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.

Shop primer for all steel surfaces, which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor

4.3.16 Mechanical Works and Steel Structures

4.3.16.1 Materials

Materials shall be new and of high-grade quality, suitable for the purpose, free from defects and imperfections, and of the classifications and grade meeting specification requirement. Material specifications, including grade or class shall be shown on the appropriate drawings.

All materials or parts used in the equipment shall be tested in conformity with the standards.

Certified Material Test Report for the materials of major/important components and/or materials for special application shall be furnished to the Employer as soon as possible after the tests are performed. Each test certificate shall identify the components for which the materials are used and shall contain all information necessary to verify compliance with the contract.

4.3.16.2 Metal Work

The contractor shall supply & install all anchors, fasteners, embedded metal work, piping, & sleeves associated with & required for the equipment to be installed under this contract, except if otherwise mentioned in the specifications.

The Contractor shall be responsible for the determination and details of all loads and forces exerted by his equipment and transferred to the foundation.

Galvanizing: Unless otherwise specified, all structural steel including ladders, platforms, hand rails and the like and all exterior and interior steel surfaces of outdoor Works, as well as bolts and nuts associated with galvanized parts shall be hot-dip galvanized, electrol-ytically galvanized or standardized, as may be appropriate to the particular case.

4.3.17 Instrumentation & Control

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.

All instrument scales and charts shall be calibrated and printed in metric units and shall have linear gradation. 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 Unit

4.3.18 Pre-Commissioning & Commissioning Facilities

i. 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 upon completion of installation of equipment and systems, shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis at his expense. 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 the technical Requirements/ specifications shall be performed by the contractor. The Contractor must strictly adhere to the Commissioning procedure as stipulated in RFS document.

ii. The contractor shall give the concerned RLDC/SLDC, UPNEDA/IMPLEMENTING AGENCY, RECPDCL & UPNEDA (if applicable) at least sixty (60) days advanced preliminary written notice and at least thirty (30) days advanced final written notice, of the date on which it intends to synchronize the Power Project to the Grid System. The synchronization equipment and all necessary arrangements / equipment including RTU for scheduling of power generated from the Project and transmission of data to the concerned authority as per applicable regulation shall be responsibility of the Contractor.

iii. The capacity of DC arrays to be installed shall be as per the terms & requirements of RFS

4.3.19 Packaging & Transportation

The Contractor is solely responsible for transporting the equipment/material, machinery with proper packaging and labour at his own cost and is also obliged to arrange for and obtain all necessary permissions, permits, consents and licenses. 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. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Upon indicating the items for which the contractor requires the C-forms, the employer may issue the C-form. Also arrangement of safe storage facility for preservation & conservation of all the incoming material is in the scope of the contractor.

Part – D

Detailed Technical Requirement

4.4 DETAILED TECHNICAL REQUIREMENTS

4.4.1 CIVIL WORKS

4.4.1.1 Topographical Survey

The Contractor shall refer the RFS document of Gujrai & Gurhah Solar Park attached as Section 6. Based on the above, the Contractor thereafter shall prepare a detailed general layout for complete solar PV Plant, with clear demarcation showing boundary wall, boundary pillars, location of control room, PV array yard, approach road, internal roads and general drainage etc. clearly marking the scope to be undertaken by te Contractor. The work shall be executed according to the specifications and good engineering practices necessary to fulfil the objectives of the survey work strictly as per requirement for execution of work.

4.4.1.2 Geo-Technical Investigations and Testing.

Geo-Technical Investigations and Testing of the proposed site shall be done by the Contractor at his own cost. All testing shall be done in a NABL accredited / Govt. Laboratory. This includes reputed government / autonomous laboratories / organizations, and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the contractor, in the presence of the Employer's representative and shall be sent to the concerned laboratory. The interim and final reports shall be made available as and when received, to the Employer.

Contractor is required to consider the Geo-Technical parameters of the proposed site as per the final Geo-Technical Investigations and Testing report vis-à-vis locations of various structures required for the project to design suitable foundations for the respective structures. Further, based on the Geo-Technical Investigations and Testing report, the Contractor shall arrange for Geo- Technical improvement wherever necessary.

