bolts for Primary Connections IS 1367 (Part III) Gr. 8.8 / ASTM A325. Bolts for Secondary Connection IS 1367 (Part III) Gr. 4.6 / ASTM A307. Anchor/foundation Bolts shall conform to IS 5624 and relevant IS code.</p> <p>2.2.3 Roof and Wall cladding:</p> <p>PUF panels shall be made of troughed permanently colour coated metal sheets of steel for roofing and side cladding (internal and external) shall conform to the requirements of Table-1 and IS: 513 for Hot-dip Zinc coated or Al/Zn coated sheets. The insulation material thickness and details shall be as specified at the relevant para in the specification.</p> <p>PUF insulated panels Metal Sheet for Roofing and side cladding consist of an external sheet as troughed permanently colour coated sheet & internal sheet as plain permanently colour coated sheet.</p> <p>The chemical composition of Troughed permanently colour metal sheet for roofing and side cladding shall conform to the provisions of same reference code to which the mechanical properties conform to.</p> <p>Plain permanently colour coated steel metal sheet for ridge and hips, flashing, trimming, closure for vertical and horizontal joints, capping etc. shall conform to the same requirements as those of troughed permanently colour coated metal sheet for roof and side cladding.</p> <p>The maximum spacing of the fastener shall be 390 mm c/c along the length of purlins/runners. However exact spacing shall be as per the design was done by</p>

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	<p>the bidder of the fastener considering the wind load, self-load and other associated load. The minimum diameter of the fastener shall be 5.5 mm and at-least 3 nos. of fastener shall be used per sheet.</p> <p>Fillers blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The fillers blocks shall be manufactured from black synthetic rubber or any other material approved by the engineer.</p> <p>2.2.4 Roof Insulation and type:</p> <p>Both metal sheets shall have an under insulation of minimum 40 mm thick PUF with density 40 +/- kg/m³ and thermal conductivity 0.019-0.023 W/(m.K) at 10°C with gutters and down take pipes along with Flashing & Top cap of the required size and colour complete with all necessary hardware complete. The roof shall be projected at-least 300 mm from the wall.</p> <p>Stiffening ribs / subtle fluting for effective water shedding and special male / female ends with full return legs on side laps for purlin support and anti-capillary flute inside lap.</p> <p>Both upper and lower sheets shall be separated through spacers and fastened through zinc /zinc-tin coated self-drilling screws. The fastener size shall be calculated as per the design or manufacturers recommendations.</p> <p>2.2.5 Wall Insulation:</p> <p>All voids of external and internal metalled walls shall have an under insulation of minimum 40 mm thick PUF with density 40 (+/- 2 kg/m³) and thermal conductivity 0.019-0.023 W/(m.K) at 10°C with proper supports etc. as approved.</p> <p>Both the walls should be separated by spacers system made up of cold-formed steel bars and fastened through zinc /zinc-tin coated self-drilling screws.</p> <p>The external wall of Inverter room facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.</p> <p>2.2.6 Doors Frames:</p> <p>Door frames shall be of the iron frame of mild steel sections. All doors shall be provided necessary fittings like hinges, handles, mortice locks, tower bolts,</p>

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	<p>stopper, hydraulic door closer, etc. of CP brass complete fixed to Pre-Engineered structure including necessary filling up of gaps at junctions with required PVC/neoprene felt etc. including hinges / pivots and double action hydraulic floor spring/ hydraulic door closer of approved brand and manufacture IS: 6315 marked, lock, handle and all necessary fittings as detailed in tender drawing or submitted by bidder in shop drawing and approved by END CUSTOMER</p> <p>The door entrance shall include Mild Steel single leaf door. The structural steel shall conform to IS 7452 and IS 2062. The holdfasts shall be made from steel flats (50 mm and 5 mm thick). The fixtures, fastenings and door latch are to be made with same materials.</p> <p>Bidder can also proposed uPVC extruded casement/ sliding doors, with complete fitting, accessories and panels as per items mentioned in DSR 2016.</p>
2.2.7	<p>Windows Frame:</p> <p>Aluminum black powder coated section, frame shall be of 92x31 mm, minimum 16G thick as per approved design. Tinted glass and aluminum grill shall be provided.</p> <p>The Bidder can also propose uPVC extruded casement/ sliding windows with complete fitting and accessories as per items mentioned in DSR 2016.</p>
2.2.8	<p>Ventilators:</p> <p>Aluminum black powder coated frame of minimum size 62x25 mm and 16G thick as per approved design. Ventilators/duct shall be provided with bird guard. Size of opening at the wall for ducts shall be as per PCU manufacture and min 18 gauge GI sheet. Ducts shall be supported with suitable means, as approved during detail engineering.</p> <p>All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, tinted for preventing solar radiations. Suitable sunshades made out of approved colour sheet will be provided to all external windows and door. The minimum projection for the sunshades will be 450 mm and 300mm wider than the width of the opening.</p>
2.2.9	<p>Rolling shutter:</p> <p>Rolling shutter (Hand operated) shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling Shutter with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast</p>

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	<p>iron clips to IS:2108 and shall be designed to withstand a wind load without excessive deflection. Metal rolling shutters and rolling grills as IS: 6248.</p>
2.2.10	<p>Plinth Protection:</p> <p>500 mm wide plinth protection minimum with 75 mm thick of cement concrete 1:3:6 (1cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth, shall be provided around the Pre-Engineered Building.</p>
2.2.11	<p>Floor Finish:</p> <p>Flooring, including preparation of the surface, cleaning etc. shall be of cement concrete flooring as per IS: 2571 with ironite hardener. The inverter room floor shall be at least 450 mm above the ground level.</p>
2.2.12	<p>Paint and Coating:</p> <p>Metal sheet shall be colour coated with total coating thickness of 40 microns (nominal) dry film thickness (DFT) comprising of silicon modified polyester (SMP with silicon content of 30% to 50 %) paint or Super Durable Polyester (XRW) paint of 20 microns (nominal) on one side (exposed face) on 5 micron (nominal) primer coat and 10 microns (nominal) SMP or Super Durable Polyester paint over 5 micron (nominal) primer coat on other side (internal face). SMP and polyester paints system shall conform to Product type 4 as per AS/ANZ 2728.</p> <p>The structural steel shall be hot-dipped galvanized, conform to IS: 4759 or relevant Indian standard</p>
2.2.13	<p>Lighting:</p> <p>The inverter room shall be provided with electric light to achieve an average illumination level of 150 Lux. However, room should be designed to utilize maximum natural light during the day.</p>
2.2.14	<p>Descriptions of PEB Structures:</p> <p>Primary Members: Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind columns, beams, truss member, base plate.</p> <p>Secondary Members: Secondary structural framing shall include the purlins, girts, eave struts, bracing, flange bracing, base angles, clips, flashings and</p>

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other miscellaneous structural parts. Suitable wind bracings sag rods to be reckoned while designing the structure.

Sealant: Sealant used for cladding shall be butyl based, two parts polysulphide or equivalent approved, non-staining material and be flexible enough not to interface with fit of the sheets.

Closures: Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations

Flashing and Trim: Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of the wall. The material shall be 26 gauge thick conforming to the physical specifications of sheeting.

Gutters and Down Comers: Gutters shall be fabricated out of same metal sheet. Material shall be same as that of sheeting. Down comers shall be of galvanized steel pipes or PVC designed to ensure proper roof drainage system.

Table-1

Group	Grade/Reference code	Yield strength (minimum) MPa	Tensile strength (minimum) MPa	Coating Class Designation	BMT (mm)	(+) ve Tolerance (mm)	Upper limit of BMT (mm)	(-) ve Tolerance (mm)	Lower Limit of BMT (mm)
I	G250/AS1397	250	320	Z275	0.6	0.04	0.64	-0.04	0.56
	SS255/ASTM A653M	255	360						
	S250GD/EN10326	250	330						
	G350/AS139	350	420						

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II	7			AZ150	0.5	0.04	0.54	-0.04	0.46
	SS340 Class 4/ ASTM A792M	340	410						
	S350G D/ EN10326	350	420						
N O T E	Minimum elongation % shall be as per relevant Standard and Code.								

All steel materials supplied by the Agency shall be in a sound condition, of recent manufacture, free from defects, loose mill scale, slag intrusions, laminations, pitting, flaky, rust, etc. and be of full weight and thickness specified.

2.3 SPECIFICATION OF STORE ROOM:

One store shed (in addition to all other stores and PEB Invertor room) shall be constructed near CMCS Room for storage of Mandatory Spares during O&M Period by bidders and later on for END CUSTOMER after O&M period. The Store shed shall be a Pre Engineered Building with framed structure.

The height of store shall be minimum 5 meters and it shall be covered from all four sides. The store PEB size shall be minimum 250 square meter (width of approx. 7-10m. Refer Technical Specifications Part A for any additional requirements). The store shall have wide gate entry for crane movement and secured against theft etc. The roof and side walls of the store shall be made of permanently color coated galvalume profile sheets. The minimum BMT (Base material thickness) of roof and side wall sheets shall be 0.5mm. Gate provision shall be made on at least three sides of the shed with suitable ramps. The store shall be at least 500mm above NGL & minimum 1 meter height brick works above plinth level all around the store room. The roof sheet shall have a projection of 500 mm on all around.

The building shall be made of structural steel material as per relevant IS codes. All RCC work shall be in line with IS: 456. Alternatively, the store shed may also be made with structural steel columns with self-supporting roof truss system. The store shed shall be designed in line with wind loads as per IS: 875, part-III.

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	<p>The store shed shall be designed as a permanent structure with 25 years age. The store shed flooring shall be made of 150mm thick RCC (reinforcement of 8 dia at 200mm c/c both side, single layer) laid over 200mm thick well graded and compacted boulders with sand. All structural members shall be painted with minimum two coats of synthetic enamel paint over one coat of primer. The design and drawing of the store shed shall be submitted for END CUSTOMER approval before start of work.</p>				
3.0	<p>GENERAL CIVIL WORKS</p>				
3.1	<p>REINFORCED CONCRETE STRUCTURE, ALLIED WORKS AND FOUNDATION</p> <p>a) All RCC works shall be designed mix as per IS 456 (2000). For structural concrete items, Ordinary Portland cement (43 Grade) conforming to IS: 8112 and Fly ash-based Portland pozzolana cement conforming to IS: 1489 (Part-1) shall be used for superstructure. Type of cement for sub-structures shall be decided based on the approved geotechnical Investigation report and special protection measures against chemically aggressive environment, specified at Cl.2.2 of Chapter C-1 of this specification.</p> <p>b) Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.</p> <p>c) Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.</p> <p>d) Reinforcement steel:</p> <table border="1"> <thead> <tr> <th>Non-coastal area</th><th>Coastal area</th></tr> </thead> <tbody> <tr> <td>Reinforcement steel shall be of high strength deformed TMT steel bars of grade minimum Fe-415 and shall conform to IS: 1786. Ductile detailing in accordance with IS: 13920 shall be adopted for superstructure and substructure of all RCC buildings/structures</td><td>Reinforcement steel shall be of high strength deformed TMT steel bars with corrosion inhibitors, Corrosion Resistant Steel (CRS) re-bars, Fusion Bonded Epoxy Coated (FBEC) re-bars or Zinc Coated re-bars of grade minimum Fe-415 shall conform to IS: 1786. Ductile detailing in accordance with IS:</td></tr> </tbody> </table>	Non-coastal area	Coastal area	Reinforcement steel shall be of high strength deformed TMT steel bars of grade minimum Fe-415 and shall conform to IS: 1786. Ductile detailing in accordance with IS: 13920 shall be adopted for superstructure and substructure of all RCC buildings/structures	Reinforcement steel shall be of high strength deformed TMT steel bars with corrosion inhibitors, Corrosion Resistant Steel (CRS) re-bars, Fusion Bonded Epoxy Coated (FBEC) re-bars or Zinc Coated re-bars of grade minimum Fe-415 shall conform to IS: 1786. Ductile detailing in accordance with IS:
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TECHNICAL SPECIFICATIONS																					
CLAUSE NO.																					
	<table><tr><td></td><td>13920 shall be adopted for superstructure and substructure of all RCC buildings / structures. Dense concrete around reinforcement, provision of thick covers, and addition of corrosion protection with re-bars shall be provided to the RCC structures</td></tr></table> <p>e) The following minimum grades of concrete for design mix and nominal mix shall be adopted for the type of structures noted against each unless not specified elsewhere.</p> <table><tr><th>Grade as per IS 456</th><th>Non-coastal area</th><th>Coastal area</th></tr><tr><td>M30</td><td>-</td><td>All RCC structural elements above and below ground level, precast concrete, transformer foundation, Equipment foundation, cable trench, oil pit, Grade Slab, Paving, culverts, road and MMS Foundation.</td></tr><tr><td>M25 (in-situ concrete) M30 (Precast)</td><td>All RCC structural elements above and below ground level, precast concrete, MMS foundation, cable trench, oil pit, Grade Slab, Paving, culverts</td><td>-</td></tr><tr><td>M25</td><td>Fencing work.</td><td>Fencing work, Base slab of drains. Plain Concrete Cement.</td></tr><tr><td>M25</td><td>Base slab of drains.</td><td></td></tr><tr><td>M15</td><td>Plain Concrete Cement.</td><td></td></tr></table> <p>The bidder shall carry out the design mix of M-30 and M-25 grade concrete on priority. The design mix shall be approved from END CUSTOMER before the start of work.</p>		13920 shall be adopted for superstructure and substructure of all RCC buildings / structures. Dense concrete around reinforcement, provision of thick covers, and addition of corrosion protection with re-bars shall be provided to the RCC structures	Grade as per IS 456	Non-coastal area	Coastal area	M30	-	All RCC structural elements above and below ground level, precast concrete, transformer foundation, Equipment foundation, cable trench, oil pit, Grade Slab, Paving, culverts, road and MMS Foundation.	M25 (in-situ concrete) M30 (Precast)	All RCC structural elements above and below ground level, precast concrete, MMS foundation, cable trench, oil pit, Grade Slab, Paving, culverts	-	M25	Fencing work.	Fencing work, Base slab of drains. Plain Concrete Cement.	M25	Base slab of drains.		M15	Plain Concrete Cement.	
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3.2	<p>* The use of nominal mix for M-20 grade (If applicable) may be accepted only in exceptional cases subject to approval of END CUSTOMER Engineer-In-Charge. The same shall be the adopted subject to approval from END CUSTOMER for specific work.</p> <p>f) In case Geotechnical investigations require any special kind of cement or higher grade of concrete, the same shall be provided. The foundation system shall be made which transfer loads safely to the soil for the module mounting structures, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. No foundation allowed on back filled soil and the foundation depth to reach upto natural ground level (NGL).</p> <p>g) All loads shall be considered in line with IS: 875. Seismic loads for design shall be in accordance with IS: 1893 and relevant Standards.</p> <p>h) IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must complied for reinforcements. IS 5525 and SP 34 shall be followed for reinforcement detailing.</p> <p>i) A minimum 75 mm thick PCC shall be provided below RCC wherever RCC structure is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS 456.</p> <p>Masonry Work</p> <p>a) Brickworks shall be using at least class designation 7.5 of approved quality as per IS: 1077, IS: 2212 and IS: 3495. Concrete blocks shall be of a minimum compressive strength of 7.5 N/mm² and shall be of Grade-A as per IS: 2185. Stone masonry work with hard stone in building works, foundation, plinth and drains shall be Coursed Rubble or Random Rubble masonry work with the stone of good quality and durability. The masonry surface shall be plastered with minimum 18mm plaster in case of CMCS walls. The stone masonry work shall be in line with IS: 1597, IS: 1122 and IS: 1126.</p> <p>b) The cement mortar for all kind of masonry work shall be in the ratio 1 cement and 6 sand by weight.</p> <p>c) Bricks/blocks required for masonry work shall be thoroughly soaked in the clean water tank for approximately two hours. Brick shall be laid in English bond style. Green masonry work shall be protected from rain. All masonry work shall be kept moist on all the faces for a period of seven days.</p> <p>d) Bricks of class designation 5.0 N/mm² and 3.5 N/mm² may be permitted to have slight distorted & rounded edges provided no difficulty shall arise on this account in laying of uniform courses in non-load bearing structures and</p>

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3.3	<p>shall be subject to the approval of END CUSTOMER. Tolerances on dimensions up to +/- 8% shall be permitted. Dimension test to be carried out as per IS code.</p> <p>e) The external wall for the building shall be 230 mm thick walls and internal wall 230/115 thick as per requirements. The external wall of CMCS facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.</p> <p>f) Use of fly ash brick for masonry shall be subjected to approval of END CUSTOMER.</p> <p>g) The suitable damp proof course shall be provided the proportion of cement, sand & aggregate shall be 1:2:4 using 6 mm down stone chips with a waterproofing admixtures. The thickness of the damp-proof course shall be minimum 40 mm.</p>
3.4	<p>Plastering All external surfaces shall have 18 mm cement plaster in two coats, under layer 12 mm thick cement plaster 1:5 and finished with a top layer 6 mm thick cement plaster 1:6 (DSR 2013-13.11). White cement primer shall be used as per the manufacturer's recommendation.</p> <p>At least one coat of plaster shall be applied to interior walls by hand or mechanically, to a total thickness of 12 mm using 1:6, 1 cement and 6 sand. Plastering shall conform to IS 1542, IS 1661, IS 1630. Oil bound washable distemper on smooth surface applied with minimum 2 mm thick Plaster of Paris putty for the control room. Plaster of Paris (Gypsum Anhydrous) conforming to IS: 2547 shall be used for plaster of Paris punning.</p>
3.5	<p>Water Supply GI pipes of Medium quality conforming to IS 1239 (Part I-1990) or CPVC pipes conforming to IS 15778 shall be used for all portable hot and cold-water distribution supply and plumbing works.</p> <p>The Sintex or equivalent make PVC storage water storage tank conforming to IS: 12701 shall be provided over the roof of the CMCS with adequate capacity for 10 No person and 24-hour requirement, complete with all fittings including float valve, stopcock etc. The capacity of the tank shall be minimum 500 litres. The tank(s) shall be suitably covered/ thermally insulated to prevent overheating of water due to direct sunlight.</p> <p>Grouting Cement mortar (1:2) grout with non-shrink additives shall be used for grouting below base plate of a column. The grout shall be high strength grout having a minimum characteristic compressive strength of min 20 N/mm² at 28 days.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
3.6	<p>Structural Steel Structural steel design shall be carried out as per IS 800 and IS 801. Structural steel shall conform IS 2062 / IS 1079 or equivalent, Pipe shall be as per medium/high grade of IS 1161, Chequered plates shall conform to IS 3502 and Hollow steel sections for structural use shall conform to IS 4923.</p>
3.7	<p>Structural Steel/Steel Sheet Painting All non-hot dip galvanised structural steel (excluding Module Mounting & SCB structure)/ Outdoor metal containers/ Enclosure/ Rolling shutter items shall be provided with paint designed for a minimum maintenance-free life of fifteen (15) years (high durability) as per ISO 12944 and IS 800 or equivalent for its corrosion category. For finishing coat suitable colour pigment shall be added. All paints including primer shall be of the reputed brand/manufacturer and as approved by the Engineer-In-charge. The method of application shall be as per the recommendations of the manufacturer. For corrosive category of refer appendix of site-specific data.</p>
4.0	<p>Transformer Yard and Metering Yard Civil Works</p> <ul style="list-style-type: none"> a) Transformer and equipment's foundations shall be founded on piles/isolated spread footings depending on the final geotechnical investigation report. Metering yard equipment's structures shall be designed as per IS 801 and IS 800. b) Transformer foundations shall have its own pit which would cover the area of the transformer and cooler banks, so as to collect any spillage of oil or oil drainage in case of emergency. The oil pit shall be filled with granite stones of 40 mm size uniformly graded. c) The bidder can propose soak pit under Transformer or Burnt oil pit at a distance connected to transformer soak pit depending upon oil quantity in Transformers. It shall be sized to accommodate the oil volume of the transformer connected to it, without backflow. The Gravel-filled level under transformer shall be in accordance with FGL outside pit and transformer bottom level. d) The area around the transformer and equipment's shall be covered with gravel and galvanized chain link fence of height min 1.8 m with fence posts and gates shall be provided. The portion of the fence covering towards rail track shall be made of a removable type for movement of the transformer during erection /removal. In addition, a small gate, 1.2 m wide shall be provided for an entry. The transformer yard fencing work shall conform to CEIG requirements.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
5.0	<p>e) Transformer track rails shall conform to IS 3443. The requirement of a fire barrier wall between transformers shall be as per Electricity Rules and IS 1646 recommendations.</p> <p>PIPE /CABLE RACKS & TRENCHES</p> <p>a) The conventional methods of cables laying and installation shall conform to IS 1255 for laying direct in ground, drawing in ducts, laying on racks in air, laying on racks inside a cable tunnel and Laying along buildings or structures, etc.</p> <p>b) Outdoor RCC Cable Trenches: RCC outdoor cable trenches in switchyard area shall be provided with pre-cast RCC removable covers with lifting arrangement. The top of outdoor trenches shall be kept at least 100 mm above the gravel level so that rainwater does not enter the trench.</p> <p>c) Indoor RCC Cable Trenches: RCC indoor cable trenches shall be provided with 50X50X4 mm angles grouted on the top edge of the trench wall for holding minimum 6 mm thick mild steel checkered plate covers conform to IS: 3502 with lifting arrangement.</p> <p>d) RCC cable trenches shall be constructed with wall thickness minimum 100 mm.</p> <p>e) Trench Drainage: The trench bed shall have a slope of approx. 1/500 along the run & 1/250 perpendicular to the run. Incase straight length exceeds 30 m, suitable expansion joint shall be provided at appropriate distances. The expansion joint shall run through vertical wall and base of the trench. All expansion joints shall be provided with approved quality PVC water stops. Suitable drainage at the lowest point of the trench shall be provided.</p>
6.0	<p>PLANT DRAINAGE SYSTEM</p> <p>a) All Drains within a plot are in Bidder's Scope. Lining of drains shall be as per provisions of Bidding Documents and applicable IS/IRC Code provisions.</p> <p>b) Surface drainage system shall be designed considering 'Heaviest rainfall in one hour in mm'. The minimum value of surface run off coefficient shall be considered as per IRC: SP:50 in the design of drainage system. The drainage system shall be designed as per the IRC specifications and prevailing industry practices.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS												
	<p>c) The drainage scheme shall be designed considering the catchment areas contributing to the existing drains, solar plant gradients and solar PV array layout. As per plant drainage requirement, a network of open drains shall be designed & provided to carry surface runoff. The drains shall be trapezoidal, rectangle section made of earthen type lining (Compacted Earth Lining) and hard surface lining (stone masonry/pitched, Boulder, Precast cement concrete/stone slab, <i>in-situ</i> cement lime/concrete lining, soil cement lining, etc.)</p> <p>d) Bidders can also propose suitable detention pond, recharge dugwells, recharge pits, recharge trenches, and recharge soakways for quick disposal of storm water in the vicinity of the solar block/plot.</p> <p>e) Bidder shall also ensure that drainage from his plot does not encroach/flood into the adjacent property and adjacent solar plots (if any). Bidder shall try to maintain existing natural drain and shall remodel the natural drains in case of any disturbance made. The same shall be as per the technical/design requirements without affecting the drainage pattern. The bidder plot drainage scheme shall include to drain out the drainage of the allotted plot and shall include contributing catchment area consisting of adjoining plots and nearby catchment area.</p> <p>f) Provision of culverts and their design to be submitted separately. The road on the culvert portions of the drains shall be concrete road.</p> <p>g) All Buildings shall be provided with plinth protection all around, sloped towards side drains. Plinth Protection shall be 75mm mm thick PCC laid over well compacted 75mm well grades brick ballast base. Building peripheral drains shall be stone masonry/brick masonry/concrete works. These side drains shall be connected to area drains by either open drains or combination of open drains and underground pipes.</p> <p>h) Grade level shall be fixed with due reference to highest high flood level of the receiving body of water. Laying of Hume pipe shall be in line with IS: 783.</p> <p>i) Recommended Side Slopes for lined and unlined drains, other than RCC drains and Brick wall drains</p> <table><tr><th>Sl</th><th>Type of Soil</th><th>Side Slopes (Horizontal: Vertical)</th></tr><tr><td>1.</td><td>Very light loose sand to average sandy soil</td><td>2: 1 to 3: 1</td></tr><tr><td>2.</td><td>Sandy loam, Ordinary soil</td><td>1.5 : 1 to 2 : 1 (in cutting) 2 : 1 (in embankment)</td></tr><tr><td>3.</td><td>Sandy gravel/murum</td><td>1.5 : 1 (in cutting) I.S : 1 to 2 : 1 (in embankment)</td></tr></table>	Sl	Type of Soil	Side Slopes (Horizontal: Vertical)	1.	Very light loose sand to average sandy soil	2: 1 to 3: 1	2.	Sandy loam, Ordinary soil	1.5 : 1 to 2 : 1 (in cutting) 2 : 1 (in embankment)	3.	Sandy gravel/murum	1.5 : 1 (in cutting) I.S : 1 to 2 : 1 (in embankment)
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	<p>All above parameters may be suitably adjusted based on inputs being made available by END CUSTOMER(Owner) for reference purpose. Also, any specific reference mentioned for Drain design in any IS Code or IRC Code would also be acceptable subject to approval of overall design during detailed Engineering stage.</p> <p>All project drains would connect to the main drains of Park as per detailed layout to be prepared during detailed Engg. stage.</p>										
7.0	<p>ELECTRIFICATION OF BUILDING</p> <p>Electrification of all building shall be carried out as per IS 732-1989, IS: 4648-1968 and other relevant standards.</p>										
8.0	<p>APPROACH ROADS</p> <p>The approach road to the Solar Power Plant shall originate from the main approach road and connect to CMCS building, Metering yard/ Switchyard and Gates (whether or not such buildings are in Bidder's scope, all internal roads and their connection to Park facilities within project would be in Bidder's Scope only).</p>										

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9.0	<p>Approach Road: The approach road to the Solar Power Plant shall originate from the main approach road and connect to all Inverter rooms, module cleaning station and gates. Approach road shall be minimum 3.0 meter wide with minimum 500 mm wide shoulder on both sides.</p> <p>Main Roads between the plots have been marked in the Layout Drawings, internal roads within the plot would be finalized as per bidder's detailed array layout.</p> <p>Internal roads (with in the plot) shall be constructed as per respective Tender Drawing.</p> <p>LIST OF APPLICABLE INDIAN STANDARDS</p> <p>Indian codes, and/or standards shall govern, in all the cases wherever they are available. In case of a conflict between such codes and/or standards and the specifications, the stringent provisions shall govern. Such codes and/or standard referred to shall mean the latest revision, amendments/changes adopted and published by the relevant agencies. In case of any further conflict in this matter, the same shall be referred to the Engineer-in-charge, whose decision shall be final and binding.</p> <p>Other internationally acceptable standards shall be accepted, only if, no Indian Standards are existing. However, other standards also will be accepted if the Bidder establishes that the works are meeting the requirements of Indian Standards also.</p> <p>A brief list of Indian Standards applicable to these works is as below:</p> <p>General</p> <table border="1"> <tr> <td>IS: 875-I</td><td>Code of Practice for Design Dead Loads for Building and Structures</td></tr> <tr> <td>IS: 875-II</td><td>Code of Practice for Design Imposed Loads for Building and Structures</td></tr> <tr> <td>IS: 875-III</td><td>Code of practice for design loads (other than earthquake) for buildings and structures.</td></tr> <tr> <td>IS: 1893</td><td>Criteria for earthquake resistant design of structures.</td></tr> <tr> <td>IS: 4326</td><td>Code of Practice for earthquake resistant design and construction of buildings</td></tr> </table> <p>Foundations</p> <table border="1"> <tr> <td>IS: 1080</td><td>Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)</td></tr> <tr> <td>IS: 1904</td><td>Code of practice for structural safety of building foundations</td></tr> <tr> <td>IS: 2950</td><td>Code of practice for design and construction of raft foundations.</td></tr> </table>	IS: 875-I	Code of Practice for Design Dead Loads for Building and Structures	IS: 875-II	Code of Practice for Design Imposed Loads for Building and Structures	IS: 875-III	Code of practice for design loads (other than earthquake) for buildings and structures.	IS: 1893	Criteria for earthquake resistant design of structures.	IS: 4326	Code of Practice for earthquake resistant design and construction of buildings	IS: 1080	Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)	IS: 1904	Code of practice for structural safety of building foundations	IS: 2950	Code of practice for design and construction of raft foundations.
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	IS: 4091	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles
	IS: 6403	Code of Practice for determination of bearing capacity of shallow foundations
	IS: 8009	Code of Practice for foundation settlement calculations
	IS: 2911	Design & Construction of Pile Foundation – Code of Practice
	Concrete Structures	
	IS: 456	Code of practice for plain and Reinforced concrete
	IS: 3370	Code of practice for concrete structures for the storage of liquids.
	IS: 3414	Code of Practice for design and installation of joints in buildings
	IS: 5525	Recommendation for detailing of reinforced concrete works
	IS: 6313	Code of practice for anti-termite measures in buildings
	IS: 13920	Ductile detailing of Reinforced Concrete Structures subjected to Seismic forces
	IS: 1904	Code of practice for design and construction of foundations in soils general requirements
	Steel Structures	
	IS: 800	Code of practice for use of structural steel in general building construction
	IS: 801	Code of practice for use of cold-formed light gauge steel structure members
	IS: 802	Code of Practice for use of Structural Steel in over Head Transmission Line Towers.
	IS: 806	Code of practice for use of steel tubes in general building construction.
	IS: 808	Dimensions for hot rolled steel beam, column channel and angle section
	IS: 811	Specification for Cold Formed Light Gauge Structural Steel Sections
	IS: 813	Scheme of symbols for welding
	IS: 1079	Hot Rolled carbon Steel Sheet and Strip – Specification
	IS: 2062	Hot Rolled Medium and High Tensile Structural Steel – Specification
	IS: 4923	Hollow steel sections for structural use.
	IS 1161	Steel tubes for structural purpose
	IS: 2721	Galvanised steel chain link fence fabric – Specification
	Painting and Coating	
	IS: 4736	Hot-dip zinc coatings on mild steel tubes
	IS: 4759	Hot-dip zinc coatings on structural steel and other allied products – Specification
	IS:1868	Anodic coatings on aluminium and its alloys
	IS 2395-I	Painting of Concrete, Masonry and Plaster Surfaces – Code of: Operations and Workmanship
	IS 2395-II	Code of practice for painting concrete, masonry and plaster surfaces: Schedule

CLAUSE NO.	TECHNICAL SPECIFICATIONS	
	IS 1477-I	Code of Practice for Painting of Ferrous Metals in Buildings: Pre-treatment
	IS:1477-II	Code of practice for painting of ferrous metals in buildings: Painting
	ISO 12944-1	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments
	ISO 12944-5	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems
	Water supply and sanitary	
	IS: 1239	Mild steel tubes and tubulars and other wrought steel fittings
	IS: 1172	Code of basic requirements for water supply, drainage and sanitation
	IS: 1742	Code of Practice for building drainage
	IS: 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
	IS: 15778	Chlorinated polyvinyl chloride pipes for potable hot and cold water distribution supplies
	IS: 16088	Chlorinated polyvinyl chloride pipes for automatic sprinkler fire extinguishing system
	IS: 10124	Fabricated PVC fittings for potable water supplies
	IS: 4985	Un-plasticized PVC pipes for potable water supplies
	IS: 13592	Un-plasticized Polyvinyl Chloride (PVC-U) Pipes for Soil and Waste Discharge System Inside and Outside Buildings Including Ventilation and Rainwater System
	IS: 12818	Un-plasticized polyvinyl chloride (PVC-U)screen and casing pipes for bore/tubewell
	IS: 2470	Code of Practice for installation of septic tanks
	Lining	
	IS 3872	Lining of Canals with Burnt Clay Tiles - Code of Practice.
	IS 3873	Laying cement concrete/stone slab lining on canals - Code of practice.
	IS 4515	Stone Pitched Lining for Canals - Code of Practice.
	IS 7113	Soil-Cement Lining for Canals - Code of Practice.
	IS 7873	Code of practice for lime concrete lining for canals.
	IS 9097	Guide for laying lining of canals with hot bitumen or bituminous felts.
	IS 10430	Criteria for Design of Lined Canals and Guidance for Selection of Type of Lining.
	IS 10646	Canal linings - Cement concrete tiles.
	IS 11809	Lining for canals by stone masonry - Code of practice.
	IRC:SP:50	Guidelines on urban drainage.
	Miscellaneous	
	IS: 1905	Code of Practice for structural use of un-reinforced masonry

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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">Annexure-2 Additional facilities related to CMCS Building</p> <p>1.0 Electric Bikes/Scooters</p> <p>1.1 <u>Two no. of Electric Scooter/Bikes along with all necessary accessories like chargers shall be supplied as a part of the subject package.</u></p> <p>1.2 The minimum range of the Electric Scooters/Bikes shall be 100kms on a single charge.</p> <p>1.3 The maximum charging time of Electric Scooters/Bikes from 0-100% battery charge shall be 6 hours.</p> <p>1.4 All necessary facilitation and expenses for registration of the Electric Scooters/Bikes in the name of EMPLOYER (as applicable) shall be in the scope of the contractor.</p> <p>1.5 The contractor shall arrange necessary insurance for the Electric Scooters/Bikes in the name of EMPLOYER (as applicable) as directed by the Engineer in charge until the completion of the O&M period of the project envisaged in the contract. Further, the contractor shall carry out all necessary periodic servicing/repair for the Electric Scooters/Bikes till the completion of the O&M period of the project as envisaged in the contract. All expenses relating to the above shall be in the scope of the contractor and no additional payment shall be made by EMPLOYER on account of the said expenses. The Contractor may arrange Extended warranty/AMC for the Scooters/Bikes at their own expense if they wish to, covering the complete O&M period applicable for the subject contract for carrying out periodic maintenance and repair works.</p> <p>1.6 The Electric Scooter/Bikes shall be painted with EMPLOYER logo (as applicable) of suitable size.</p> <p>2.0 Rooftop Solar PV System for Parking Shed and CMCS Buildings</p> <p>2.1 The CMCS Building and Car parking sheds shall be installed with rooftop Solar PV panels on their roofs. The Roofs of the CMCS building as well as parking shed shall be suitably designed to facilitate rooftop Solar PV installation. The rooftop Solar PV installation shall cover the entire roof area of the CMCS building and parking shed (after practical exclusions for any roof mounted equipment). A Battery Energy Storage Management System (AC coupled/DC Coupled) with suitable capacity shall be installed along with the Rooftop Solar PV System. All associated equipment for integration of Solar PV panels of CMCS building and parking shed to the BESS including but not limited to Inverters, Cables, Switchgear/Junction boxes etc. shall be installed by the contractor.</p> <p>2.2 The Solar PV system coupled with BESS shall be suitable for Grid connected as well as standalone (microgrid operation) mode of operation. The Solar PV System</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>coupled with BESS shall be integrated with the CMCS Auxiliary LT Switchgear through a changeover switch which facilitates Grid connected as well as standalone operation.</p> <p>2.3 The BESS shall be sized (with necessary margin for degradation and other loss factors) to meet a minimum requirement of charging two electric bikes/scooters during non-solar hours. Sizing calculations shall be submitted for approval during detailed engineering.</p> <p>2.4 A minimum of 1 universal Electric car charging socket/port shall be provided in each car parking slot in the parking shed. The charging port shall be suitable for the common EV car models available in Indian market. A minimum of 4 Electric Scooter/Bike Charging sockets/ports shall be provided in the Scooter/Bike parking slot of the parking shed.</p> <p>2.5 The detailed design of the above facilities shall be reviewed during detailed engineering.</p> <p>3.0 Viewing Gallery/ Observation deck over CMCS building</p> <p>A provision of viewing gallery/ observation deck shall be provided over the CMCS building. The gallery shall be located in such a manner with suitable elevation so that it faces the Solar PV plant providing panoramic view. It should have a minimum height (clear) of 4 mtrs and a minimum area of 20 sq mtrs. Suitable roof shall be provided for the observation deck. Safe approach/access is to be provided to the deck and SS railing shall be provided all around the deck.</p>
1	<div>- - -00 BOS)-</div> <div>-</div> <div>PAGE</div>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>PART-B D – GENERAL SYSTEMS</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS									
	<div>D-1 WEATHER MONITORING STATION</div> <p>As a part of weather monitoring station, Bidder shall provide following measuring instruments with all necessary software & hardware required to integrate with SCADA so as to enable availability of data from meteorological instrument in SCADA. Each instrument shall be supplied with necessary cables, transmitters and accessories (Trackers, Mounting and base stand etc.) provided by OEM of the sensors only.</p> <p>Aux. power required by instruments and data logger (If supplied) shall be from UPS only. Data logger shall have provision to receive redundant power supply. All the instruments to be supplied shall have valid calibration certificate.</p> <p>Single sensor for measuring combination of Wind Speed, Wind Direction, Relative humidity and Rainfall is also acceptable however offered sensor shall meet the specification as mentioned in following sections.</p> <p>Bidders are advised to ascertain themselves, the applicable regulation related to weather data which has to be transmitted to control centers like SLDC/RLDC (Telemetry). Any signal/parameter/equipment though not specifically mentioned but which are required as per statutory regulation are also included in the scope of bidder.</p> <div>1.0 SOLAR RADIATION SENSORS</div> <p>Contractor shall provide Solar Radiation Sensors as per specification given in following section. Contractor has the option to provide these sensors on separate base or on a single base (radiation monitoring station), shadow ring and transmitter etc. provided by the OEM. Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with solar radiation sensors. Bidder shall provide Instrument manual in hard and soft form.</p> <div>1.1 Pyranometer</div> <p>Bidder shall provide minimum 02 (Two) numbers of Secondary Standard Pyranometers as per ISO 9060 for measuring incident solar radiation as per following.</p> <ul style="list-style-type: none">Global Horizontal Irradiance (GHI)- 1 Nos.Global Inclined Irradiance (GII)-1 Nos <div>Technical Requirement of Pyranometer (for GHI and GII)</div> <table><tr><th>Sl.No</th><th>Details</th><th>Values</th></tr><tr><td>1.</td><td>Principle</td><td>Thermopile</td></tr><tr><td>2.</td><td>Spectral Response.</td><td>310 to 2800 nm</td></tr></table>	Sl.No	Details	Values	1.	Principle	Thermopile	2.	Spectral Response.	310 to 2800 nm
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1.	Principle	Thermopile								
2.	Spectral Response.	310 to 2800 nm								

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2.0	3.	Sensitivity	Min 7 micro-volt/w/m ²
	4.	Time response (95%):	Max 15 s
	5.	Nonlinearity:	±0.5%
	6.	Temperature Response:	±2%
	7.	Tilt error:	< ±0.5%.
	8.	Zero offset thermal radiation:	±7 w/m ²
	9.	Zero offset temperature change	±2 w/m ²
	10.	Operating temperature range:	0 deg to +80 deg.
	11.	Uncertainty (95% confidence Level):	Hourly- Max-3%, Daily- Max-2%
	12.	Non stability:	Max ±0.8%
	13.	Response Time(95% of final value)	<5 sec
	<p>Additionally, 01 (one) number second class pyranometer as per ISO 9060 for measurement of Diffuse Horizontal Irradiance (DHI) shall also be supplied.</p> <p>Shadow ring/ball for measuring DHI shall require no regular adjustment and shadow ring/ball. Pyranometer shall be shaded throughout the day and shall be exposed to diffuse solar radiation only to provide DHI value without any calculation.</p> <p>All the Pyranometer have to be mounted at single location at shadow free area. The GII Pyranometer has to be at the same inclination as the angular tilt of module mounting structure. The above quantity of pyranometers shall be installed at central weather monitoring system.</p> <p>Bidder shall provide 1 (One) no. Battery powered portable handheld data logger supplied by the OEM of the offered Pyranometer.</p> <p>In addition to the above, bidder shall provide one pyranometer each with same specification & SCADA integration for every 100MW capacity and part thereof to be installed at various locations inside Project which shall be finalized during detailed engineering stage. The mounting structure shall have provision to fix the pyranometer in horizontal and tilted position. Bidder also needs to provide additional pyranometer with same specification & SCADA integration for the purpose of PG test as specified in the PG test procedure chapter.</p>		
2.0	TEMPERATURE SENSORS		