4.4.1.3 Other Investigations

The contractor shall be responsible for collecting necessary data (earth quake data, wind velocity data, weather related data like Temperature, humidity, flood, rainfall etc) and carry out all other necessary studies/investigations (Shadow Analysis etc) as required for construction, execution and smooth operation of the plant.

4.4.1.4 Planning and Designing

a) The solar plant shall be designed so as to conform to the latest engineering designs, architectural values and aesthetic features etc.

b) The Contractor has to plan and design all the Civil Engineering Structures/works as per the topographical survey, Geo-Technical Investigations, Other Investigations/studies, Testing reports etc.

c) The Contractor shall develop general layout drawing for the complete solar PV Plant including but not limited to plant array field, internal roads and pathways, drainage system, approach roads (ensuring no water logging in the plant premises) along with sanitary plumbing layout etc. All designs & drawings have to be developed based on specifications given in the Bid documents, soil report and relevant IS codes unless otherwise specified. All details related to internal electrification, water supply and sewerage system should be clearly shown in the drawings.

d) Basic and Layout design of the project shall be in accordance with internationally

accepted practice. Appropriate IS Codes (latest version) shall be used wherever available. The Contractor should be able to provide various international and national references, when required by employer, to substantiate his design.

e) All structures for civil works shall be designed for severe combination of loads, considering wind seismic loads etc. The Contractor shall get the structural design done as per the relevant IS codes or international practices

4.4.1.5 Site Development

Before commencement of work including land development of the project site, the Contractor must visit the site to assess the actual ground conditions and familiarize himself with the site conditions. All due attention necessary must be given to the drainage, water runoff and general slope/gradient of the terrain and plant area. As far as possible the excavated material, which is suitable for fill, shall be used in project area itself. In case the earth filled is brought from outside the plant, the contractor shall provide the necessary royalty challan Waste material shall be disposed-off in sites to be identified and arranged by contractor himself at his own cost.

4.4.1.6 Site Levelling and Grading

The EPC contractor is responsible for making the site ready and easily approachable by clearing of bushes, felling of trees (if required with appropriate approval from concerned authority), levelling of ground (wherever required) etc. for commencing the project. It is to ensure that land must be graded and levelled properly for the flow of water. It is advisable to follow the natural flow of water at the ground. If the land pocket needs any filling of sand, it is to ensure that the filled earth must be well compacted as per the relevant IS standards.

4.4.1.7 Fencing of the Project

The complete project area shall to be protected from foreign ingress and unauthorized access by fencing all along its periphery. The Contractor shall provide GI Chain Link all around the periphery of the plant. The height of fencing shall be at least 2m above the finished ground level. The construction of peripheral fencing and Main Entry gate shall conform to the relevant IS Standards and practices. **The chain link fencing shall compromise of G.I chain link fencing with mesh size 75x75 mm with a nominal mesh size of 3.15 mm diameter . However, t**he complete design, materials and the erection of chain link fencing shall be done as per standard engineering practices.

Fencing of Switchyard and Transformer Yard: The fencing work required for electrical switchyard shall be of barbed wire / twisted G.I. fencing wire in accordance with relevant IS Standards, CEIG and other statutory requirements (if any).

4.4.1.8 Foundations

The contractor is responsible for the detailed soil investigation and subsequent foundation design of the structures and equipment in the plant. The foundation design and drawing of the module mounting structures, buildings and other important equipments and structures shall be submitted to the employer for review & reference as per Engineering Information Schedule.

The foundation system shall be made which transfer loads safely to the soil for the module mounting structures, depending on Geotechnical Investigation, geographical condition, regional wind speed, bearing capacity, slope stability etc. The support structure & foundation shall be designed with reference to the existing soil conditions, Geotechnical investigation, geographical conditions, slope stability etc. and shall be capable to withstand wind speed applicable for the zone whichever is higher, using relevant Indian wind load codes. The structures and foundations shall also conform to the seismic conditions pertaining to the zone (using relevant Standards and codes).

Civil foundation design for Module Mounting Structure (MMS), Control Room, Inverter Room, Equipment Room and other equipment's shall be made in accordance with the National Building Code, relevant BIS Codes and as per site conditions.