Sl.No	Details	Values
1.	Principle	RTD (Platinum) Resistance proportional to temperature
2.	Range	0-50 °C
3.	Accuracy	± 0.2 °C
4.	Operating Temperature	0 to 50 °C
5.	Radiation Shield	Non-aspirated Radiation Shield

Sl.No	Details	Values
1.	Principle	RTD (Platinum) Resistance proportional to temperature
2.	Range	0-70 °C
3.	Accuracy	± 0.2 °C
4.	Operating Temperature and calibration	0 to 70 °C

Sl.No	Details	Values
1.	Principle	RTD (Platinum) Resistance proportional to temperature
2.	Range	0-100 °C
3.	Accuracy	± 0.2 °C
4.	Operating Temperature	0 to 100 °C

Sl.No	Details	Values
1.	Principle	Frequency proportional to wind speed/Ultrasonic Sensor
2.	Velocity range	0-60 m/ sec

TECHNICAL SPECIFICATIONS																
CLAUSE NO.																
3.1	<table><tr><td>3.</td><td>Threshold</td><td>0.3 m/s</td></tr><tr><td>4.</td><td>Operating Temperature</td><td>0 to 50 deg C</td></tr><tr><td>5.</td><td>Accuracy</td><td>3% (upto 35 m/s), 5% (Above 35 m/s) RMS</td></tr></table>	3.	Threshold	0.3 m/s	4.	Operating Temperature	0 to 50 deg C	5.	Accuracy	3% (upto 35 m/s), 5% (Above 35 m/s) RMS						
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	4.	Operating Temperature	0 to 50 deg C													
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	Wind Direction Sensor (Qty- 1no)															
<table><tr><th>Sl.No</th><th>Details</th><th>Values</th></tr><tr><td>1.</td><td>Principle</td><td>Potentiometric type sensor (Resistance proportional to Wind direction) /Ultrasonic Sensor</td></tr><tr><td>2.</td><td>Range</td><td>0-360 deg</td></tr><tr><td>3.</td><td>Accuracy</td><td>±5 deg</td></tr><tr><td>4.</td><td>Operating Temperature</td><td>0 to 50 deg C</td></tr></table>	Sl.No	Details	Values	1.	Principle	Potentiometric type sensor (Resistance proportional to Wind direction) /Ultrasonic Sensor	2.	Range	0-360 deg	3.	Accuracy	±5 deg	4.	Operating Temperature	0 to 50 deg C	
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4.0	RELATIVE HUMIDITY (%) (Qty- 1no)															
	<table><tr><th>Sl.No</th><th>Details</th><th>Values</th></tr><tr><td>1.</td><td>Range</td><td>0-100 %</td></tr><tr><td>2.</td><td>Accuracy</td><td>±3%</td></tr><tr><td>3.</td><td>Resolution</td><td>1%</td></tr><tr><td>4.</td><td>Operating Temperature</td><td>0 to 50 deg C</td></tr></table>	Sl.No	Details	Values	1.	Range	0-100 %	2.	Accuracy	±3%	3.	Resolution	1%	4.	Operating Temperature	0 to 50 deg C
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1.	Range	0-100 %														
2.	Accuracy	±3%														
3.	Resolution	1%														
4.	Operating Temperature	0 to 50 deg C														
5.0	Additional Measurement															
	<p>As per regulatory requirement, following measurement for the Solar PV is also included in the scope of bidder.</p> <ul style="list-style-type: none">i. Direct Normal Irradiance (DNI)ii. Sunrise and Sunset timeiii. Rainfall (mm)iv. Cloud Cover –(Okta)v. Air density <p>Instrument and accuracy for the above-mentioned measurement shall comply with applicable regulation (“Implementation of the framework on forecasting, scheduling and imbalance handling for Renewable Energy (RE) generating stations including Power Parks on Wind and Solar at Inter-State Level”).</p>															
6.0	CALIBRATION															
	<p>All the measuring instruments to be supplied shall have valid and traceable calibration certificate. Each Pyranometer shall be recalibrated at an interval not more than two years and all other instruments shall be recalibrated at an interval not more than four years.</p>															

CLAUSE NO.	TECHNICAL SPECIFICATIONS																
7.0	<p>DATA LOGGER</p> <p>Weather Monitoring system shall be provided with standalone Data logger suitable for outdoor application with IP65 Protection and industrial grade hardware suitable for operating temperature up to 55 Deg. C. Data logger shall be calibrated and proven in field for at least one year in outdoor environment. Data logger shall have following minimum features:</p> <table> <tr> <td>Processor</td><td>32 bits</td></tr> <tr> <td>Time synchronization</td><td>With Built in GPS Clock or with Solar SCADA GPC Clock</td></tr> <tr> <td>Wireless communication</td><td>GSM/GPRS Modem</td></tr> <tr> <td>Data storage</td><td>SD card, Min 2GB for storage of raw and processed data locally at resolution of 1 Second for retrieval whenever required. Data to be stored shall be in unencrypted CSV or equivalent format.</td></tr> <tr> <td>Display</td><td>LCD display for easy maintenance and debugging for site engineer</td></tr> <tr> <td>Scan resolution</td><td>3 sec or better</td></tr> <tr> <td>Analog to Digital Converter (ADC)</td><td>16 Bit, Sampling -10 Hz (Min)</td></tr> <tr> <td>I/P Channel</td><td>As required with 20 % spare of each type of channel</td></tr> </table> <p>It shall have facility for arithmetic processing (Time Integration, Simple Average, and Moving Average etc.) of incoming raw data. Data logger shall be interfaced with Solar SCADA on Modbus preferably on TCP-IP. Vendors shall submit Factory Acceptance Test (FAT) report and procedure before dispatch of material to site. Bidder must provide all the settings in the data logger in the FAT and same shall be witnessed and approved before final dispatch. The settings in the data logger and also the scaling of WMS parameters related to GHI/GTI, and other parameters related to PG test shall be witnessed by Engineer in-charge during SAT. END CUSTOMER site shall be free to install their own equipment for GHI in case the Engineer In- charge feels the same appropriate. Bidder to refer to the PG test procedure chapter for additional Data logger for the pyranometers offered for the PG test purpose to record data and present in SCADA during the execution of PG test procedure. All necessary tests as prescribed for the solar plant data logger shall be applicable for additional data logger also.</p>	Processor	32 bits	Time synchronization	With Built in GPS Clock or with Solar SCADA GPC Clock	Wireless communication	GSM/GPRS Modem	Data storage	SD card, Min 2GB for storage of raw and processed data locally at resolution of 1 Second for retrieval whenever required. Data to be stored shall be in unencrypted CSV or equivalent format.	Display	LCD display for easy maintenance and debugging for site engineer	Scan resolution	3 sec or better	Analog to Digital Converter (ADC)	16 Bit, Sampling -10 Hz (Min)	I/P Channel	As required with 20 % spare of each type of channel
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Data logger shall be provided with key-locked door access and all the cables (Power and Signal) to the data logger shall be protected with heavy duty HDPE pipes.</p> <p>Project file (software, settings and sample reports) shall be handed over to site on permanent storage media (CD/DVD) in two copies after data integrity is verified by site and weather monitoring is commissioned. Any configuration changes shall be possible only with authorized User ID and password.</p> <p>8.0 METEOROLOGICAL STATION</p> <p>Sensors shall be installed at suitable height for which Mast/Structure for the sensor shall be provided by the bidder. Proper fencing shall be provided around meteorological station where the Pyranometer, Wind, Ambient Temp. Sensor, Data logger etc. are installed.</p> <p>9.0 SOILING STATION</p> <p>The Soiling Measurement System shall measure the performance loss from a PV array due to accumulation of dust, dirt, and other site-specific contaminants, collectively known as “soiling”. Soiling Stations shall use two full-sized modules. One is allowed to soil naturally, while the other is cleaned with an automatic washing system. Power and energy are monitored for both modules.</p> <p>Bidder scope cover supply of complete system and its installation that includes Data logger, Automatic Module Cleaning System, cabling, software setup and interface with solar SCADA as per the technical requirement mentioned herein. Bidder shall also provide Solar PV module and its support structure.</p> <p>One soiling station for every 100MW capacity and part thereof shall be provided.</p> <p>TECHNICAL REQUIRMENT</p> <p>The system shall consist of an automatic cleaning system that prevents soiling accumulation on the PV reference module (clean one), another PV module (Soiled one) which is allowed to accumulate soiling at the site-specific rate, an electronic data acquisition and analysis unit.</p> <p>All components are provided in outdoor rated NEMA 4/IP 65 enclosures for long-term outdoor use. All cables are rated for outdoor use.</p> <p>Following requirements are to be taken care by bidder:-</p> <p>i) Data logger shall be field tested and shall be in satisfactory operation for a period not less than 6 Months.</p>

TECHNICAL SPECIFICATIONS																			
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ii)	Data logger shall be calibrated (Measurement uncertainty less than 2%) before dispatch and calibration shall be traceable to any National/International lab. Data logger shall have flash memory not less than 1GB for local storage of data.																		
iii)	Bidder shall submit the write up detailing the philosophy of measurement of soiling loss in his proposal. Measurement shall be based on comparison of Isc & Power.																		
iv)	Datalogger shall have feature that includes but not limited to Moving Average calibration, Time Integration etc.																		
v)	Bidder to facilitate the interfacing of data of Soiling Station to Solar SCADA on Modbus TCP/IP for trending, storage, retrieval and display of data.																		
	Automatic Cleaning System The automatic cell-washing system cleans the PV reference module for accurate measurements. The system uses a suitable liquid spray to clean the reference module at user-determined intervals. The liquid tank is minimum 100 Liter. Under typical soiling conditions the liquid reservoir must be refilled periodically using the suitable liquid specified by OEM of Soiling station/PV module supplier. Bidder shall supply 2 Nos of spare spray nozzle along with supply.																		
	Measurements The following measurement readouts are available via the Modbus interface: Direct Soiling loss readout shall be available in SCADA for display and recording.																		
	Temperature Rating The system shall be rated for operation in ambient air temperatures from -20 °C to 60 °C. Any alternate technology proposed by bidder shall be reviewed during detailed engineering stage for acceptance.																		
10.0	PV Analyzer (complete KIT with software) Bidder shall provide minimum 2 Numbers of PV Analyzer Kits of reputed make to measure the PV Module performance. Analyzer kit shall have all necessary hardware connectors and required software for data analysis. The Offered make and model must not be obsolete and shall have valid calibration certificate. It must have required servicing facility indigenously and must have required software for data analysis.																		
	<table><tr><th>SL No</th><th>Details</th><th>Values</th></tr><tr><td>1.</td><td>PV Voltage</td><td>0-1500 V DC</td></tr><tr><td>2.</td><td>PV Current</td><td>0-30 A DC</td></tr><tr><td>3.</td><td>Voltage Accuracy</td><td>+/- 0.25 V</td></tr><tr><td>4.</td><td>Current Accuracy</td><td>+/- 40 mA</td></tr><tr><td>5.</td><td>Operating Temperature</td><td>0-45 Deg C</td></tr></table>	SL No	Details	Values	1.	PV Voltage	0-1500 V DC	2.	PV Current	0-30 A DC	3.	Voltage Accuracy	+/- 0.25 V	4.	Current Accuracy	+/- 40 mA	5.	Operating Temperature	0-45 Deg C
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TECHNICAL SPECIFICATIONS																																																	
CLAUSE NO.																																																	
	<div>D-2 FIRE FIGHTING AND ALARM SYSTEM</div>																																																
11.0	<div>GENERAL</div> <p>The SPV plant shall be equipped with suitable fire protection & firefighting systems for protection of entire equipment, switchyard & control room as per CEIG requirements.</p> <p>Bidder shall comply with recommendation of Tariff Advisory Committee for incurring minimal premium for insurance. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.</p>																																																
12.0	<p>The firefighting system for the proposed power plant for fire protection shall consist of:</p> <div><div>a) Sand buckets</div><div>b) Portable fire extinguishers</div><div>c) Microprocessor based fire alarm panel.</div></div>																																																
12.1	<div>Portable Fire Extinguishers and Sand Buckets</div> <p>Bidder to provide following numbers of type tested portable fire extinguishers as per relevant code in the rooms mentioned below.</p> <table><tr><th>Rooms</th><th>DCP Type (ABC type) (10 Kg. Capacity)</th><th>CO₂ Type 9 kg capacity</th><th>Foam Type Hand 9 kg</th><th>Hand Portable pressurized water CO₂ 9 Litre</th><th>Sand Buckets</th></tr><tr><td>Control Room</td><td>2</td><td>2</td><td>1</td><td>1</td><td>1</td></tr><tr><td>Each Inverter Room</td><td>1</td><td>1</td><td></td><td></td><td></td></tr><tr><td>ACDB Room(If applicable</td><td>1</td><td>1</td><td></td><td></td><td></td></tr><tr><td>Each Transformer Yard</td><td>1</td><td>1</td><td>1</td><td></td><td>1</td></tr><tr><td>Switchyard/Metering Yard</td><td>2</td><td>2</td><td></td><td></td><td>1</td></tr><tr><td>Security Room</td><td></td><td>1</td><td></td><td>2</td><td></td></tr><tr><td>Pantry</td><td></td><td></td><td></td><td>2</td><td></td></tr></table>	Rooms	DCP Type (ABC type) (10 Kg. Capacity)	CO ₂ Type 9 kg capacity	Foam Type Hand 9 kg	Hand Portable pressurized water CO ₂ 9 Litre	Sand Buckets	Control Room	2	2	1	1	1	Each Inverter Room	1	1				ACDB Room(If applicable	1	1				Each Transformer Yard	1	1	1		1	Switchyard/Metering Yard	2	2			1	Security Room		1		2		Pantry				2	
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12.2	<div>Microprocessor based fire alarm panel</div>																																																

CLAUSE NO.	TECHNICAL SPECIFICATIONS
12.3	<p>Bidder to provide intelligent microprocessor based main fire alarm panel of modular construction complete with central processing unit, input and output modules, power supply module, supervision control and isolator modules with 10% spare provisions in each loop. Fire detection alarm system shall include) but not limited to the following items</p> <ol style="list-style-type: none"> 1. Fire Alarm control Panel 2. Multi Sensor smoke detector 3. Heat Detectors 4. Hooter cum strobe 5. Manual call Point 6. Hooter 7. Fault isolation modules 8. Control Modules 9. Cables from Sensors to Fire panels. 10. Digital output from the fire detection system shall be integrated with SCADA 11. Network Control Module 12. Interfacing of Fire Alarm System with SCADA for display and storage of status and alarm in SCADA <p>Multi sensor type smoke detectors and heat detectors shall be provided for below false ceiling areas of control room and ACDB and/or inverter rooms. One (01) sensor shall be provided for each 20 sqm of area. All the cable trench inside the control room and inverter room shall be provided with Multi Sensor smoke detector.</p> <p>Fault Isolation module shall be provided in every room and for every 15 sensors at location proposed by Bidder to be approved by employer during detail engineering.</p> <p>Fire Alarm Control Panel Indication</p> <ol style="list-style-type: none"> i. Alarm conditions shall be immediately displayed on the control panel and in SCADA. Alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged the LED shall remain lit. A subsequent alarm received from another zone after acknowledgement shall illuminate the alarm LED and the panel display shall show the new alarm information. ii. During an alarm condition, an alarm tone shall sound within the control panel until the alarm is acknowledged. iii. If the audible alarm signals are silenced for any reason, they shall automatically resound if another zone is activated.

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	<p>iv. All alarm signals shall be automatically “locked in” at the control panel until the operated device is returned to its normal condition and the control panel is manually reset.</p> <p>There shall be weatherproof Hooter cum strobe outside and strobe inside each Inverter room and control room for indication fire alarm for respective zone/area at suitable location that is visible from all direction. All the hardware, relay and accessories required for completeness of fire alarm system is in Bidder scope. Fire alarm system shall have its own battery and charger and it shall be provided power from UPS DB. Each Inverter room and control room shall also be provided with manual call point, Alarm acknowledge and reset facility for alarm for respective zone only.</p> <p>Bidder shall submit document to employer for approval that will include fire alarm system configuration, layout, BoM, Datasheet and necessary test report.</p> <p>Bidder shall consider 30 % design and aging margin for selection of nos. of sensors in each loop and length of each loop. Bidder shall submit the certificate from OEM indicating maximum nos. of sensors in single loop and maximum length of single loop allowed with offered panel and type of cable to be used. Each Fire Alarm Control panel shall have provision for minimum 10 (Ten) % rounded to next higher integer but not less than 2 (two) nos. spare loops for future use of employer in CMCS room. For ICR 1 spare loop may be considered and shall be acceptable.</p> <p>In case bidder proposes outdoor inverter with shed arrangement, the bidder must ensure that the inverter has provision of fire sensing system. Else, the fire detection system must be provided in the Inverter shed.</p> <p>Bidder shall submit Site Acceptance Test (SAT) for approval by employer. Complete fire alarm system shall be checked at site for verification of faithful performance and completeness of the system. Bidder shall carry out necessary modification and supply hardware/accessories if required free of cost at site.</p>

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	<p style="text-align: center;">D-3 MODULE CLEANING SYSTEM</p> <p>Bidder shall propose Dry-Robotic cleaning system only for cleaning of Solar PV modules. The technical specifications/minimum technical requirements of Dry Robotic Cleaning System are furnished below:</p> <p>1.0 GENERAL</p> <p>This part of technical specification is intended to cover the requirements for the Supply, Installation, Operation & Maintenance of water-less module cleaning system in the solar power projects with Fixed Tilt MMS for successful installation and trouble-free operation for the plant design life. The major work involves in this package is Supply, fabrication, transportation assembly at site and erection of Robotic Module Cleaning System on the Module Mounting Structure.</p> <p>2.0 SCOPE OF WORKS</p> <p>The scope of works covers complete design, engineering, supply, fabrication, delivery at site, erection / assembly at site, Robotic Module Cleaning system with accessories along with mounting structure and SCADA, testing commissioning, operation, and maintenance for 03 years of Robotic module cleaning system mounted on MMS, after commissioning.</p> <p>2.1 SUPPLY</p> <p>The bidder shall supply the Robotic Module Cleaning system units, mounting structures, antennas (including Aluminum poles for its fixing), communication tools, charging system, spares, remote operation management & analytics tools, SCADA communication tools and any other system related requirement for successful installation & operation of Robotic Module Cleaning System. The structural material of docking and reversing station and connecting bridge between two adjacent tables supplied and fabricated as per requirement shall be in the scope of bidder.</p> <p>2.2 ASSEMBLY, INSTALLATION & COMMISSIONING</p> <p>a) Installation of module cleaning system units, Gateways / antennas (including Aluminum poles and its associated civil works) including cable connection if any, communication tools, SCADA connectivity,</p>

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	<p>remote operation management and analytic tools. The bidder shall be responsible for the installation and commissioning of the complete system required for successful operation of the system.</p> <p>b) The bidder scope includes complete erection, testing & commissioning of docking & reversing station along with required supporting arrangement to the correctness for movement of robots.</p> <p>c) Development of SCADA dashboards, analytics, signal status, alarms, control features etc. shall be scope of bidder.</p> <p>2.3 OPERATION & MAINTAINACE</p> <p>All activities related to Operation and maintenance of Module cleaning system during O&M Stage after successful installation and commissioning of project shall be in bidder's scope. The scope would include all necessary O&M spares as required for successful operation.</p> <p>3.0 TECHNICAL REQUIREMENTS</p> <p>The bidder shall comply with the technical requirements given below.</p> <p>a) Module cleaning is performed without any use of water and under a relative humidity of minimum 85%. The cleaning system shall be capable of cleaning the modules during operational hours after the rainfall. The module system should move continuously and systematically across the entire solar panel array on daily basis (except during the rain). The self-powered photovoltaic panel self-cleaning function should be installed on the docking or reversing station. Module installed directly over robot would also be acceptable subject to meeting other conditions.</p> <p>b) The bidder shall ensure module cleaning system shall clean local soil under given climatic condition.</p> <p>c) The cleaning robots shall use dry cleaning to achieve waterless cleaning without cleaning medium. The cleaning robot shall adopt the method of walking along the component frame, and the length of the robot should be adapted to the layout size of the components of this project.</p> <p>d) The cleaning robot must adopt a self - powered mode and perform cleaning work during the daily non - generation period and does not occupy power generation resources. The self-charging module should preferably be built on the robot itself to avoid charging unit failure rate.</p>

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	<p>e) The module cleaning system shall have self-locking arrangement against sliding and during any wind event. The system shall be able to withstand basic wind speed of min. 170kmph (47m/s) standing position at docking or reversing station. The design shall be as per relevant local and international codes. Windproof measures should be installed at the bottom of the docking station to prevent the equipment from being blown up by strong winds.</p> <p>f) The cleaning robots shall be able to operate for basic wind speed of minimum 50 kmph at all positions. The cleaning robot shall have provision to return to its docking / reversing station automatically in the event of high wind scenarios. High wind scenario refers to the wind speed beyond which the cleaning robots shall not be recommended to operate by robotic supplier.</p> <p>g) The robots shall run cleaning cycle with fixed MMS, so necessary coordination/communication shall be achieved.</p> <p>h) The proposed model / system shall have approval of all the major module supplier (Modules with frame/ Module without frames) without such approvals the system shall not be accepted. Bidder shall submit such approvals for acceptance to owner along with their proposal during vendor approval.</p> <p>i) Bidder to share the module frame drawings for each module supplier for which approval from module suppliers have been taken.</p> <p>j) Bidder to conduct proto test for modules selected for the project. For this, bidder need to conduct accelerated test on the modules under dusty ambient condition for 10000 cleaning cycles considering daily cleaning for 25 years. Failure of test shall result in rejection of cleaning system. The cycle qty 10000 should be readable from host PC of robot, and the screen shut of host PC should be provided.</p> <p>k) The system manufacturer shall guarantee that due to operation of cleaning system there shall be no scratch and no damage of any kind/ form to the glass/frame/micro-cracks in solar cells, ARC coating of the module during its entire operation life. The rotating cleaning brush of the cleaning robot should be made of materials that will not damage the surface of the photovoltaic module. There is no need to clean the media during the cleaning process to achieve waterless cleaning. The cleaning range of the brush must cover the entire photovoltaic panel area, and the cleaning is complete.</p> <p>l) The whole body of the cleaning robot adopts anticorrosive design, which can adapt to the project site environment.</p>

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4.0	<p>m) The equipment should have sufficient rigidity and good overall mass distribution. The force on the component by the walking wheel should be subjected to detailed mechanical calculations and experiments. During the project period, the frame and glass of the component should not be adversely affected or caused consequences such as cracking.</p> <p>n) The traveling wheels and guide wheels should be made of materials that have little effect on the component frame and the component itself to prevent long-term walking to damage the component frame.</p> <p>o) Bidder shall supply & install min. five nos. sample system within 15 days of installation of 1st set of MMS Tables along with battery & self-charging modules for prototype testing for compatibility of MMS with proposed system at locations specified by owner. Actual supply planning shall be adjusted as per direction of EIC.</p> <p>p) All components being used / proposed for the module cleaning system shall be of high-quality conforming to relevant national/international standards and approved by owner prior to final order.</p> <p>q) Bidder shall provide fully automated solution to clean the rows daily at least one cycle (in back-and-forth direction). A minimum of 75% of trackers/MMS tables(as applicable) shall conform to the above condition. Further, the bidder shall also provide an alternate automated solution to use one robot for multiple rows for the remaining areas with smaller row length. However, this will be decided during detailed engineering w.r.t. overall layout and site conditions.</p> <p>r) All structural / mechanical / electrical components should be in compliance to corrosion class/category applicable for the site. In case of any damage to corrosion protection measures, due replacement of component would be in Bidder scope. Accordingly, any temporary platforms, site concreting etc. as required for assembly of material before installation shall be in bidder scope.</p> <p>s) All the exposed structures should preferably be in aluminum material.</p> <p>FUNCTIONAL REQUIREMENTS</p> <p>a) The docking stations, antennas and any other module cleaning system requirement shall be installed in a manner such that it shall not create any shadow on the installed Modules on the MMS and not create hinderance on the movement of vehicles. Any discrepancy or generation loss found later in view of same to be compensated by</p>

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	<p>bidder. The shadow calculation should preferably be simulated by PVSYST software.</p> <ul style="list-style-type: none"> b) All components of the system shall be weather and dust proof conforming to IP65. The system shall be able to work in extreme temperature variation of (-) 5 degree Celsius to (+) 60 degree Celsius. c) Availability of module cleaning systems at any given point of time shall not be less than 99%. The remaining 1% affected system if any shall be made functional within 24 hours of timeline. d) The system shall be such that no external power supply is required for its operation i.e. the system shall be provided with self-charging module with battery. The self-powered system of the cleaning robot includes solar panels, batteries and their auxiliary devices. It has the functions of self- generation, charging, storage and self-detection, without the need to provide an external power supply. e) After the cleaning robot is fully charged, the single way running distance must be not less than 1500 meters. f) The cleaning robot should have the function of detecting the remaining battery power when it is started, so as to avoid stopping to block components in the middle of the battery board due to insufficient power. g) The cleaning robot should have a jam detection function. When it detects that it cannot run, the robot provides an alarm indication to prevent jamming and damage in the middle of the battery board. h) The cleaning robot should have anti-falling measures to avoid falling from the photovoltaic panel when walking; at the same time, it should be fixed with a wind-proof mechanism when stopping at the docking station to prevent the robot from sliding or falling due to high winds. i) The parts of the cleaning robot should be able to operate safely and continuously under normal working conditions, and there should be no problems such as excessive stress, temperature rise, corrosion, and aging. j) The equipment should have a fault alarm function. When the equipment fails, it should be able to automatically alarm when it fails to start, stop, or stop in the middle. k) When the robot run tilt, it should be able to correct itself automatically, and bidder to submit videos and technology logic to proof this function during detailed Engg. approval stage. If robot still tilts and gets stuck and not able to run, alarm signal should be sent to control system. l) The bidder shall guarantee that losses due to soiling upon usage of the cleaning system shall not exceed 0.5% of the module output of the

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5.0	<p>each 12.5MWac PV block on a daily basis. Bidder shall provide Test reports / On-field data of the operational plants to ensure guaranteed soiling loss.</p> <ul style="list-style-type: none"> m) Prepare and furnish detailed Bill of Materials, Dispatch lists, and any other list of bought out items required in connection with the fabrication of the system. n) The bidder shall ensure that the battery operates at an ambient temperature of 52-degree Celsius. The battery shall be non-flammable type and shall not catch fire during operation / rest condition for the given temperature range. o) The time required to charge the battery shall be max. 4 hours. p) The module cleaning system brushes shall be robust enough to work in contact with water in case of rain and during removal of bird marks etc. q) The bridge between the sub-arrays should have sufficient rigidity to ensure the stable passage of the robot. r) The bridge should create no shadow on modules during site complete operating/generating time. s) The Manufacturer shall set up a Prototype in the factory to match actual designed MMS, Bridge and Docking / Reversing station, with modules of appropriate rating prior to mass production. The table length shall be at least 50 meters. The Prototype will be witnessed by the owner's team. Trial operations and inspections shall be carried out as per agreed plans. The Manufacturer shall modify the design as necessary to comply with the observations made during the inspection. The Manufacturer shall start the mass production of Robot material only after the Prototype trials and inspections are completed to the satisfaction of the owner's team and the modifications are agreed upon. <p>TECHNICAL SPECIFICATIONS FOR COMPONENTS</p> <p>The module cleaning system components shall meet the following min. criteria.</p> <ul style="list-style-type: none"> a) Aluminum Profiles: extrusion process, profiles alloy 6063 or better suitable for corrosion class/category applicable for the site or better. b) Batteries: The life expectancy of batteries shall ensure that system can run the given range in single charge with 11-degree ground slope. BIS certificate mandatory required for the battery pack.

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	<div><div><div>c) Solar Panel: Linear Performance warranty of 25 Years with maximum power degradation at the end of 25 years shall not be more than 20% (with maximum allowed degradation of 2% in first year followed by 0.6% degradation from year-2 onwards). Product warranty against manufacturing & workmanship defects shall be 15 years. However,product design life should be 25 years.</div><div>d) PLC: Programmer logic controller system.</div><div>e) Electronic component: Life expectancy</div><div>f) Cleaning Brush / Microfiber cleaning elements or other elements: Life expectancy of at least 18 months of operation.</div><div>g) Electronic Conductive covered wiring: Life expectancy for entire plant design life with a durability of 80 degree Celsius</div><div>h) Rotating parts such as ball bearings and wheels – Manufactures to specify.</div><div>i) Running wheels’ material shall be EPDM or better.</div><div>j) The wind hook should be able to prevent robot from wind blowing up, as well to prevent robot wheels to run on module glass.</div><div>k) Any other component not mentioned: Plant design life.</div></div></div>									
6.0	<div><div>OPERATION, MONITORING & MAINTENANCE</div><div>The following tables describe the testing procedure by category:</div><div><div>a) Daily Operation</div><table><tr><th>Event</th><th>Action</th><th>Outcome</th></tr><tr><td>Start command</td><td>The master instructs each unit to start cleaning its solar array</td><td>Each unit unlocks itself and start the cleaning purpose</td></tr><tr><td>Parking Command</td><td>Each unit activates its parking command</td><td>Once the unit completes the cleaning cycle</td></tr></table></div><div>b) Monitoring and Reporting</div></div>	Event	Action	Outcome	Start command	The master instructs each unit to start cleaning its solar array	Each unit unlocks itself and start the cleaning purpose	Parking Command	Each unit activates its parking command	Once the unit completes the cleaning cycle
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	<table><tr><th>Action</th><th>Report</th></tr><tr><td>Unit receives a start command from the master</td><td>Cleaning start plus battery status</td></tr><tr><td>Unit completed the cleaning process and parks</td><td>Cleaning ended plus current battery status</td></tr></table>	Action	Report	Unit receives a start command from the master	Cleaning start plus battery status	Unit completed the cleaning process and parks	Cleaning ended plus current battery status										
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	c) Selection Process																
	While the default scenario is to activate all units together, the master or the proposed system should have an enable / disable function that enables to initiate the cleaning process in specific arrays only. In order to verify the enable / disable functionality, during the acceptance test, some of the units shall be disabled and verified that all disable units stay in their parking position after a start command has been given.																
	d) Service level Matrix																
	The service level matrix shall be as mentioned below:																
	<table><tr><th>Call Priority</th><th>Definitions</th><th>Fault resolution time</th></tr><tr><td>A(Critical)</td><td>System is on the solar array outside cleaning hours</td><td>Within 12 hours from notice</td></tr><tr><td>B (High)</td><td>Cleaning service is not affecting more than 10% of the solar arrays, or 5 units are outside the solar arrays, the higher of the two</td><td>Within 3 business day from notice</td></tr><tr><td>C (Medium)</td><td>Cleaning service is not available affecting 10% or less of the solar arrays or 5 units are outside the solar arrays.</td><td>Within 7 business day</td></tr><tr><td>D (Low)</td><td>Cosmetic or other fault with little or no impact</td><td>Within 20 business day</td></tr></table>		Call Priority	Definitions	Fault resolution time	A(Critical)	System is on the solar array outside cleaning hours	Within 12 hours from notice	B (High)	Cleaning service is not affecting more than 10% of the solar arrays, or 5 units are outside the solar arrays, the higher of the two	Within 3 business day from notice	C (Medium)	Cleaning service is not available affecting 10% or less of the solar arrays or 5 units are outside the solar arrays.	Within 7 business day	D (Low)	Cosmetic or other fault with little or no impact	Within 20 business day
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The vendor shall categorically mention the following as part of the documentation.																	

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	<p>a) The range of the robots / robotic solution for the applicable location of the project w.r.t the temperature, humidity, rainfall, seismic zone, wind zone etc. and all the other constraining factors.</p> <p>b) The number of operating cycles required for achieving the target generation / CUF for the solar plant, for all types of site conditions applicable in the given project.</p> <p>c) Detailed O&M Manual w.r.t the cleaning processes to be followed during the monsoon season.</p> <p>d) Any other critical information which would be necessary for successful operation and maintenance of the robotic cleaning system.</p> <p>7.0 Mandatory Spares 2% of the total population of robots shall be supplied as spares. Further, 5% of major components of robotic cleaning system shall be provided as spares. Final list of spares (Main components) would be as per approval of EIC / OEM's recommendation for successful operation and Maintenance of System.</p> <p>8.0 SCADA Communication</p> <p>8.1 Data & Monitoring</p> <p>Robotic Cleaning System must necessarily measure, record, store & display live data for following data streams from each robot.</p> <ol style="list-style-type: none"> 1. All electrical parameters of battery but not limited to Current, Voltage, Charge (Ah) 2. Temperature of battery & motor 3. Motor End Voltage & Current 4. Communication Gateway Status 5. Robot information and its status (Stand by, Docking Station, Sleep, Running, Error mode, End Station, Power low, Interlock, Voltage, Current etc.) 6. Gateway wise status 7. IP address of all gateway device 8. Robot set points / Control Status 9. Robot start, stop time and robot run time

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8.2	<p>10. Robot, motor and battery healthiness status</p> <p>11. Alarm and events related to robotic cleaning system operation but not limited to information mentioned in serial no. 4.</p> <p>12. Total number of robots available</p> <p>13. Total number of robots in cleaning operation (Instant Value)</p> <p>14. Total number of robots under maintenance / breakdown</p> <p>15. No. of cycles competed by robots since commissioning (Monthly, Quarterly, Yearly), which should be displayed on the SCADA monitoring screen.</p> <p>16. No. of hours competed by robots since commissioning (Monthly, Quarterly, Yearly), which should be displayed on the SCADA monitoring screen.</p> <p>17. Total duration of operation since commissioning (Monthly, Quarterly, Yearly), which should be displayed on the SCADA monitoring screen.</p> <p>18. Length covered by each robot since commissioning (Monthly, Quarterly, Yearly), which should be displayed on the SCADA monitoring screen.</p> <p>19. Area covered by each robot since commissioning (Monthly, Quarterly, Yearly), which should be displayed on the SCADA monitoring screen.</p> <p>20. No. of cycle completed by battery (Charge- Discharge Cycle), which should be displayed on the SCADA monitoring screen.</p> <p>21. Monthly, Quarterly, Yearly details of battery status as described below.</p> <p>22. Electrical Parameters of PV panel used for charging</p> <p>23. Daily percentage of operation cycle completed by individual Robot</p> <p>24. Any other data stream as may be measured by specific robot supplier</p> <p>25. Memory maps with data type details shall be shared by the bidder for the listed data points</p> <p>26. Robot position on the row are visible from SCADA through GPS.</p> <p>Reports</p> <ol style="list-style-type: none"> 1. Daily, Weekly, Monthly & Annual Reports: 2. Robot Availability – details should include reasons of unavailability. 3. Alarms, Events & Breakdown Analysis 4. Robot Run Summary (day wise) 5. Robot & Robot Parts healthiness report

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<p>8.3</p> <p>8.4</p> <p>8.5</p>	<p>6. Any specific issues or abnormalities during the period</p> <p>Database:</p> <ol style="list-style-type: none"> 1. All data points as mentioned in above clause I. and any additional measured data (as may be available) from the robots must be stored locally as a time series data for at least 1 year. 2. Robotic System must expose all raw data measured at site to owner's Cloud. 3. All operational, monitoring, performance data shall be transferred to SCADA on owner's servers only. 4. Access/ Storage of robot operational data to robotic supplier shall be provided only through approval of owner. 5. All Robot data to be available to plant local SCADA system on Modbus-TCP protocol or any open protocol. <p>Notification Requirements</p> <ol style="list-style-type: none"> 1. Operation failure with error code 2. Robot unable to start its operation due to internal fault 3. Robot unable to start its operation due to external cause like weather condition etc., 4. Low Battery, Battery state of charge 5. Temperature of battery 6. PV Panel Failure Status 7. Communication failure 8. Motor Failure 9. Motor Temperature 10. Memory maps with data type details shall be shared by the bidder for the listed notifications. <p>Hardware Requirement</p> <ol style="list-style-type: none"> 1. Processor series i5/i7 - 11th Gen 2. Hard disk drive type – SSD, 1TB 3. Cabinet – Rugged series is preferred 4. OS windows 11 pro x64. 5. RAM – 32GB 6. Endpoint security software – Symantec/ Norton/ Kaspersky Antivirus. 7. Dual Network Interface Card/ Ethernet is preferred.

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9.0	<p>Desktop/ Laptop shall be provided at MCR for Monitoring purpose. In addition, bidder shall also provide their support for integration of robotic communication system to the main SCADA system of the solar plant as required.</p> <p>Bidder to conduct a complete SCADA prototype test to show its communication system locally or in India, to allow buyer to understand bidder's system and R&D ability.</p> <p>ADDITIONAL REQUIREMENTS</p> <ol style="list-style-type: none"> 1. As bidder is providing the system for structure for different ranges. Bidder to demonstrate the running capacity for each system type separately either at field or at bidder factory works. 2. Bidder to give battery Make, Model, Datasheet, charging time under typical sunshine day (calculation for charging time of battery for all different range). 3. Internal calculations showing the number of charging cycles used up in a year and compare with battery's allowed cycles in a lifetime. Bidder to give a calculation for lifetime cycles. 4. Bidder to provide their internal quality test for checking of distance travelled by system with full charge on battery. It must travel the minimum specified distance (with 20% margin to take care of degradation of battery). The same shall be monitored by the owner on sample basis. 5. Statement from Bidder with list of components to be replaced in a lifetime based on running plant. The same shall be based on actual project experience with reference list. 6. Bidder to confirm parameters in which probability of PCB burning or other failure is expected due to overload, as the system might not be able to track the obstacles while running of the robots. 7. Bidder to provide details on type of charger used, its characteristics & IP. Bidder shall provide calculation for adequacy of PV panel and charger. 8. Bidder to confirm mechanism for replacement if Battery is not covering the committed length and failure in battery charging. Bidder to submit list of such cases reported for any of the previously installed project. 9. Bidder to confirm the systems available to protect against overloading of drive, there should be a Control system with a Protection system as backup. 10. Bidder shall be responsible for witnessing and approval of Prototype of the entire structure as per the GA and erection drawing of bidder.

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	<p>Prototype test of MMS structures for different cases shall be carried out at EPC vendor factory/ site in presence of owner's engineer in charge for approval for mass production. Test report shall be submitted to the owner for approval.</p> <ol style="list-style-type: none"> 11. Bidder to furnish all materials, labor, tools and plants and all consumables required for fabrication and supply of module cleaning systems. 12. All items of work shall be executed in accordance with the relevant specifications and the provisions of the contract. Vendors are not generally expected to stipulate any conditions of their own or deviate from the General & Supplementary Conditions of the Contract and Specifications. However, if it becomes necessary, all such deviations shall be indicated clause-wise in a separate schedule. Deviations mentioned or brought out elsewhere in the tender other than in the above schedule, will not be entertained and such offers which do not conform to the above requirements are liable to be summarily rejected. 13. The work shall be executed strictly according to the relevant and latest edition of international standards/ Project Technical Specifications / ISO Standards, and/or instruction and direction given by the owner Engineer-in-Charge. 14. No work under this specification will be provided for by any agency other than the Bidder, unless specifically mentioned otherwise elsewhere in the Contract.

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3.0	<p>i. 25-year lifetime design (at least) considering local ambient conditions and in respect of all the applicable and relevant standards.</p> <p>ii. 5-year warranty starting with the Project Commercial Operation Date (COD) for robot along with the complete mounting assembly and its parts.</p> <p>iii. 25 years for Corrosion and UV protection.</p> <p>AMC requirements shall be as per technical specification part A.</p> <p>INSURANCE</p> <p>The bidder's insurance liabilities pertaining to the scope of works are detailed out in Clauses titled Insurance in General Conditions of Contract. The bidders insurance liabilities during O&M period has been brought out in Chapter D-5 Clause 4.0.</p>

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	<p style="text-align: center;">D-5 OPERATION AND MAINTENANCE</p> <p>1.0 The successful bidder shall carryout Operation and maintenance of complete SPV Plant along with power evacuation system till the terminal point of the subject package specified elsewhere in this document (and any other facility beyond terminal point specifically included in the scope of the work of the package as per technical specification Part -A) from date of commissioning of full project capacity. Additionally, bidder to refer commercial portion of bidding document for details regarding O&M of part capacity commissioned. During O&M period, END CUSTOMER personnel shall have unrestricted entry to the solar plant and Control Room any time. END CUSTOMER may suitably depute its personals to associate with O&M activities. Contractor shall assist them in developing expertise through their day to day O&M activities. All records of maintenance must be maintained by the contractor which can be accessed by END CUSTOMER on demand. These records are to be handed over to END CUSTOMER after the O&M period of contract.</p> <p>2.0</p> <p>3.0 The bidder shall be responsible for supply of all spare parts, repairs / replacement of any defective equipment at his own cost as required from time to time during the O&M period.</p> <p>The contractor shall be responsible for the Operation and Maintenance of the entire Solar PV plant during the O&M period. The brief scope of works is listed below. The details shall be further elaborated by the bidder in the O&M manual to be submitted to END CUSTOMER for approval.</p> <ul style="list-style-type: none"> (a) Ensuring successful operation of SPV Plant for optimum energy generation. (b) Ensuring Breakdown maintenance, Preventive maintenance overhauls, Arranging visit of O&M experts (when required) to maximize the availability of the solar plant. (c) Daily work of the operators involves logging the voltage, current, power factor, power and energy output of the SPV plant, temperature, logging down individual array output data once a day (d) The operator shall record monthly energy output of each array and transformer and reports shall be prepared on performance of SPV plant (e) Submission of periodical reports to the owner on the energy generation & operating conditions of the SPV plant. (f) Ensuring Safety and protection of the plant by deputing sufficient security personals (g) Monitoring, controlling, troubleshooting, maintaining of records, registers. (h) Supply of all type of maintenance spares, consumables and fixing / application of the same. In order to meet the emergent requirements, contractor, with the permission of Employer can utilize the mandatory spares being supplied under the contract. However, the used spares shall

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	<p>(i) Cleaning of the plant including array yard on regular basis and as and when required.</p> <p>(j) Cleaning of drains, cable trenches, box culverts etc.</p> <p>(k) Module washing as per as per approved schedule.</p> <p>(l) Herbicide spray and grass cutting on a periodic basis</p> <p>(m) The contractor shall at his own expense provide all amenities to his workmen as per applicable laws and rules.</p> <p>(n) The Contractor shall ensure that all safety measures are taken at the site to avoid accidents to his employees or his Co-contractor's employees</p> <p>(o) The Contractor shall immediately report the accidents, if any, to the Engineer In charge & to all the concerned authorities as per prevailing laws of the state.</p> <p>(p) The Contractor shall comply with the provision of all relevant Acts of Central or State Governments including payment of Wages Act 1936, Minimum Wages Act 1948, Employer's Liability Act 1938, Workmen's Compensation Act 1923, Industrial Dispute Act 1947, Maturity Benefit Act 1961, Employees State Insurance Act 1948, Contract Labor (Regulations & Abolishment) Act 1970 or any modification thereof or any other law relating whereto and rules made there under from time to time.</p> <p>(q) In order to ensure longevity, safety of the core equipment and optimum performance of the system the contractor should use only genuine spares of high quality standards.</p> <p>(r) Deployment of Plant in Charge, adequate number of technical support staff and other supporting personnel during the O&M period</p> <p>(s) Bidder is required to maintain adequate O&M spare during the O&M contract period of the Solar PV plant with the view to maximize availability and generation of the plant. In case, Contractor uses mandatory spares, provided by END CUSTOMER, the contractor shall have to return/replenish the spare(s) of the matching quality, quantity and rating within shortest possible time.</p> <p>(t) At the time handing over of the plant by the contractor to END CUSTOMER, the contractor shall handover equipment and spares in healthy condition.</p> <p>(u) Bidder has to take Comprehensive Annual Maintenance Contract (AMC) from Original Equipment Manufacturer (OEM) or OEM authorized service provider for a period of 10 years for the following components:</p> <ul style="list-style-type: none"> • PCU System <ul style="list-style-type: none"> Replacement of spares like inductors, capacitors, electronic cards as per OEM recommendations • SCADA • PPC system (If applicable) • • Dry cleaning/Robotic Cleaning if offered.

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	<p>Comprehensive AMC shall include all preventive maintenance and breakdown maintenance including replacement of any component to ensure that equipment is working satisfactorily as per design/system requirement. During AMC period, the OEM or its representative are required to visit at least once a year or as per OEM recommendation cycle for periodic maintenance. During AMC period, the OEM is required to respond within one working day through telecom or any electronic mean. In case of breakdown of the system, OEM has to send their representative within 72 hours. For the minor faults not hampering the generation e.g. communication, display etc., the OEM has to get the fault rectified within 7 working days.</p> <p>Failure from the OEM to adhere the activity and the time schedule may lead to BG encashment.</p> <p>(v) Replacement of equipment/spare parts/ updating of softwares being phased out or not being supported by OEM's is also included in bidder's scope.</p> <p>(w) Contractor shall be responsible to carry out all test and work as required by statutory regulation in effect as on date of Techno-commercial bid opening during O&M period.</p>						
4.0	<p>Insurance</p> <p>(a) END CUSTOMER shall take Fire & Allied Peril insurance during O&M period. Insurance for theft to be taken by contractor.</p> <p>(b) Workmen's Compensation Insurance</p> <p>This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following:</p> <table><tr><td>Workmen's Compensation</td><td>-</td><td>As per Statutory Provisions</td></tr><tr><td>Employee's Liability</td><td>-</td><td>As per Statutory Provisions</td></tr></table> <p>(c) Comprehensive Automobile Insurance</p> <p>This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations,</p>	Workmen's Compensation	-	As per Statutory Provisions	Employee's Liability	-	As per Statutory Provisions
Workmen's Compensation	-	As per Statutory Provisions					
Employee's Liability	-	As per Statutory Provisions					

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	<p>irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated:</p> <table><tr><td>Fatal Injury</td><td>:</td><td>Rs.100,000 each person</td></tr><tr><td></td><td>:</td><td>Rs.200,000 each occurrence</td></tr><tr><td>Property Damage</td><td>:</td><td>Rs.100,000 each occurrence</td></tr></table> <p>(d) Comprehensive General Liability Insurance</p> <p>The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion.</p> <p>The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.</p>	Fatal Injury	:	Rs.100,000 each person		:	Rs.200,000 each occurrence	Property Damage	:	Rs.100,000 each occurrence
Fatal Injury	:	Rs.100,000 each person								
	:	Rs.200,000 each occurrence								
Property Damage	:	Rs.100,000 each occurrence								
5.1	<p>LIQUIDATED DAMAGES FOR SHORTFALL IN GENERATION DURING O&M</p> <p>Refer Chapter 1-A, Part A (Appendix – 3A)</p>									
5.2	<p>Deleted</p>									
6.0	<p>Handing over of the Plant</p> <p>(a) At the end of the contract period, the contractor shall hand over the plant and equipment back to the owner in completely safe and healthy condition and without any pending defect.</p> <p>(b) The items supplied by END CUSTOMER on returnable basis, such as spares parts (from mandatory spares or through procurement)), consumables, tools and plants, documents etc. shall be returned back to END CUSTOMER. Else suitable recoveries shall be made from the Contractor’s bills.</p>									
7.0	<p>After O&M period, END CUSTOMER may at its discretion decide to extend the existing O&M contract on mutually acceptable terms & conditions or undertake the O&M of the SPV Plant on its own.</p>									

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8.0	<p>Methodology for payment during O&M of Part Commissioned Capacity and Methodology for Levy of Liquidated Damages for Shortfall in Generation during O&M of Part Commissioned Capacity</p> <p>8.1 The successful bidder shall carry out Operation and Maintenance of Part Commissioned SPV Plant along with part commissioned power evacuation system till Terminal Point from the date of commissioning of part capacity upto the period when the full SPV plant has been commissioned.</p> <p>8.2 Bidder shall be eligible for Pro rata payment for carrying out O&M of part commissioned AC Capacity for the period in excess of the stipulated three years of O&M of Complete SPV Plant as per original scope. This shall enable start and finish of O&M of the Complete SPV Plant at the same time.</p> <p>8.3 Further, the levy of LD for shortfall in generation during this part O&M period (if any) shall also be calculated on pro-rata basis of part commissioned AC Capacity as per the target generation in approved PV syst and actual generation of part commissioned AC Capacity at site for that particular period. Suitable GHI correction shall be applied in deriving the target generation as per the above provisions.</p> <p>8.4 All other provisions pertaining to Payment for O&M of part commissioned capacity, LD levy (if any) during this part commissioned and Capping of LD for shortfall during O&M of Part commissioned capacity shall be as per the provisions mentioned elsewhere in the technical specification.</p>

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	<div>D-6 O&M TARGET GENERATION TEST (OTGT)</div> <p>The actual test to arrive at the annual target generation for O&M period shall be conducted at Site by the Contractor in presence of the Employer as described in this chapter. This test shall be binding on all the parties of the Contract. Any special equipment, instrumentation tools and tackles along with manpower required for the successful completion of the O&M TARGET GENERATION TEST (OTGT) shall be provided by the Contractor free of cost. The accuracy class of the instrumentation shall be as per the relevant clause of documents.</p> <p>Any consecutive three months period for the purpose of conducting OTGT shall be chosen on the discretion of END CUSTOMER.</p> <p>Bidder to refer Clause 1.0 of Chapter 2-A for O&M Target Generation.</p> <p>1. Bidder has to follow the benchmark O&M practices during the OTGT to ensure that the plant is performing at the most optimum parameter. Bidder shall clean the Modules mandatorily every 15 days during OTGT. Additionally, bidder to monitor the Soiling loss through the Soiling loss station and start the cleaning as soon as the Soiling loss exceeds 1.5% for wet cleaning or 0.5% for dry-robotic cleaning as per applicability,, even if 15 days of cleaning cycle are not complete.</p> <p>Sample calculation sheet (for a generic Site) for arriving month wise target generation (actual radiation shall be as mentioned in Sub-Part 1-A of Part-A) for 50 MW capacity from Tracker /MMS Fixed tilt system having 62.5 MWp DC capacity is shown in Table- A. The sample calculations shall be considered only for reference purpose.</p> <p>Table –A (Sample Calculation for a Generic Site, Actual Radiation as per Sub-Part 1-A of Part-A)</p> <table><tr><th>Month</th><th>Actual Radiation (kWhr/m2) (*)</th><th>Target Generation (MWhr) Tracker System (62.5 MWp) Finalized during Detailed Engg.(*)</th></tr><tr><td></td><td></td><td>A</td></tr><tr><td>January</td><td>165</td><td>9750</td></tr><tr><td>February</td><td>170</td><td>10125</td></tr><tr><td>March</td><td>180</td><td>10500</td></tr><tr><td>April</td><td>190</td><td>10875</td></tr><tr><td>May</td><td>185</td><td>10500</td></tr><tr><td>June</td><td>160</td><td>9000</td></tr><tr><td>July</td><td>145</td><td>7875</td></tr></table>	Month	Actual Radiation (kWhr/m2) (*)	Target Generation (MWhr) Tracker System (62.5 MWp) Finalized during Detailed Engg.(*)			A	January	165	9750	February	170	10125	March	180	10500	April	190	10875	May	185	10500	June	160	9000	July	145	7875
Month	Actual Radiation (kWhr/m2) (*)	Target Generation (MWhr) Tracker System (62.5 MWp) Finalized during Detailed Engg.(*)																										
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CLAUSE NO.	TECHNICAL SPECIFICATIONS																				
	<table><tr><td>August</td><td>140</td><td>7500</td></tr><tr><td>September</td><td>150</td><td>8250</td></tr><tr><td>October</td><td>155</td><td>8625</td></tr><tr><td>November</td><td>160</td><td>9000</td></tr><tr><td>December</td><td>160</td><td>9375</td></tr><tr><td></td><td>1960</td><td>111375</td></tr></table>			August	140	7500	September	150	8250	October	155	8625	November	160	9000	December	160	9375		1960	111375
August	140	7500																			
September	150	8250																			
October	155	8625																			
November	160	9000																			
December	160	9375																			
	1960	111375																			
	<p>Generation and Insolation assumed by END CUSTOMER for illustration purpose.</p> <p>3. In addition to the pyranometers to be supplied under the scope of work, the contractor install additional one pyranometer each for every 100MW capacity and part thereof (total 6 for 600MW Block) calibrated pyranometers at horizontal plane at locations mutually agreed by Contractor and END CUSTOMER. The additional pyranometers shall be free of cost on returnable basis.</p> <p>4. Contractor shall also install data logger to store all the pyranometers data during test period. A valid test reports for the installed pyranometers shall be submitted by the Contractor for approval to END CUSTOMER. The output of both pyranometers mounted on horizontal plane shall be made available at SCADA during the complete test duration i.e. three month period.</p> <p>Average Reading of all the Pyranometers supplied under the scope of work (excluding the ones offered on returnable basis) shall be considered Measured Global Horizontal Solar Insolation for the site.</p> <p>5. During the O&M target generation test period, the modules shall be 17 deg Fixed tilt</p> <p>6. Actual energy exported from the plant shall be noted for three consecutive month period. For this purpose, the net energy exported at the metering point (As per Part-A of Section VI) and pyranometers reading shall be noted at agreed frequency on daily basis for entire test period.</p> <p>7. This measured value of energy shall be compared with Target Generation” of the OTGT.</p> <p>Following factors shall be considered for computing the “target Generation” and shortfall (if any)</p> <p>a) Effect of any meteorological parameters shall not be considered except of solar radiation.</p> <p>b) Variation of energy output on account of Generation loss due to grid outage (or power evacuation system outside the scope of the Bidder): The measured global solar radiation of the period of the outage of the power evacuation system shall be excluded to calculate the cumulative global Insolation for the OTGT period. Under such situation, the radiation corresponding to the warm-up time of inverter as per data sheet shall also be adjusted to arrive at the cumulative global insolation for the OTGT period.</p>																				

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	<p>If the difference of reading between the two horizontally mounted pyranometers installed in the vicinity of each other at a particular location exceeds more than 2%, the test shall be halted and resumed only after rectification of errors which has led to mismatch. The data of that particular day(s) shall be discarded and test period shall be extended by same numbers of day(s).</p> <p>The test shall be repeated in case of outage of following equipment for more than 7 days.</p> <ol style="list-style-type: none">1. Inverter transformer2. Power Conditioning Unit3. SCADA and data logger combined4. All the pyranometers. <p>If bidder is not able to demonstrate O&M Target Generation test during these three (03) months he shall be given one more chance to demonstrate the test. In this case, the steps for test shall be repeated again as above after carrying out necessary modification/replacement and Carrying out RCA (Root Cause Analysis)</p> <p>In case, the shortfall during OTGT is due to the Non-performance of the PV Modules, bidder shall be responsible for bringing the issue to the notice of the Employer at the earliest with necessary evidence showing clearly that the shortfall in generation during OTGT is due to PV Modules and not attributable to the Systems supplied by the bidder, erection issues and/or O&M practices followed by bidder during OTGT.</p> <p>A sample calculation for shortfall/excess in energy generation for period from 10th January to 09th April for OTF Calculation and O&M Target Calculation for the site is given in Table-B.</p> <p>Table-B: A sample calculation for the Solar Plant for OTF Calculation by OTGT and O&M Target</p> <table><tr><th>Month</th><th>(a) Global Solar Insolation of the month (kWhr/m²) (Data provided by END CUSTOMER)</th><th>(b) Target Generation (MW/hr) (Final Target generation as per Table-A)</th><th>(c) No of test days of the month</th><th>(d) Reference Solar Insolation (a) x (c) / (N_{dm}*)</th><th>(e)CHANGED Target Generation of the month (MW/hr) (b)x(d)/(a)</th><th>(f) Measured Global Horizontal Solar Insolation (kWhr/m²)</th></tr><tr><td>January</td><td>165</td><td>9750</td><td>22</td><td>117.1</td><td>6919.35</td><td>120</td></tr></table>	Month	(a) Global Solar Insolation of the month (kWhr/m ²) (Data provided by END CUSTOMER)	(b) Target Generation (MW/hr) (Final Target generation as per Table-A)	(c) No of test days of the month	(d) Reference Solar Insolation (a) x (c) / (N _{dm} *)	(e)CHANGED Target Generation of the month (MW/hr) (b)x(d)/(a)	(f) Measured Global Horizontal Solar Insolation (kWhr/m ²)	January	165	9750	22	117.1	6919.35	120
Month	(a) Global Solar Insolation of the month (kWhr/m ²) (Data provided by END CUSTOMER)	(b) Target Generation (MW/hr) (Final Target generation as per Table-A)	(c) No of test days of the month	(d) Reference Solar Insolation (a) x (c) / (N _{dm} *)	(e)CHANGED Target Generation of the month (MW/hr) (b)x(d)/(a)	(f) Measured Global Horizontal Solar Insolation (kWhr/m ²)									
January	165	9750	22	117.1	6919.35	120									

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	February	170	10125	28	170	10125	171
	March	180	10500	31	180	10500	187
	April	190	10875	9	57	3262.5	61
	TOTAL	$\Sigma(a)$ 705	$\Sigma(b)$ 41250	$\Sigma(c)$) 90	$\Sigma(d)$ 524.10	$\Sigma(e)$ 30806.85	$\Sigma(f)$ 539
	* N _{dm} = Nos of days in the month						
	Test is assumed to start from 10 January till 9 th April						
	Cumulative Reference Solar Insolation for OTGT Period, i.e. 90 days – (D)				$\Sigma(d) = 524.10 \text{ kWhr/m}^2$		
	Cumulative Changed Target Generation for OTGT period, i.e. 90 days- (E)				$\Sigma(e) = 30806.85 \text{ MWhr}$		
	Cumulative Measured Solar Insolation for OTGT Period, i.e. 90 days – (F)				$\Sigma(f) = 539 \text{ kWhr/m}^2$		
	Corrected Target Generation for OTGT period- (G)				$(E \times F)/D = 30806.85 \times 539/524.1$ $= 31682.87 \text{ MWhr}$		
Measured/Achieved Generation at site during OTGT Period – (H)				32682.87 MWhr			
Total excess in Energy for the test period – (I)				$H-G = 32682.87-31682.87$ $=1000.0 \text{ MWhr}$			
O&M Test factor for calculating Target generation (OTF)				$= (H) / (G) =$ $32682.87/31682.87$ $=1.0316$			
Target Yearly Generation (G _y)				111375 MWhr			
Modified Target Generation for 1st year of O&M after successful OTGT				$= G_Y \times \text{OTF}$ $= 114894.45 \text{ MWhr}$			
Bidder to note that OTF should be greater than or equal to 1 (OTF >=1) for successful completion of OTGT.							

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	<p style="text-align: center;">D-7 SAFETY MANAGEMENT</p> <p>1.0 Bidder shall submit the Safety Plan and the Safety Coordination Procedure as per the requirement of relevant Attachments of the bidding documents.</p> <p>2.0 During the execution of the contract, the bidder and it's sub-vendor(if any) shall follow safety procedures for the safety of the personnel and the equipment during erection, testing, commissioning, operation and the maintenance during the contract period as per the regulatory requirements and the as per the original equipment manufacturer's recommendations.</p> <p>3.0 All the expenses, charges towards compliance of the safety norms by the bidder as per the Safety Plan, Safety Policy, and the Safety Coordination Procedures are deemed to be included in the bid price. No additional claims shall be entertained towards meeting the safety requirements. Minimum price to be quoted for 'Safety Aspects/ compliance to Safety Rules' shall be as per relevant clause of bidding document.</p> <p>4.0 Safety sign board to be provided near outdoor transformer yard, HT switchgear and all such risk zone areas.</p>

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	<p style="text-align: center;">D-8 CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM</p> <p>1.0 General Requirements</p> <p>1.01 The intent of the specification is to define the functional & design requirements for the CCTV System meant for gathering video information from the various areas of the power plant with display and recording facilities with night vision and motion sensors as per requirement.</p> <p>1.02 The Contractor shall be responsible for selection, design, engineering, manufacture, testing at manufacturer's works/site, installation of all the equipment supplied as covered in this specification and commissioning of the system meeting the intent & functional requirements of the specification. All the power supply (UPS), cables, cable trays, power packs, erection hardware (viz. junction boxes, brackets glands, nut-bolts, conduits etc.) and mounting are also included in Contractor's scope.</p> <p>1.03 The Contractor's scope shall also include successful demonstration of functional requirements specified herein complete in all respects and shall guarantee satisfactory performance of the equipment under stipulated variations of voltage and frequency.</p> <p>1.04 The bidder should offer new(Not refurbished cameras), Obsolete cameras and not an end-of-life product which shall be verified by the owner during detailed engineering.</p> <p>1.05 The number of camera units, servers, network switches, wireless equipment etc. and their locations shall be finalized during detailed engineer for effective functional requirements.</p> <p>1.06 Any other equipment, module, software required for the safe and satisfactory operation, control, protection, monitoring, testing and maintenance of the system shall also be included by the Bidder within the lump sum quoted price.</p> <p>1.07 The equipment furnished under this section shall meet the requirements of all the applicable international codes and standards or their latest amendment Codes and Standards. Camera certification has to be CE/FCC/UL or equivalent.</p> <p>1.08 Comprehensive warranty for 10 years for the entire CCTV system being offered.</p> <p>1.09 Bidder/Integrator shall provide project specific Authorization from the OEM incorporating the fact that the OEM shall provide technical support / troubleshooting during commissioning and operation of the and ensure that the maintenance is being done by the authorized agencies/personals till the completion of the Warranty.</p> <p>2.00 POWER SUPPLY ARRANGEMENT</p>

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2.01	<p>The CCTV System along with all its components i.e., network switches, storage devices, servers, LAN switches, cameras etc. shall be powered from UPS system. The contractor shall also provide local power distribution boxes as required for sub-distribution of UPS supply.-</p>
2.02	<p>For cameras to be located in remote areas where the UPS power supply cannot be extended due to voltage drop etc., then such cameras can be grouped and fed from mini-UPS. Individual mini-UPS shall be provided for the cameras which cannot be grouped. The contractor shall also provide local power distribution boxes as required for sub-distribution of supply from these mini-UPS to cameras. The location of mini-UPS & power distribution scheme shall be finalized during detail engineering.</p>
2.03	<p>If the offered equipment is operating at voltage level other than what is available as auxiliary supply, the Contractor shall provide all required hardware, to make the offered system compatible with specified power supply arrangement.</p>
3.00	<p>DESIGN, TECHNICAL REQUIREMENTS AND CYBER SECURITY</p>
3.01	<p>The CCTV system shall be able to provide surveillance of different locations in the plant like entry/exit gates, ICR's(Indoor and outdoor) in entire layout CMCS(Indoor and Outdoor) and all across the periphery. The periphery shall be covered by the CCTV such that at a time all the periphery is covered irrespective of the direction the PTZ camera is facing. The same shall be verified during detailed engineering.</p> <p>It is to be ensured</p> <p>that location of camera shall be such that it should cover the WMS locations inside the plant. Other strategic locations if any shall be decided during detailed engineering design. The exact locations shall be decided during detailed engineering.</p> <p>The CCTV system shall be designed as a standalone IP based network architecture. The system shall use video signals from different cameras at different locations, process the video signals for viewing on monitors at different locations and simultaneously record all the video streams using H.264 or better compression technique. Joystick and mouse-keyboard controllers shall be used for Pan, Tilt, Zoom and other functions of desired cameras.</p> <p>The monitoring of these cameras shall be done at main Control Room or as finalized in detailed engineering. The required no. of hardware/software licenses to meet the requirements shall be supplied by the contractor.</p>
3.04	<p>Camera and database servers shall offer both video stream management, video stream storage management. These servers shall also manage and store configuration information/database for the whole system. Recording frame rate & resolution in respect of individual camera shall be</p>

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	<p>programmable. It shall be possible to view and record at different resolutions and frame rates and this shall be individually programmable on every camera.</p> <p>It shall be possible to take back-up of system configuration and database on portable media device and restoring the same if required.</p> <p>3.05 System shall ensure that once recorded, video cannot be altered.</p> <p>3.06 Camera server shall be provided with a minimum of 32 TB of storage space or as calculated per requirement to store recordings of all cameras for the specified days. All recordings shall have camera ID, Location, Date, and time of recording.</p> <p>3.07 It shall be possible to view, record, search and replay simultaneously without affecting the performance of the system.</p> <p>3.08 The system supplied shall be complete in all respects for reliable performance. The Contractor shall submit the detailed block schematic, video, signal & power wiring diagram, describing the connections between the network switch/camera server Systems and various cameras, monitors, keyboard, and joystick.</p> <p>3.09 The camera & Video Management Software shall conform to ONVIF profile S, G, T and M or latest available applicable ONVIF profile at the time of detail engineering.</p> <p>3.10 The camera OEM is desired to have valid H.265 HEVC Certificate and should be listed on following official website of HEVC.</p> <p>3.11 The network cameras supplied must be manufactured in accordance with the ISO 9001 and 14001 standards.</p> <p>3.12 The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.</p> <p>3.13 The proposed camera is desirable to have Brute force delay protection and be verified for a tamper-resistant hardware module, certified to Common Criteria like EAL4.</p> <p>3.1 The Camera to be provided along with all the components / parts / assembly / software used in the offered hardware and software all the latest cybersecurity regulation and other certifications as applicable with latest amendments thereof. It shall also be checked/verified to ensure that the camera should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There</p>

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	a) PTZ Dome Cameras High Definition (HD) PTZ cameras	
	Image Device	1/2.8-1/3" Progressive scan CMOS
	Lens	4.45-4.7 /- 130-137 mm focal length
	Optical Zoom	30x or better
	Digital Zoom	12x or better
	Number of Pixels/Effective resolution	1920X1080 (Full HD)/2 MP at 25/30 IPS
	Video compression	H.264, H.265 Main Profile/High profile
	Sensitivity	Color mode 0.6 lux, B/W mode 0.04lux @30IRE, F1.6
	Horizontal Angle of view	55.4 deg(wide)- 3.5 deg (Tele) minimum
	Focus	Auto with Manual Override
	Iris Range	F1.6-F2.9
	Iris Control	Auto with Manual Override
	Back Light Compensation	Required
	White Balance	Automatic with mode selection options
	Electronic Shutter	1/50 to 1/10000 Auto
	S/N Ratio	>50dB
	Audio	Full Duplex or 2-way
	Automatic Gain Compensation	Up to 18 dB
	Power Supply	The camera power supply should preferably be of the same make as that of camera and suitable for the model no. offered. If the Power supply from the Camera OEM is not available, approval for the power supply shall be accorded during detailed engineering.
	Gain Control	Auto/Off
	Day/Night selection	Auto On-Off
	IR cut filter	Yes
	Protocols	IPV4/IPV6, RTP, UDP, TCP/ IP, HTTP, HTTPS, FTP,DHCP, IGMP V2/V3, ICMP, ARP, SMTP, SNTP, SNMP, MQTT or equivalent.
	Security	Password protection, Digest authentication, camera to boot with authorized firmware.
	Auto Resume after Power Failure	Yes

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CLAUSE NO.																																									
	<table><tr><td>Multiple Streams</td><td>H.264 /H.264 & H.264/Motion JPEG, H.265 with HEVC Certificate.</td></tr><tr><td>Operating resolution</td><td>4 streams at 25 FPS in H.265/H.264</td></tr><tr><td>Analytics</td><td>Motion detection, Temper detection and other preferred additional analytics .</td></tr><tr><td>PoE supply IEEE 802.3af compliant or better</td><td>Yes</td></tr><tr><td>Rate Control</td><td>VBR/CBR</td></tr><tr><td>Cybersecurity requirement.</td><td>To comply to all latest cybersecurity regulations in India with all latest amendments thereof.</td></tr><tr><td>Other Features</td><td></td></tr><tr><td></td><td>On screen Menu display and WDR 120 dB, ONVIF Profile G, S, T and M compliant.</td></tr><tr><td>WDR</td><td>Automatic Picture Enhancement to give a balanced picture where there is too much/too little light</td></tr><tr><td></td><td></td></tr><tr><td></td><td>Minimum 2 Alarm I/Ps & 1 alarm output</td></tr><tr><td>PTZ Specifications</td><td></td></tr><tr><td>Pan</td><td>360 Deg Continuous</td></tr><tr><td>Tilt</td><td>180 deg</td></tr><tr><td>Manual Tilt Speed</td><td>0.1 deg/sec to 280 deg/sec</td></tr><tr><td>Manual Pan Speed</td><td>0.1 deg/sec to 250 deg/sec</td></tr><tr><td>Preset Positions</td><td>Minimum 256</td></tr><tr><td>Preset Pan Speed</td><td>280 deg/sec min</td></tr><tr><td>Preset Tilt Speed</td><td>250 deg/sec min</td></tr><tr><td>Maximum Operating conditions</td><td>-10 °C to 55 °C</td></tr></table>	Multiple Streams	H.264 /H.264 & H.264/Motion JPEG, H.265 with HEVC Certificate.	Operating resolution	4 streams at 25 FPS in H.265/H.264	Analytics	Motion detection, Temper detection and other preferred additional analytics .	PoE supply IEEE 802.3af compliant or better	Yes	Rate Control	VBR/CBR	Cybersecurity requirement.	To comply to all latest cybersecurity regulations in India with all latest amendments thereof.	Other Features			On screen Menu display and WDR 120 dB, ONVIF Profile G, S, T and M compliant.	WDR	Automatic Picture Enhancement to give a balanced picture where there is too much/too little light				Minimum 2 Alarm I/Ps & 1 alarm output	PTZ Specifications		Pan	360 Deg Continuous	Tilt	180 deg	Manual Tilt Speed	0.1 deg/sec to 280 deg/sec	Manual Pan Speed	0.1 deg/sec to 250 deg/sec	Preset Positions	Minimum 256	Preset Pan Speed	280 deg/sec min	Preset Tilt Speed	250 deg/sec min	Maximum Operating conditions	-10 °C to 55 °C
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	b) Fixed Cameras																																								
	High Definition (HD) Fixed Camera																																								
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CLAUSE NO.	TECHNICAL SPECIFICATIONS	
	Focus	Auto with Manual Override
	Multiple Streams	4 streams at 2MP, 25 FPS in H.264/H.265
	Iris Range	1.7
	Audio	Full Duplex or 2-way
	IR cut filter	Yes
	Protocols	IPV4/IPV6, RTP, UDP, TCP, IP, HTTP, HTTPS, FTP,DHCP, IGMP V2/V3, ICMP, ARP, SMTP, Sntp, SNMP, MQTT or equivalent
	Security	Password protection, Digest authentication, camera to boot with authorized firmware.
	Iris Control	Auto with Manual Override
	Analytics	Motion detection, Temper detection and additional analytics as available.
	PoE supply IEEE 802.3af compliant	Yes
	SD/SDHC/SDXC in Camera (For Local alarm recording & scheduled local recording)	Yes, minimum 256 GB capability
	Rate Control	VBR/CBR
	Back Light Compensation	Required
	White Balance	Automatic with mode selection options
	Electronic Shutter	1/50 to 1/10000 Auto
	S/N Ratio	>50dB
	Automatic Gain Compensation	Up to 18 dB
	Power Supply	The camera power supply should be of the same make as that of camera and suitable for the model no. offered. If the Power supply from the Camera OEM is not available, power supply shall be endorsed by the OEM.
	Gain Control	Auto/Off
	Day/Night selection	Auto On-Off
	Other Features	
		WDR 120 dB, ONVIF Profile G, S, T and M compliant.
	WDR	Automatic Picture Enhancement to give a balanced picture where there is too much/too little light

CLAUSE NO.	TECHNICAL SPECIFICATIONS	
		Minimum One Alarm I/P Minimum One Alarm O/P
	Maximum Operating conditions	-10 °C to 55 °C
	<p>4.03 Camera Housing & Mount</p> <p>a) All the cameras and accessories are to be housed in Weatherproof IP 65 environmental housing made of aluminum and Sun shroud. The housing, with heater and blower installed, shall provide protection for camera/lens assemblies in the ambient temperature range of - 0 deg. C to 50 deg. C.</p> <p>b) For non-Dome type cameras, the housing shall also have a thermostatically controlled heater kit. Continuous duty blower kit (with suitable filters) for purge air arrangement / Window wipers shall be available within the housing for cameras as indicated against each application.</p> <p>c) The camera mount, camera housing and camera power supply should be of the same make as that of camera and suitable for the model no. offered as specified by the manufacturer.</p>	
4.04	<p>Keyboard & Joystick-</p> <p>The keyboard shall have full function used for system control and programming for selection of various Network switches, camera/database servers, camera functions including pan, tilt and zoom lens controls and shall be ergonomically designed.</p> <p>Joystick shall be provided for achieving all control functions.</p>	
4.05	<p>Workstation</p> <p>Operators' workstation & network switch station shall be in Control Room or as finalized during the detailed engineering. The size of the display screen shall be minimum 55 inches/ inline to the requirement for the complete camera coverage in the screen. Bidder must ensure that the LED screen pixel density shall match with the offered camera pixel density or higher.</p>	
4.06	<p>WIRELESS CONNECTION EQUIPMENT (FOR CAMERA SPECIFIED ON WIRELESS CONNECTIVITY):</p> <p>If contractor offer any camera with wireless connectivity, Access points for these cameras shall be mounted on lighting mast/pole. Wireless equipment and type of</p>	

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>wireless connectivity shall be decided during detailed Engineering. Wireless communication for the above should be subscribing to the latest Cyber security standards including encryption. The wireless modem should support dynamic encryption techniques.</p> <p>4.07 NETWORK SWITCH:</p> <p>All the network switches shall be of high quality and shall be sized to meet the functional requirements as specified. The common switch to which all networks are connected shall be Layer-III switch/router. All the interconnecting cables between network switches shall be fiber optic only. All fiber optic cables shall be terminated directly to network switches through optical fiber port without using media converters. Bidder to ensure that minimum 100% cores are kept as spares in all type of optical fiber cables.</p> <p>5.0 CABLES:</p> <p>Cables shall be of FRLS PVC sheathed cables for use in CCTV and shall conform to latest edition of Indian/International standards. Fiber optic cables are to be provided (as applicable). The remaining cables can be as per CCTV supplier's standard. For details of Fiber Optic cables, refer subsection INST CABLE. All the cables and the hardware required for powering the system are also in the scope of Contractor. All cables required for interfacing alarm contact inputs (to be provided by employer) to CCTV system are also in scope of contractor.</p> <p>5.01 For estimation of cable quantities, erection hardware, hardware for wireless communication etc., the Bidder shall refer to General Layout Plant, Equipment Location Plans drawings & other relevant drawings to be finalized during detailed engineering. All the cables are to be provided by the Contractor on as required basis.</p> <p>6.0 Location of CCTV:</p> <p>Bidder to note:</p> <ol style="list-style-type: none"> I. Final/Exact location of the CCTV cameras shall be reviewed during detailed engineering. II. The relevant drawings pertaining to location and the location of the console shall be finalized during the detailed engineering.