In general, the MMS foundation shall be constructed using RCC/Concrete Pile foundation of required diameter and depth as per approved design

4.4.1.9 ……...

4.4.1.10 Pathways and Roads

Suitable approach road and internal roads shall be made to carry safe and easy transportation of equipment and material at the project site. These roads shall provide easy and fast approach to each location of the plant. Approach road from nearest main road to control room shall be flexible type bituminous road and shall be constructed with sufficient width (minimum 3.0 m) with 0.5 m wide shoulder on both side). The road must be well compacted as per the latest relevant IS codes and MORTH updated till date.

All Peripheral roads and pathways shall be provided for easy access and shall be hard roller type. However, the approach road from main gate to control room shall be of WBM type.

For illumination of all approach roads and peripheral pathways, reference shall be made to relevant Electrical Specifications

The Internal pathways between alternate row of solar panels shall be levelled and good enough for carrying panels, material, Module washing/cleaning, easy movement for carrying out smooth and trouble free operation and maintenance of the plant.

4.4.1.11 Drainage System

Drainage philosophy based on site area levels and invert levels of drains shall be developed by the contractor to ensure no water stagnation in the plant. Contractor shall design and construct suitable drainage system for rain & storm water, Flood water etc. Also, cross drainages shall be designed and constructed by contractor, if required and shall be designed as per site rainfall data flood data and other standard criteria and shall be constructed with brickwork/RCC/RR masonry as suitable for the site conditions. The construction shall include dressing of sides and ramming of bottoms including mucking of the excavated soil and disposal of surplus excavated soil as directed by the employer. The drains outfall shall be connected to the nearest **main** drain.

Keeping in view of the topography and flood levels of the area necessary cutting, filling & leveling work shall be taken up by the contractor to have different benches suitable to respective project (Plot) requirement as well as compatible with the Road network.

The drainage shall be planned according to the final contour of the area after finalizing/ attaining the modified levels after the required cutting, filling & leveling work. There will be main storm drain along the Roadside which will receive inflows from the different blocks drainage system. The grade/ gradient shall be planned keeping in view of the NSL as well as the existing natural drainage line so that the storm water is safely drained off from the Plant/ Project area. This storm water can also be conserved in suitable Pool and can be utilized again.

4.4.1.12 Entry Gates

The Contractor shall provide suitable number of Entry Gates at suitable locations so as to ensure the safety of the plant as well as easy movement of the Vehicles carrying equipments, material etc during execution and O & M of the plant. **The entry gates shall include one main gate and another wicket gate for pedestrians and one number Security cabin/Guard room adjacent to each wicket gate.** The gate shall be provided with required paint and accessories necessary for smooth operation of gate. The main gate shall be of overall size of minimum 5m width by 3m height. The location, number and exact size of these gates shall be decided in consultation with employer during detailed engineering to meet site requirements.

4.4.1.13 Security Cabin/Guard Room

Security cabin/Guard room provided at entrance gate shall be of RCC type. Dimensions of security cabin shall be minimum 3m x 3m. In addition to this, Indian type W/C including wash basin and accessories shall be provided attached to the security cabin. All the necessary plumbing and sanitary lines shall be drawn. Necessary electrical connections for lighting and exhaust fan in W/C shall be provided.

4.4.1.14 Control Room Inverter Room and Equipment Room

The contractor shall construct Control Room, Inverter Room, Equipment Room and Buildings based on the Geotechnical Investigation, site conditions as per the system design for smooth execution as well as O & M of the Solar PV Plant. The Grade slab level of the Buildings shall be Minimum 600 mm above the surrounding ground level.

The control room for operation of the Solar PV Plant shall be made up of RCC/PEB Frame structure as per relevant Codes and site conditions. The layout, general arrangement etc shall be designed as per system requirement. Control Room shall also have the provision of Store room of adequate size for proper storage of Inventory/Spares/ Tools/ Tackles etc.