TECHNICAL SPECIFICATIONS	
CLAUSE NO.	
	<div>D-9 SITE ESTABLISHMENT FOR BHEL</div>
1.0	<div>General</div> <p>The Contractor shall be fully responsible for establishing, provisioning, maintaining, and operating the complete site infrastructure and amenities required to support BHEL’s project execution and operation & maintenance (O&M) activities at the site. The entire scope of site establishment shall remain active and in working condition for the construction phase duration as well as the O&M period, or until specifically released by the BHEL Site In-Charge. The contractor shall ensure that all infrastructure, utilities, manpower, equipment, and services provided are in compliance with applicable safety, statutory, and environmental norms, and are maintained in safe, clean, and efficient condition throughout the contractual duration.</p>
2.1	<div>Site Infrastructure and Utilities</div> <p>The contractor shall provide a minimum of two air-conditioned Porta Cabins per 250 MW solar block, having a combined area of not less than 400 sq. ft. The office units shall be equipped with desks, chairs, fans, lighting, fire extinguishers, and electrical plug points. IT infrastructure including laptops or desktops with licensed software, a multifunction A4/A3 printer and high-speed document scanner, LED television, and unlimited internet dongles shall be provided for BHEL’s use. All office units shall remain functional and accessible for the full duration of the project execution and O&M phase</p> <p>A separate mobile or environmentally friendly toilet container with water tank shall also be installed nearby. All necessary electrical and civil works including water pipeline and plumbing shall be executed by the contractor. The Porta Cabins shall be powered by the main green solar system or individual microgrids.</p> <p>Provision of water supply through Sintex-type water tanks, including necessary plumbing, refilling arrangements, and sanitation support shall be ensured. Hygienic prefabricated western-style toilets with ventilation, septic tanks, and plumbing connections shall be installed and maintained. Outdoor and indoor LED lighting shall be installed for safe working conditions during low light hours.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
2.2	<p>Security and Surveillance</p>
	<p>The contractor shall install a complete CCTV system covering all strategic points, including entry, storage, and work areas, consisting of PTZ and fixed cameras, NVR/DVR systems with display and storage, and power backup. Site fencing using metallic posts and GI chain-link mesh, guard cabins, and secure storage containers shall also be provided and maintained to ensure security of personnel and materials.</p>
2.3	<p>Site Preparation and Access</p>
	<p>Clearing, levelling, and preparation of internal WBM roads shall be carried out for the smooth and safe movement of men and materials. Wooden fencing shall be installed around key areas to prevent unauthorized access and entry of animals.</p>
2.4	<p>Pantry, Housekeeping, and Daily Services</p>
	<p>A pantry with gas stove, hot plate, LPG cylinder, utensils, and provision of basic hospitality with refreshments shall be ensured for BHEL personnel and site visitors. Daily housekeeping and drinking water supply shall be arranged. Required PPE (helmets, shoes, gloves, jackets) and first-aid kits shall be stocked and made accessible.</p>
2.5	<p>Manpower Support</p>
	<p>Trained manpower including helpers, operators, security personnel, storekeepers, and housekeeping staff shall be deployed as per requirement. All statutory requirements including PF, ESI, safety training, and PPE compliance shall be ensured by the contractor.</p>
2.6	<p>Accommodation and Transport</p>
	<p>The contractor shall provide a well-furnished Minimum 2 numbers of 2 BHK AC house with cook, lighting, furniture, water, electricity, LPG gas refills, and utensils for BHEL officials' accommodation or minimum four double bed AC rooms in hotel in Bikaner city. Additionally, an air-conditioned 4-wheeler SUV vehicle, in excellent roadworthy condition with a professional driver, shall be made available for official use of BHEL</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
3.0	<p>Minimum movement of vehicle shall be from Bikaner city to Solar plant and inside the plant on daily basis and minimum two times in a month vehicle will go out of the city throughout the project execution and O&M duration.</p> <p>Notes</p> <p>The contractor shall ensure availability and operational readiness of all above-mentioned infrastructure, manpower, and equipment throughout the construction and O&M period, as per BHEL's instructions. Any required consumables, maintenance, or repairs shall be done at the contractor's cost. The infrastructure shall remain the property of the contractor and may be removed after commissioning of the full project.</p>

PART-B
CHAPTER-E
QUALITY ASSURANCE

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>E-1 QUALITY ASSURANCE CHAPTER</p> <p>COMPONENTS</p> <ol style="list-style-type: none"> 1) Array Junction Box/ String Monitoring Box 2) PCU 3) LT Switchgear & LT Busduct 4) Cabling, Earthing, Lightning Protection. 5) Control Cables 6) LT Power Cables 7) MV (3.3kV/ 6.6 kV/ 11kV/ 33kV) Cables 8) HT Switchgear 9) SCADA and Accessories 10) DC System <ol style="list-style-type: none"> a) Battery b) Battery Charger c) DC Health Monitoring System 11) Station Lighting 12) Transformer 13) Energy Meter 14) Module cleaning System and Ventilation 15) Robotic Module Cleaning System <p>Components wise QA Chapter has been furnished in Annexure - I. Indicative list of Vendors Approved for Electrical Components & Civil works are enclosed at Annexure - II of this section.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: right;">Annexure - I</p> <p>1) ARRAY JUNCTION BOX/ STRING MONITORING BOX/ STRING COMBINER BOX</p> <p>Array Junction quality plan should include the following:</p> <p>A) Checks on bought out items as per internal standards of the manufacturer</p> <p>B) In-process checks, as per internal standards of the manufacturer</p> <p>C) Sample tests as per following:</p> <ol style="list-style-type: none"> 1) IR-HV-IR test (sampling as per General Inspection Level-II and AQL 1.0% as per IS 2500 Part 1) 2) String Monitoring Card/ Power Supply card/ DC-DC Converter function check (sampling as per General Inspection Level-II and AQL 1.0% as per IS 2500 Part 1) 3) Communication Function Test (sampling as per General Inspection Level-II and AQL 1.0% as per IS 2500 Part 1) 4) Degree of protection visual checks like gasket profile, sealing arrangement, paper pull check

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">2) PCU (Inverter)</p> <p>PCU quality plan should include the following</p> <p>A) Incoming Quality Checks on bought out items as per relevant standard as mentioned in Technical Specifications (TS)</p> <p>B) In-process quality checks</p> <p>C) Routine tests as per following on the assembled PCU:</p> <ol style="list-style-type: none"> 1) Check of Dimension, Paint shade, Paint Adhesion, Thickness, make, rating, degree of protection, doors. 2) Uploading of Software to control board and checking of general parameter setting including protection settings (Manufacturer to perform on 100% Panel) 3) Control Circuit functional check including operation of contactors, relay and Circuit breakers (Manufacturer to perform on 100% Panel) 4) Display Panel functionality including Digital Input/Output check, Direction of rotation and ON-OFF control of the fans, Protection function check (by simulation or direct method), Abnormal voltage and frequency, DC ground fault, DC reverse polarity, AC & DC Over voltage, Calibration test (DC Voltage, AC Voltage and Frequency), Testing of wake up / auto start and stop with grid connectivity, Manual ON/OFF from PCU MMI with grid connectivity, IR test on main and control circuit, HV test on main and control circuit. (Manufacturer to perform on 100% Panel) <p>D) Following sample tests on the assembled PCU: (1 Panel per offered lot)</p> <ol style="list-style-type: none"> 1. Sample testing to include measurement of phase currents, efficiencies, harmonic content and power factor at four points preferably 25%, 50%, 75% and 100% of the rated nominal power. 2. Maximum power point tracking (MPPT) functional check

CLAUSE NO.	TECHNICAL SPECIFICATIONS														
<div><div>ATTRIBUTES / CHARACTERIS-TICS</div><div>ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY</div></div>	3) LT SWITCHGEAR & BUS DUCT														
	LT SWITCHGEAR														
	(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
	<div>→</div>	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per END CUSTOMER Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per END CUSTOMER spec	All Routine tests as per END CUSTOMER
	Sheet Steel (IS :513)	Y	Y		Y	Y		Y							
	Aluminum Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y							
	Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y							
	Support Insulator	Y	Y	Y	Y			Y							
	Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y
	Energy Meters (IS : 13010, 13779)	Y	Y				Y	Y			Y				Y
	Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y				
	Protection & Aux. Relays (IS : 3231) (IEC 60255 / IEC 61850)	Y	Y				Y	Y			Y				Y
	Control & Selector Switches (IS : 13947)	Y	Y				Y	Y			Y				
	CT's & PT's (IS 2705 / 3156)	Y	Y					Y							Y
	MCCB (IS : 13947)	Y	Y					Y			Y				
	Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y
	Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y				
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y					
Control Terminal Blocks	Y	Y				Y	Y								

CLAUSE NO.	TECHNICAL SPECIFICATIONS														
<div><div>ATTRIBUTES / CHARACTERISTICS</div><div>↓</div><div>ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY</div><div>↓</div></div>	LT SWITCHGEAR														
	(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
		Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per END CUSTOMER Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per END CUSTOMER spec	All Routine tests as per END CUSTOMER spec. & IS
	Fuse (IS 13703)	Y	Y				Y	Y							
	Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y
	Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				
	Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
	MCB (IS : 8828)	Y	Y				Y	Y			Y				
	Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
	Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
	LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y	Y		Y	Y	Y
	Notes:														
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.															
2. Makes of all major Bought Out Items will be subject to END CUSTOMER approval.															

CLAUSE NO.	TECHNICAL SPECIFICATIONS													
	ELECTRICAL ACTUATOR WITH INTEGRAL STARTER													
	Test/Attributes Characteristics <div></div>													
	ITEM/ COPONENT / SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard & Specification®	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Grease leakage ®	Local/ Remote (Open-Stop-Close) Operation® Safety check (Single phasing, Phase correction, Tripping etc.) (A)
	ELECTRICAL ACTUATOR WITH INTEGRAL STARTER(I S_9334)													
	Motor	Y	Y	Y	Y	Y								
	Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.													
	® - Routine Test (A) - Acceptance Test Y - Test applicable													

CLAUSE NO.		TECHNICAL SPECIFICATIONS												
4) CABLING, EARTHING, LIGHTNING PROTECTION														
MODULE NO. SQE-16		Page 1 of 1												
ATTRIBUTES / CHARACTERISTICS														
ITEMS/COMPONENTS / SUB SYSTEMS														
Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)		Y	Y	Y	Y		Y		Y		Y	Y	Y	Y
Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)		Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y
Cable glands(BS-6121)		Y												Y
Cable lug		Y												Y
Lighting wire (IS-694)		Y										Y		
Flexible conduits		Y										Y		Y
Conduits (Galvanise & Epoxy) IS-9537 & IS-2629, 2633, 6745		Y		Y					Y			Y		Y
RCC Hume Pipe (IS-458)												Y		
Cable termination & straight through joint (IS 13573)		Y										Y		Y
Cable Trays, bends, tees, crosses, Flexible supports system & accessories IS-513, 2629,2633,6745		Y		Y		Y	Y	Y		Y		Y	Y	Y
Trefoil clamp		Y												Y
GI flats for earthing & lighting protection (IS 2062, 2629, 6745,2633)		Y		Y						Y		Y		Y
GI wire (IS-280)		Y										Y		
Fire Sealing System (BS –476)												Y	Y	Y
.Note:1.This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2.* Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the END CUSTOMER technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot. This test is not applicable on bends, tees & crosses. 3. Make of all items will be subject to END CUSTOMER approval														

CLAUSE NO.	TECHNICAL SPECIFICATIONS														
	5) CONTROL CABLES														
	Attributes / Characteristics														
	Item / Components / Sub System Assembly														
	Copper (IS-8130)	Y	Y	Y	Y		Y								
	PVC insulation Compound (IS: 5831)	Y		Y			Y				Y	Y			
	FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1)	Y	Y	Y							Y	Y			
	Extrusion & curing /Manufacturing of Core		Y			Y						Y			
	Core Laying							Y							
	Armour wire/strip	Y	Y	Y											
	Inner sheath	Y	Y												
	Armouring		Y					Y							
	Outer Sheathing		Y						Y						
	Finished Cable (IS-5831, ASTM-D2843, IS10810 (Part 58), IEC-60754 Part-1, IEC 60332 part III cat B)							Y	Y	Y	Y	Y		Y	Y
	Wooden drum (IS-10418) /Steel Drum		Y										Y	Y	
	Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought out items will be subject to END CUSTOMER approval.														

CLAUSE NO.	TECHNICAL SPECIFICATIONS	
	ROUTINE TESTS	Following routine tests shall be carried out on each drum of finished cables for all sizes.
	1)	Conductor Resistance test
	2)	High voltage test
	ACCEPTANCE TESTS	Following Acceptance tests shall be carried out on each size of cables, in the offered lot.
	A) For Conductor (as per sampling plan mentioned in IS: 1554)	
	1)	Annealing test (Copper)
	2)	Resistance test
	B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 1554)	
	1.	Measurement of Dimensions
	2.	Tensile Tests
	3.	Elongation Test
	4.	Torsion Test For Round wires only
	5.	Wrapping Test
	6.	Resistance Test
	7.	Mass of Zinc coating test For G S wires / Formed wires only
	8.	Uniformity of Zinc coating For G S wires / Formed wires only
	9.	Adhesion test For G S wires / Formed wires only
	10.	Freedom from surface defects
	C) For PVC insulation & PVC Sheath (as per sampling plan mentioned in IS: 1554)	
	1)	Test for thickness
	2)	Tensile strength & Elongation before ageing (for tests after ageing see "D")
	D) Ageing test:	
	If the compound manufacturer is carrying out Ageing test, test report of compound manufacturer is to be reviewed. If the compound manufacturer is not carrying out ageing test, then cable manufacturer will carry out ageing test & the test report will be reviewed by owner (quantum of	

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	ageing test sample shall be one sample /batch)		
	E) Following tests will be carried out on completed cables as per IS on each size:		
		1)	Insulation resistance test (Volume resistivity method)
		2)	High voltage test
	F) Following tests shall be carried out on only one size of offered lot (comprising of all sizes):		
		1)	Thermal stability test on PVC insulation and outer sheath
		2)	Oxygen index test on outer sheath
		3)	Smoke density rating test on outer sheath
		4)	Acid gas generation test on outer sheath
	G) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable will be carried out as per following sampling plan:		
			This test will be carried out using composite sampling i.e. irrespective of size; cables of one particular type (i.e. armoured, unarmoured) will be bunched together, as per calculations in line with the IEC. All sizes of armoured & unarmoured cables shall be covered.
	H) Following tests shall be carried on one length of each size (armoured & unarmoured) of offered lot:		
		1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, drum / outer sheath extrusion's batch number marking
		2)	Measurement of Eccentricity & Ovality
	GENERAL NOTE:		
	(a) In case of manufacturers / supplier who have supplied cables in the past through Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by owner and Main Contractor at the time of final inspection. Owner and Main Contractor will also witness routine tests on cables on 10% sample basis. (b) In case of manufacturers / supplier WHO HAVE NOT SUPPLIED cables in the past through Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by Owner at the time of final inspection. Owner will witness routine tests on cables for the first order on 10% sample basis and Main Contractor will witness routine tests on cables for the first order on 100% basis.		
	1. For Smoke Density rating test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection. 2. For Acid Gas Generation test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection. 3. For Oxygen Index test: if the test result without conditioning is within (+)7% of the minimum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection. 4. In case the test results without conditioning do not meet the maximum/minimum specified value, the manufacturer may exercise the option of retesting the samples after conditioning as per standard.		

CLAUSE NO.	TECHNICAL SPECIFICATIONS	
	ROUTINE TESTS	
	Following routine tests shall be carried out on each drum of finished cables for all types (PVC / XLPE insulated) & sizes.	
	3)	Conductor Resistance test
	4)	High voltage test
	ACCEPTANCE TESTS	
	Following Acceptance tests shall be carried out on each size of each type (PVC / XLPE insulated) of cables, in the offered lot.	
	A) For Conductor (as per sampling plan mentioned in IS: 1554 / 7098)	
	1)	Annealing test (Copper)
	2)	Tensile Test (Aluminum)
	3)	Wrapping Test (Aluminum)
	4)	Resistance test
	B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 1554 / 7098)	
	1.	Measurement of Dimensions
	2.	Tensile Tests
	3.	Elongation Test
	4.	Torsion Test For Round wires only
	5.	Wrapping Test
	6.	Resistance Test
	7.	Mass of Zinc coating test For G S wires / Formed wires only
	8.	Uniformity of Zinc coating For G S wires / Formed wires only
	9.	Adhesion test For G S wires / Formed wires only
	10.	Freedom from surface defects
	C) For PVC / XLPE insulation & PVC Sheath (as per sampling plan mentioned in IS: 1554 / 7098)	
	1)	Test for thickness
	2)	Tensile strength & Elongation before ageing (for tests after ageing see "D")
	3)	Hot set test (For XLPE insulation)
	D) Ageing test:	
	If the compound manufacturer is carrying out Ageing test, test report of compound manufacturer is to be reviewed. If the compound manufacturer is not carrying out ageing test, then cable manufacturer will carry out ageing test & the test report will be reviewed by owner (quantum of ageing test sample shall be one sample /batch	

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																									
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	ROUTINE TESTS		
	Following routine tests shall be carried out on each drum of finished cables for all types & sizes.		
	1)		Conductor Resistance test
	2)		High voltage test
	3)		Partial discharge test (for Screened cables only)
	ACCEPTANCE TESTS		
	Following Acceptance tests shall be carried out on each size of each type (voltage rating) of cables, in the offered lot.		
	A) For Conductor (as per sampling plan mentioned in IS: 7098 Part II)		
	1)		Annealing test (Copper)
	2)		Tensile Test (Aluminum)
	3)		Wrapping Test (Aluminum)
	4)		Resistance test
	B) For copper tape / Wires (as per sampling plan mentioned in IS: 7098 Part II)		
	1)		Measurement of Dimensions
	2)		Conductivity check
	B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 7098 Part II)		
	1.		Measurement of Dimensions
	2.		Tensile Tests
	3.		Elongation Test
	4.		Torsion Test For Round wires only
	5.		Wrapping Test
	6.		Resistance Test
	7.		Mass of Zinc coating test For G S wires / Formed wires only
	8.		Uniformity of Zinc coating For G S wires / Formed wires only
9.		Adhesion test For G S wires / Formed wires only	
10.		Freedom from surface defects	
C) For XLPE insulation & PVC Sheath (as per sampling plan mentioned in IS: 7098 Part II)			
1)		Test for thickness	
2)		Tensile strength & Elongation before ageing (for tests after ageing see “D”)	
3)		Hot set test (For XLPE insulation)	

CLAUSE NO.	TECHNICAL SPECIFICATIONS																				
	<p>D) Ageing test:</p> <p>If the compound manufacturer is carrying out Ageing test , test report of compound manufacturer is to be reviewed. If the compound manufacturer is not carrying out ageing test, then cable manufacturer will carry out ageing test & the test report will be reviewed by owner (quantum of ageing test sample shall be one sample /batch)</p> <p>(a) In case of manufacturers / supplier who have supplied cables in the past through Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by owner and Main Contractor at the time of final inspection. Owner and Main Contractor will also witness routine tests on cables on 10% sample basis.</p> <p>(b) In case of manufacturers / supplier WHO HAVE NOT SUPPLIED cables in the past through Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by Owner at the time of final inspection. Owner will witness routine tests on cables for the first order on 10% sample basis and Main Contractor will witness routine tests on cables for the first order on 100% basis.</p> <p>1. For Smoke Density rating test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.</p> <p>2. For Acid Gas Generation test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.</p> <p>3. For Oxygen Index test: if the test result without conditioning is within (+)7% of the minimum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.</p> <p>4. In case the test results without conditioning do not meet the maximum/minimum specified value, the manufacturer may exercise the option of retesting the samples after conditioning as per standard.</p> <p>E) Following tests will be carried out on completed cables as per IS on each size of each type</p> <table> <tr> <td>1)</td><td>Insulation resistance test (Volume resistivity method)</td></tr> <tr> <td>2)</td><td>High voltage test</td></tr> <tr> <td>3)</td><td>Partial discharge test (for Screened cables only)</td></tr> </table> <p>F) Following tests shall be carried out on only one size of offered lot (comprising of all sizes & types)</p> <table> <tr> <td>1)</td><td>Thermal stability test on outer sheath</td></tr> <tr> <td>2)</td><td>Oxygen index test on outer sheath</td></tr> <tr> <td>3)</td><td>Smoke density rating test on outer sheath</td></tr> <tr> <td>4)</td><td>Acid gas generation test on outer sheath</td></tr> <tr> <td>5)</td><td>Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable</td></tr> </table> <p>G) Following tests shall be carried on one length of each size of each type of offered lot:</p> <table> <tr> <td>1)</td><td>Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, marking of drum no. / Batch number of outer sheath extrusion</td></tr> <tr> <td>2)</td><td>Measurement of Eccentricity & Ovality</td></tr> </table> <p>GENERAL NOTE:</p> <p>(a) In case of manufacturers / supplier who have supplied cables in the past through Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by owner and Main Contractor at the time of final inspection. Owner and Main Contractor will also witness routine tests on cables on 10% sample basis.</p> <p>(b) In case of manufacturers / supplier WHO HAVE NOT SUPPLIED cables in the past through</p>	1)	Insulation resistance test (Volume resistivity method)	2)	High voltage test	3)	Partial discharge test (for Screened cables only)	1)	Thermal stability test on outer sheath	2)	Oxygen index test on outer sheath	3)	Smoke density rating test on outer sheath	4)	Acid gas generation test on outer sheath	5)	Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable	1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, marking of drum no. / Batch number of outer sheath extrusion	2)	Measurement of Eccentricity & Ovality
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by Owner at the time of final inspection. Owner will witness routine tests on cables for the first order on 10% sample basis and Main Contractor will witness routine tests on cables for the first order on 100% basis.
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CLAUSE NO.	TECHNICAL SPECIFICATIONS															
<div>TESTS</div> <div>ITEMS</div>	9) SCADA & ACCESSORIES															
	PROGRAMMABLE LOGIC CONTROLLER															
	1. PLC Panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	2. Control Desk With PLC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Note: 1) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure along with relevant supporting documents.																
*Applicable for PLC Y - Test Applicable , ® - Routine Test (A) - Acceptance Test																

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																																																																																					
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CLAUSE NO.	TECHNICAL SPECIFICATIONS															
	INSTRUMENTATION CABLE															
	TESTS															
ITEMS																
1. Instrument cable twisted and shielded																
Conductor(IS-8130)	Y			Y			Y									
Insulation(VDE-207)				Y	Y	Y	Y						Y			Y
Pairing/Twisting				Y	Y		Y									
Shielding				Y			Y			Y						
Drain wire	Y			Y			Y		Y	Y						
Inner Sheath				Y	Y	Y	Y						Y	Y		
Outer Sheath				Y	Y	Y	Y						Y	Y		
Over all cable Cable Drums(IS-10418)	Y	Y	Y	Y	Y		Y	Y			Y				Y	
<p>Note : High Temp. cables shall be subjected to tests as per VDE-207(Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.</p> <p>Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all items.</p> <p>Note : ® - Routine Test A - Acceptance Test Y - Test Applicable</p> <p>Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)</p> <ul style="list-style-type: none"> * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1) ** Characteristic Impedance, Attenuation, Mutual Capacitance, Cross Talk (As applicable) <p>+ Sample size will be One No. of each size/type per lot.</p> <p>++ Sample size will be One No. sample for complete lot offered irrespective of size/type.</p>																
BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN														PAGE 23		

CLAUSE NO.	TECHNICAL SPECIFICATIONS																		
<div>ITEMS</div> <div>TESTS</div>	POWER SUPPLY FOR C&I SYSTEMS (UPS/BATTERY/BATTERY CHARGER/ACDB/DCDB)																		
	UPS/CONVERTER (IEC-146 PT 4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	VOLTAGE STABILISER	Y	Y	Y	Y	Y				Y	Y				Y				
	LEAD ACID BATTERY(TUBLAR)-IS-1651																	Y	
	LEAD ACID BATTERY (PLANTE)-IS-1652																	Y	
	NICKEL CADMIUM BATTERY (IS-10918/IEC-623)																	Y	
	SMF BATTERY																	Y	
	ACDB/DCDB	Y	Y													Y	Y	Y	Y
	BATTERY CHARGER	Y	Y	Y	Y	Y				Y				Y	Y	Y	Y	Y	Y
	R-Routine Test																		
	* Transfer time and Over shoot /under shoot during load & system transfer shall be recorded . Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.																		

CLAUSE NO.	TECHNICAL SPECIFICATIONS							
	Ni- Cd BATTERY							
	ATTRIBUTES / CHARACTERISTICS 							
	ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY 							
		Dimensions & Finish	Impact Strength	Conformance to relevant part drg. & Manufacturer' s standards	Resistance to Alkali	Chemical composition	Nickel Plating thickness	Paint Shade, Thickness, Adhesion & Finish
								Routine & acceptance tests as per relevant standard
	Container & Lids	Y	Y	Y	Y			
	Vent Plugs	Y		Y	Y			
	Perforated Steel Strips	Y		Y	Y		Y	
	Active Material for Positive & Negative Plates			Y		Y		
	Separators	Y		Y	Y			
	Electrolyte			Y		Y		
	Inter-cell Connectors & Fasteners	Y		Y	Y		Y	
	Battery Stand	Y			Y			Y
	Cell Insulators	Y		Y	Y			
	Stack Assembly	Y		Y				
	Ni-Cd Battery (IS : 10918)	Y						Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to END CUSTOMER approval.								
BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN			TECHNICAL SPECIFICATION			E	PAGE 26	

CLAUSE NO.	TECHNICAL SPECIFICATIONS										
	<div><div>BATTERY CHARGER</div><div>(of capacity up to 24 V / 48 V, 150 A DC)</div></div>										
	<div>Attributes / Characteristics</div> <div>→</div>										
	<div>Items / Components / Sub- assembly</div> <div>↓</div>	Make, Model, Type, Rating	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per approved drgs	Ripple Content Test, Load Limiter operation & AVR Operation Test	Operational & Functional Checks of aux. Devices like annunciator, switches, indicators etc.	HV & IR Test	Burn-In Test	Dynamic response test	AC input current measurement test	Temperature rise test
	Battery Charger	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	<div>Note</div> <div><div>1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.</div><div>2. Makes of all major Bought Out Items will be subject to END CUSTOMER approval.</div></div>										

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[illegible]

CLAUSE NO.	TECHNICAL SPECIFICATIONS													
	Lighting Transformer (IS-11171)	Y									Y	Y		
	Epoxy & Galvanised Conduit (IS-9537, 2629, 2633, 4759, 6745)	Y	Y									Y		Y
	LED Luminaire Quality Requirements													
	1) LED modules to conform to IS: 16103 part 2. Manufacturer to issue a certificate of compliance for the same.													
	2) Control gear to conform to IS 15885 part 2 section 13. Manufacturer to issue a certificate of compliance for the same.													
	3) LED luminaire to conform to IS 16107 part 2 section 1. Manufacturer to issue a certificate of compliance for the same.													
	4) LED luminaire marking to be as per IS 16107 part 2 section 1. Manufacturer to issue a certificate of compliance for the same.													
	5) Acceptance tests as per IS 16107 part 2 section 1 to be carried out on LED luminaire except long duration tests i.e. a) Chromaticity coordinates & correlated color temperature (CCT); b) Color rendering index (CRI). Manufacturer will submit a COC for above tests i.e. CCT & CRI													
	6) LED driver make, model, type & rating may be as per recommendations of LED module manufacturer.													
	Notes:													
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.														
2. Make of all major Bought Out Items will be subject to END CUSTOMER approval														

CLAUSE NO.	TECHNICAL SPECIFICATIONS									
	LT INDOOR TRANSFORMER (DRY TYPE TRANSFORMER)									
	<div>Attributes / Characteristics</div> <div>Items/ Components Sub Systems</div>	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	Routine Test as per relevant standard / END CUSTOMER
	Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y	
	Copper Conductor	Y	Y	Y		Y				
	Insulating Material	Y			Y	Y				
	CRGO Lamination & Built Core	Y							Y	
	Porcelain Bushing /Insulator (IS:2544 / 5621)	Y	Y	Y					Y	Y
	Gasket (IS 2712)	Y	Y						Y	Y
	Off-Circuit Tap Changer	Y							Y	Y
	Core Coil Assembly	Y						Y		
	Marshalling Box	Y								Y
	WTI, Thermistor, Terminal Connector	Y							Y	
	Complete Transformer (IS:11171 / IEC 60076)	Y								Y
	Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all item. 2) All major Bought out Items will be subject to END CUSTOMER approval.									

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	<p>Portable FIRE EXTINGUISHERS</p> <p>a) All fire extinguishers shall be tested as per relevant standard.</p> <p>b) Performance / function test shall be carried out on sampling basis as per relevant code / standard.</p>		
BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN		E	PAGE 35

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																																																																																																																																																																																																																													
	<div>MODULE WASHING SYSTEM: PIPES, FITTINGS, VALVES, STRAINERS, NOZZLES ETC.</div> <table><tr><th rowspan="2">S N</th><th>Tests/Check</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></tr><tr><th>Items / Components</th><th>Material Test</th><th>DPT/MPI / RT</th><th>Ultrasonic Test</th><th>WPS/ WQS/PQR</th><th>Hydraulic / Water Fill Test</th><th>Pneumatic Test</th><th>Assembly Fit up</th><th>Dimensions</th><th>Functional/operational Test</th><th>Other Tests</th><th>All Tests as per relevant Std</th><th>REMARKS</th></tr><tr><td>1</td><td>Pipes & Pipe Fittings</td><td>Y_a</td><td>Y_b</td><td></td><td></td><td>Y¹</td><td></td><td></td><td>Y</td><td></td><td></td><td>Y</td><td></td></tr><tr><td>2</td><td>Gate/ Globe/ Check valve</td><td>Y_a</td><td>Y_b</td><td>Y_c</td><td></td><td>Y²</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y₃</td><td></td><td></td></tr><tr><td>3</td><td>Nozzles</td><td>Y_a</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>4</td><td>Strainers</td><td>Y_a</td><td>Y_b</td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td>Y₅</td><td></td><td></td></tr><tr><td>5</td><td>HDPE Pipes</td><td>Y_a</td><td></td><td></td><td></td><td>Y¹</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>6</td><td>Site Welding</td><td></td><td>Y₄</td><td></td><td>Y</td><td>Y¹</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td colspan="14">NOTES (MEANING OF SUPERSCRIPTS)</td></tr><tr><td>a</td><td colspan="13">One per heat/heat treatment batch/lot.</td></tr><tr><td>b</td><td colspan="13">On machined surfaces only for castings and on butt welds.</td></tr><tr><td>c</td><td colspan="13">For shaft/spindles > or = 40 mm</td></tr><tr><td>1</td><td colspan="13">100% Hydraulic test shall be carried out at 1.5 time design pressure or 2 times of working pressure or as per Technical specification/Data sheet/ governing standard.</td></tr><tr><td>2</td><td colspan="13">Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.</td></tr><tr><td>3</td><td colspan="13">Blue matching, wear travel for gates, valves, pneumatic seat leakage, and reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes. Functional checks of the valves for smooth opening and closing shall also be done. Valves shall be offered for hydro test in unpainted condition. Anti-corrosive protection shall be tested as per applicable code.</td></tr><tr><td>4</td><td colspan="13">10% of welds (Root and finished welds) shall be subjected to DPT.</td></tr><tr><td>5</td><td colspan="13">Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review as applicable.</td></tr></table>	S N	Tests/Check													Items / Components	Material Test	DPT/MPI / RT	Ultrasonic Test	WPS/ WQS/PQR	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Other Tests	All Tests as per relevant Std	REMARKS	1	Pipes & Pipe Fittings	Y _a	Y _b			Y ¹			Y			Y		2	Gate/ Globe/ Check valve	Y _a	Y _b	Y _c		Y ²	Y	Y	Y	Y	Y ₃			3	Nozzles	Y _a							Y					4	Strainers	Y _a	Y _b						Y		Y ₅			5	HDPE Pipes	Y _a				Y ¹			Y					6	Site Welding		Y ₄		Y	Y ¹								NOTES (MEANING OF SUPERSCRIPTS)														a	One per heat/heat treatment batch/lot.													b	On machined surfaces only for castings and on butt welds.													c	For shaft/spindles > or = 40 mm													1	100% Hydraulic test shall be carried out at 1.5 time design pressure or 2 times of working pressure or as per Technical specification/Data sheet/ governing standard.													2	Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.													3	Blue matching, wear travel for gates, valves, pneumatic seat leakage, and reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes. Functional checks of the valves for smooth opening and closing shall also be done. Valves shall be offered for hydro test in unpainted condition. Anti-corrosive protection shall be tested as per applicable code.													4	10% of welds (Root and finished welds) shall be subjected to DPT.													5	Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review as applicable.												
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	<p>B. VENTILATION SYSTEM</p> <ul style="list-style-type: none">Split/Window Cassette Air conditioner less than 10 TR will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate.Fans, Filters etc. shall be tested as per requirements of relevant standard. <p>15. Robotic Module Cleaning System</p> <table><tr><th><div>ATTRIBUTES / CHARACTERISTICS</div><div>ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY</div></th><th>Make, Type, Model, Rating & TC</th><th>Dimensions & Finish</th><th>Constructional, Functional & Operational Features as per END CUSTOMER</th><th>Item to conform to relevant Standards</th><th>Paint shade, thickness, adhesion & finish</th><th>Functional Checks as per Approved Datasheet</th><th>Degree of Protection Routine test as per END CUSTOMER spec.</th><th>All Routine Tests as per relevant standard</th></tr><tr><td>Cleaning Agent (Cloth/Brush etc.)</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Battery</td><td>Y</td><td>Y</td><td></td><td>Y</td><td></td><td></td><td></td><td>Y</td></tr><tr><td>Controller</td><td>Y</td><td></td><td>Y</td><td>Y</td><td></td><td>Y</td><td></td><td></td></tr><tr><td>Charger</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td>Y</td><td></td><td>Y</td></tr><tr><td>Motor</td><td>Y</td><td></td><td>Y</td><td>Y</td><td></td><td>Y</td><td>Y</td><td>Y</td></tr><tr><td>PC for MCS</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td>Y</td><td></td><td></td></tr><tr><td>Ethernet Cable</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td>Y</td></tr><tr><td>Software and OS</td><td>Y</td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>UPS</td><td>Y</td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td></tr><tr><td>Sensors/Limit Switch</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td>Y</td><td></td><td></td></tr><tr><td>Drive Mechanism</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td></tr><tr><td>Solar PV panel (If Applicable)</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td>Y</td><td></td><td>Y</td></tr><tr><td>Complete robotic module cleaning System</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr></table> <p>Note:</p>	<div>ATTRIBUTES / CHARACTERISTICS</div> <div>ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY</div>	Make, Type, Model, Rating & TC	Dimensions & Finish	Constructional, Functional & Operational Features as per END CUSTOMER	Item to conform to relevant Standards	Paint shade, thickness, adhesion & finish	Functional Checks as per Approved Datasheet	Degree of Protection Routine test as per END CUSTOMER spec.	All Routine Tests as per relevant standard	Cleaning Agent (Cloth/Brush etc.)	Y	Y	Y	Y					Battery	Y	Y		Y				Y	Controller	Y		Y	Y		Y			Charger	Y			Y		Y		Y	Motor	Y		Y	Y		Y	Y	Y	PC for MCS	Y			Y		Y			Ethernet Cable	Y			Y				Y	Software and OS	Y		Y						UPS	Y		Y	Y				Y	Sensors/Limit Switch	Y			Y		Y			Drive Mechanism	Y	Y	Y	Y				Y	Solar PV panel (If Applicable)	Y	Y	Y	Y		Y		Y	Complete robotic module cleaning System	Y	Y	Y	Y	Y	Y	Y	Y
<div>ATTRIBUTES / CHARACTERISTICS</div> <div>ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY</div>	Make, Type, Model, Rating & TC	Dimensions & Finish	Constructional, Functional & Operational Features as per END CUSTOMER	Item to conform to relevant Standards	Paint shade, thickness, adhesion & finish	Functional Checks as per Approved Datasheet	Degree of Protection Routine test as per END CUSTOMER spec.	All Routine Tests as per relevant standard																																																																																																																							
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Controller	Y		Y	Y		Y																																																																																																																									
Charger	Y			Y		Y		Y																																																																																																																							
Motor	Y		Y	Y		Y	Y	Y																																																																																																																							
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Drive Mechanism	Y	Y	Y	Y				Y																																																																																																																							
Solar PV panel (If Applicable)	Y	Y	Y	Y		Y		Y																																																																																																																							
Complete robotic module cleaning System	Y	Y	Y	Y	Y	Y	Y	Y																																																																																																																							

PROJECT: BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID
CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN

INDICATIVE VENDOR LIST
SUB-SYSTEM: ELECTRICAL

DOC NO. :
REVISION NO. 00
PAGE : 1

Sl. No.	ITEM	QP / INS CAT.	QP No.	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
1.	Power Conditioning Unit (PCU)/ Inverter(central) Contractor to ensure the conditions mentioned in tender document w.r.t Preference to Make in India policy.	I	Q-002	Schneider	Bangalore	A	
				ABB	Bangalore	A	
				Bongfiglioli	Germany	A	
				Fecon	Germany	A	
				AEG	Bangalore	A	
				Hitachi-Hirel	Gandhinagar	A	
				Hitachi-Hirel	Sanand	A	
				Vacon	Bangalore	A	
				TBEA	China	A	
				TBEA Green Energy	Bangalore	A	Up to 3.125 MW
				Delta	Bangalore	A	
				SUNGROW POWER SUPPLY	China	A	
				SUNGROW	Bengaluru	A	3.125 MW
				SINENG China	China	A	3.125MW L&T CPSU Project
				SINENG India	India	A	3.125 300MW Nokhra, 2.5MW for 20MW Auraiya
				Kehua	China	A	
				Fimer India	Bengaluru	A	5 MVA
2.	IGBT for Power Conditioning Unit/Inverter	Part of PCU/Inverter MQP		Infineon		A	
				Mitsubishi		A	
				Fuji Electric		A	
3.	Inverter (String) Contractor to ensure the conditions mentioned in tender document w.r.t Preference to Make in India policy.	I	Q-002a	Huawei	China	A	
				Sungrow Developers India Private Limited	Bangalore	A	295 KW at 50 degree C
				Ginlong Technologies	China	A	255 KW
4.		II	Q-003	Trinity Touch	Palwal	A	Up to 24 In / 1 out

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
	String Monitoring Box (SMB)/String Combiner box (SCB)			Hensel	Sriperumbudur	A	Up to 24 In / 1 out
				AEG	Bangalore	A	
				Statcon	Pilkhwa	A	Up to 22 In / 1 out
				Weidmuller	Spain	A	
				HPL	Sonipat	A	Up to 22 In / 1 out
				Vrinda Nano Technologies Pvt.	Haryana	A	Up to 22 In / 1 out
				Sertel Electronics	Chennai	A	Up to 22 In / 1 out
5.	Inverter Transformer	I	Q-004	Raychem	Pune	A	Up to 16.8 MVA
				Toshiba Transmission & Distribution Systems (India) Pvt. Ltd.	India	A	Up to 12.5 MVA
				Sudhir Power	Silvassa	A	
				Shilchar	Vadodara	A	
				Hammond	Canada	A	
				Ornet Transformer	Kadi, Gujarat	A	Up to 16.8 MVA
				Telawne Power Equipment's	Taloja and Rabale	A	
				Uttam (Bharat)	Jaipur	A	Up to 12.5 MVA
				Tesla Power Equipment's & Projects	Govindpura, Bhopal	A	Up to 17.6 MVA
				Danish	Jaipur	A	Up to 16.8 MVA
6.	DC Cable Connector	III		Any make-model which is Type Tested as per EN 50521: 2008 or having marking of VDE/ CE/UL/ CSA/ "BIS with CML no." (Refer Note-1)			
7.	Floor mounted Draw out type indoor/outdoor LT Switchgear Panel (MCC etc.) Refer Note-4	Ref Note 2D	Q-005	L&T	Mumbai / Coimbatore/ Ahmednagar	A	BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
				GE	Bangalore	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				C&S Electric	Noida / Hardwar	A	
				Schneider	Nasik	A	ACB from Schneider, France
				Unilec	Gurgaon	A	
				Siemens	Kalwa	A	
				Tricolite	Manesar	A	
				Pyrotech	Udaipur	A	
				Nitya Electrocontrols	Noida	A	
8.	LV Air Circuit Breaker	Ref Note 2D		C&S Electric	Noida	A	*(part of Swgr MQP)
				L&T	Mumbai	A	
				GE	Bangalore	A	
				Siemens	Germany	A	
				Schneider	France	A	
9.	Floor mounted Fixed type indoor/outdoor LT Switchgear Panel (ACDB/ DCDB/MLDB/BMK etc.) Refer Note-4	Ref Note 2D	Q-005	Switching Circuits	Kolkata	A	BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
				Hindustan Control & equipment Ltd	Kolkata	A	With fabrication & painting at unit II & MP Electrical Narendrapur
				Maktel	Vadodara	A	Prior Type Testing
				Jakson	Greater Noida	A	
				Vidyut Control	Gaziabad	A	
				Novateur Electrical & Digital Systems Pvt. Ltd	Rohad (Jhajjar)	A	
				Pyrotech	Udaipur	A	
				Conquerent Control System	Manesar	A	Conditions apply, up to 1250A

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Control & Schematics	Hyderabad	A	
				Positronics	Vadodara	A	
				Anand Power Ltd.	Noida	A	
				Voltech Manufacturing Company	Thiruvanamalai (Tamilnadu)	A	
				BCH Electric Limited	Faridabad Haryana	A	ACDB/DCDB/MLDB/BMK
				Ultima Switchgear Limited	Roorkee	A	Up to 250 Amp
				Additionally, all vendors identified for Floor mounted Draw out type indoor/outdoor LT Switchgear Panel			
10	Wall mounted fixed type indoor / outdoor LT Switchgear non compartmentalized Panel (Lighting panels / AC / DC Fuse boards etc.) Refer Note-4	III		Control Devices	Kolkata	A	BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
				Jasper	Noida	A	
				Havells	Faridabad	A	
				Novateur Electrical & distribution	Murthal	A	
				Avaid Technovator	Manesar	A	
				Additionally, all vendors identified for Floor mounted Draw out type indoor LT Switchgear Panel			
				Additionally, all vendors identified for Floor mounted fixed type indoor LT Switchgear Panel			
11	Lighting & Welding Transformer	III		Southern Electric	Chennai	A	
				Indcoil	Thane	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Pragati	Thane	A	
				Prayog	Pune	A	
				Precise	Mumbai	A	
				Logicstat	Delhi	A	
				Gujarat Plug in	Vadodara	A	
				AE	Thane	A	
				Power Pack Enterprises	Mumbai	A	
				Amex Impex	Ahmedabad	A	
12	LT CT/PT/CBCT/ Control Transformer	III		Kappa	Bangalore	A	
				Southern Electric	Chennai	A	
				Precise	Mumbai	A	
				G&M (CBCT Only)	Baroda	A	
				Silkaans	Mumbai	A	
				Ind Coil	Mumbai	A	
				Pragati	Thane	A	
				Prayog	Pune	A	
				AE	Mumbai	A	
				Logicstat	Delhi	A	For control transformer only
				C&S Electric	Noida	A	For CT only
				Newtek	Aurangabad	A	For CT/PT/Control transformer
13	1.1KV LT Power Cable (From SMB/SCB to PCU)	Refer Note- 2A	Q-006	Universal Cable Ltd.	Satna	A	
				NICCO	Shamnagar, Kolkata	A	
				Torrent Cable Ltd	Nadiad	A	
				In cab	Pune	A	
				Hindustan Vidyut Products Ltd	Faridabad	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				KEI Industries	Bhiwadi	A	
				Delton Cable Ltd	Faridabad	A	A) Unarmoured cable all sizes. B) Armoured cable up to 3.5 x 240 sq. Mm with GI strip armour and 1CX70 sq mm with Al strip armour
				Paramount Cable	Khushkhera	A	
				Polycab Wires Pvt. Ltd	Daman	A	
				Gemscabs Industries	Bhiwadi	A	
				Cords Cables	Bhiwadi	A	
				Havells India Ltd.	Alwar	A	
				Sri ram Cables	Bhiwadi	A	
				Ravin Cables	Pune	A	
				Thermocables	Hyderabad	A	
				Sbee Cables	Bangalore	A	
				Suyog Cables	Vadodara	A	
				Gupta Power Cables	Khurda	A	
				Finolex	Pune	A	
				Scot Innovation wires and cables	Baddi	A	
				Anhui Hualing	China	A	
				LS Cable	Korea	A	
				Radiant Cables	Hyderabad	A	
				Tirupati Plastomatics	Jaipur	A	
				Apar Industries	Khatalwada, Umbergaon	A	Up to 3.3 KV cable grade

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Special Cables	Rudrapur	A	1CX400 Sqmm, 1.9kV/3.3kV DC Cable
				ABB Kabel	Germany	A	
				Advance cable	Bengaluru	A	
				Step Industries	Shahjahanpur	A	
				Taihan Electric Wire	Korea	A	
				Tbea Shandong	China	A	
				CMI	Baddi	A	
				Dynamic Cables	Jaipur	A	LT XLPE Cable with AL Conductor
				Indo Alusys	Bhiwadi	A	
14	1.1 KV Control Cable	Refer Note-2B	Q-007	Universal Cable Ltd.	Satna	A	
				NICCO	Kolkata	A	
				Torrent Cable Ltd	Nadiad	A	
				Incab	Pune	A	
				Polycab WiresPvt. Ltd	Daman	A	
				Hindustan Vidyut Products Ltd	Faridabad	A	
				KEI Industries	Bhiwadi	A	
				Delton Cable Ltd	Faridabad	A	
				Paramount Cable	Khushkhera	A	
				Gemscabs Industries	Bhiwadi	A	
				Cords Cables	Bhiwadi	A	
				SPM Cables	Hyderabad	A	
				Elkay Telelink	Faridabad	A	
				Havells India Ltd.	Alwar	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				R.R. Kabel	Silvasa	A	
				Ravin Cables	Pune	A	
				Gupta Power cable	Khurda	A	
				Thermocables	Hyderabad	A	
				Finolex	Pune	A	
				Sbee Cables	Bangalore	A	
				Suyog Cables	Vadodara	A	
				Scot Innovation wires and Cables	Baddi	A	
				Anhui Hauling	China	A	
				LS Cable	Korea	A	
				Radiant Cables	Hyderabad	A	
				Tirupati Plastomatics	Jaipur	A	
				Apar Industries	Umbergaon	A	
				Special Cables	Rudrapur	A	
				Advance cable	Bengaluru	A	
				Step Industries	Shahjahanpur	A	
				Taihan Electric Wire	Korea	A	
				Tbea Shandong	China	A	
				CMI	Baddi	A	
				Goyoline Fibres(I) Ltd	Daman	A	
				Indo Alusys	Bhiwadi	A	
15	HT Cable Up to 11KV	Refer Note-2C	Q-008	Universal Cable Ltd.	Satna	A	
				NICCO	Kolkata	A	
				Torrent Cable Ltd	Nadaid	A	
				Incab	Pune	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Polycab Wires Pvt. Ltd	Daman	A	
				KEI Industries	Bhiwadi	A	
				Havells India Ltd.	Alwar	A	
				Sri ram Cables	Bhiwadi	A	
				Krishna Electrical Industries	Gwalior	A	
				Apar Industries	Valsad	A	
				Finolex	Pune	A	
				KEC International	Vadodara	A	
				Tirupati Plastomatics	Jaipur	A	
				Gupta Power	Kashipur	A	
				Paramount	Khuskhera	A	
				Gemscab	Bhiwadi	A	
				Sterlite	Haridwar	A	
				CMI		A	For 1Cx240
16	HT Cable up to 33kV	Refer Note-2C	Q-009	Universal Cable Ltd.	Satna	A	
				Torrent Cable Ltd	Nadiad	A	
				Polycab Wires Pvt. Ltd	Daman	A	
				KEI Industries	Bhiwadi	A	
				Havells India Ltd.	Alwar	A	
				Apar Industries	Valsad	A	
				Finolex	Pune	A	
				KEC International	Vadodara	A	
				Gupta Power	Kashipur	A	
				Paramount	Khuskhera	A	
				Gemscab	Bhiwadi	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Sterlite Power	Haridwar	A	
				Gupta Power	Kashipur	A	
17	EHV Cable	I	Q-010	KEC	Vadodara	A	Up to 220 KV
				Iljin Electric	South Korea	A	Up to 132 KV
				KEI Industries	Bhiwadi	A	Up to 132 KV
				Phelps Dodge	Bangkok	A	Up to 132 KV
				LS Cable & System Ltd	South Korea	A	Up to 400 KV
				LS Cable & System Ltd	Bhiwadi	A	Up to 132 KV
				Taihan Cable & Solution Co. Ltd.	South Korea	A	Up to 400 KV
				Universal Cable Ltd.	Satna	A	Up to 132 KV
18	DC Cable (Interconnecting SPV Modules, SPV Module to SMB/SCB, SMB/SCB to PCU/Inverter)	I	Q-011	Siechem	Pondicherry	A	Upto 35 sq.mm.
				Apar	Khatalwada	A	
				Polycab		A	
				KEC		A	
				Leoni	Siechem	A	6 mm2
				LAPP	Korea	A	Up to 12 mm2
19	Earthing & Lightning Protection Material like Earthing electrode, Copper bonded rod, Copper Flat, GI Strip/GI Wire etc.	III		Main contractor Approved source			
20	HT Cable Termination Kit & Straight Through Jointing Kit (Heat shrinkable type)	III		3M Electro & Communication	Pune	A	Upto 33kV

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Raychem	Halol	A	Upto 33kV
				Hari Consolidated	Delhi	A	Upto 33kV
				BEHR BIRCHER CELLPACK BBC INDIA PRIVATE LIMITED	INDIA	A	56MW KAWAS and 300MW CPSU
21	Lighting fixtures with accessories including lamp (Filament type & LED type)	III		Crompton	Mumbai		Main contractor approved source is acceptable.
				Bajaj Electricals	Mumbai		
				Philips	Noida		
				Wipro	Mumbai		
				Surya Roshni	Noida		
				Goldwyn	Noida		
22	MCB Boxes/Junction boxes / Link Boxes/ Test Link Box/ Adopter box, Switch Boxes, Pull Boxes (Hot Dip Galvanized)	III		i. Main Contractor approved sources including galvanization ii. BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no, Refer Note-4			
23	Industrial /welding receptacles & boxes	III		Schneider	Nasik	A	
				BCH	Faridabad	A	
				Ajmera	Mumbai	A	
				Sakthi & Crown	Chennai	A	
				Any other make having CE / UL / CSA mark or BIS approval with valid CML number.			
24	PVC conduit/hume pipe/lighting wire/GI pipes/HDPE pipe/Structural Steel/	III		Main Contractor approved sources with BIS licensee with valid CML number / ISI marked with valid CML number			

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
	GI steel rigid conduit/ epoxy conduit/DWC Pipe						
25	MV Switchgear Panel (Refer Note-4)	I	Q-012	BHEL	Bhopal	A	Upto 33kV
				Megawin	Salem	A	Upto 33kV
				L&T	Ahmednagar	A	Upto 33kV
				Siemens	Mumbai	A	Upto 33kV
				Jyoti	Vadodara	A	Upto 33kV
				ABB	Nasik	A	Upto 33kV
				Schneider	Kolkata	A	Upto 11KV -Salt lake works -VG series Interrupter made at Salt Lake Works
				Trisquare	Haryana	A	Upto 33kV
				Technocraft	Bhiwandi, Thane	A	Upto 33kV
				Sterling Generators Pvt. Ltd.	Silvasa	A	Upto 33kV
				Popular Switchgears Pvt. Limited	Nashik	A	Upto 33kV 1250 Amp
				Tricolite	Manesar	A	Upto 33kV
26	MV Vacuum Type Circuit Breaker	I & (part of Swgr MQP)		Siemens	Mumbai	A	Upto 33kV
				BHEL	Bhopal	A	Upto 33kV
				L&T	Ahmednagar	A	Upto 33kV
				ABB	Nasik	A	Upto 33kV
				ABB	Italy	A	Upto 33kV
				Megawin	Salem	A	Upto 33kV

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Jyoti	Vadodara	A	Upto 33kV
				Schneider	Kolkata	A	Upto 11kV
27	IEC 61850 compliant Numerical Protection Relays	I (Part of Swgr MQP)		SEL	Pullman, USA	A	END CUSTOMER approved make shall be acceptable
				ALSTOM T&D	Stafford, UK	A	
				ALSTOM T&D	Chennai	A	
				ABB	Finland	A	
				ABB	Baroda	A	
				GE Multilin	Zamudio, Vizcaya, Spain/ Markham, Ontario, Canada	A	
				Schneider	Stone, UK	A	
				Siemens	Germany	A	
				Siemens	Goa	A	
28	Single Rod Air Terminal Lightning Arrestor	III		Main Contractor approved sources: subject to manufacturer / supplier having valid Type Test Report as per IS 2309: 2005 or equivalent Standard			
29	ESE Lightning Arrestor	III		Main Contractor approved sources: subject to manufacturer / supplier having valid Type Test Report as per latest version of NFC 17-102 & country of origin documents			
30	Lighting Poles	III		Main Contractor approved sources			
31	RSJ Poles and Accessories	III		Main Contractor approved sources			

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
32	Cable Lug	III		Dowell	Mumbai	A	
				Billets Elektro Werke Ltd. (3 D)	Umbergaon	A	
				Chetna	Nasik	A	
				Additional Vendors with Make-Model having mark of VDE/ UL /CSA / BIS with CML no. Refer Note-1 or Main contractor approved source.			
33	Cable Gland	III		Any Make-Model having mark of VDE/ UL /CSA / BIS with CML no. Refer Note-1 or Main contractor approved source			
34	GI Cable Tray, fitting, accessories including bends.	III		Inar Profiles Ltd	Enkapalli (Vishakhapatnam)	A	
				Vatco	Mumbai	A	Galvanization at Sigma Mumbai
				Indiana cable trays	Mumbai	A	Galvanization at Karamtara galvanizer- Mumbai
				Industrial Perforation	Kolkata	A	Galvanized and offered for inspection at Industrial Perforation Pvt Ltd, Ganganagar , Kolkata, WB
				Ratan Projects	Howrah	A	Galvanization at DMP Projects- Howrah
				India Electric Syndicate	Kolkata	A	Galvanization at BMW Industries/B.P Projects- Howrah
				Sterlite engg.	Mumbai	A	
				Premier Power Products	Howrah	A	Galvanising at Neha Galvaniser- Howrah
				Indiana Gratings	Pune	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				M.J. Engineering	Okhla/ Bhiwadi	A	
				T.R.G	Chennai	A	Galvanization at TM Radhakrishna Chetty & Co- Chennai
				Amtech	Pune	A	Galvanization at B.G. Shirke – Pune
				Kannade Anand Udyog	Mumbai	A	Fabrication at their units: Plot No. 42, Morivali, MIDC Thane & Plot No.: D-35 Anand Nagar MIDC, Addl. Ambernath , Dist.Thane Galvanization and offer the galvanized cable trays for inspection at D-34 Anand Nagar MIDC, Addl. Ambernath, Dist.Thane.
				Rukmani	Raipur	A	Ladder type cable trays only
				Passive Infra	Hasangarh (Rohtak)	A	
				Unitech Fabricators & Engineers	Howrah/ Hoogly (Kolkata)	A	
				Patny System	Hyderabad	A	
				Rabi Engg	Kolkata	A	Galvanizing from END CUSTOMER approved
				MKSD Industries	Taloja	A	Galvanising at Encorp Power trans PVT Ltd, Palghar
				Reliable Sponge	Kalunga	A	
				Rukmani	Hoogly	A	Galvanization at Rukmani Fab & Gal- Howrah

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Eros Metal Works	Nagpur	A	
				Maheshwari Electricals Manufacturer Pvt. Ltd	Ghaziabad	A	Galvanization at M/s Shivam Engineers & Fabricators, Ghaziabad
				Indmark Formtech	Pune	A	
35	Cable Tray Flexible Tray Support System	III		Vatco	Mumbai	A	Galvanising at Sigma Mumbai
				Inar profiles	Enkapalli	A	
				Industrial perforations	Kolkata	A	
				Premier power products	Howrah	A	Galvanising at Neha Galvaniser- Howrah
				Sterlite engg.	Mumbai	A	
				Indiana gratings	Pune	A	Galvanising at Poona Galvaniser- Pune
				Amtech	Pune	A	Galvanising at B.G. Shirke- Pune
				Ratan Projects	Howrah	A	Galvanization at END CUSTOMER approved
				MKSD Industries	Taloja	A	Galvanising at Encorp Power trans PVT Ltd, Palghar
				Maheshwari Electricals Manufacturer Pvt. Ltd	Ghaziabad	A	Galvanization at M/s Shivam Engineers & Fabricators, Ghaziabad
				Indmark Formtech	Pune	A	
				Patny Systems	Hyderabad	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
36	Conventional gate/globe valve/ check valve (size up to 600 NB & rating pr class up to 300)/ fittings- (MS/GI/CS/SS) & (forged/ formed)/ nozzles/ strainers/filters/ pump (up to 30kw)/ HDPE pipes/fittings/ hoses.	III		Main Contractor approved sources accepted			
37	High Velocity Water Spray System (HVWS)	III		Main Contractor approved sources accepted			
38	MS PIPE (BLACK/GI) (IS 1239:2011 / IS 3589:2001) (UPTO 1000 NB)/	III		Main Contractor approved sources; BIS marked, manufacturers with valid BIS license			
39	AB Tariff energy meter	III		SEMS	Udaipur/Solan	A	
				Elster	Mumbai	A	
				L&T	Mysore	A	
40	RELAY TEST KIT	III		Main Contractor Approved source accepted			
41	Transformer (Oil filled type) Refer Note-4	I	Q-019	BHEL	Bhopal	A	up to 400 kV Class
				GE(T&D)	Naini	A	up to 400 kV Class
				Toshiba	Hyderabad	A	up to 400 kV Class
				TELK	Agnamaly, Kerala	A	up to 400 kV Class
				ABB	Vadodara/Sweden	A	up to 765 kV Class
				CG Power & Industrial Solutions Ltd.	Mandideep	A	up to 400 kV Class
				Siemens	Mumbai	A	up to 400 kV Class

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				EMCO	Thane	A	up to 400 kV Class
				BHEL	Jhansi	A	up to 220 kV Class
				Schneider	Vadodara	A	up to 50 MVA, 132 kV Class
				T&R	Changodar, Ahmedabad	A	up to 90 MVA, 132 kV Class, Conditions Apply
				T&R	Moraiya, Ahmedabad	A	250 MVA, 400kV
				Kanohar	Meerut	A	up to 16 MVA, 33 kV Class
				Atlanta Electricals	Plot No. 1701/02, Anand	A	Up to 50MVA, 132kV Class
				EMCO	Jalgaon	A	up to 16 MVA, 33 kV Class
				Kirloskar	Mysore	A	up to 16 MVA, 33 kV Class
				Andrew Yule	Chennai	A	up to 10 MVA, 33 kV Class
				Tesla (Unit-2)	23A, Sector-B, Industrial Area, Govindpura, Bhopal	A	up to 5.0 MVA, 33 kV Class
				Indotech Transformers	Kancheepuram District, Chennai	A	up to 180 MVA, 220 kV Class
				Hammond Power Solutions	Hyderabad	A	up to 10 MVA, 33 kV Class
				CG Power & Industrial Solutions Ltd.	Malanpur	A	up to 7.5 MVA, 33 kV Class
				ECE	Sonepat	A	up to 4.0 MVA, 11 kV Class
				Kalpa Elektrikal	Bangalore	A	Up to 1.4MVA, 11 KV Class
				Voltamp	Savli	A	up to 3.5 MVA, 33 kV Class
				Kirloskar	Pune	A	up to 2.0 MVA, 33 kV Class
				RAYCHEM RPG	Pune	A	Up to 5 MVA, 33 kV Class

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Esennar	Medak	A	Up to 16 MVA, 66 kV Class
				Technical Associate Ltd	Sitarganj	A	220 kV Class
				SkipperSeil Limited	Bhiwadi	A	up to 50/63 MVA, 132 KV
				Meiden T&D (India) Limited	Nellore	A	up to 63 MVA, 132 kV Class
				KRYFS Power Components Ltd	Silvassa	A	Up to 2.5 MVA, 33 kV Class
				Sudhir Transformers	Bangalore	A	Up to 12.5 MVA, 33kV Class
				Sudhir Power Ltd	Silvassa	A	Up to 12.5 MVA, 33kV Class
42	Dry Type Transformer (Refer note 4)	I	Q-020	ABB	Savli	A	up to 8 MVA, 24 kV Class
				Raychem	Pune	A	Up to 3.5 MVA, 33 kV Class
				Toshiba	Hyderabad	A	Up to 2.0 MVA, 33 kV Class
				BHEL	Jhansi	A	Up to 6.3 MVA, 33 kV Class
				Kirloskar	Pune	A	Up to 4.0 MVA, 33 kV Class
				Voltamp	Savli	A	Up to 3.25 MVA, 33 kV Class
				Hammond Power Solutions	Hyderabad	A	Up to 95 KVA, 33 kV Class
				Sudhir Power Ltd	Silvassa	A	Up to 1 MVA, 11 KV Class
43	RS485	III		Main Contractor Approved source accepted.			
44	CAT 6 LAN CABLE	III		Main Contractor Approved source accepted			
45	NIFPS for Power Transformer / Inverter Duty Transformer	III		CTR	Pune	A	
				EASUN-MR TAP CHANGERS (P) LTD	Pondicherry	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				M/s Tectonicus Service	Nashik	A	
				Vimal Fire Controls Pvt Limited	Vadodara	A	For IDT Only
				M/S VENDERE SALES SERVICES		A	For IDT Only
46	BUSDUCT-ISOLATED PHASE (MV BUSDUCT)	I	Q-022	BHEL (CEP)		A	
				C & S ELECTRIC		A	
				REEP INDUSTRIES PVT LTD		A	
				Godrej & Boyce	Plot No 495, Bangalore	A	33kV, 3150A segregated phase HV busduct
				POWERGEAR LTD		A	
47	LT Bus Duct (Insulated Sandwiched Type)	II	Q-023	C&S Electric	G Noida/Haridwar	A	
				Henikwon	Malasiya	A	
				Jasper Engg Ltd	Noida		
				Schneider	Vadodara		
				KGS	Chennai		
				L&T	Coimbatore		
48	LT Bus Duct (Air Insulated NSPBD)	II	Q-024	C&S Electric	Gr Noida / hardwar	A	
				Stardrive	Chennai	A	
				Unilec	Gurgaon	A	
				Spaceage SWGR	Bawal	A	
				REEP	Chennai	A	
				Empro	Chennai	A	
				Nitya Electro Control	Noida	A	
				Jasper Engg	Noida	A	
				Schneider	Vadodara	A	

				Powergear	Chennai/Hindupur	A	
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Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Powerways	Noida	A	
				Vidyut Control	Sonipat/ banglore	A	
49	Complete Tracker System	II		Gamechange Solar Services India Private limited		A	
				Antai Technology Company Ltd	China	A	
				M/s Nextracker India Pvt Ltd		A	
50	Automatic Module Cleaning System	III		Main Contractor approved sources			
51	Fire Extinguisher	III		BIS approved sources with valid BIS License			
52	Static Var Generator with Accessories	I		TBEA Xi'an Electric Technology Co. Ltd	Xi'an, China	A	Up to 50 MVAR 33KV

Above list shows manufacturers proposed by main contractor for listed items and are acceptable to END CUSTOMER

Note: This is a Standard List applicable for all END CUSTOMER Solar Projects. However, for items involving small quantity or urgency at site, the categorization may be modified as per requirement with the concurrence of Head (RE QA).

A - For those items proposed vendor is acceptable to Customer. To be indicated with letter "A" in the list along with the condition of approval, if any.
DR-mean that manufacturer proposed by main contractor for the items will be assessed by END CUSTOMER. Main contractor is obliged to procure the item from "DR" category manufacturer only after written approval from END CUSTOMER.

Under QP / INSPN CATEGORY column:

CAT-I: For these items the Quality Plans approved by END CUSTOMER & final acceptance will be on physical inspection & witness by END CUSTOMER as per approved QAP. **CAT-II:** For these items the Quality Plans approved by END CUSTOMER. However, no physical inspection shall be done by END CUSTOMER. The final acceptance by END CUSTOMER shall be on basis of verification of documents as per approved QP. Physical inspection *to be witnessed by END*

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
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CAT-III: For these items Main supplier approves the Quality Plans. The final acceptance by END CUSTOMER shall be on basis of COC (Certificate of Conformance) by the Main supplier.

General Notes:

1. Vendor acceptance is subject to Sub-QR and Technical Clearance as applicable. Sub-QR/Prove-ness criteria as per the scope/technical specification shall also be applicable for consideration as approved manufacturer/vendor
2. Vendor list & inspection category of the mandatory spares shall be as mentioned above.
3. For item not appearing in the above list, Main Contractor to approach END CUSTOMER for acceptable vendors & inspection categorization of the same.
4. END CUSTOMER Approval conditions to above identified vendors shall be adhered to. Vendor's approval conditions will be informed on specific

Note-1- "TYPE TEST REPORT AS PER EN 50521" OR "VDE / CE / UL / CSA MARKING CERTIFICATION PREFERABLY FROM THIRD PARTY AGENCY" OR "BIS APPROVAL LETTER" SHALL BE SUBMITTED FOR END CUSTOMER'S VERIFICATION /INFORMATION.

Note-2-

A. Category of inspection for LT Power Cable:

TOTAL CONTRACT QUANTITY PER SIZE	CATEGORY OF INSPECTION
For cable total quantity ≤ 2.5 km	Cat-III - submission of TC & Certificate of Conformance by Main Contractor for the manufacturers having successfully supplied to any END CUSTOMER project-site through corporate contracts for at least 2 years
For Cable total quantity above 2.5 km up to 10 km per size/type	Cat-II for the manufacturers having successfully supplied to any project-site through Corporate contracts for at least 2 years
For Cable total quantity above 10 km per size/type	Cat-I

B. Category of inspection for Control Cable:

TOTAL CONTRACT QUANTITY PER SIZE	CATEGORY OF INSPECTION
For cable total quantity ≤ 2.5 km	Cat-III - submission of TC & Certificate of Conformance by Main Contractor for the manufacturers having successfully supplied to

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
							any END CUSTOMER project-site through corporate contracts for at least 2 years
	For cable total quantity above 2.5 km per size/type						Cat-II for the manufacturers having successfully supplied to any project-site through corporate contracts for at least 2 years
C. Category of inspection for HT cables							
TOTAL CONTRACT QUANTITY PER SIZE/TYPE					CATEGORY OF INSPECTION		
LESS THAN EQUAL TO 500 M					CAT-III		
GREATER THAN 500 M					CAT-I		
D. Category of Inspection for LT Switchgear and LV Air circuit breaker:							
For LT Switchgear connected with String inverter					CAT-I		
LT Switchgear for other auxiliaries					CAT-II		
Note-3- Indicative List of acceptable galvanizing sources:							
1. M J Engg,Delhi 2. Indmark , Pune 3. A.V. Engg, Kolkata 4. Inar Profiles, Vishakapatnam 5. Anand Udyog, Mumbai 6. Techno Engg,Chandigarh 7. Steelite Engg, Mumbai			8. National Galvanizer, Kolkata 9. Unistar Galvanizer, Kolkata 10. B.P. Project. Kolkata 11. Bajaj Pune 12. Electrocure Industries, Mumbai 13. B.G. Shirke, Pune 14. Gurpreet Galvanizer, Hyderabad		15. Sigma, Mumbai 16. Radhakrishnan Shetty, Chennai 17. Karamtara Mumbai 18. Poona Galvanizers Pune 19. Neha Galvanizer- Kolkata 20. Unitech Fabricators & Galvanizers- Hoogly		22. Indian Gratings, Pune 23. Encorp Power trans PVT Ltd, Palghar 24. Reliable Sponge, Kalunga 25- Rukmani Fab & Gal- Howrah

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
					21. Patny Systems-Mehdak		
<p>Note-4: Raw material & Bought Out components for main equipment will be finalized with vendor identified by Main Contractor.</p>							
<p>Note-5: “VDE / CE / UL / CSA MARKING CERTIFICATION PREFERABLY FROM THIRD PARTY AGENCY” OR “BIS APPROVAL LETTER” SHALL BE SUBMITTED FOR END CUSTOMER’s VERIFICATION /INFORMATION.</p>							
<p>Note-6: Every 10th Inspection call of Cat II and Cat III items received by RIO for that week shall be surveillance inspected / tested by END CUSTOMER/ Authorized agency.</p>							
<p>Note-7: The surprise visit of Vendors works of Cat II and Cat III items shall be done by END CUSTOMER / Authorized agency during manufacturing of items under supply to verify whether the vendor is following agreed documents, procedure/ QAP, Inspection documents, Third party inspection wherever envisaged, Main contractor inspection records, etc.</p>							
<p>Note-8: Main contractor to ensure and facilitate the Remote Inspection at the manufacturing works as and when END CUSTOMER may not attend physically for inspection of Cat I item(s) as per approved QAP due to unavoidable circumstances. Main contractor to finalize the required procedure in advance during manufacturing stage. At least 03 no’s recordable real time cameras to be used based on the item to be inspected, at least one out of 03 camera to be controlled by the other side of manufacturer works. Sufficient space and light (20 Lux) to be ensured.</p>							
<p>Note-9: Main Contractor will consider only those additional sub-vendors for their relevant projects who have been assessed and found acceptable by them and sub-vendors who have already supplied the proposed equipment of equal to or higher rating (viz. standard items like Cables, Switchyard Equipment(s), etc.) in other projects. Main Contractor shall provide an undertaking to this affect. Further, Main Contractor shall submit the Vendor proposal to RE QA along with their Internal assessment report & supporting credentials and shall also provide an undertaking that based on their Internal assessment, the proposed sub-vendor has been assessed and found acceptable by them and it has requisite capabilities & supply experience and is suitable for supplying the proposed item/scope of sub-contracting.</p>							

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
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Note-10 For Auxiliary Transformers (Oil Filled & Dry Type- below 1.0 MVA, 33 KV Class):

1. Main Contractor's approved sub-vendors will also be acceptable subject to sub-vendor shall have minimum two years of supply experience for similar rating & type of transformers.
2. END CUSTOMER will review the Routine Test Inspection Report, witnessed by Main Contractor as per IS 2026/IS 1180 for Oil Filled Transformer and as per IS 11171 for Dry type Transformer

Note-11: Contractor to ensure the conditions mentioned in tender document w.r.t Preference to Make in India policy for above items.

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
1.	Battery (Lead Acid - Plante)/for UPS / Intelligent Battery Charger	III		Hoppecke batterien gmbh & co kg	Germany	A	
				Exide	Kolkata	A	
2.	Battery (Ni-Cd) for UPS / Intelligent Battery Charger	III		Saft india limited	Bengaluru	A	
				HBL power	Hyderabad	A	Up to 990AH (H type)
				Saft	France/Sweden	A	
				Hoppecke Batterien Gmbh & Co Kg	Germany	A	
3.	Battery Charger	II		Amararaja	Tirupati	A	
				HBL- Power System	Hyderabad	A	
				Chhabi electrical	Jalgaon	A	
				Chloride Power	Kolkata	A	
				Statcon	Hapur	A	Up to 220, V 850 A
				Dubas	Banglore	A	Up to 220 V, 250 A
				Saft Nife Power Systems	Singapore	A	
				Masstek	Jalgaon	A	
4.	Control Desk	III		Pyrotech Workspace Solutions Pvt Ltd	Udaipur	A	BOI shall be as per LOA approved sources
				Cosmos Media Products Pvt Ltd	Greater Noida	A	1.H block should be from knurr Germany. 2.Complete integrated mosaic grid should be procured from END CUSTOMER approved sources like Pro Plan/Subklew 3.solid acrylic surface should be procured from Du Pont/END CUSTOMER approved sources 4.Extruded Al profile structure should

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
							be procured from Hindalco (With Knurr design)
				Adarsha Control System Pvt Ltd	Bengaluru	A	1.Mosaic items should be from END CUSTOMER approved sources. 2. Acrylic solid surface (ASS) should be procured from Du Pont /END CUSTOMER approved sources 3. wood works are to be done by M/S C K Furn Bengaluru
5.	Fiber optic cable	III		KEC International Ltd	Mysore	A	
				Apar Industries Limited	Valsad	A	
				HFCL	Goa	A	
				Aksh Fibre	Bhiwadi	A	
				Finolex	Pune/Goa	A	
				M/S Birla Cable Limited	Rewa	A	
				Jiangsu Tongguang	China	A	
				R&M	Switzerland	A	
				Molex	UK	A	
				Corning	USA	A	
				Polycab India Ltd	Halol	A	
				U M Cable	Silvasa	A	
6.	Fire alarm panel	II		Notifier	USA	A	
				Autronica	Norway	A	
				TYCO	USA	A	Simplex Brand
				Bosch Security System	Bengaluru	A	Detector, Hooter, MCP, Modules, Panel shall be from M/s Bosch Make
				Schrack	Austria	A	
				Edwards	Mexico	A	
				Toshniwal Industrial Pvt Ltd	AJMER	A	M/s Notifier Make Fire Alarm Panel

				M/s Shield fire safety	UK	A	
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Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				and security ltd			
				Jhonson Controls	USA	A	Simplex Brand
7.	Instrument Cables (F, G & T/C Cables)	III		Tempsens instruments (i) Pvt Ltd-unit-II	Udaipur	A	0.5 SQMM F&G TYPE CABLES
				Havells India	Alwar	A	Type F cable
				Paramount Communication ltd	Khuskhera	A	PVC, FRLS type
				Polycab	Daman	A	PVC, FRLS type
				Delton	Faridabad	A	PVC, FRLS type
				KEI	Bhiwadi	A	
				Elkey Telelinks	Faridabad	A	PVC, FRLS type
				CORDS	Kaharani	A	PVC, FRLS type
				CORDS	Bhiwadi	A	PVC, FRLS type
				Nicco	Kolkata	A	PVC, FRLS type
				Universal Cable	Satna	A	PVC, FRLS type
				Thermocables	Hyderabad/Mah boobnagar	A	A, B, F&G
				Gupta Power Infrastructure Ltd.	Khurdha	A	PVC, FRLS, Shielded, Multi Pair, Twisted Type A, B, F&G
				CMI	Faridabad	A	PVC, FRLS type / 0.5 SQMM F&G TYPE CABLES
				Advance Cables Pvt Ltd	Bengaluru	A	0.5 SQMM F&G TYPE CABLES
				Gemscab Industries Ltd	Bhiwadi	A	0.5 SQMM F&G TYPE CABLES
				Apar Industries Limited	Valsad	A	0.5 SQMM F&G TYPE CABLES
				Suyog Electricals Ltd	Halol	A	0.5 SQMM F&G TYPE CABLES
				Special Cables Pvt Ltd	Rudrapur	A	0.5 SQMM F&G TYPE CABLES
				T C Communication	Ghaziabad	A	PVC, FRLS type
				TEW & C	USA	A	
				Habia cables	Sweeden	A	
				Kerpen cables	Germany	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Lapp cables	Germany	A	
				Goyolene Fibers (India) Pvt Ltd	Silvassa	A	F&G type Cable
				KEC International	Vadodara	A	
				Thermo elecrt Bv	Netherland	A	
8.	24V Intelligent Battery charger DC/ DCDB/BHMS	III		Chabbi Electricals	Jalgaon	A	Rectifier module, Controller module and Battery Health monitoring system shall be of M/s VERTIV make
				Eltek SGS Pvt Ltd	Gurgaon	A	Unit-II for assembly and function testing only
				Masstech Controls Pvt Ltd	Jalgaon	A	Rectifier modules shall be of Setec, China
				Vertiv Energy Pvt Ltd	Mumbai	A	Rectifier module, Controller module and Battery Health monitoring system shall be of M/S VERTIV China
9.	Master Slave Clock System	II		Signals and Systems Pvt. Ltd. (SANDS)	Chennai	A	
				Masibus	Gandhinagar	A	
				Sertel Electronics Pvt. Ltd.	Chennai	A	
				Hopf Elektronik GmbH	Germany	A	
				Hathway	USA	A	
				Mein Berg	Germany	A	
				Moser Baer AG	Switzerland	A	
	PLC Based SCADA System			Rockwell	Sahibabad	A	
				Emerson automation solution Intelligent platforms Pvt Ltd	Bengaluru	A	PLC modules from Emerson USA
				ABB	Bengaluru	A	

10	(Ref Note 4)	I	SQP	Honeywell	PUNE	A	1-PLC modules should be procured from M/s Honeywell Co Ltd, Korea.
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Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
							All Major BOI From END CUSTOMER Approved
				Siemens	Nashik	A	
				Phoenix Contact Electronics GmbH	Germany	A	
				Mitsubishi Electric Corporation	Japan USA	A	iQF and iQR PLC series Iconics SCADA
				Schneider Electric System India Pvt Ltd	Chennai	A	Modules From Schneider, France And All Major BOI From END CUSTOMER Approved Make
				Schneider Electric India Pvt Ltd	Bengaluru	A	Modules From Schneider, France And All Major BOI From END CUSTOMER Approved Make
11	PLC System Integrators	I		Trinity Touch Private Limited	Palwal, Haryana	A	System Integrator of Phoenix Germany Make
				Virtual Automation	Ranga Reddy	A	System integrator for schneider make
				Cotmac Electronics Pvt Ltd	Pune	A	System integrator for Seimens make
				Tech-Masters	Hyderabad	A	System integrator for Emerson Management IP make
				Powertech Switchgear (I) Pvt Ltd	Sonepat	A	System integrator for schneider make
				Unity Industrial Automation Pvt Ltd	Delhi	A	System integrator for Rockwell make
				EMCONS	Ranchi	A	System integrator for Rockwell make
				M D Industries	Vadodara	A	System integrator for M/s Emerson make system
				Velox automation	Surat	A	System integrator for Siemens make
				Vision Comptel	Kolkata	A	System integrator for Emerson make
				Adaptive engineering Private limited	Ahemdabad	A	System integrator for schneider make

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Greenwave Solutions Private Limited	Kolkata	A	System integrator for Rockwell make
				Dreamz Automation	Ghaziabad	A	System integrator for Siemens make
				Creative Robotics	Ghaziabad	A	System integrator for Honeywell make
				Kruti Techno Engineer Pvt Ltd	Chhapraula (GB nagar)	A	System integrator for Siemens make
				EDS Instruments & Systems pvt Ltd	Chennai	A	System integrator for Honeywell make
				Delsys automation Technologies pvt ltd	Chennai	A	System integrator for Emerson make
				Hindustan Control and Equipment Ltd	Kolkata	A	System integrator for Emerson make
				Vollkraft Engineering And Consultant (P) Ltd	Kolkata	A	System integrator for Emerson make
				SSM Infotech Solution Pvt Ltd	Surat	A	System integrator for schneider make
				Sun Industrial Automation	Chennai	A	System integrator for schneider make
				Netware Computers	New Delhi	A	System integrator for Honeywell make
				Armax Automation Private Limited	Bengaluru	A	System integrator for ABB make
				Nandi Powertronics	Bengaluru	A	System integrator for Mitsubishi make
				Ladder Automation Solution Pvt Ltd	Gurugram	A	For M/s Honeywell make System
				Divya Engineers	Chennai	A	For M/s Siemens make system
12	UPS with ACDB	III		Fuji Electric	Kancheepuram	A	UPS systems less than 10KVA
				Vertiv Energy Pvt Ltd	Pune	A	up to 125 KVA for 1 phase & 300 KVA for 3 phase
				Vertiv Energy Pvt Ltd	Mumbai	A	Upto 160 KVA

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
				Hitachi Hirel Power Electronics Pvt Ltd	Sanand	A	Upto 120KVA, Single phase IGBT
				Fuji Electric	Pune	A	Up to 100 KVA single phase
				KELTRON	TRIVENDRUM	A	
				Merlin & Gerin	France	A	
				Gutor	Switzerland	A	
				AEG (Saft)	Germany	A	
				Fuji Electric	Japan	A	
				Power One Micro System	Bangalore	A	20 KVA
13	SMF lead-acid battery for microprocessor Based fire alarm panel	III		Exide	Kolkata	A	
				Amara Raja	Trupati	A	
				HBL Power System	Hyderabad	A	
MC-1	Blank Panels / Cabinets	III		Main Contractor Approved Sources			
MC-2	Compression Fittings (SS)	III		Main Contractor Approved Sources			
MC-3	Computer Furniture	III		Main Contractor Approved Sources			
MC-4	Desk for OWS/EWS/Printer/Server	III		Main Contractor Approved Sources			
MC-5	FRP Junction Box	III		Main Contractor Approved Sources			
MC-6	Graphic Interface Unit	III		Main Contractor Approved Sources			
MC-7	Impulse Pipes/Tubes	III		Main Contractor Approved Sources			
MC-8	Level Indicator (Float & Board type)	III		Main Contractor Approved Sources			

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
MC-9	Mini UPS-Type C configuration	III		Main Contractor Approved Sources			
MC-10	Printer (Inkjet / Laser)	III		Main Contractor Approved Sources			
MC-11	Terminal Block	III		Main Contractor Approved Sources			
MC-12	Instrumentation valve & Fitting	III		Main Contractor Approved Sources			
MC-13	Weather station panel (comprising of Pyranometer, anemometer & thermometer etc.)	III		Any make-model with VDE/ CE/UL/ CSA marking or BIS approved with CML no			
MC-14	Operator Workstation	III		Main Contractor Approved Sources			DELL/HP/IBM/LENEVO/COM PAQ/FUJITSU OR OEM APPROVED
MC-15	Container	III		Main Contractor Approved Sources			
MC-16	CCTV	III		Main Contractor Approved Sources			

LEGENDS:

1.0 SYSTEM SUPPLIER / SUB SUPPLIER APPROVAL STATUS CATEGORY

A - For those items proposed vendor is acceptable to Customer. To be indicated with letter "A" in the list along with the condition of approval, if any.

SQP-Standard Quality Plan RQP-Reference Quality Plan

2.0 QP INSPECTION CATEGORY:

CAT - I: For those items the Quality Plans are approved by Customer and final acceptance will be on physical inspection witness by Customer

CAT - II: For those items the Quality Plans are approved by the Customer. However, no physical inspection shall be done by the Customer. The final acceptance by Customer shall be on the basis of review of documents.

CAT - III: For these items Quality control to be exercised as per Main contractor Quality Assurance System. The final acceptance by END CUSTOMER shall be on the basis of Certificate of Conformance (COC) by Main Contractor.

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE, M/s	PLACE	SC APPL Status	REMARKS
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UNITS/WORKS: Place of manufacturing- Place of main supplier of multi units/works.

NOTE - 3: For the items not appearing in the pre-award list and falls in the scope of supply of the bidder, bidder and Customer will mutually be discussed in future.