The building shall be constructed for housing Electrical MCC, Panels with space for Maintenance, Office Space with adequate furniture, SCADA Room, Battery Room , Conference Room suitable for minimum 10 persons, Rest Room for 02 persons, Toilet Block, Pantry and all other facilities and amenities required for smooth Operation & Maintenance of the Plant. The office space in the control room must have at least 6 Chairs of industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift),

a 10 seater conference table of min Width* Depth* Height dimensions as 700*1500*745 mm, adequate no. of fans, tube lights/LED(s), at least 2 storage cabinets etc.

The Control Room shall have minimum 02 numbers of Overhead tanks of minimum 2000 litre capacity of reputed make for proper water storage , one over the control Room and the other shall be for Toilet Block and Pantry Room with proper fresh water and sewage arrangement and septic tank with Soak pit shall be provided.

Electrical Panel Room shall have provision of ramp of adequate slope and width as well as rolling shutters of adequate size for loading and unloading of Electrical panels and machinery.

Inverter rooms shall be located at suitable locations corresponding to solar arrays. The number of Inverter rooms, layout etc shall be designed as per system requirement and the same submitted by the contractor for the review of the employer before commencement of work.

Inverter Rooms shall be Pre-Engineered Building (PEB) or standard RCC framed structures as per requirement with cable trench arrangement located in the PV array field and shall be constructed as per National Building Code and as per relevant BIS Codes.

The layout of Inverter room shall be designed so as to divert the heat generated from each inverter outside the room. The Contractor shall have to get the structural design done as per the prevailing IS codes.

Adequate nos. of split AC of reputed make units shall be provided by the Contractor in the Control Room & Inverter Room to maintain the required operating temperature and ensure trouble free operation of the equipment installed.

The Contractor shall submit Preliminary Drawings/Execution Drawings with Architectural and Structural design and details for review/approval of the Employer. The Employer reserves the right to modify the layout as per requirements. Based on any modifications/recommendations, the Contractor shall submit the Final Drawings for review/approval of the Employer. All kind of works shall be carried out as per the relevant standards

4.4.1.15 Specifications

I. Specification for Pre-Engineering Building

Specification

The purpose of this document is to define the specifications of Control Room Interior and Control Desk.

Scope of Work: The scope of the project includes designing; engineering, supply & installation Control Room Interiors. All the components like ceiling, flooring, panelling, Glass partitions, Control desks, ceiling light & luminaire's electrical etc. must look integrated and therefore it shall be treated as a part of one single solution i.e., Control Room. To ensure an integrated solution, to qualify as per the international control

room design & safety norms.

Designing, testing, integration etc., all complete, preparation of the related drawings, documents, etc. of the Control room shall be in the Control Room Interior Solution Provider scope. It is mandatory for the bidder that the control room should have all the components like ceiling, flooring, control desks, panelling, partitions & illumination to avoid interface & quality related issues.

The entire design proposal must be Flexible, Dynamic, Scalable, Expandable and re-deployable to accommodate any technological changes / future needs which are not envisaged now. Hence 100% modular interior system (prefabricated and ready to install) solution is required. In a typical control room the environment is defined by four major components viz : Ceiling, Flooring, Control Desks & Wall panelling is defined by these components. To achieve must needed quality in terms of integrity, functionality, safety & ergonomics and to avoid interface related issues during and after execution. It is mandatory for the bidder that the control room interior comply with ISO 11064 and completes the installation activities of the same.

Ceiling Material - Factory made acoustic modular metal false ceiling of powder coated panels. Make shall comprise of perforated & non-perforated metal panels made through CNC laser Cutting, bending & punching. Panel shall be of 0.6mm CRCA sheet of approved powder coating finish. Panels shall be designed to achieve shape and design as per the design consultant with the combination of acrylic panels with lights, designed to enhance visual feel, with provision for easy installation and maintenance, integrated lighting, and scope for integration of building services like HVAC and fire detection/ fighting system. Metal modular false ceiling must have Noise absorption coefficient (NRC) value 0.60 according to IS:8225-1987, ISO: 354-1985 and ASTM 423-90. Test Report to be submitted along with the technical Bid.