NOTE-4 - Major Bought-Out-Items are to be procured from LOA approved sources & the same shall be finalized during the finalization of Manufacturing Quality Plan. MQP shall be duly vetted by OEM with their project specific authorization letter.

	PROJECT/PACKAGE:	BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN		LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	DOC NO		
	BID DOCUMENT NO:				REV. NO.		
	Main supplier:			SUB SYSTEM: CIVIL WORKS	DATE		
	Contract No. :						
SL. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
1.	GALAVANISED STEEL STRUCTURES (LATTICE & PIPE) FOR SWITCHYARD AND TRANSMISION LINE	I		VIJAY TRANSMISSION LTD	RAIPUR	A	
				UNITECH POWER TRANSMISSION LTD	NAGPUR	A	
				ASSOCIATED POWER STRUCTURES	VADODARA	A	
				R.S. INFRAPROJECTS PVT. LTD	SURAJPUR	A	
				NEW MODERN TECHNOMECH	MAYURBHANJ (ORRISA)	A	
				GOOD LUCK STEEL TUBES	SIKANDRABAD	A	
				UNIQUE STRUCTURES & TOWERS LTD.	RAIPUR	A	
				VATCO ELEC-POWER PVT. LTD.	NAVIMUMBAI (GALVANISING AT SIGMA GALVANISER NAVI MUMBAI)	A	
				R.S. INFRAPROJECTS PVT. LTD	SIKANDRABAD	A	
				ADVANCE STEEL TUBE	SAHIBABAD	A	
				SANGAM STRUCTURES LTD.	ALLAHABAD	A	
				RELIABLE SPONGE PVT LTD UNIT III	KALUNGA	A	
				VSP ENTERPRISES PVT. LTD	SONEPAT	A	
				RICHARDSON & CRUDDAS (1972) LTD	NAGPUR	A	
				H.S. ENGINEERING WORKS	GHAZIABAD (GALVANIZING AT M/S SHIVAM ENGINEERS AND FABRICATORS,	A	Only for Switchyard structures

	PROJECT/PACKAGE:	BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN			LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	DOC NO		
	BID DOCUMENT NO:					REV. NO.		
		Main supplier:				SUB SYSTEM: CIVIL WORKS	DATE	
	Contract No. :							
SL. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS	
					GHAZIABAD)			
				L&T	PITAMPUR	A		
				L&T	PONDICHERRY	A		
				NAMPA STEEL	HOWRAH	A		
				SKIPPER LIMITED	HOWRAH	A		
				MAN STRUCTURALS PVT. LTD.	JAIPUR	A		
				GANGES INTERNATIONALE PVT. LTD.	PUDDICHERRY	A		
				SUN ENGINEERING	PUDUKKOTTAI (GALVANIZING AT VLS INDUSTRIES GALVANIZING UNIT, PUDUKKOTTAI)	A	CHEMICAL TEST AT END CUSTOMER APPROVED	
				TOPLINE SWITCHGEAR PVT. LTD.	MEHSANA	A	FOR LATTICE STRUCTURE ONLY	
	KEC INTERNATIONAL LIMITED	JABALPUR	A					
2.	COLOUR COATED METAL DECK & CLADDING SHEET (COIL)	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-		
3.	PROFILERS FOR COLOUR COATED METAL DECK & CLADDING SHEETS	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-		
4.	ELECTROFORGED GRATING	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-		

	PROJECT/PACKAGE:	BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN			LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	DOC NO		
	BID DOCUMENT NO:					REV. NO.		
		Main supplier:				SUB SYSTEM: CIVIL WORKS	DATE	
	Contract No. :							
SL. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS	
5.	MODULE MOUNTING STRUCTURE (MMS)	II	-	MAIN CONTRACTOR APPROVED SOURCE	-	-		
6.	CEMENT	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-		
7.	REINFORCEMENT STEEL	III	-	STEEL AUTHORITY OF INDIA LTD. (SAIL)		A		
				JINDAL STEEL & POWER LTD. (JSPL)		A		
				TATA STEEL LIMITED.		A		
				RASHTRIYA ISPAT NIGAM LTD. (RINL)	VISAKHAPATNAM, ANDHRA PRADESH	A		
				JSW STEEL LTD.	RAIGAD, MAHARASHTRA BELLARY, KARNATAKA.	A		
				ESL STEEL LIMITED.	BOKARO, JHARKHAND	A		
				JSW ISPAT SPECIAL PRODUCTS LTD.	RAIGARH, CHHATTISGARH	A		
8.	STRUCTURAL STEEL FOR ICR/ SCB/ PEB/ FENCING/ GATE	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE			Main Contactor approved sub-vendor	
9.	CONSTRUCTION CHEMICALS, WATER PROOFING COMPOUNDS AND GROUTS	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-		
10.	PAINT AND PAINTING SYSTEM	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-		
11.	FIREPROOF DOORS	III	-	MAIN CONTRACTOR APPROVED SOURCES WITH VALID PROTOTYPE TEST REPORT FROM CBRI/CPRI/GOV. LAB.)	-	-		
12.	CI PIPES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-		

	PROJECT/PACKAGE:	BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN			LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	DOC NO	
	BID DOCUMENT NO:					REV. NO.	
	Main supplier:				SUB SYSTEM: CIVIL WORKS	DATE	
	Contract No. :						
SL. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
13.	MS BLACK/GI PIPES (IS:3589, IS:1239)	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
14.	RCC PIPES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
15.	CPVC/UPVC PIPES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
16.	PVC WATER STOP	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
17.	POLYTHENE WATER STORAGE TANKS	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
18.	BITUMEN	III	-	ALL GOVERNMENT REFINARIES	-	-	
19.	HIGH SOLID CONTENT LIQUID APPLIED URETHANE BASED ELASTOMERIC MEMBRANE FOR WATER PROOFING	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-	
20.	CERAMIC / VITRIFIED TILES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
21.	PARTICLE BOARDS, PLYWOOD, MDF	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
22.	PRE-ENGINEERED BUILDINGS	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-	
23.	FOUNDATION BOLT, HEX BOLT, STEP BOLT	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-	
24.	NUTS AND WASHERS	III	-	MAIN CONTRACTOR APPROVED SOURCE	-	-	

	PROJECT/PACKAGE:	BALANCE OF SYSTEM PACKAGE FOR DEVELOPMENT OF 1500MW GRID CONNECTED SOLAR PV PROJECTS AT RVUNL'S SOLAR PARK IN BIKANER, RAJASTHAN			LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	DOC NO	
	BID DOCUMENT NO:					REV. NO.	
	Main supplier:					DATE	
	Contract No. :						
SL. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
<p>LEGENDS:</p> <p>1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY EMPLOYER) A – For these items proposed vendor is acceptable to Employer. To be indicated with letter “A” in the list along with the condition of approval, if any. DR – For these items “Details required” for Employer review. To be identified with letter “DR” in the list.</p> <p>2. QP/INSPN CATEGORY: CAT-I: For these items the Quality Plans are approved by Employer and the final acceptance will be on physical inspection witness by Employer. CAT-II: For these items the Quality Plans approved by Employer. However, no physical inspection shall be done by Employer. The final acceptance by Employer shall be on the basis review of documents as per approved quality plan. CAT-III: For these items the Quality control to be exercised as per Main Contractor Quality Assurance System. The final acceptance by Employer shall be on the basis of Certificate of conformance (COC) by Main Contractor. UNITS/ WORKS: Place of manufacturing Place of Main Supplier of multi units/works.</p> <p>NOTE 1: Approval is conditional and subject to Sub QR / Proveness clearance as specified in the contract specification. Further for any change in the Technical Specification at later stage vendor approval will be reviewed accordingly.</p> <p>NOTE 2: For the items placed in CAT-III for Civil Works, the review and final acceptance shall be done by Employer-EIC/ FQA on the basis of MTC / certificate of conformance in line with Technical Specifications/FQP.</p>							

Disclaimer for Indicative Vendor List

1. Reasonable efforts have been made to collate the sub-vendors proposed by the various main contractors from time to time against different Projects/Packages and accepted by END CUSTOMER for various items. However, in case of error/omission, if any, and represented by the successful bidder this will be addressed during the execution of the contract based on the material evidence available with END CUSTOMER / Main Contractor.
2. The approved sub-vendor list drawn is not based on END CUSTOMER driven enlistment process but based on the sub-vendors proposed by various Main Contractors. As such, it is possible that some of the Suppliers/Manufacturers who may be involved in similar work/process may not be appearing in the list as such sub-vendors may not have been proposed by Main Contractors against END CUSTOMER Contracts.
3. In case the successful bidder chooses to propose additional sub-vendors with relevant experience after the award of the contract such sub-vendors will be considered , provided the proposals are received sufficiently in time so as not to impede the progress of the contract.
4. Sub-vendors have been grouped under different categories of items. It is possible that an item characterized by certain specific features such as range and type required as per Main Contractor's design requirements may not be in the range of the listed sub-vendor's manufacturing process/capability. As such the main contractor to ascertain the vendor's capability to meet his specific requirements before considering a sub-vendor.
5. It is to be noted by the bidders that any shortfall in contract performance attributable to the sub-vendor listed will not absolve the contractor from his contractual obligations in any manner.
6. The approval was granted based on the evaluation of relevant capabilities and facilities possessed by the sub-vendor at the time of evaluation. Also, some of the sub-vendors may not be active. As such, the successful bidder is to carry out his own due diligence before considering the listed sub-vendor for subletting: the current status of the sub-vendor, the continued availability of productive resources including Human Resources.
7. The list of sub-vendors is periodically revised to include new sub-vendors. Such a revision may also see a deletion of certain sub-vendors who may have been disqualified on grounds of inadequate performance or banned in line with END CUSTOMER's banning policy.

Clause No.	Quality Assurance for Civil Works
	<u>QA CIVIL WORKS</u>
1.0	SAMPLING AND TESTING OF CONSTRUCTION MATERIALS
a)	Before execution of any civil work the contractor shall conduct full-scale suitability tests on various construction and building material such as soil, fine and coarse aggregates, cement, construction chemicals, supplementary cementitious materials and construction water to ascertain their suitability for use and the concrete mix designs conducted from reputed institutes such as NCCBM-Ballabgarh, CSMRS-Delhi, selected IIT's, etc. as agreed by the Employer. The test samples for such full-scale testing shall be jointly sampled and sealed by the Employer and contractor, thereafter these shall be sent to the concerned laboratory through the covering letter signed by field quality assurance department (FQA)/EIC representative of the Employer. Format for sampling and testing of cement, coarse aggregate, fine aggregate, chemical admixture, fly ash, water, concrete mix design is enclosed at Annexure-I .
b)	The contractor shall timely initiate the action with regard to the evaluation of aggregates and other building material including concrete mix design, so as to ensure completion of these tests before start of civil works at site, thereby not affecting any project work. The test reports and recommendations for suitability of the materials including concrete mix design shall be promptly submitted by the contractor to the Engineer-in-charge (EIC)/ Field Quality Assurance (FQA) Department of Employer.
2.0	LABORATORY AND FIELD TESTING
a)	The field laboratory for QA activities shall be established and installed with the adequate facilities to meet the requirement of envisaged day to day tests during execution of the work. Temperature and humidity controls shall be available wherever necessary during testing of samples. The contractor shall furnish a comprehensive list of testing equipment/ instrument required to meet the planned/scheduled tests for the execution of works for EIC acceptance/ approval. The contractor shall mobilize the requisite laboratory equipment and QA manpower in well advance prior to the planned test activity. The tests which cannot be carried out/do not have facilities for testing in the field laboratory shall be done at Employer acceptable third-party testing laboratory.
b)	All equipment and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the EIC. The calibration certificates shall specify the fitness of the equipment and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipment and instruments by NABL or such accrediting agency complying with ISO/IEC-17025 accreditation and the calibration reports shall be submitted to EIC for their review and acceptance.
c)	The QA activities (include all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirements) in all respects as specified in the technical specifications/ drawings / data sheets / quality plans / relevant standard codes / contract documents shall be carried out at no extra cost to the Employer.
d)	The contractor shall carry out testing in accordance with the latest relevant IS/standards /codes and in line with the requirements of the technical specifications / quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the EIC.

Clause No.	Quality Assurance for Civil Works
3.0	FIELD QUALITY PLAN
a)	Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) and obtain approval of Employer. This document shall detail out for all the works, equipment, services, quality practices and procedures etc. in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items / activities required as per the contract / schedule of items, right from material procurement to completion of the work at site.
4.0	PURCHASE AND SERVICE
a)	To facilitate advance planning of material testing/ approval of bought out items (BOI), well before the start of activity as per L-2 network, representative samples shall be procured by the contractor from approved sub-vendors and submitted to the EIC for his approval before bulk procurement. In case of manufacturers test certificate (MTC) is submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. MTC of all bought out items (BOI) shall essentially contain all the test parameters / characteristics specified in the technical specifications / standards / codes. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested at the Employer acceptable third-party lab. Approval of material / sample by the Employer shall not relieve the contractor of his responsibility, for their conformance to the specification, as well as the requisite performance and quality of material.
b)	<p>Structural steel (plates and rolled sections i.e. channels, beams & angles) conforming to IS 2062 and Reinforcement steel conforming to IS 1786 supply if in the scope of the contractor shall be procured directly from Primary Steel Producers (Refer NOTE below). Any procurement route, other than direct procurement from primary steel producer, shall require prior approval of END CUSTOMER. Currently, Primary Steel Producers acceptable are as below:</p> <ol style="list-style-type: none"> 1. SAIL 2. JSW Steel Ltd 3. Jindal Steel & Power 4. Tata Steel Ltd. (for Reinforcement steel/TMT bars, Flat products) 5. RINL (for long products/Rolled sections and Reinforcement steel/TMT bars) 6. ArcelorMittal Nippon Steel India Ltd. (for Flat products/ Steel Plates) 7. ESL Steel Ltd. (for Reinforcement steel/TMT bars) and 8. JSW Ispat Special Products Ltd. (for long products/Rolled sections and Reinforcement steel/TMT bars). <p>Subsequently, if any new Primary Steel Producer/s are proposed during execution of contract, the same may be considered for acceptance subject to meeting the following qualifying requirements:</p> <ul style="list-style-type: none"> ❖ The proposed supplier should be a Primary Steel Producer, having a minimum production capacity of one million tons per annum (MTPA). ❖ The proposed supplier should be a regular manufacturer of Steel Plates and / or Rolled Sections and / or Reinforcement Steel for the last two years as on date of submission of proposal. ❖ The proposed supplier should also be a registered licensee with Bureau of Indian Standards for BIS:1786/2062 at the time of submission of proposal.

Clause No.	Quality Assurance for Civil Works
	<p>NOTE: The “Primary Steel Producer” shall mean Steel Producer of any capacity, irrespective of process route, starting their operations from iron making using iron ore, virgin or processed, with necessary refining facilities and rolling/processing facilities, at a single location or else in multiple locations provided that the entire gamut of iron and steel production, from iron making to finished steel production, is owned by the same company or its subsidiary company(ies). Provided that the iron making capacity is sufficiently matching the steel making capacity. Further, downstream units should use material from the upstream units of the same company or its subsidiaries.</p> <p>i. In case of non-availability of certain steel section/s i.e. Angles (smaller than 100x100x10 mm), MS flats, rounds, square bars and chequered plate, conforming to IS:2062, from above acceptable primary steel producers the Main contractor may source these sections directly from SAIL approved Conversion/Wet Leasing agent subject to the conditions given below:</p> <ol style="list-style-type: none"> 1. Main Contractor to ensure continuity of BIS license of the manufacturer for the sections being manufactured for Employer supply. 2. Billets shall be procured from Employer approved Main Steel Producers. Proper records for traceability from raw material to final product shall be maintained. 3. Testing of one sample per 40 MT for each type of section/size or part thereof shall be carried out as per IS:2062 on finished product for physical and chemical properties. <u>The sampling and testing for physical and chemical tests on finished product at Conversion/Wet Leasing agent shall be mandatorily witnessed by main contractor.</u> All such reports along with requisite BIS license(s), SAIL approval, MTCs etc. shall be presented during final inspection by END CUSTOMER. 4. Each lot of delivery of finished product shall be accompanied with co- relatable Manufacturer’s Test Certificate (MTC). MTC of finished sections shall be correlated with original MTC for Billets received from Main Steel Producer. 5. The material shall bear the identification mark of re-roller embossing on the rolled sections. 6. Employer will have access to carry out the surveillance checks for in-process stage. 7. In case of any defects are seen in the material at any stage, Main Contractor will replace the material without any cost implication to Employer. <p>ii. In case of non-availability of certain size/s of steel tubes conforming to IS:1161 and Hollow (square and rectangular) steel sections conforming to IS: 4923 from above acceptable primary steel producers, the same may be sourced from BIS approved sources having valid BIS license subject to the conditions given below:</p> <ol style="list-style-type: none"> 1. Main Contractor to ensure continuity of BIS license of the manufacturer for the sections being manufactured for Employer supply. 2. Raw materials shall be procured from Employer approved Main Steel Producers. 3. Testing of samples of steel tubes and hollow sections from each lot shall be carried out as per IS: 1161 & IS: 4923 respectively on finished product. 4. Each lot of delivery of finished product shall be accompanied with co- relatable Manufacturer’s Test Certificate (MTC).

Clause No.	Quality Assurance for Civil Works
<p>c)</p> <p>d)</p>	<p>5. Employer will have access to carry out the surveillance checks for in-process stage.</p> <p>6. In case of any defects are seen in the material, Main Contractor will replace the material without any cost implication to Employer.</p> <p>For Module Mounting Structure, the structural steel (other than those specified at 'b' above) may be procured from main contractor approved sources having valid BIS license, subject to condition that they otherwise meet the requirement of technical specification.</p> <p>For transmission line tower/Switchyard structures, for steel conforming to IS:2062, the sub vendor may use own rolling facility's re-rolled sections, only if valid POWERGRID re-roller approval is available. All the requirements as per clause 'b) i)' above shall be applicable.</p>

ANNEXURE - I**Format of Request Letter for Evaluation of Materials**

Ref: _____

Date: _____

To,

Sub.: Evaluation of materials and concrete mix design

Dear Sir,

We have awarded the work of on M/s vide our LOA No. dated for execution of Civil Works. Based on provisions of contract, M/s are expected to get the following tests/ evaluation done through your laboratory and accordingly the tests have been described below.

M/s have been advised to deposit the requisite evaluation/ testing charges and to deliver the test samples of quantities, specified below.

1. Evaluation of Cement:

- a) To carry out different physical tests on cement samples i.e. Blaine's fineness, initial and final setting time, soundness and compressive strength at 3, 7 and 28 days as per IS: 4031 and drying shrinkage and specific gravity in case of PPC.
- b) To carry out chemical analysis of the cement samples as per IS: 4032, including the total alkali content of the cement (Na_2O equivalent).
- c) To advise the suitability of cement based on the test results of a) and b) above.

2. Evaluation of Aggregates:

- a) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and flakiness index, as per IS: 383 & IS: 2386.
- b) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis soundness, deleterious material, silt content, clay content and organic impurities and mica content as per IS: 383 & IS: 2386.
- c) To prepare evaluation report based on test results of a) and b) above and to advise regarding suitability of fine and coarse aggregates to be used with the cement of 1) above.

3. Evaluation of Flyash Sample (if applicable):

- a) To carry out various physical and chemical tests on fly ash sample i.e. Blaine's fineness, lime reactivity, specific gravity, loss on ignition and other chemical tests as per IS: 3812, conforming to grade-I.
- b) To advise the suitability of fly ash sample based on the test results of a) above.

4. Evaluation of water: To carry out various physical and chemical tests as per IS: 456 and IS: 3025.**5. Evaluation of admixtures:** To carry out various physical and chemical tests as per IS: 9103.

Note: Test certificate shall be obtained from the supplier to compare the values given in Table 2 of IS: 9103 i.e. uniformity requirements.

6.	<p>Concrete Mix Design: Based on the provisions of technical specification, the Following may be specified by site Construction department/Quality department **</p> <p>a) For RCC Work</p> <ul style="list-style-type: none"> i. Grade of concrete ii. Slump required, mm: iii. Cement- Type and grade iv. Max Size of Aggregates, mm v. Exposure conditions vi. Maximum water-cement ratio vii. Minimum cement content viii. Plasticizer/ admixture to be used or not (If yes, specify the brand/ type/batch no. of plasticizer) ix. Fly ash to be used or not (If yes, indicate % of fly ash to be used) <p>c) For PCC work: Same as i) to ix) of a) above</p> <p>d) For piling work (if required): Same as i) to ix) of a) above</p> <p>b) Details of material sampled: In order to facilitate the above mentioned tests, specified quantities of samples have been collected and sealed jointly (by Employer – Quality department, Construction department and contractors' representative) is being sent for testing. The impression of seal has also been punched below.</p> <p>a) Quantity of material required for each mix-design:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Sl. No.</th> <th style="width: 40%;">Material Description</th> <th style="width: 50%;">Quantity Required</th> </tr> </thead> <tbody> <tr> <td>i)</td> <td>Cement</td> <td>2 bags (sealed in double polythene bags)</td> </tr> <tr> <td>ii)</td> <td>Coarse Aggregates</td> <td>100 Kg of each fraction as explained below : e.g.; If Maximum size of aggregates (MSA) is 20mm, then 100 Kg each of 20-10mm and 10mm down are required. If MSA is 40mm then 100Kg each of 40-20mm, 20-10mm and 10mm down are required.</td> </tr> <tr> <td>iii)</td> <td>Fine Aggregates</td> <td>200Kg</td> </tr> <tr> <td>iv)</td> <td>Chemical Admixtures</td> <td>2 Litres</td> </tr> <tr> <td>v)</td> <td>Water</td> <td>100 Litres</td> </tr> <tr> <td>vi)</td> <td>Fly ash (If decided to be used)</td> <td>100Kg</td> </tr> </tbody> </table> <p>b) Quantity of material required for Alkali-Aggregate reactivity</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Sl. No.</th> <th style="width: 40%;">Material Description</th> <th style="width: 50%;">Quantity Required</th> </tr> </thead> <tbody> <tr> <td>i)</td> <td>Coarse aggregate</td> <td></td> </tr> <tr> <td>a)</td> <td>80-40mm</td> <td>60Kg</td> </tr> <tr> <td>b)</td> <td>40-20mm</td> <td>60Kg</td> </tr> <tr> <td>c)</td> <td>20-10mm</td> <td>60Kg</td> </tr> <tr> <td>d)</td> <td><10mm</td> <td>60Kg</td> </tr> </tbody> </table>					Sl. No.	Material Description	Quantity Required	i)	Cement	2 bags (sealed in double polythene bags)	ii)	Coarse Aggregates	100 Kg of each fraction as explained below : e.g.; If Maximum size of aggregates (MSA) is 20mm, then 100 Kg each of 20-10mm and 10mm down are required. If MSA is 40mm then 100Kg each of 40-20mm, 20-10mm and 10mm down are required.	iii)	Fine Aggregates	200Kg	iv)	Chemical Admixtures	2 Litres	v)	Water	100 Litres	vi)	Fly ash (If decided to be used)	100Kg	Sl. No.	Material Description	Quantity Required	i)	Coarse aggregate		a)	80-40mm	60Kg	b)	40-20mm	60Kg	c)	20-10mm	60Kg	d)	<10mm	60Kg
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		ii)	Fine aggregates	60Kg
		iii)	Cement	2 samples (1 bag each), contemplated for use in construction.
	c) Impression/ Punch Mark of seal:			
	<p>You are requested to kindly forward us the test reports along with the recommendations regarding the suitability of materials to us at the earliest.</p> <p>Thanking you,</p> <p style="text-align: right;">Yours faithfully, Name: Contact Number: Email ID: (Quality department Representative of Employer)</p> <p>Note:</p> <ol style="list-style-type: none"> 1. Based on provisions of technical specification, the testing charges for all the above-mentioned tests shall be borne by the contractor. 2. The content of the letter is for guidance only, and if required may be suitably modified to suit the specific requirements of the package in consultation with Construction and quality department. <p>** This line may be deleted in the letter sent to the institute.</p>			
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	<p>PART-B F – GENERAL TECHNICAL REQUIREMENTS</p>

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	<p>F-1 GENERAL TECHNICAL REQUIREMENTS</p> <p>1.0 INTRODUCTION</p> <p>This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.</p> <p>2.0 BRAND NAME</p> <p>Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.</p> <p>3.0 BASE OFFER & ALTERNATE PROPOSALS</p> <p>The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Employer. Sufficient amount of information for justifying such proposals shall be furnished to Employer along with the bid to enable the Employer to determine the acceptability of these proposals.</p> <p>4.0 COMPLETENESS OF FACILITIES</p> <p>a) Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.</p> <p>b) All equipment furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been</p>

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	<p>specifically detailed in the respective specifications, unless included in the list of exclusions.</p> <p>All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.</p> <p>5.0 Codes & Standards</p> <p>5.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:</p> <ul style="list-style-type: none"> a) Bureau of Indian Standards (BIS) b) Indian electricity act c) Indian electricity rules d) Indian Explosives Act e) Indian Factories Act and State Factories Act f) Indian Boiler Regulations (IBR) g) Regulations of the Central Pollution Control Board, India h) Regulations of the Ministry of Environment & Forest (MoEF), Government of India i) Pollution Control Regulations of Department of Environment, Government of India j) State Pollution Control Board. k) Rules for Electrical installation by Tariff Advisory Committee (TAC). l) Any other statutory codes / standards / regulations, as may be applicable. <p>5.2 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:</p> <ul style="list-style-type: none"> a) Japanese Industrial Standards (JIS) b) American National Standards Institute (ANSI) c) American Society of Testing and Materials (ASTM) d) American Society of Mechanical Engineers (ASME) e) American Petroleum Institute (API) f) Standards of the Hydraulic Institute, U.S.A. g) International Organization for Standardization (ISO)

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	<ul style="list-style-type: none"> h) Tubular Exchanger Manufacturer's Association (TEMA) i) American Welding Society (AWS) j) National Electrical Manufacturers Association (NEMA) k) National Fire Protection Association (NFPA) l) International Electro-Technical Commission (IEC) m) Expansion Joint Manufacturers Association (EJMA) n) Heat Exchange Institute (HEI)
5.3	<p>Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, alongwith the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.</p>
5.4	<p>As regards highly standardized equipment National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.</p>
5.5	<p>In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.</p>
5.6	<p>Two (2) English language copies of all-national and international codes and/or standards which are not available with END CUSTOMER and same is used in the the plant, equipment, civil and structural works shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.</p>
5.7	<p>In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.</p>
6.0	<p>EQUIPMENT FUNCTIONAL GUARANTEE</p> <ul style="list-style-type: none"> a) The functional guarantees of the equipment under the scope of the Contract is given elsewhere in the technical specification. These guarantees shall

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<p>7.0</p>	<p>supplement the general functional guarantee provisions covered under General Conditions of Contract.</p> <p>b) Liquidated damages for shortfall in meeting functional guarantee(s) during the performance guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.</p> <p>DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS</p> <p>a) Design of Facilities</p> <p>All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.</p> <p>The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.</p> <p>b) Maintenance and Availability Considerations</p> <p>Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.</p> <p>c) Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.</p> <p>Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 kgs during erection and maintenance activities.</p> <p>Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the contractor for lifting the equipment and accessories covered under the specification.</p> <p>8.0</p> <p>DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR</p>

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	<p>a) Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.</p> <p>b) The Contractor shall furnish engineering data/drgs. for entire equipment covered under this specification in accordance with the schedule of information as specified in Technical Specification and Data sheets.. This documentation shall include but not be limited to the following :</p> <p>a) INSTRUCTION MANUALS</p> <p>The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipment covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Employer the Instruction Manuals shall be submitted. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.</p> <p>(a) Erection & Commissioning Manuals/Checklists</p> <p>The erection & Commissioning Manuals/Checklists shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.</p> <ul style="list-style-type: none"> a) Erection strategy. b) Sequence of erection. c) Erection instructions. d) Critical checks and permissible deviation/tolerances. e) List of tool, tackles, heavy equipment like cranes, dozers, etc. f) Bill of Materials g) Procedure for erection. h) General safety procedures to followed during erection/installation. i) Procedure for initial checking after erection.

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	<p>j) Procedure for testing and acceptance norms.</p> <p>k) Procedure / Check list for pre-commissioning activities.</p> <p>l) Procedure / Check list for commissioning of the system.</p> <p>m) Safety precautions to be followed in electrical supply distribution during erection</p> <p>(b) Operation & Maintenance Manuals</p> <p>i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Employer to operate, maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Employer.</p> <p>ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Employer for records.</p> <p>iii. A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.</p> <p>iv. The manuals shall include the following :</p> <p style="padding-left: 40px;">a. List of spare parts along with their drawing and catalogues and procedure for ordering spares.</p> <p style="padding-left: 40px;">b. Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.</p> <p style="padding-left: 40px;">c. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.</p> <p>v. Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub-assembly - wise required for the complete plant.</p>

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	<p>vi. On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Employer indicating lubrication method for each type/category of bearing.</p> <p>b) Project Completion Report</p> <p>The Contractor shall submit a Project Completion Report at the time of handing over the plant. After final acceptance of individual equipment /system by the Employer, the Contractor will update all original drawings and documents for the equipment/ system to "as built" conditions and submit.</p> <p>c) ENGINEERING INFORMATION SUBMISSION SCHEDULE</p> <p>Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.</p> <ul style="list-style-type: none"> a) Information that shall be submitted for the approval of the Employer before proceeding further, and b) Information that would be submitted for Employer's information only. <p>The Engineering Information Schedule shall be updated month-wise.</p> <p>The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.</p> <p>d) ENGINEERING PROGRESS AND EXCEPTION REPORT</p> <p>Report giving the status of each engineering information including</p> <ul style="list-style-type: none"> (a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission (b) Drawings which were not submitted as per agreed schedule. <p>The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.</p> <p>e) TECHNICAL CO-ORDINATION MEETING</p> <ul style="list-style-type: none"> • The Contractor shall organize and attend at least one monthly progress Meetings with the Employer/Employer's representatives during the period of Contract at mutually agreed venues for review of progress & resolving

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	<p>technical clarifications, if any. The Contractor shall attend such meetings at his own cost and fully co-operate with such persons and agencies involved during the discussions.</p> <ul style="list-style-type: none"> • The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that, if required, the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself. • The Contractor shall furnish monthly progress report to the Employer detailing out the progress achieved on all erection activities as compared to the schedules. This shall be supplemented by printed colour photographs and video in VCD/DVD indicating various stages of erection and the progress of the work done at Site. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary. <p>f) DESIGN IMPROVEMENTS</p> <p>The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.</p> <p>If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.</p> <p>g) EQUIPMENT BASES</p> <p>A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.</p> <p>h) PROTECTIVE GUARDS</p> <p>Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.</p> <p>i) LUBRICANTS, SERVO FLUIDS AND CHEMICALS</p> <p>The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and</p>

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j)	<p>essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder.</p> <p>As far as possible lubricants marketed by reputed companies shall be used. The variety of lubricants shall be kept to a minimum possible.</p> <p>Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Employer alongwith lubrication requirements.</p> <p>Lubrication</p> <p>Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.</p> <p>Material of Construction</p> <p>All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.</p>

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<p>k)</p> <p>l)</p> <p>m)</p>	<p>RATING PLATES, NAME PLATES & LABELS</p> <p>Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.</p> <p>Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.</p> <p>Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.</p> <p>Nameplates shall be as per best practices of the industry</p> <p>All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.</p> <p>All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system</p> <p>TOOLS AND TACKLES</p> <p>The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.</p> <p>The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Employer.</p> <p>Welding</p>

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	<p>If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be performed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.</p> <p>n) COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES</p> <p>All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer's standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.</p> <p>o) PROTECTION AND PRESERVATIVE SHOP COATING</p> <p>Protection</p> <p>All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or overground environment as the case may be.</p> <p>Preservative Shop Coating</p> <p>All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.</p> <p>Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.</p> <p>Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.</p> <p>All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Employer.</p>

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<p>9.0</p>	<p>All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.</p> <p>Painting for Civil structures shall be done as per relevant part of technical specification</p> <p>QUALITY ASSURANCE PROGRAMME</p> <p> a) The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with IS/ISO-9001.A quality assurance programme of the contractor shall generally cover the following: b) <ul style="list-style-type: none"> (a) His organisation structure for the management and implementation of the proposed quality assurance programme (b) Quality System Manual (c) Design Control System (d) Documentation and Data Control System (e) Qualification data for bidder's key personnel. (f) The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc. (g) System for shop manufacturing and site erection controls including process, fabrication and assembly. (h) Control of non-conforming items and system for corrective actions and resolution of deviations. (i) Inspection and test procedure both for manufacture and field activities. (j) Control of calibration and testing of measuring testing equipment. (k) System for Quality Audits. (l) System for identification and appraisal of inspection status. (m) System for authorising release of manufactured product to the Employer. (n) System for handling, storage and delivery. </p>

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	<p>(o) System for maintenance of records, and</p> <p>(p) Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.</p> <p>c) GENERAL REQUIREMENTS - QUALITY ASSURANCE</p> <p>a) All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS- 01-QAI-P- 01/F3. If bidder wishes to appoint a TPIA for inspection on his behalf, same shall be intimated during finalisation of Quality plans. Such agency and their representative's credential would be reviewed and approved by END CUSTOMER as per applicable procedures.</p> <p>b) Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.</p> <p>c) Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.</p> <p>d) The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These</p>

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	<p>approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative along with Contractor's QA representative or an END CUSTOMER approved TPIA on behalf of Contractor and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.</p> <p>e) No material shall be dispatched from the manufacturer's works before the same is accepted, subsequent to predispatch final inspection in presence of Contractor's QA representative or an END CUSTOMER approved TPIA on behalf of Contractor, including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for dispatch by issuance of Material Despatch Clearance Certificate (MDCC).</p> <p>f) All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.</p> <p>g) The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-CQA-W- 11/F1. The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.</p> <p>h) All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer.</p> <p>All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.</p> <p>a) All brazers, welders and welding operators employed on any part of the contract either in Contractor's/sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.</p>

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	<p>b) Welding procedure qualification & Welder qualification test results shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.</p> <p>c) For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.</p> <p>d) Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.</p> <p>e) No welding shall be carried out on cast iron components for repair.</p> <p>f) All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.</p> <p>g) All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.</p> <p>All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.</p> <p>a) The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01- QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.</p>

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	<p>b) For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract. **</p> <p>c) Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.</p> <p>d) The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.</p> <p>e) Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.</p> <p>f) For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.</p>

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	<p>g) Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.</p> <p>Environmental Stress Screening</p> <p>a) Environmental stress screening test process / procedure for eliminating infant mortile components for DDCMIS / PLC based system & for other systems having substantial electronics components (as determined by employer) like Electronic transmitter, CCTV components, PA systems etc. shall be necessarily furnished for any sub vendors proposed for vendor assessment and approval for this contract. For other approved sub vendors of above mentioned systems, contractor shall furnish the test procedure for eliminating infant mortile components in case, if it is asked for by the employer before these items are offered for inspection / dispatched to site.</p> <p><u>Software Reliability / Quality Certification</u></p> <p>a) Certification from OEM's authorized signatory that software offered with DDCMIS, PLC, CCTV, PA, Pyrometer, CEMS, AAQMS, EQMS, BHMS etc. declaring that the all the offered software(s) had gone through the established software quality test and offered software is not of β-version and offered software is also free from all known bugs as on date of approval of systems documents by END CUSTOMER as a part of quality documentation review and approval process during detail engineering.</p> <p>An indicative list of sub-vendors which has been accepted by END CUSTOMER in the past for Corporate Awarded similar packages based on the respective Technical Specifications are enclosed in the tender specification for reference purpose only. The purpose of this list is to provide general guidance to the prospective Bidders / Main Contractors for this package only. Further, this list is indicative in nature and may undergo revision for future packages based on the performance feedback received from Owner's sites / other agencies about the supplier / sub vendors / supplied material. However, it is not the intention to limit the sub- vendor to only such names appearing in the above list and Main contractor is free to propose additional sub-vendors in his bid offer which will be subject to END CUSTOMER sub-vendor assessment system upon receipt of requisite details in a time bound mutually agreed schedule. Moreover listed suppliers may or may not be able to supply the material as per current Tech Specifications for the present package. Bidder is required to enquire before finalizing the suppliers / sub vendors for the present contract to meet provisions of the current Tech Specs.</p>

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<p></p> <p></p> <p></p> <p></p> <p>d) QA DOCUMENTATION PACKAGE</p> <p>hard tick</p>	<p>Standard Manufacturing Quality Plan (SQP)/Indicative Manufacturing Quality Plan(IQP)/ Standard Field Quality Plan (SFQP)/ Indicative Field Quality Plan(IFQP) are enclosed for the major items, which can be used as a reference purpose for item under consideration.</p> <p>The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified subcontractors and shall be submitted to the Employer for approval within a time bound schedule drawn during detailed engineering process. Such sub-vendor proposed in his bid offer shall be deemed to be identified in DR category and upon final acceptance by END CUSTOMER in writing, contractor can place order on such accepted sub-vendor only.</p> <p>Monthly progress reports on sub-contractor detail submission / approval shall be furnished as per Engineering Co-ordination Procedure. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract. Sub-vendor whose details are not submitted within the agreed cut-off date, shall be deemed to be withdrawn by the contractor.</p> <p>The Contractor shall be required to submit the QA Documentation in two copies and two CD ROMs, as identified in respective quality plan with</p> <p>b) Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.</p> <p>The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.</p> <p>The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-Rom may be issued not later than three weeks.</p> <ul style="list-style-type: none"> ▪ Typical contents of QA Documentation is as below:- <ul style="list-style-type: none"> a) Quality Plan b) Material mill test reports on components as specified by the specification and approved Quality Plans. c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans. d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment. e) Heat Treatment Certificate/Record (Time- temperature Chart) f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).

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	<p>g) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.</p> <p>h) Certificate of Conformance (COC) wherever applicable.</p> <p>i) MDCC</p> <ul style="list-style-type: none"> ▪ Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system. ▪ Before dispatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review. <p>(a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.</p> <p>(b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.</p> <p>(c) If a decision is made dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.</p>

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<p>e)</p> <p>f)</p>	<p>Project Manager's Supervision</p> <p>To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause , the Contractor shall proceed to comply with the Project Manager's decision.</p> <ul style="list-style-type: none"> ▪ The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following: <ul style="list-style-type: none"> (a) Interpretation of all the terms and conditions of these documents and specifications: (b) Review and interpretation of all the Contractor's drawing, engineering data, etc: (c) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract : (d) Inspect, accept or reject any equipment, material and work under the contract : (e) Issue certificate of acceptance and/or progressive payment and final payment certificates (f) Review and suggest modifications and improvement in completion schedules from time to time, and (g) Supervise Quality Assurance Programme implementation at all stages of the works. <p>INSPECTION, TESTING AND INSPECTION CERTIFICATES</p> <ul style="list-style-type: none"> ▪ The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection. ▪ The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

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	<ul style="list-style-type: none"> ▪ The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies. ▪ The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract. ▪ When the factory tests have been completed at the Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract. ▪ In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing. ▪ The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

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<p>g)</p> <p>10.0</p>	<ul style="list-style-type: none"> <li>▪ To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month. <li>▪ All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by END CUSTOMER. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector. <p>ASSOCIATED DOCUMENT FOR QUALITY ASSURANCE PROGRAMME:</p> <ul style="list-style-type: none"> <li>c) List of items requiring quality plan and sub supplier approval. Format No.:QS-01-QAI-P-01/F3-R0. <li>d) Manufacturing Quality Plan Format No.: QS-01-QAI-P-09/F1-R1 <li>e) Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1. <p>PRE-COMMISSIONING AND COMMISSIONING FACILITIES</p> <p>The Contractor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. During commissioning the Contractor shall carry out system checking and reliability trials on various parts of the facilities. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in the Contractor's quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the contractor.</p> <p>The pre-commissioning and commissioning activities of the equipment/systems furnished and installed by the contractor shall be the responsibility of the Contractor. The Contractor shall provide, in addition, temporary instrumentation and other measuring devices, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such operations.</p>

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h)	<p>All erection & commissioning checks shall be as per manufacturer's manual on mutually agreed terms</p> <p>(a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included elsewhere in the Technical Specifications.</p> <p>(b) The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.</p> <p>(c) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.</p> <p>(d) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over for commissioning (start-up), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SCL (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] to be furnished by the manufacturer/supplier.</p> <p>(e) The Contractor shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.</p>

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11.0	<p>SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION</p> <p>In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:</p> <ul style="list-style-type: none"> (a) Working platforms should be fenced and shall have means of access. (b) Ladders in accordance with Employer's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.
12.0	<p>PACKAGING AND TRANSPORTATION</p> <p>All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Employer's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.</p>
13.0	<p>ELECTRICAL ENCLOSURE</p> <p>All electrical equipment and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.</p>
14.0	<p>Instrumentation and Control</p> <p>All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.</p> <ul style="list-style-type: none"> a) All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale. All scales and charts shall be calibrated and printed in Metric Units b) All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear. c) All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better.

CLAUSE NO.	TECHNICAL SPECIFICATIONS																				
15.0	<p>ELECTRICAL NOISE CONTROL</p> <p>The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801-2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.</p>																				
16.0	<p>ELECTRONIC MODULE/COMPONENT DETAILS</p> <p>The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments, peripherals etc.</p> <p>It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.</p> <p>Annexure-1 of GTR</p> <table><tr><th>S. N.</th><th>Description Of Documents</th><th>No of Prints (Sets)</th><th>NO. OF CD-ROMs /Floppy</th></tr><tr><td>1.</td><td>Drawings for Initial Submission (Either "FOR APPROVAL" or "FOR INFORMATION Category) and re-submissions after review by END CUSTOMER(including Data sheets/ Calculations, all Equipment/instrument schedule, BOM etc)</td><td>8</td><td>1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)</td></tr><tr><td>2.</td><td>Final Approved Drawings (Cat-I & Cat – IV Approved) (As referred in SI no: 1 above)</td><td>3</td><td>4 CD- Roms</td></tr><tr><td>3.</td><td>Documents / Drawings "AS BUILT "</td><td>3</td><td>4 CD- Roms</td></tr><tr><td>4.</td><td>Type test reports (Intial)</td><td>8</td><td>1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)</td></tr></table>	S. N.	Description Of Documents	No of Prints (Sets)	NO. OF CD-ROMs /Floppy	1.	Drawings for Initial Submission (Either "FOR APPROVAL" or "FOR INFORMATION Category) and re-submissions after review by END CUSTOMER(including Data sheets/ Calculations, all Equipment/instrument schedule, BOM etc)	8	1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)	2.	Final Approved Drawings (Cat-I & Cat – IV Approved) (As referred in SI no: 1 above)	3	4 CD- Roms	3.	Documents / Drawings "AS BUILT "	3	4 CD- Roms	4.	Type test reports (Intial)	8	1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)
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	S. N.	Description Of Documents	No of Prints (Sets) NO. OF CD-ROMs /Floppy
	5	Type test reports (Final)	1 2 CD-Roms
	6.	Piping / Equipment Analysis (Transient) etc, Model study reports (Draft) Including the input/output data etc.	8 1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)
	7.	Piping / Equipment Analysis (Transient) etc, Model study reports (Final Approved) Including the input/ output data etc.	2 4 CD-Roms
	8	Erection manual "Draft "	4 sets 1 CD ROMS
	8	Erection manual "Final "	4 sets 1 CD ROMS
	9	Operation & Maintenance manual "DRAFT"	4 sets 2 CD ROMS
	10	Operation & Maintenance manual "FINAL"	4 sets 4 CD ROMS
	11	Commissioning Procedure (If applicable) (DRAFT)	4 sets 1 CD ROMS
	12.	Commissioning Procedure (If applicable) (FINAL)	4 sets 1 CD ROMS
	13	Performance and Guarantee test Procedure (Draft)	8 1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)
	14.	Performance and Guarantee test Procedure (Final)	8 1 Soft Copy (2 Floppy or 1 no of CD-Rom or through E-Mail)

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	Annexure-1 of GTR			
	S. N.	Description Of Documents	No of Prints (Sets)	NO. OF CD-ROMs /Floppy
	16	Progress Reports	8	3 FLOPPIES
	16	Project completion report	3 Sets	3CD ROMS
	17	QA programme including Organisation for implementation and QA system manual (with revision-servicing)	1	1 CD-ROM
	18	Vendor details in respect of proposed vendors including contractor's evaluation report.	1	1 CD –ROM
	19	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.		
		i) For review/comment -	3	1 set of soft copy
		(ii) For final approval 1 set floppies	4	1 CD ROM
	20	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals		
		Draft	4 sets	
		Final	4 sets	2 CD ROMS
	21	Monthly Vendor Approval /QP approval status	2 sets	1 FLOPPY
	22	QA Documentation Package for field activities on equipment / systems at site	2 Sets	2 CD ROMS
	23	QA Documentation Package for field activities on equipment / systems at site	2 Sets	2 CD ROMS

17. General instructions

CL. NO	DESCRIPTION
17.1	Engineering activities:
	As engineering is in the scope of vendor, all the engineering activities are to be expedited by bidder. Separate L3 schedule for completion engineering activities with MDL (master drawing list) has to be submitted to BHEL/ Owner and weekly report has to be sent to BHEL- Project Manager.
	Engineering activities has to be reviewed on daily basis through VC till completion of engineering activities without fail.
	Liasioning with owner for approval of engineering document & drawing is in the scope of bidder till approval & Any BHEL intervention required for design approval at owner's engineering office, travel expense to be incurred for engineering drawing approval has to be borne by bidder. (to &fro)
	Bidder to comply with L3 schedule for engineering document submission. Comments furnished by BHEL/Owner has to be replied immediately/ within 72 hrs of receipt of comment from BHEL/Owner. In case of non-reply, and delay beyond L3 BHEL is having the rights to submit the compliance report on behalf of bidder at the risk of bidder.
	BHEL may impose delay in engineering charges on bidder for BHEL/ man hours w.r.t delay in L3.
17.2	Geo-technical investigation & Topo-survey:
	Topo-survey & Geo technical investigation team has to be mobilized immediately after receipt of LOA at site.
	Concrete mix design has to be immediately carried out at site on receipt of LOA/ award.
	Required numbers of piles for trial pile test as per IS 2911 has to be cast/ rammed (reinforcement shall be used in case of non-availability of actual column section) at site immediately after receipt of LOA/award from BHEL for various pile depths nearest to theoretical pile capacity calculation.
	Testing of all materials at site laboratory or approved laboratory outside, submitting test reports, arranging supervision etc and execution of the contract.
	Mix design for all concreting may be carried out either at site or from a reputed institute; Bidder have to ensure adding of admixture to ensure better work ability, strength & durability.
	All quality standards, tolerances, welding standards & other technical requirements shall be strictly adhered to. Bidder shall fully apprise Bidder'sself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions & site-specific parameters and shall include for all such conditions & contingent measures in the bid, including those which may not have been specifically brought out in the specifications.
	Setting up by Bidder a testing laboratory (one AC lab size 4.5 mtr x 6 mtr and 1 non-AC lab 4.5 mtr x 4.5 mtr) in the field to carry out all relevant tests. Detail of laboratory equipments as per relevant annexure of this tender is to be arranged by Bidder within accepted rate. For conducting day to day test, one number of chemists to be deployed as necessary
	Civil enabling works (if included) covers site office, temporary stores for equipment & cement, pre-assembly/storage yards, construction & maintenance of temporary roads and drains etc.
	Maintenance of construction water network, construction power network, under Bidder's custody.
	All quality standards, tolerances, welding standards & other technical requirements shall be strictly adhered to. Bidder shall fully apprise themselves of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site-specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.
	Mix design for all concreting may be carried out from a reputed institute; Bidder have to ensure adding of admixture and minimizing of cement content in line with relevant latest BIS.

	Drawings, documents attached along with the tender are for guidance and tender purpose only.	
	The scope shall include other related works although may not be specifically mentioned along with incidental items, but are necessary for completion of the work as a whole.	
	Topographical survey and geo-technical investigation report/ data, if furnished along with tender, may be used for reference purpose only. No claim/ compensation whatsoever in this regard shall be entertained by BHEL at a later date.	
	Bidder shall supply all material covered under supply part of price schedule as well as specified items covered under service part. Unless otherwise specified in price schedule, Bidder shall obtain prior approval from BHEL/ owner regarding manufacturer/ make of all items under Bidder scope of supply (under service part or supply part of price schedule).	
	The quantities of the various items mentioned in the specification/ schedule are approximate, based on very preliminary information and may vary to any extent or to be deleted altogether. The accepted rates of each item will remain firm throughout the period of execution including extension, for reasons whatsoever, as long as variation in the total value of the work executed under any part of this contract including extra items, if any,	
17.3	OVER RUN CHARGES	
	Not applicable for this tender.	
17.4	REVISION ON ACCEPTED CONTRACT RATE	
	Not applicable in this tender.	
17.5	TOOLS & PLANTS (TO BE PROVIDED BY BIDDER)	
	Tentative list of T&P to be deployed by Bidder for successful completion of work is detailed below.	
	It may be noted that the list is not exhaustive and is only for general guidance. Bidder are required to provide all necessary T&P (other than those specified to be provided by BHEL, if any) measuring (calibrated) instruments & handling equipments for timely completion of total work as per contract. In case of project requirement, some activities may have to pre-pone. In such cases Bidder may have to deploy additional T&P. Accepted rate shall be inclusive of such requirements.	
	In the event of any failure on Bidder's part and as a result progress of work suffers, BHEL may at his discretion also terminate the contract on this ground and take out any or whole amount of the contract from Bidder's scope. In line with, in the event of Bidder's failure to deploy necessary & sufficient T&P/ IMTEs, BHEL also reserve the right to arrange the same at Bidder's risk & cost including transportation cost of same from any of BHEL site/ other agency & charges as applicable shall be deducted from Bidder's RA bill, in case progress of work is suffered. Decision of BHEL in this regard will be final & binding on Bidder.	
	Following major T&Ps to be arranged by Bidder within the time as indicated against each T&P:	
	Major T&P items	
	2 nos minimum 10/ 12 T capacity hydra. (crawler or four-wheel drive suitable for driving in desert)	1st – Within 25 days. 2nd – As per site requirement
	4 nos Fork lift (crawler or four-wheel drive suitable for driving in desert)	1st – Within 25 days. 2nd – As per site requirement.
	site establishment- capacity as per contract, CCTV & light mast at strategic locations of site.	Within 25 days.
	4 no long bed tractor for continuous material feeding (crawler or four-wheel drive suitable for driving in desert)	As per site requirement
	2 no hydraulic excavator/ Poclain.	As per site requirement
	1 no JCB.	As per site requirement.
	1 no minimum 15 cum/ hr capacity portable automatic	As per site requirement

	concrete batching plant.	
	1 no minimum 30 cum/ hr capacity automatic concrete batching plant with printing facility (To be commissioned at site)	As per site requirement
	4 nos ajax or equivalent transit mixer / mobile mixer (4.5/ 5/ 6 M3 capacity), peak period 5 nos transit mixer.	To be commissioned within 30 days from start of work.
	2 nos minimum 20 cum/ hr, lift 12 mtr capacity concrete pump.	As per site requirement
	8 nos of tractor augur & 2 nos of DTH boring machine (based upon site requirement)	As per site requirement.
	1 no concrete coring machine for drilling in concrete upto 150 mm dia alongwith diamond bits.	As per site requirement
	8 no crawler mounted pile ramming machine-min engine power of 85kW (min depth for 3m deep drive). (in case of ramming piles).	As per site requirement
	2 nos minimum 5 HP self priming dewatering pump (diesel/ electric).	As per site requirement.
	2 nos minimum 10 HP submersible mono-block electric pump (KOS-1040+of Kirloskar or equivalent).	As per site requirement
	2 nos minimum 2 HP self priming dewatering pump (diesel/ electric).	As per site requirement
	2 nos minimum 1.5/ 2 HP capacity curing pump (pump for curing at heights).	As per site requirement
	3 no dozer.	Within 30 days.
	12 mm thick min ply shuttering board (Around 1000 sqm).	As per site requirement
	4 nos dumper.	Within 25 days.
	2 nos reinforcement bending machine.	As per site requirement.
	2 nos reinforcement cutting machine.	As per site requirement
	1,000 RM MS scaffolding pipe/ ACROW PIPE preferably with cup lock system.	As per site requirement
	2 nos power driven earth rammer.	As per site requirement
	1 no vibromax	As per site requirement.
	1 no minimum 200 T capacity compression testing machine.	As per site requirement
	Civil laboratory equipments as per list with temporary building one AC lab, size – 4.5 mtr x 6 mtr and 1 non-AC lab, size – 4.5 mtr x 4.5 mtr.	Within 45 days.
	2 no total station with adequate arrangement for surveyors.	Within 30 days.
	1 no theodolite 1 second accuracy.	Within 15 days.
	2 nos auto level & staff + 2 nos as required.	Within 15 days.
	125 nos concrete cube moulds.	Within 15 days.
	Adequate no of small trucks 2T/ 5T for movement within site.	Within 15 days.
	2 nos drinking water tank (Around 5000 lit capacity).	As per site requirement.
	1 nos truck mounted water tank (minimum 3000 lit) capacity with sprinkler arrangement.	As per site requirement.
	4 no minimum 10 KVA electric generator.	As per site requirement.
	10 nos concrete vibrator with adequate needle (8 nos diesel driven + 8 nos electric driven).	As per site requirement
	Portable fire extinguishers as below: Soda acid – 10 sets, Dry chemical powder – 10 sets CO2 – 5 sets, Water & sand bucket (4 buckets in one stand) – 5 sets, Fire hose with nozzle (50 m length) – 4 sets.	As per site requirement
	T&P shown in the above-mentioned list are minimum	As per site requirement

	requirement. Mobilisation schedule as mutually agreed at site for major T&Ps, have to be adhered to so as to meet the project requirement. Further requirement will be reviewed time to time at site and Bidder will provide additional T&P/ equipments to ensure completion of entire work within schedule/ target date of completion without any financial implication to BHEL. Bidder will have to give advance intimation & certification regarding capacity etc prior to dispatch of heavy equipments.	
	In the event of delay in commissioning of batching plant as per above schedule, Bidder shall arrange ready mix concrete from BHEL's approved agencies within plant premises.	As per requirement.
	All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by Bidder at Bidder's own cost in working condition.	
	In the event of non mobilisation of any T&P by Bidder and as a result progress of work suffers, BHEL reserves the right to deduct suitable amount from Bidder's dues.	
	ANY OTHER CONSUMABLE	
	1 No scanner, printer cum Xerox machine to be provided by Bidder, during the period from start of contract till completion of contract period, including extension, if any. No separate payment shall be made on this account and the accepted rate shall be inclusive of the same. These shall remain Bidder's properties and may be taken out after completion of the work. These shall be deployed at site from the 1st month onwards. In case of Xerox machine papers shall be provided by BHEL & other consumables (printer ink/ ribbon) should be provided by Bidder.	
	Deleted	
17.6	CONSTRUCTION OF TEMPORARY OFFICE, STORES ETC.	
	Bidder shall arrange at Bidder own cost cleaning and grass removing of area allotted, construction of Bidder's temporary office/ stores, cement godown, fabrication yards etc. and also the watch and ward of all the above. Materials required for the same shall be provided by Bidder at Bidder's own cost.	
	BHEL contemplates to provide land for storage yard more that one places within plant premises. However; during execution, based on actual site conditions, requirement and approaches, the above may change suitably.	
	Any damage of free supply material (PV module or tracker/MMS material) after issue of MRC to bidder will be reposibility of bidder. Bidder has to replenish the damaged items of the same make at his own cost. If any replenishment will be done by BHEL/ Owner the same will be recovered from Bidders bill with applicable overheads as per provisions of contract. Any damage to the PV Modules/ tracker/MMS system after taking over by Bidder upto the O&M period shall be responsibility of the Bidder. The Bidder shall obtain necessary insurance cover for the same. The insurance cover shall be effective from the date of delivery of the modules/ tracker/MMS system at site. For further details of the insurance may please refer the SCC.	
	In case of tracker supply, as electronics materials are very sensitive in nature, the same has to be kept in fully covered store.	
17.7	CIVIL LABORATORY	
	Bidder shall establish and maintain civil laboratory with necessary equipment as per relevant annexure to carry out following tests as listed below.	
	Compressive strength of cement, concrete cubes, bricks etc.	
	Water absorption test of bricks.	
	Earth compaction test (proctor density/ dry density and optimum moisture content, etc).	

	Conducting of test for setting time and compressive strength of cement.
	Sieve analysis of fine aggregates and coarse aggregates.
	Bulking test of fine aggregates.
	Sieve analysis, moisture content, specific gravity and crushing strength of course aggregates.
	Rapid moisture meter
	Other than above mentioned test, any testing required to be carried out at site as per Quality Plan and technical specification have to be arranged by Bidder for all the works at Bidder's own cost.
17.8	DEWATERING
	Bidder shall ensure at all times that Bidder work area & approach/ access roads are free from accumulation of water, so that the materials are safe and the erection/ progress schedule are not affected. No separate claim in this regard shall be admitted by BHEL. No separate payments for dewatering of subsoil, surface water or catchments water, if required, at any time during execution of the work including monsoon period shall be considered by BHEL.
17.9	LAND
	Land will be provided free of cost by BHEL to the extent available/ considered necessary by BHEL to Bidder for Bidder office, store, cement store, within plant premises. Availability of land within plant boundary is very limited and Bidder have to plan and use the existing land considering the use of land by other civil/ mechanical/ electrical contractors and storage of plant machineries & materials. The existing land shall be shared by all erection agencies.
	Land, as available, may be provided for labour colony within the plot boundary by BHEL/ owner. Bidder should visit the site to asses the site condition regarding feasibility of use of land for the purpose. Bidder have to construct temporary labour colony/ hutment as per Bidder requirements after obtaining approval of formalities from statutory body
	Bidder shall provide minimum 1 no overhead water tank with minmum 20 nos. tap in Bidder labour colony for drinking/ washing etc purpose. One no cemented area of suitable width, length, with tap(s) for washing purpose etc also to be provided.
	Bidder shall provide minimum 10 nos of Indian type toilet in Bidder's labour colony.
	Bidder will be responsible for handing back all lands, as handed over to him by BHEL/ owner.
17.10	WATER
	Bidders scope
17.11	ELECTRICITY
	CONSTRUCTION POWER & GENERAL ILLUMINATION NETWORK- Bidders scope
	Bidder shall make his own arrangement of electricity for labour hutment.
17.12	CONSUMABLE
	All consumables, like paint, fuel, chemicals, lubricants etc. required for the scope of work, shall be arranged by Bidder at Bidder cost unless otherwise specifically mentioned in the contract.
	All consumables to be used for the job shall have to be approved by owner/ BHEL prior to use.
	In the event of Bidder's failure to bring necessary and sufficient consumables, BHEL may arrange for the same at Bidder's risk and cost. The entire cost towards this along-with overhead shall be paid by Bidder or deducted from Bidder's bills.
17.13	TEST CERTIFICATE FOR T&P
	All T&P, lifting tackles, ramming machine, concrete accessories and other material to be deployed/ supplied by Bidder must bear valid/ latest test certificates for Bidder suitability before Bidder use/ application and the documents shall be preserved at site.
17.14	IMTE

	Bidder shall ensure deployment of reliable & calibrated instrument, measuring, and test equipment (IMTE). The IMTE shall have test calibration certificate from authorized/ Govt approved agencies. Bidder shall also keep provision of alternate engagement for such IMTE so that the work does not suffer when a particular IMTE is sent for calibration. Re-testing/ re-calibration shall also be arranged by Bidder at Bidder own cost at regular interval during the period of use as advised by BHEL.
17.15	QUALITY CONTROL & QUALITY ASSURANCE
	Bidder engineers & supervisors shall be adequately qualified and also inclined to do a quality job. The quality assurance engineer shall co-ordinate all aspects of quality control, inspection, implementation of quality assurance procedures laid down in Quality Plan and technical specification by BHEL. Bidder shall fill up quality assurance log sheets/ formats and submit to BHEL for joint inspection and acceptance. Bidder shall fill up, maintain & preserve the quality records in computerized media. BHEL's authorized representative shall be given free access at all time to such quality related records etc for inspection, review etc.
17.16	QUALITY ASSURANCE PROGRAMME
	Bidder shall arrange for suitable quality assurance programme to control all activities pertaining to the scope of work, as necessary. Such programs shall be outlined by Bidder & shall be finally accepted by BHEL. A quality assurance programme of Bidder shall generally cover the following
	Organization structure and qualification data for Bidder key personnel for the management and implementation of the proposed quality assurance programme.
	The procedure for source inspection, incoming raw material inspection, verification of material purchased etc.
	System for maintenance of records.
	GENERAL REQUIREMENTS – QUALITY ASSURANCE
	All materials, components and equipments covered under the specification shall be procured, manufactured, erected, commissioned and tested, as applicable, at all stages as per comprehensive quality assurance programme. An indicative programme for inspection/ test, to be carried out by Bidder, for some of the major items is given in the respective technical specification.
	Field quality plan will detail out the quality practices and procedures etc to be followed by Bidder site quality control organization, during various stages of site activities from receipt of material/ equipment at site.
	BHEL reserves the right to carry out quality audit and quality surveillance of the systems and procedures of Bidder's quality management. Bidder shall provide all necessary assistance to enable BHEL to carry out such audit.
	Quality audit/ approval of the results of test & inspection will not prejudice the right of BHEL to reject an equipment service not giving desired performance and shall not in no way limit Bidder's liabilities and responsibilities in earning satisfactory performances of equipment/ service as per specification.
	Repair/ rectification procedure to be adopted to make any job acceptable shall be subject to the approval of BHEL.
	All the latest relevant IS codes as per technical specification should be available with Bidder at site with in 45 days from the date of placement of LOI or otherwise specified by Construction Manager/ Project Manager, BHEL.
17.17	HEALTH, SAFETY & ENVIRONMENT
	It is imperative on Bidder's part to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social up-liftment, conversion of packing woods to school furniture, keeping good relation with local populace etc.

	Round the clock experienced paramedical personnel with first aid facility & one ambulance including driver, fuel etc, and shall be available at site, being provided by bidder's agency. The above facilities will be shared by various contractors working at site if any (actual cost will be distributed among various contractors under BHEL at site proportionally to their contract price). The subject facility will be strengthened as per the requirement during peak work progress at site. Individual contractor may co-ordinate with the supplying/ providing agency in this regard. No medical facility within/ near the site shall be provided by BHEL. In case such facility is not provided by Bidder of this tender, BHEL will recover cost as applicable. Decision of BHEL in this regard shall be final & binding on Bidder.
	No staff quarter shall be provided by BHEL.
	No borrow area for earth shall be arranged/ provided by BHEL.
	Temporary approaches for erection/ work spots under the scope of work, as required for movement of cranes, trailers, trucks, transit mixers, dumpers, etc. shall be arranged by Bidder at Bidder own cost.
	Bidder shall solely be responsible for the safety, quality, & quantity of material after it is handed over and issued to Bidder by the BHEL.
	Bidder shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. Bidder shall observe safety rules and codes applied by the BHEL at site without exception.
	Emergency vehicle must be provided & kept separately as stand-by.
	Non-conformity of safety rules and safety appliances will be viewed seriously
	Bidder shall be responsible for provision of all safety notices and safety equipment required both by the relevant legislation and BHEL, as he may deem necessary.
	BHEL shall have the right at his sole discretion to inspect any construction plant/ equipment for which material is required to be used and if in his opinion, its use is not safe, he may forbid its use. BHEL shall entertain no claim due to such prohibition and BHEL shall not entertain Bidder's any claim towards additional safety provisions/ conditions to be provided for/constructed as per the BHEL's instructions.
17.18	Further, any such decision of the BHEL shall not, in any way, absolve Bidder of Bidder responsibilities and in case, use of such an entry thereof into the site area is forbidden by the BHEL, Bidder shall use alternative methods with the approval of the BHEL without any cost implication to BHEL or extension of work schedule.
17.19	Where it is necessary to provide and/ or store petroleum products or petroleum mixtures and explosives, Bidder shall be responsible for carrying-out such provision and/ or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act, 1948, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have prior approval of the BHEL. In case, any approvals are necessary from the Chief Inspector (Explosives) or any statutory authorities, Bidder shall be responsible for obtaining the same.
17.20	All equipment used in construction and erection by Bidder shall meet Indian/ International Standards and where such standards do not exist, Bidder shall ensure these to be absolutely safe. All equipments shall be strictly operated and maintained by Bidder in accordance with manufacturer's operation Manual and safety instructions and as per Guidelines/ rules of BHEL in this regard.
17.21	Periodical examinations and all tests for all lifting/ hoisting equipment & tackles shall be carried-out in accordance with relevant provisions of Factories Act 1948, Indian Electricity Act 1910 and associated laws/ rules in force from time to time. A register of such examinations & tests shall be properly maintained by Bidder and will be promptly produced as & when desired by BHEL or by the person authorized.
17.22	Bidder shall provide suitable safety equipment of prescribed standard to all employees and workmen according to the need, as may be directed by BHEL who will also have right to examine these safety equipments to determine their suitability, reliability, acceptability and adaptability.

17.23	Where explosives are to be used, the same shall be used under the direct control and supervision of an expert, experienced, qualified and competent person strictly in accordance with the Code of Practices/ Rules framed under Indian Explosives Act pertaining to handling, storage and use of explosives.
17.24	Bidder shall provide safe working conditions to all workmen and employees at the Site including safe means of access, railings, stairs, ladders, scaffoldings etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent person. For erection, Bidder only shall use good and standard quality of material.
17.25	No repair work shall be carried out on any live equipment. BHEL must declare the equipment safe and a permit to work shall be issued by BHEL before Bidder carry out any repair work. While working on electric lines/ equipments whether live or dead, suitable type and sufficient quantity of tools will have to be provided by Bidder to electricians/ workmen/ officers.
17.26	Bidder shall employ necessary number of qualified, full time electricians/ electrical supervisors to maintain Bidder temporary electrical installations.
17.27	Bidder shall employ trained safety officer to supervise day to day safety aspects of the equipments and workmen, who will co-ordinate with BHEL safety officer. In case of work being carried out through sub-contractors, sub-contractor's workmen/ employees will also be considered as Bidder's employees/ workmen for the above purpose.
17.28	The name and address of Bidder safety officer will be promptly informed in writing to BHEL with a copy to safety officer-In charge before he starts work or immediately after any change of the incumbent is made during currency of contract.
17.29	In case any accident occurs during the construction/ erection or other associated activities undertaken by Bidder thereby causing any minor or major or fatal injury to Bidder's employees due to any reason, whatsoever, it shall be Bidder's responsibility to promptly inform the same to BHEL in prescribed form and also to all the authorities envisaged under the applicable laws.
17.30	BHEL shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and/ or property, and/ or equipments. In such cases, Bidder shall be informed in writing about the nature of hazards and possible injury/ accident and Bidder shall comply to remove shortcomings promptly.
17.31	Bidder shall not be entitled for any damages/ compensation for stoppage of work due to safety reasons above and the period of such stoppage of work will not be taken as an extension of time for completion of the facilities and will not be the ground for waiver of levy of penalty.
17.32	Bidder shall follow and comply with all safety rules of BHEL, relevant provisions of applicable laws pertaining to the safety of workmen, employees' plant and equipment as may be prescribed from time to time without any demur, protest or contest or reservation. In case of any inconformity between statutory requirement and Safety Rules of BHEL referred above, the later shall be binding on Bidder unless the statutory provisions are more stringent.
17.33	In case BHEL is made to pay such compensation then Bidder is liable to reimburse BHEL such amount in addition to compensation indicated above.
17.34	These insurance covers have to be taken prior to start of Bidder work at subject project and he shall make available the Policy to Construction Manager, BHEL for necessary verification before commencement of work. However, irrespective of such verification/ acceptance, sole responsibility to maintain adequate insurance cover for Bidder's workmen, T&P, assets etc all times during the period of contract shall lie with Bidder. Regarding the aforesaid insurance cover, Bidder shall directly deal with Insurance Company for all matters regarding the insurance in Bidder's scope.

17.35	If Bidder do not take all safety precautions and/or fails to comply with the Safety Rules as prescribed by BHEL or under the applicable law for the safety of the equipment and plant and for the safety of personnel and Bidder do not prevent hazardous conditions which cause injury to Bidder's own employees or employees of other contractors, or BHEL's employees or any other person who are at site or adjacent thereto, Bidder shall be responsible for payment of compensation to employer as per amount mentioned in tender document.
17.36	SPECIFIC REQUIREMENTS FOR ISO 9002
	Bidder shall ensure that all Bidder's staff/ employees are exposed to periodical training programmes conducted by qualified agencies/ personnel on ISO 9002 Standards.
	Bidder shall ensure that the quality is maintained in all the works connected with this contract at all stages of the requirement of BHEL.
	Bidder shall ensure that all Inspection, Measuring and Testing equipment that are used, whether owned by Bidder or used on loan, are calibrated by the authorized agencies and the valid calibration certificate will be available with them for verification by BHEL. A list of such instruments possessed by Bidder at site with its calibration status is to be submitted to BHEL Engineer for control.
	Bidder shall ensure that fitness certificate of the tools & plants, that are in use, whether owned by Bidder or issued on loan, are tested by authorised agency and the valid fitness certificate is available for verification by BHEL.
	Bidder shall arrange for the inspection of the works at various stages as required by BHEL. Bidder shall take immediate corrective action for the non-conformances if any, observed and pointed out by BHEL.
17.37	GENERAL TECHNICAL REQUIREMENTS (CODES AND STANDARDS)
	Except where otherwise specified, the plant/ equipment shall comply with appropriate Indian Standard or an agreed internationally accepted Standard Specification as mentioned elsewhere in tender, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, Bidder shall give all particulars and details as necessary; to enable BHEL to identify all of the plant/ equipment in the same detail as would be possible had there been a standard specification.
	Where Bidder propose alternative codes or standards Bidder shall include in Bidder's tender one copy (in English) of each standard specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.
	In the event of any conflict between the codes & standards referred above, and requirements of this specification, the requirements which are more stringent shall govern.
	Tools used during erection and commissioning/ completion shall not be accepted except with the specific approval of the engineer.
	Wherever specified or required the plant/ equipment shall conform to various statutory regulations such as Indian govt Regulation, Indian Electricity Rules, Indian Explosive Act, Factories Act etc, wherever required, obtaining approval for plant/ equipment supplied under the specification from statutory authorities shall be Bidder's responsibility.
17.38	GENERAL SERVICES TO BE RENDERED BY BIDDER
	Services for construction, erection, testing, commissioning/ completion & accessories/ items under the contract shall include but not be limited to the following.
	Bidder shall be the custodian of all the materials issued till the plant/ equipment is officially taken over by the owner/ BHEL after complete erection and commissioning/ completion. Bidder shall maintain adequate security personnel and security measures for proper precaution and safety of material.
	Deployment of all skilled and unskilled manpower required for erection supervision, watch & ward, for commissioning/ completion and other services to be rendered under this specification.

	Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under scope of this specification except otherwise specified.
	Supply of all consumables, etc as well as materials required for temporary supports, scaffolding etc as necessary for such construction work, unless specified other wise.
	Providing support services for Bidder erection staff eg construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, watch and ward for security and safety of the materials under Bidder's custody etc, as required.
	Maintaining proper documentation of all site activities undertaken by Bidder as per the proforma mutually agreed with BHEL, submitting monthly progress reports as also any such document as and when desired by BHEL/ owner, taking approval of all statutory authorities eg, Factory Inspector, Provident Fund authority etc. for respective portions of work under the jurisdiction of such statutes of laws.
	As part of overall project management activity, Bidder shall be responsible for proper co-ordination of erection activities during various phases of execution of the contract. Bidder shall identify a person designated as construction manager, with whom BHEL shall interact on matters related to execution of the contract. The construction manager shall be the single point contact person on Bidder's behalf. BHEL shall interact with the construction manager only on all matters on co-ordination between BHEL and Bidder. For timely completion of work Bidder may have to work in one or more shifts. Bidder will not be eligible for any extra charge on this account.
	Bidder shall confine all Bidder field operations to those works which can be reformed without subjecting the equipment and materials to adverse effects, during inclement weather conditions, like monsoon, storms etc and during other unfavourable construction conditions. No field activities shall be performed by Bidder under conditions which might adversely affect the quality and efficiency thereof, unless special precautions or measures are taken by Bidder in proper and satisfactory manner in the performance of such works and with the concurrence of the engineer. Such unfavourable construction conditions in no way relieve Bidder of Bidder responsibility to perform the works as per the schedule.
	Bidder shall supply all the skilled workmen like mill-wright fitters, surveyor, erection manpower, electricians, riggers, sarangs, erectors, carpenters, pipe fitters, masons, ladders, tin-smiths, instrument machanics etc, in addition to other skilled, semi-skilled and unskilled workmen required for all works of handling and transportation from site store to erection site, erection, testing and commissioning/ completion contemplated under this specification. Only fully trained and competent men with previous experience on the job shall be employed. They shall hold valid certificates wherever necessary. BHEL reserve the right to decide on the suitability of the workers and the other personnel who will be employed by Bidder. BHEL reserves the right to insist on removal of Bidder's any employee at any time, if they find him unsuitable and Bidder shall forthwith remove him.
	The supervisory staff employed by Bidder shall be technically qualified and experienced in the area of work. They shall ensure proper out turn of work and discipline on the part of labour put on the job by Bidder and in general see that the works are carried out in a safe and proper manner and in coordination with other labour and staff employed directly by BHEL or other contractors of BHEL and BHEL's client.
	Bidder shall also furnish daily labour report showing by classification the number of employees engaged in various categories of work a progress report of work as required by BHEL engineer.
	The work shall be executed under the usual conditions affecting major power plant construction and in conjunction with numerous other operations at site. Bidder and Bidder's personnel shall co-operate with other personnel, and other contractors, co-ordinating Bidder work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

	Bidder supervisory staff shall execute the work in the most substantial and workman like manner in the stipulated time. Accuracy of work and aesthetic finish are essential part of this contract. Bidder shall be responsible to ensure that assembly and workmanship conform to the dimensions and tolerance given in the drawing/ instruction given by BHEL Engineer from time to time.
	It is Bidder responsibility to engage Bidder workman in shifts or on overtime basis for achieving the target set by BHEL during erection, commissioning/ completion and testing period. Bidder accepted rate shall include all these contingencies.
	Any other service, although not specifically called for but required for a contract of the size and nature indicated in the specification.
17.39	GENERAL GUIDELINES FOR FIELD ACTIVITIES
	Bidder shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.
	Bidder shall co-operate with owner/ BHEL and other contractors working in site and arrange to perform his work in a manner so as to minimise interference with other contractor's works. BHEL's engineer shall be notified promptly of any defect in other contractors' works that could affect Bidder work. If Bidder's rescheduling work is requested by the owner's/ BHEL's engineer in the interest of overall site activities, the same shall be complied with by Bidder. In all cases of controversy, the decision of BHEL shall be final and binding on Bidder without any commercial implication.
	The engineer shall hold weekly meeting of all the contractors working at site at a time and a place to be designated by the engineer. Bidder shall attend such meetings and take notes of discussions during the meeting and the decisions of the engineer and shall strictly adhere to those decisions in performing this work. In addition to the above weekly meeting, engineer may call for other meetings either with individual contractors or with Bidder's selected number and in such a case Bidder, if called will also attend such meetings.
	Time is the essence of the contract and Bidder shall be responsible for performance of Bidder's work in accordance with the specified construction schedule. If at any time Bidder are falling behind the schedule, Bidder shall take necessary action to make good of such delays by increasing Bidder work to comply with the schedule and shall communicate such action in writing to the engineer, satisfying that his action will compensate for the delay. Bidder shall not be allowed any extra compensation for such action.
	BHEL shall however not be responsible for any statutory/ legal or any other issues arising due to deployment of additional labour or materials or supply of any other services to Bidder.
	The works under execution shall be open to inspection & supervision by BHEL's/ Owner's engineer at all times. Bidder shall give reasonable notice to BHEL before covering up or otherwise placing beyond the reach of inspection any work, in order that same may be verified, if so desired by owner/ BHEL.
	Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents the same shall be brought to the notice of BHEL's engineer, Manufacturer's interpretation in such cases shall be binding on Bidder.
	Bidder shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. All registration and statutory inspection fees, if any, in respect of the work executed by Bidder shall be in Bidder's account.

	All the works such as cleaning, checking, levelling, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipment for checking and erection of MMS as per general engineering practice at site, cutting, grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up, bolting/ welding, etc as may be applicable in such erection and necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by Bidder as part of the work.
	It is Bidder's responsibility to do the MMS/tracker system alignment etc if necessary, repeatedly to satisfy engineer, with all the necessary tools & tackles, manpower etc. The alignment will be complete only when jointly certified so, by Bidder engineer and MMS representative/ BHEL. Also, Bidder should ensure that the alignment is not disturbed afterwards.
	Equipment and material, in case wrongly installed, shall be removed and reinstalled to comply with the design requirement at Bidder expense, to the satisfaction of BHEL/ owner.
	After identification of erection materials by BHEL, it shall be Bidder responsibility to take delivery of materials from supplied vehicle/ storage yard by Bidder's own manpower and re-stack the leftover materials as per erection sequence at store at Bidder own cost. The entire activities are to be carried out under supervision of BHEL's engineer.
17.40	PROJECT MANAGEMENT/ CONSTRUCTION MANAGEMENT
	To meet the need of construction management at site, Bidder shall provide the following services within accepted rates.
	PLANNING & MONITORING
	Bidder shall prepare detail construction schedule (L-3) in consultation with Construction Manager, BHEL as per completion/ milestone schedule of the project. This schedule must include all milestone and key activities for each sub-systems/ component in the areas of engineering (wherever applicable), procurement, manufacture (wherever applicable), excavation/ construction/ erection. This network must conform to following overall project schedule. However, further micro break-up of schedule based on major milestone schedule shall be drawn at site prior to start of work. Bidder should also ensure monitoring of these activities at least weekly basis to start with and on daily basis whenever required by BHEL. The project schedule might undergo revision/ modification periodically, for which Bidder may have to prepare/ modify construction schedule periodically in consultation with BHEL.
	Bidder shall also prepare progress report indicating progress on key activities, management summary for critical activities, list of actions requiring attention of BHEL. This schedule is to be preferably made in PRIMAVERA/ MS PROJECTS, so that the same is compatible with BHEL's project management software.
	Bidder site office must have facilities of communications like Fax, E-mail, and telephone with STD facility within a month from LOI.
	PROGRESS REPORTING
	Bidder shall submit daily, weekly and monthly progress reports for work force, materials reports, consumables report and other reports as per pro-forma considered necessary by the BHEL. In case of any failure on Bidder's part to comply with this, BHEL may at its discretion, consider to withhold part payment against Bidder's RA bills.
	The progress report shall indicate the progress achieved against planned with reasons indicating delays, if any, and shall give the remedial actions which Bidder intends to take to make good the slippage or lost time, so that further works again proceed as per the original program and the slippages do not accumulate and effect the overall program.
	The daily work force reports shall clearly indicate the work force deployed, category-wise specifying also the activities in which they are engaged.