Modular Panelling - Factory made removable type self inter lockable metal panels with front sheet of Preformed Textured Hot dip galvanized sheet with rigid polyvinylchloride (PVC) film on one side and on the other side a coating to avoid rust (sheet thickness 0.6mm & PVC Coating atleast 0.11mm). The metal wall Panelling and Partitions surface finish shall be made up of EN ISO 11925-2, EN 13823 certified material. The back cover of the panel shall be made up of 0.6mm thick CRCA/GI sheet of approved colour. The panelling design shall comprise of specially designed combination of perforated and non-perforated panels through CNC laser Cutting, bending & punching. Panels shall be designed to achieve shape and design as per the design consultant and shall be fixed using GI/CRCA hook fitting on structure. Overall system thickness for panelling shall be 60mm to 90mm and for partition shall be 70mm to 120mm.

Wood, Gypsum, Aluminium Composite Panels, Laminates, Fabric and Paint are prone to damages & ageing. These components shall not be used to ensure maintenance free working environment. Control Room Interior Solution Provider to submit an undertaking on letterhead to comply the same.

As per design, panel shall comprise of perforation for making panelling and partitions acoustically sound. Acoustic grade fire retardant fabric (minimum 1mm thick) will be fixed (on the back side of perforated tiles) at some parts of the Control Room facility.

Modular Rigid PVC Metal Paneling

Straight Metal Paneling : Panelling/cladding tiles shall be designed to achieve shape and design as per the design consultant. To enhance the aesthetic, appeal the control room interior solution provider must include diffused & concealed light elements in the control room wall panelling. These illumination elements must have provision of for quick & easy installation & maintenance. These concealed lights shall have RGB combination and shall be controlled through a touch screen mounted on the supervisor/main control desk. Various light colours like blue for VIP visit, green for normal operations and red for emergency shall indicate different control room scenarios and shall have additional customizations also.

Design

The cladding panels shall be made up of combination of two sheets locked and riveted together and polystyrene shall be used as infill to achieve strength and acoustics. The front tile (PVC pre-coated metal sheet) shall be perorated/ non-perforated as per the design requirement and the back tile (Powder coated 0.6mm CRCA steel sheet and powder coating thickness 0.06mm to 0.09mm) shall be designed in such a manner that it fits on the back portion of the front tile. Once the tiles are assembled then these will be riveted. These tiles shall be bent through CNC, machine punched & laser Cut to achieve perfect accuracy.

Structure shall be made from modular, heavy duty powder coated CRCA frame (minimum sheet thickness 1mm) and shall allow uninterrupted flow of wires/cable/tubes of maximum diameter 25mm.

Structure shall be securely connected from wall, roof and floor. It shall be made up of minimum 1mm thick vertical slotted rolled C sections (Upright) and horizontal rolled 'C' connectors. Grid of desired dimension shall be formed by Vertical and horizontal sections having 20 to 50mm pitch.

Curved Acoustic Metal Panelling/Partition: - All the technical specifications shall be like straight metal panelling, but the shape shall be perfect curve to provide more space for mounting of the LED's.

Ergonomic compliance report as per latest ergonomic norms of ISO 11064 to be submitted. Being one of its kind facilities; the control room deserves a tested & proven product having genuine design.

Shutters & Side Legs: - Front, back shutters shall be of 18mm Laminated MDF Board with premium finish. Side leg shall be of 25mm of the same finish. Hinges shall have five year's warranty against manufacturing defects. Proposed console shall comply with the BIFMA X7.1 standard. The consoles (open plan) must not emit TVOC(A), Formaldehyde i.e. 152 $\mu g/m^{2}*hr$, 6.2 $\mu g/m^{2}*hr$ respectively. This is to ensure healthier air quality for the operators. Therefore, the proposed console must be Greenguard Gold certified. Control Room Solution Provider should have had this certificate for at-least three years prior to April 1st, 2021. Valid certificate needs to be submitted from (UL/Intertek) along with the bid.

To avoid distraction of operators because of unwanted noise generated from movement of chairs/people in the control room it is necessary that the proposed

flooring shall damp such impact noises. The decorative acoustic flooring shall reduce impact sound by 14dB (ISO 717-2)). It shall be twin-layer linoleum built up from 2mm acoustic laminate and 2mm Corkment backing.