	Weekly progress review meetings will be held at site/VC during which actual progress during the week vis-à-vis scheduled program shall be discussed or actions to be taken for achieving targets. For discussions, Bidder shall present program of subsequent week. Bidder shall constantly update/ revise Bidder's work program to meet the overall requirement.
	Periodic progress reviews on the entire activities of execution in respect of supply and works in Bidder's scope will be held once in a month at Bangalore/ VC/ site. These meetings will be attended by Bidder reasonably higher officials and will be used as a forum for discussing all areas where progress needs to be expedited. Bidder shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.
	During construction Bidder shall take an average forty colour digital photograph/ slides (indicating date) each month (not less than nine per week) of the works during progress..
	Bidder have to provide for electronic/ computerized storing and re-production/ printing/ plotting of various data, log sheets, protocols, measurements etc. These may be stored in CD (as per requirement) and handed over to BHEL as per requirement.
	SITE ORGANIZATION
	Bidder shall maintain a site organization of adequate strength in respect of manpower, construction machinery and other implements at all time for smooth execution of the contract headed by a competent construction manager for site operations with sufficient level of authority to take site decisions. Bidder will submit organization chart (showing the name of Site-in-Charge) with individual bio-data indicating various levels of experts to be posted for supervision in the fields of supervision and execution, quality, material management, planning, safety, etc. The organization shall be reinforced from time to time, as required to make up slippage (if any) from schedule without any commercial implication to BHEL. The organization chart is to be submitted within 10 days from the date of LOI.
17.41	CONSTRUCTION MANAGEMENT
	Based on the approved program, Bidder shall submit a program of construction/ erection/ commissioning for the implementation. These programs would be amplified showing start of erection and subsequent activities and shall form the basis for site execution and detail monitoring. The three-monthly rolling program with the first month's program being tentative based on the site condition would be prepared based on these programs. Bidder shall also be involved along with owner/ BHEL to tie up detailed resources mobilization plan over the period of the contract matching with the performance targets.
	The program would be jointly finalized by Bidder's site in-charge with BHEL/ owner's project coordinator as well as the site-planning representative. The erection program will also identify sequential events matching financial turnover.
	Bidder are liable to furnish all documentary evidences towards payment of Works Contract Tax as and when required by BHEL.
17.42	HEALTH SAFETY & ENVIRONMENT
	It is imperative on Bidder's part to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social up-liftment, conversion of packing woods to school furniture, keeping good relation with local populace etc.
	Round the clock experienced paramedical personnel with first aid facility & one ambulance at site to be arranged by Bidder at Bidder's own cost. No medical facility within/ near the site shall be provided by BHEL. However, BHEL/ owner shall provide one room (without furniture) for use as first aid.
	No staff quarter shall be provided by BHEL.
	No borrow area for earth shall be arranged/ provided by BHEL.
	All individual site erection, temporary approaches required for movement of cranes, trailers, trucks, transit mixers, dumpers, etc shall be arranged by Bidder at Bidder's own cost.
	Bidder shall solely be responsible for the safety, quality, & quantity of material after it is handed over and issued to Bidder by the BHEL.

17.43	DESIGN OFFICE AND FABRICATION DRAWING
	As engineering is in the scope of bidder, design & drawings are to be submitted in speedy manner to enable BHEL to get approval from Owner. Bidder will prepare & submit within 15 days of receipt, the design, detail fabrication/ shop drawing including tabulated form of bill of materials (BOM), joint calculations, for comments/ approval of BHEL at the office of BHEL/ Owner. BHEL reserves the right to assess the capability of the agency to be deployed by Bidder for preparation of such design document/ drawing, and prior approval from BHEL Engineering office at Bangalore, is required for appointment of such agency. Bidders design engineer has to be sent to BHEL or owner's design office for approval of drawing/document if any. No payment will be made separately for the above.
	Since time is the essence of the contract, Bidder must indicate the location of Bidder's design office where from such detailed activities will be made operative.
	Bidder shall submit progress report pertaining to engineering design & drawing, by 7th of each month, drawing-wise, section-wise cumulative bill of materials for which engineering drawing has been issued to them and status of engineering design & drawing. 5 set of Hard copy (BHEL site +owner site +documentation+bidder-site & office) drawing to be made available with BHEL & owner's reference at site
17.44	EXECUTION OF CONTRACT AGREEMENT
	Bidder's responsibility under this contract commences from the date of issue of the Letter of Intent by Bharat Heavy Electricals Limited. Bidder shall submit an unqualified acceptance to the Letter of Intent/ Award within the period stipulated therein. Bidder shall be required to execute an agreement in the prescribed form, with BHEL, within a reasonable time after the acceptance of the Letter of Intent/ Award, and in any case before releasing the first running bill. The contract agreement shall be signed by a person duly authorized/ empowered by Bidder.
17.45	OTHER POINTS
	While Bidder scope include deplyment of all resources, like T&P, materials, consumables, manpower including supervision etc for proper completion of the subject job and no sub-contracting for execution of the job is allowed by BHEL, depending on project's requirement and on prior acceptance of BHEL, Bidder may associate agencies for deployment of skilled/ unskileld manpower only for site execution. Bidder should arrange all resources, like T&P, materials, consumables, supervision etc directly for the subject job.
	Drawings issued, if any, are for tender purpose only. No additional financial implication will be entertained by BHEL at a later date on account any alteration to this.
	In addition to prevalent statutory laws, act, etc, Bidder shall also consider of statutory guidelines regarding The Building and Other Construction Workers (Regulation of Employment & Condition of Service) Act, 1996 along with associated Central/ State Govt Rules.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;"> PART-B G – ERECTION CONDITIONS OF CONTRACT </p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>G-1 ERECTION CONDITIONS OF CONTRACT</p> <p>1.0</p> <p>GENERAL</p> <p>The following provisions shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work of this contract which is to be performed at site. The erection requirements and procedures not specified in these documents shall be in accordance with the recommendations of the equipment manufacturer, or as mutually agreed to between the Employer and the Contractor prior to commencement of erection work.</p> <p>The Contractor upon signing of the Contract shall, in addition to a Project Coordinator, nominate another responsible officer as his representative at Site suitably designated for the purpose of overall responsibility and co-ordination of the Works to be performed at Site. Such a person shall function from the Site office of the Contractor during the pendency of Contract.</p> <p>2.0</p> <p>CODE REQUIREMENTS</p> <p>The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Government of India Rules & Codes, accepted good practices in the industry and shall fulfill all statutory requirements.</p> <p>3.0</p> <p>ELECTRICAL SAFETY REGULATIONS</p> <p>The contractor shall ensure that entire electrical installation work is executed by adopting applicable statutory safety regulations and best practices in the industry. The Contractor shall employ the necessary number of qualified, full time electricians to maintain his temporary electrical installation.</p> <p>4.0</p> <p>INSPECTION AND TESTING INSPECTION CERTIFICATES</p> <p>The provisions of the clause entitled Inspection and Testing in the Technical Specification, shall also be applicable to the erection portion of the Works. The Employer shall have the right to re-inspect any equipment though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Employer rejects any equipment, the Contractor shall make good for such rejections either by replacement or modification/ repairs as may be necessary to the satisfaction of the Employer. Such replacements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
5.0	<p>CONTRACTOR'S SITE OFFICE ESTABLISHMENT</p> <p>The Contractor shall establish an Office at the Site and keep posted an authorized representative for the purpose of the Contract. Any written order or instruction of the Employer or his duly authorized representative shall be communicated to the said authorized resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.</p>
6.0	<p>CONTRACTOR'S FIELD OPERATION</p> <p>The Contractor shall keep the Employer informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the Employer shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the Employer or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.</p> <p>The Contractor shall have the complete responsibility for the conditions of the Work-Site including the safety of all persons employed by him or his Sub-Contractor and all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the Employer is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.</p>
7.0	<p>PROTECTION OF WORK</p> <p>The Contractor shall have total responsibility for protecting his works till it is finally taken over by the Employer. No claim will be entertained by the Employer or the representative of the Employer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because of any other agency/individual not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.</p>
8.0	<p>FACILITIES TO BE PROVIDED BY THE CONTRACTOR</p>
8.1	<p>Contractor's site office Establishment</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract.</p>
8.2	<p>Tools, tackles, and scaffoldings</p> <p>The Contractor shall provide all the construction equipment, tools, tackles, and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipment covered under the Contract. The Contractor shall arrange machinery & equipment such as Dozer, Hydra, Cranes, Trailer, etc. wherever required for the purpose of fabrication, erection, and commissioning.</p>
8.3	<p>Testing Equipment and Facilities:</p> <p>The contractor shall provide the necessary testing equipment and facilities.</p>
8.4	<p>Testing of construction material at the site:</p> <p>Contractor shall make arrangements for the testing of construction material at the site wherever required, under the scope of services of the contract.</p>
8.5	<p>First-aid</p> <p>The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.</p>
8.6	<p>Water</p> <p>Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite/colony.</p>
9.0	<p>FIRE PROTECTION</p> <p>The work procedures that are to be used during the erection shall be those which minimize fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site regularly. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.</p> <p>All materials used for storage or for handling of materials shall be of water proof and flame resistant type. All the other materials such as working drawings, plans etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.</p> <p>The Contractor shall provide suitable quantity & type fire protection equipment for the warehouses, office, temporary structures etc.</p>
10.0	SECURITY
	<p>The Contractor shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss.</p>
11.0	PACKAGING AND TRANSPORTATION
	<p>All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling, and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.</p> <p>12.0 CRATING</p> <p>All equipment and materials shall be suitably coated, wrapped, or covered and boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.</p> <p>Equipment shall be packed with suitable desiccants, sealed in water proof vapour-proof wrapping and packed in lumber of plywood enclosures, suitably braced, tied and skidded. Lumber enclosures shall be solid, not slatted.</p> <p>Desiccants shall be either silica gel or calcium sulphate, sufficiently ground to provide the required surface area and activated prior to placing in the packaging. Calcium sulphate desiccants shall be of a chemical nature to absorb moisture. In any case, the desiccant shall not be of a type that will absorb enough moisture to go into solution. Desiccants shall be packed in porous containers, strong enough to withstand handling encountered during normal shipment. Enough desiccant shall be used for the volumes enclosed in wrapping.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Packaging or shipping units shall be designed within the limitations of unloading facilities and the equipment which will be used for transport. Complications involved with ocean shipment and the limitations of ports, railways and roads shall be considered. It shall be the Contractor's responsibility to investigate these limitations and to provide suitable packaging to permit safe handling during transit and at the job site.</p> <p>Electrical equipment, control and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearing and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.</p> <p>Equipment having antifriction or sleeve bearings shall be protected by weather tight enclosures.</p> <p>Coated surfaces shall be protected against impact, abrasion, discolouration and other damage. Surfaces which are damaged shall be repaired.</p> <p>All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors. All female threaded openings shall be closed with forged steel plugs. All pipings, tubing, and conduit equipment and other equipment openings shall be sealed with metallic or other rough usage covers and tapped to seal the interior of the equipment piping, tubing, or conduit.</p> <p>Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.</p> <p>Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.</p> <p>While packaging the material, care shall be taken for the limitation from the point of view of availability of railway wagon sizes in India.</p>
13.0	MATERIALS HANDLING AND STORAGE
13.1	All the equipment furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage spaces by the Contractor.
13.2	Contractor shall be solely responsible for any shortages or damage in transit, handling and / or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
13.3	The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time to avoid damage of such equipment at Site.

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13.4	All electrical panels, controls gear, motors and such other devices shall be properly dried by heating before they are installed and energised. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.
13.5	All the electrical equipment such as motors, etc. shall be periodically tested for insulation resistance from the date of receipt till the date of commissioning and a record of such measured insulation values maintained by the Contractor. Such records shall be open for inspection by the Employer.
13.6	The Contractor shall ensure that all the packing materials and protection devices used for the various equipment during transit and storage are removed before the equipment are installed.
13.7	The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.
13.8	All the materials stored in the open or dusty location must be covered with suitable weatherproof and flameproof covering material wherever applicable.
14.0	<p>CONSTRUCTION MANAGEMENT</p> <p>Contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Employer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.</p> <p>The Employer shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor.</p>
15.0	<p>FIELD OFFICE RECORDS</p> <p>The Contractor shall maintain at his Site Office up-to- date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be available for inspection & review to the Employer.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
16.0	PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY
16.1	The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection of all persons including members of public and employees of the Employer and his own employees and all public and private property including structures, building, other plants and equipment and utilities either above or below the ground.
16.2	The Contractor will ensure provision of necessary safety equipment such as barriers, sign - boards, warning lights and alarms, etc. to provide adequate protection to persons and property.
17.0	PAINTING All exposed metal parts of the equipment including pipings, structure railings, etc. wherever applicable, after installation unless otherwise surface protected, shall be first painted in accordance with relevant codes & standards, after thoroughly cleaning all such parts of all dirt, rust, scales, greases, oils and other foreign materials by wire brushing, scraping or sand blasting.
18.0	UNFAVOURABLE WORKING CONDITIONS The Contractor shall confine all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects during inclement weather conditions, like monsoon, storms, etc. and during other unfavourable construction conditions. No field activities shall be performed by the Contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precautions or measures are taken by the Contractor in a proper and satisfactory manner in the performance of such Works and with the concurrence of the Employer. Such unfavourable construction conditions will in no way relieve the Contractor of his responsibility to perform the Works as per the schedule.
19.0	PROTECTION OF MONUMENTS AND REFERENCE POINTS The Contractor shall ensure that any finds such as relic, antiquity, coins, fossils, etc. which he may come across during the course of performance of his Works either during excavation or elsewhere, are properly protected and handed over to the Employer.
20.0	FOUNDATION DRESSING & GROUTING FOR EQUIPMENT/ EQUIPMENT BASES The surfaces of foundations shall be dressed to bring the top surface of the foundations to the required level, prior to placement of equipment/equipment bases on the foundations. All the equipment/ equipment bases shall be grouted and finished as per these specifications unless otherwise recommended by the equipment manufacturer.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>21.0</p> <p>22.0</p> <p>23.0</p>	<p>SHAFT ALIGNMENTS</p> <p>All the shafts of rotating equipment shall be properly aligned to those of the matching equipment to as perfect accuracy as practicable. The equipment shall be free from excessive vibration to avoid overheating of bearings or other conditions which may tend to shorten the life of the equipment. The vibration level of rotating equipment measured at bearing housing shall conform to VDI 2056. All bearings, shafts and other rotating parts shall be thoroughly cleaned and suitably lubricated before starting.</p> <p>DOWELLING</p> <p>All the motors and other equipment shall be suitably doweled after alignment of shafts with tapered machined dowels as per the direction of the Employer.</p> <p>CABLING</p> <p>All cables shall be supported by conduits or cable tray run in air or in cable channels. These shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turn made of symmetrical bends or fittings. When cables are run on cable trays, they shall be clamped at a minimum intervals of 2000mm.</p> <p>Each cable, whether power or control, shall be provided with a metallic or plastic tag of an approved type, bearing a cable reference number indicated in the cable and conduit list (prepared by the Contractor), at every 5 meter run or part thereof and at both ends of the cable adjacent to the terminations. Cable routing is to be done in such a way that cables are accessible for any maintenance and for easy identification.</p> <p>Sharp bending and kinking of cables shall be avoided. Installation of other cables like high voltage, coaxial, screened, compensating, mineral insulated shall be in accordance with the cable manufacturer's recommendations. Wherever cables cross roads and water, oil, sewage or gas lines, special care should be taken for the protection of the cables in designing the cable channels.</p> <p>In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop fault at a later date.</p> <p>Control cable terminations shall be made in accordance with wiring diagrams, using identifying codes subject to the Employer's approval. Multicore control cable jackets shall be removed as required to train and terminate the conductors. The cable jacket shall be left on the cable, as far as possible, to the point of the first conductor branch. The insulated conductors from which the jacket is removed shall be neatly twined in bundles and terminated. The bundles shall be firmly but not tightly tied utilizing plastic or nylon ties or specifically treated fungus protected cord made for this purpose. Control cable conductor insulation shall be securely and evenly cut.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
<p>24.0</p> <p>A)</p> <p>B)</p> <p>C)</p> <p>D)</p> <p>E)</p>	<p>The connectors for control cables shall be covered with a transparent insulating sleeve so as to prevent accidental contact with ground or adjacent terminals and shall preferably terminate in Elmex terminals and washers. The insulating sleeve shall be fire resistant and shall be long enough to over pass the conductor insulation. All control cables shall be fanned out and connection made to terminal blocks and test equipment for proper operation before cables are corded together.</p> <p>EQUIPMENT INSTALLATION</p> <p>GENERAL REQUIREMENTS</p> <p>The Contractor shall furnish all construction materials, tools and equipment and shall perform all work required for complete installation of all control and instrument equipment furnished under this specification.</p> <p>Contractor shall prepare detailed installation drawings for each equipment furnished under this specification. Installation of all equipment/systems furnished by this specification shall be as per installation drawings.</p> <p>Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. The procedures shall be acceptable to the Employer.</p> <p>The Contractor shall coordinate his work with other suppliers where their instruments and devices are to be installed under specifications.</p> <p>INSTALLATION MATERIALS</p> <p>All materials required for installation, testing and commissioning of the equipment shall be furnished by the Contractor.</p> <p>REGULATORY REQUIREMENTS</p> <p>All installation procedures shall confirm with the accepted good engineering practice and with all applicable governmental laws, regulations and codes.</p> <p>CLEANING</p> <p>All equipment shall be cleaned of all sand, dirt and other foreign materials immediately after removal from storage and before the equipment is installed.</p> <p>INSTALLATION OF FIELD MOUNTED INSTRUMENTS/DEVICES AND NON-FREE</p> <p>Standing Equipment</p> <p>The installation drawings for all field mounted equipment/instrument/devices furnished under this specification shall meet the requirements of this specification, applicable codes and standards and recommendations of manufacturers of</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>instruments/devices. In addition to above relevant Portion as specified elsewhere in technical specification may be referred.</p> <p>Field mounted instruments and accessories shall be bracket or sub panel mounted on the nearest suitable firm steel work or masonry. The brackets, stands, supports and other miscellaneous hardware required for mounting instruments and accessories such as receiver gauge, air set, valve manifold, purge-meter etc. shall be furnished and installed. No field mounted instruments shall be installed such that it depends for support or rigidity on the impulse piping or on electrical connection to it.</p> <p>All free standing instrumentation cabinets and panels shall be located within the construction tolerances of +/- 3 mm of the location dimensions indicated on the plant arrangement drawings.</p> <p>Non-free standing local enclosures and cabinets shall be mounted in accessible locations on columns, walls, or stands. Bracket and stands shall be fabricated as required to install the local enclosures and cabinets in a workman like manner. Rough edges and welds on all fabricated supports shall be ground smooth. The supports shall be finished with two coats of primer and two coats of paint as specified in this part.</p> <p>F) DEFECTS</p> <p>All defects in erection shall be corrected to the satisfaction of the Employer and the Project Manager. The dismantling and reassembly of Contractor furnished equipment to remove defective parts, replace parts, or make adjustments shall be included as a part of the work under these specifications.</p> <p>The removal of control and instrument equipment in order to allow bench calibration, if required, and the re-installation of the said equipment after calibration shall also be included as a part of the work under these specifications.</p> <p>G) EQUIPMENT PROTECTION</p> <p>All equipment to be erected under these specifications shall be protected from damage of any kind from the time of contract award until commissioning of each unit.</p> <p>The equipment shall be protected during storage as described herein.</p> <p>Equipment shall be protected from weld spatter during construction.</p> <p>Suitable guards shall be provided for protection of personnel on all exposed rotating or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy removal and maintenance.</p> <p>Equipment having glass components such as gauges, or equipment having other easily breakable components, shall be protected during the construction period with plywood enclosures or other suitable means. Broken, stolen, or lost components shall be replaced by the Contractor.</p>

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<p>25.0</p>	<p>Machine finished surfaces, polished surfaces, or other bare metal surfaces which are not to be painted, such as machinery shafts and couplings shall be provided temporary protection during storage and constructional periods by a coating of a suitable non- drying, oily type, rust preventive compound.</p> <p>DEVIATIONS DISPOSITIONING:</p> <p>Any deviation to the contract and employer approved documents shall be properly recorded in the format prescribed by END CUSTOMER. All the deviations shall to the knowledge of employer's representative for suitable dispositioning.</p>
<p>26.0</p>	<p>STATUTORY REQUIREMENTS</p> <p>In addition to the local laws and regulations, the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract.</p> <p>All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of any statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees for such inspection and/or registration shall be borne by the Contractor.</p>
<p>27.0</p>	<p>EMPLOYMENT OF LABOUR</p> <p>In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the Contractor , the Contractor will be expected to employ on the work only his regular skilled employees with experience of the particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.</p> <p>All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.</p> <p>In case the Employer becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contract Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the Employer may make such payments and shall recover the same from the Contractor's Bills.</p>
<p>28.0</p>	<p>WORK & SAFETY REGULATIONS</p> <p>The Contractor shall ensure proper safety of all the workmen, materials, plant and equipment belonging to him or to Employer or to others, working at the Site. The</p>

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	<p>Contractor shall also be responsible for provision of all safety notices and safety equipment required both by the relevant legislation and the Employer as he may deem necessary.</p> <p>Where it is necessary to provide and/or store petroleum products or petroleum mixtures and explosives, the contractor shall be responsible for carrying-out such provision and/or storage in accordance with the rules and regulations laid down in petroleum act 1934, explosives act, 1948, and petroleum and carbide of calcium manual published by the chief inspector of explosives of India. All such storage shall have prior approval of the employer. In case, any approvals are necessary from the chief inspector (explosives) or any statutory authorities, the contractor shall be responsible for obtaining the same.</p> <p>Where explosives are to be used, the same shall be used under the direct control and supervision of an expert, experienced, qualified and competent person strictly in accordance with the Code of Practices/Rules framed under Indian Explosives Act pertaining to handling, storage and use of explosives.</p> <p>All equipment used in construction and erection by Contractor shall meet Indian/International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All construction and erection equipment shall be strictly operated and maintained by the Contractor in accordance with statutory safety regulations. Periodical Examinations and all tests for all lifting/ hoisting equipment & tackles shall be carried-out in accordance with the relevant provisions of Factories Act 1948, Indian Electricity Act 1910 and associated Laws/Rules in force from time to time.</p> <p>The Contractor shall provide suitable safety equipment of prescribed standard to all employees and workmen according to the need, as may be directed by Employer who will also have right to examine these safety equipments to determine their suitability, reliability, acceptability and adaptability.</p> <p>(a) Working platforms should be fenced and shall have means of access.</p> <p>(b) Ladders in accordance with statutory safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.</p> <p>The Contractor shall provide safe working conditions to all workmen and employees at the Site including safe means of access, railings, stairs, ladders, scaffoldings etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent person. For erection, good and standard quality of material only shall be used by the Contractor.</p> <p>The Contractor employing workmen whether temporary, casual, probationer, regular or permanent or on contract, shall employ at least one full time officer exclusively as Safety Steward to supervise safety aspects of the equipment and workmen, who will co- ordinate with the Employer's Safety Officer. In case of work being carried out through sub-Contractors, the Sub-Contractor's workmen/employees will also be considered as the Contractor's employees/workmen for the above purpose</p>

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	<p>In case any accident occurs during the construction/ erection or other associated activities undertaken by the Contractor thereby causing any minor or major or fatal injury to his employees due to any reason, whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Employer and also to all the authorities envisaged under the applicable laws.</p>						
28.1	The Contractor shall follow and comply with relevant provisions of applicable laws pertaining to the safety of workmen, employees plant and equipment as may be prescribed from time to time without any demur, protest or contest or reservation.						
28.2	<p>If the Contractor does not take all safety precautions and/or fails to comply with the Safety Rules as prescribed by the Employer or under the applicable law for the safety of the equipment and plant and for the safety of personnel and the Contractor does not prevent hazardous conditions which cause injury to his own employees or employees of other Contractors, or the Employer's employees or any other person who are at Site or adjacent thereto, the Contractor shall be responsible for payment of compensation to Employer as per the following schedule:-</p> <table><tr><td>1</td><td>Fatal injury or accident. These are causing death applicable</td><td>Rs. 1,00,000/- per person</td></tr><tr><td>2</td><td>Major injuries or accident</td><td>Rs. 20,000/- per person for death/ causing 25% or more injury to any permanent disablement to person workmen or employees whosoever</td></tr></table> <p>Permanent disablement shall have same meaning as indicated in Workmen's Compensation Act. The compensation mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the Workmen's Compensation Act and rules framed thereunder or any other applicable laws as applicable from time to time. In case the Employer is made to pay such Compensation then the Contractor is liable to reimburse the Employer such amount in addition to the compensation indicated above.</p>	1	Fatal injury or accident. These are causing death applicable	Rs. 1,00,000/- per person	2	Major injuries or accident	Rs. 20,000/- per person for death/ causing 25% or more injury to any permanent disablement to person workmen or employees whosoever
1	Fatal injury or accident. These are causing death applicable	Rs. 1,00,000/- per person					
2	Major injuries or accident	Rs. 20,000/- per person for death/ causing 25% or more injury to any permanent disablement to person workmen or employees whosoever					
28.3	If the Contractor observes all the Safety Rules and Codes, Statutory Laws and Rules during the currency of Contract awarded by the Employer and no accident occurs then the Employer may consider the performance of the Contractor and award suitable "ACCIDENT FREE SAFETY MERITORIOUS AWARD" as per scheme as may be announced separately from time to time.						
29.0	<p>INSURANCE</p> <p>The following provisions will also apply to the portion of works to be done beyond the Contractor's own or his Sub- Contractor's manufacturing Works and all statutory obligations shall be fulfilled.</p>						

CLAUSE NO.	TECHNICAL SPECIFICATIONS										
	<p>Workmen's Compensation Insurance</p> <p>This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following:</p> <table border="0"> <tr> <td>Workmen's Compensation</td><td>- As per Statutory Provisions</td></tr> <tr> <td>Employee's Liability</td><td>- As per Statutory Provisions</td></tr> </table> <p>Comprehensive Automobile Insurance</p> <p>This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated:</p> <table border="0"> <tr> <td>Fatal Injury</td><td>: Rs.100,000 each person</td></tr> <tr> <td></td><td>: Rs.200,000 each occurrence</td></tr> <tr> <td>Property Damage</td><td>: Rs.100,000 each occurrence</td></tr> </table> <p>Comprehensive General Liability Insurance</p> <p>The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. .</p> <p>The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.</p> <p>This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.</p>	Workmen's Compensation	- As per Statutory Provisions	Employee's Liability	- As per Statutory Provisions	Fatal Injury	: Rs.100,000 each person		: Rs.200,000 each occurrence	Property Damage	: Rs.100,000 each occurrence
Workmen's Compensation	- As per Statutory Provisions										
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>PART-B H – MANDATORY SPARES</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p style="text-align: center;">H-1 MANDATORY SPARES</p> <p>1.0 GENERAL</p> <p>The general requirements pertaining to the supply of mandatory spares is as under.</p> <p>(a) The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the Owner to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in the Bid Forms and Price Schedules. Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.</p> <p>(b) Whenever the quantity is indicated as a percentage, it shall mean percentage of total population of that item in the station (project), unless specified otherwise, and the fraction will be rounded off to the next higher whole number.</p> <p>(c) Wherever the requirement has been specified as a 'set' it will include the total requirement of the item for a unit, module or the station or as specified. Where it is not specified a 'set' it will include the total requirement of the item for a unit, module or the station or a as specified. Where it is not specified a 'set' would mean the requirement for the single equipment/system as the case may be. Also one set for the particular equipment. e.g. 'set' of bearings for a pump would include the total number of bearings in a pump. Also the 'set' would include all components required to replace the item; for example, a set of bearings shall include all hardware normally required while replacing the bearings.</p> <p>(d) The Owner reserves the right to buy any or all the mandatory spares parts.</p> <p>(e) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.</p> <p>(f) All mandatory spares shall be delivered at site at least two months before scheduled commissioning of the solar plant. However, spares shall not be dispatched before dispatch of corresponding main equipment.</p> <p>(g) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.</p> <p>(h) The Mandatory Spares shall be handed over to the Bidder during O&M Period for use in the Plant Capacity Block through an Indemnity Bond (Format Attached). The spares shall be replenished by the bidder as and when it is used.</p> <p>(i) The spares in total quantity shall be returned to the Employer in working condition at the end of the O&M Period.</p>

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
1.0	H-2 BILL OF MATERIAL Schedule No. 1 :PLANT AND EQUIPMENT INCLUDING TYPE TEST AND MANDATORY SPARES		
	A1	Main Equipment for Project	
	1	DC Cables	Lot
	2	LT Cables	Lot
	3	HT Cables	Lot
	4	String Combiner Box	Lot
	5	Power Conditioning Unit	Lot
	6	LT Switchgear	Lot
	7	HT Switchgear/RMU	Lot
	8	Inverter Transformer	Lot
	9	Fire Protection System of Inverter Transformer	Lot
	10	Auxiliary transformer	Lot
	11	Earthing and lightning Protection	Lot
	12	Illumination System	Lot
	13	SCADA , PPC, OFC, Meters (ABT, PQ meters etc.) & Time Synchronization Equipment	Lot
	14	UPS and Chargers with Battery	Lot
	15	Fire Detection System	Lot
	16	Module Cleaning System (Robotic)	Lot
	17	33kV Outdoor Equipment (if applicable)	Lot
	18	Dynamic Reactive Power Compensation Equipment other than inverters, harmonic filters	Lot
	19	Misc. Equipment (other than Specified Above)	Lot
		TOTAL (A) (MAIN EQUIPMENT)	

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	B	Mandatory Spares		
	1a.	String Inverter with A.C. Combiner box as applicable	2% of total population for highest capacity	
	1b.	Central Inverter	1 No. of each make/type*	
	2	MCCB	2 nos. of each type and rating	
	3	33kV Circuit Breakers(For metal enclosed swgr in ICOG/sub pooling switchgear)	1 no. of each type for interchangeable rating	
	4	33kV RMU, if offered for Project	1 complete set interchangeable for all types	
	5	Electrical Bushing for 33kV RMU (if replaceable type)	1 no. of each type	
	6	Power pack for HT Swgr , if offered for Project	10% of total population or 2 Nos, whichever is higher	
	7	33 kV Current Transformer for HT switchgear	3 no. of each type and rating	
	8	33 kV Potential Transformer for HT switchgear	3 no. of each type and rating	
	9	33 kV Bus Potential Transformer	3 no. of each type and rating	
	10	33 kV Surge Arrestor for HT switchgear	3 no. of each type and rating	
	11	Earthing Trolley	1 no. of each type and rating	
	12	Numerical relay for 33kV HT Switchgear(Inverter stations and Main Pooling)	1 no. of each type	
	13	33kV Switchgear-Voltage Detecting Insulator(VDI) and Voltage Presence Indicator(VPI)	10% of total population	
	14	Electronic Cards for PCU	5% of total population for each type	
	15	IGBT Unit for PCU	5% of total population	
	16	DC/Semiconducting Fuse	5% of total population	
	17	AC Fuse of rating more than 10 Amp	25 nos. of each rating	
	18	String Combiner Box	0.5% of total population	
	19	SCADA ethernet switch	5% of total population for each type	
	20	SCADA firewall gateway	1 nos. of each type	
	21	Module Connector Set (Male & Female) with wire	set	300
	22	DC Cable (SPV Module to SCB)	km	10
	23	DC Cable (SCB to PCU) of highest size(if applicable)	km	2

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	24	HT Cable 33kV of highest size (if applicable)	km	1
	25	Inverter station Auxiliary transformer (Highest size)	1 No for upto 150MW cumulative capacity,else 2Nos	
	26	Spares related to UPS/Battery charger		
	26.1	UPS/Battery charger for inverter station/sub pooling system	5% of total population for each type and rating	
	26.2	Electronic Cards for UPS/ battery charger (inverter station and CMCS)	5% of total population for each type and rating	
	26.3	Spare Battery bank for inverter station/sub pooling system UPS/charger with mounting rack (To be kept in CMCS battery room)	1 set	
	27	Spares related to Inverter Transformer (replaceable for all ratings supplied under package)		
	27.1	Inverter Transformer (of higher size and replaceable for all ratings supplied under package)	No.	1
	27.2	Set of Valves for Inverter transformer	set	1(for cumulative Capacity upto 150 MW) else 2 Nos.
	27.3	WTI with contacts of Inverter transformer	Nos.	
	27.4	OTI with contacts of Inverter transformer	Nos.	
	27.5	Buchholz relay complete of Inverter transformer	Nos.	
	27.6	Pressure Relief Device of Inverter Transformer	Nos.	
	27.7	Magnetic Oil Gauge (MOG) of Inverter Transformer	Nos.	
	27.8	HV and LV Bushing with metal parts and gaskets of Inverter Transformer(Each Type)	Nos.	
	28	33 kV Outdoor Equipment(if applicable)		
	28.1	33 kV outdoor Current Transformer	1 no. of each rating	
	28.2	33 kV Outdoor Potential Tranformer	1 No of each type	
	28.3	33 kV Outdoor Surge Arrestor	Nos.	1
	28.4	33 kV Isolator (one pole)	Nos.	1
	29	Tracker Consumables	Deleted	
	31	Dry Robotic Cleaning System		
	31.1	Cleaning robot complete with all accessories	2% of total population of each type	
	31.2	Major components of robotic cleaning system	5% of total population of each type	
	32	PQ Meter(class-A type)	No	1

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	Schedule No. 2 : LOCAL TRANSPORTATION AND INLAND TRANSIT INSURANCE AND OTHER LOCAL COSTS INCIDENTAL TO DELIVERY OF PLANT & EQUIPMENT AND MANDATORY SPARES			
	Schedule No. 3 : INSTALLATION SERVICES FOR SOLAR PV PROJECT			
	A	Main Equipment		
	1	Module Mounting Structure (MMS)	Lot	1
	2	DC Cables	Lot	1
	3	LT Cables	Lot	1
	4	HT Cables	Lot	1
	5	String Combiner Box	Lot	4
	6	Power Conditioning Unit	Lot	1
	7	LT Switchgear	Lot	1
	8	HT Switchgear/RMU	Lot	1
	9	Inverter Transformer	Lot	1
	10	Fire Protection System of Inverter Tranformer	Lot	1
	11	Auxiliary transformer	Lot	1
	12	Earthing and lightning Protection	Lot	1
	13	Illumination System	Lot	1
	14	SCADA , PPC, OFC, Meters (ABT, PQ meters etc.) & Time Synchronization Equipment	Lot	1
	15	UPS and Chargers with Battery	Lot	1
	16	Fire Detection System	Lot	1
	17	Module Cleaning System (Robotic)	Lot	1
	18	33kV Outdoor Equipment (if applicable)	Lot	1
	19	Dynamic Reactive Power Compensation Equipment other than inverters, harmonic filters	Lot	1
	20	Misc. Equipment (other than Specified Above)	Lot	1
		TOTAL (A) - Main Equipment		
	B	Civil Works		
1	Site levelling and Cleaning including related Civil Works		LUMPSUM	
2	Road Related Works including any Culverts		LUMPSUM	
3	Drainage System including Recharge Pits / Crossing		LUMPSUM	
4	CMCS, store and other Buildings / Metering Yards / Porta Cabins including all Civil Works		LUMPSUM	
5	Foundation and Installation of MMS		LUMPSUM	
6	Inverter Room/station related Civil Works		LUMPSUM	
6	Transformer Yard / IDT Related Civil Works		LUMPSUM	
7	Civil works for reactive power compensation equipment, harmonic filter etc.			
8	Misc Civil Works (other than Specified Above)		LUMPSUM	

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																					
	C	Operation & Maintenance (O&M) Charges																																				
	1	For THREE (03) Year	LUMPSUM																																			
	2	AMC for 10 Years	LUMPSUM																																			
		TOTAL (C)- (O&M) & AMC																																				
	D	Safety Aspects / compliance to Safety Rules																																				
		Amount linked to Safety Aspects/ compliance to Safety Rules	LUMPSUM																																			
	Schedule-4: SCHEDULE OF UNIT RATE																																					
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	<p>Schedule-6: Site Establishment</p> <table><tr><th>Sl no.</th><th>Description</th><th>Unit</th></tr><tr><td>1</td><td>Hiring of site establishment services</td><td>Lumpsum</td></tr><tr><td>2</td><td>Hiring of Site staff accommodation</td><td>Lumpsum</td></tr><tr><td>3</td><td>Hiring of vehicles</td><td>Lumpsum</td></tr><tr><td>4</td><td>Hiring of Security services</td><td>Lumpsum</td></tr><tr><td>5</td><td>Hiring of safety officer</td><td>Lumpsum</td></tr><tr><td>6</td><td>TAXI for O&M duration</td><td>Lumpsum</td></tr><tr><td>7</td><td>Accommodation during execution and O&M</td><td>Lumpsum</td></tr></table>	Sl no.	Description	Unit	1	Hiring of site establishment services	Lumpsum	2	Hiring of Site staff accommodation	Lumpsum	3	Hiring of vehicles	Lumpsum	4	Hiring of Security services	Lumpsum	5	Hiring of safety officer	Lumpsum	6	TAXI for O&M duration	Lumpsum	7	Accommodation during execution and O&M	Lumpsum
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CLAUSE NO.	TECHNICAL SPECIFICATIONS
	<p>Notes</p> <ol style="list-style-type: none"> 1. Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by the bidder shall be the specified percentage (%) of the total population required to meet the specification requirements. In case the quantity of mandatory spares so calculated happen to be a fraction, the same shall be rounded off to next higher whole number. 2. Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc. these shall cover all the items supplied and installed and the breakup for these shall be submitted in the bid. 3. In case, the bidder offers any other design, whose spares are not indicated in the above list, the bidder shall offer spares (of each type) applicable to offered design with quantities generally in line with the approach followed in the list above. 4. In case the description/quantity for any items mentioned in this schedule is at variance from what has been stated in the technical specifications and its subsequent clarifications the stipulations of the Technical Specification and its subsequent amendment and clarification shall prevail. 5. Interchangeability and Packing: All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended replacements. 6. Identification : Each spare shall be clearly marked and labeled on the outside of the packing with its description when more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification. 7. The prices quoted in Schedule Nos. 1, 2, & 3 shall be inclusive of all Taxes, Duties, Levies & charges, except Goods and Services Tax (GST), payable in the Employer's country. Goods and Services Tax (GST) applicable in the Employer's country as on seven (7) days prior to the deadline for Bid submission on goods and services specified in Schedule Nos. 1, 2, 3 shall not be included in respective schedules, but shall be quoted separately in Schedule No. 6. 8. If rating and make/type of circuit breakers in ICOG and pooling switchgear incomer panels are not same, then spare breaker for each make/type and rating suitable for ICOG and pooling switchgear shall be supplied as per quantity mentioned in Mandatory Spares. 9. Unless stated otherwise a 'set' means items or sub-items required for each type/size range of the assembly/sub-assembly, required for complete replacement in one equipment / system as the case may be. It is further, intended that the assembly/sub-assembly which have different orientation (like left hand or right hand, top or bottom), different direction of rotation or mirror image positioning or any other reasons which result in maintaining two different sets of the spares to be used for the subject assembly/sub-assembly, these shall be considered as different types of assembly/sub-assembly. 11. Wherever for the Mandatory Spares under "Unit Price" Column "LOT" has been mentioned, bidder has to furnish the "Total price" only 12. Price of each and every item is to be given separately. In case, Bidder mentions 'Not Applicable' against an item in the bid and later on the same spare is found to be applicable during detailed engineering, the vendor shall supply such spares free of cost. 13. In case of multiple ratings of same make and type for Central Inverters, One no. of highest rating alone shall be accepted provided the same is interchangeable with other offered ratings (including compatibility of foundation).