The modular metal panelling & metal ceiling must comply to the lead-free directive to ensure restriction of hazardous substances so that the final product does not contaminate the environment. The final product i.e. modular metal ceiling & modular metal paneling does not contain hazardous substances, so it is necessary that the modular metal panelling and modular metal ceiling shall be RoHS certified (from UL / Intertek). Valid Certificate to be submitted along with the technical bid.

It is well known that metal is resistant to fire as compared to wood & fabric. However, from fire and safety point of view, to ensure that the used material is not subjected to any kind of surface treatment which provokes fire. The proposed wall panelling and ceiling tiles should be Class A certified as per ASTM E84 (from UL/Intertek) for surface spread of flame and smoke generation. This is mandatory to ensure that the materials used in the interiors do not provoke fire. Valid Certificate/Report from UL/Intertek to be submitted along with the technical bid.

Seismic safety of user & control room equipment is a prime concern area. The metal ceiling and modular metal panelling must sustain the seismic vibrations as per design spectrum IS 1893 for zone 4 vibrations. The test must be carried out by authorized government agency. Test Report to be submitted along with the technical bid.

To provide acoustically superior environment and ensure proper attenuation of airborne sound, it is necessary that the sound transmission class (STC) value of wall panelling and partition should be 35 (According to IS: 9901 (Part III) – 1981, DIN 52210 Part IV- 1984, ISO: 140(Part III) -1995, test report to be submitted along with the technical bid.

The critical components of the control room i.e. designer metal ceiling, carpet/laminated flooring, modular metal wall panelling/partitions must not emit formaldehydes, TVOC beyond permissible limits i.e. 9 $\mu g/m^3$, 0.22 mg/m^3 respectively. This is to ensure healthier air quality for the operators. Therefore, the control room interior shall be Greenguard Gold Certified (Modular Metal Ceiling, Flooring & Modular Metal wall panelling) from UL/Intertek. Valid certificate needs to be submitted along with the bid.

Tiles Perforation – To achieve acoustics without deteriorating the aesthetical appeal of the control room it is necessary that the wall panelling and ceiling tiles have micro-perforations (less than 1.5mm diameter each) all over the surface with a density of 5000 holes per square feet. UL audit certified design feature on modular wall panelling tile having clean perforations and providing smooth finish on front fascia of tiles. The tile shall have 5000 holes per square feet on front side of the tile. Valid UL audit certificate to be submitted along with the technical bid.

Metal modular false ceiling must have Noise absorption coefficient (NRC) value 0.60 according to IS:8225-1987, ISO: 354-1985 and ASTM 423-90. Test Report to be submitted along with the technical Bid.

Structure shall be made from heavy duty powder coated CRCA steel sheet (minimum sheet thickness 0.8 to 1.6mm). It shall be securely grouted from roof with help of anchor fastener and GI self-threaded rods. It shall be formed with the help of slotted

rolled W sections (stiffener) and Master C section with help of M6 cage nut and bolts.

Illumination: - Control Room illumination shall be designed as per ISO 11064 norms. Valid lux level report to be submitted along with the bid.

To avoid dark spots/areas in the control room it is necessary that continuous linear lights are used across the width/length of the control room. UL audit certified design feature of integrated channel in ceiling for quick installation & replaceability of continuous linear light: The ceiling system having integrated inbuilt channel for installation of cove lights and shall permit quick and easy replacement of cove light without using any tools. Replacement to be carried out within 120 Seconds per meter. Valid UL audit Certificate to be submitted along with the technical bid.

The wall panelling shall be robust & strong enough to sustain the routine loads/minor impacts of typical control room environment. The wall panelling/partition structure shall have UL Audit Certified feature of load bearing capacity of 300 Kgs to hold any display unit on clamp having minimum length of 750mm. Valid UL audit Certificate to be submitted along with the technical bid.

UL Audit Certified feature of Modular wall Panelling tile having secure locking arrangement for equidistant mounting. Locking arrangement enables easy replacement without using any tool within 20 seconds. The feature shall provide easy flexibility of locking all tiles in one column through gravity. Valid UL audit Certificate to be submitted along with the technical bid.

The non-uniform gaps between the designer metal ceiling and the adjacent walls/partition shall be covered with calcium silicate ceiling.

Glass partitions will be made of 12mm toughened glass with 300mm modular metal partition/panelling at the bottom. Modular metal partition/panelling shall have the same material as that of metal panelling/partition. The proper structure shall be made to ensure fixing of glass from RCC slab above the false ceiling and support on partition structure below. Straight & vertical structural members shall not be visible. Glass shall be fitted on anodized extrusion with tool-less technology and having a provision for replacing the glass with perforated sheet/acoustic tile by removing the glass NOTE: - The nature of installation should be replaceable, expandable, and flexible to cater to the future expansion/technical up-gradation.

Metallic Door: - With door hinges and locking arrangements and both way handle. Prepare with rigid thermo fused film metal panels. Specification: 0.6mm thick Metal panel sheets, cavity shall be filled with adequate quantity of honeycomb. Material of the partition and that of metal door will remain the same.

12mm thick frameless tempered clear glass door: - With door spring and locking arrangements and both way handle and patch fittings. Specifications: Tempered glass is formed by heating glass to the softening point in a horizontal tempering stove, and then quickly cooling it. Safety (tempered): when broken, it spits into tiny harmless pieces.

False floor: Top of the flooring shall be similar to the Acoustic Flooring. The acoustic laminate should be made up of twin-layer linoleum built up from 2mm Laminate. The Panel should

a. Have density of 1600KgM^3.

b. Fire resistance DIN EN 1366-6 2005-02.
c. Core material thickness should be minimum 30mm.

False floor panels shall rest on edge support rigid grid system having Galvanized Iron base plate dimensions as 100mm X 100mm. The stringer should be fixed on pedestal having height adjustment of ±25mm.

A prototypical design approach must be adopted for design of control centres & consoles so, it must be prepared in strict compliance to ISO 11064 i.e. Ergonomic Design of control centres. Professional control room interior solution provider to submit an ergonomic study report including control room & desk along with the bid. The study must cover, Lux level reports as per industry acceptable illumination levels, spatial arrangement for efficient & safe movement of operators within the control room during normal and emergency situations, Ideal viewing angles (of operators) to ensure little head movement and minimal eye movement. All these considerations must be shown in the drawings during bid submission and the report must be signed by an ergonomist who has an experience of doing at-least two projects of control room ergonomic study.

The requirements must be elaborated via a smart virtual-reality module with auto-recommendation during design approval stage before commencement of job.

The control desk solution shall conform to high standard of engineering as mentioned in the document; meeting the specified codes, standards and designs. It shall be capable of performing 24X7 operations under the specified environmental condition. The console should be UL Listed & valid certificate to be submitted along with the bid.

Table top: - The material of the working surface shall be 25mm thick MDF. The control room interior solution provider must ensure that the top finish of the worksurface is scratch resistant. Therefore, the top finish shall be of high-pressure ANSI/NEMA LD3 certified scratch-resistant Laminate. The proposed console's life cycle should be assessed (from approved LCA consultant) for environmental impacts associated with all the stages of a product's life for cradle to grave analysis.

The EPD (Environmental product declaration) of control desk must be verified in accordance with ISO 14025 (from UL/Intertek) for Impacts on Environment by Console. Valid certificate to be submitted along with the bid.

Structure: - Made of heavy duty extruded vertical and horizontal Aluminium profiles of 6005 grade. The extrusions shall be duly powder coated with 40+ microns over all surfaces. All sheet metal parts must be finished with a durable, black, electrostatic powder coating. The Control Room Interior Solution Provider must have trademark registration certificate issued by Government of India for the console proposed in this tender. Trademark registration certificate to be submitted along with the bid.

To allow future extension and expansion, a weld free system shall be proposed. Interconnecting joints shall not be visible. The structure shall be rigid enough to withstand BIFMA X5.5: 2014 (Latest Edition) tests. Following tests shall be qualified to ensure the stability of the structure:

a. Concentrated Functional Load Test (minimum 90 Kgs)
b. Distributed Functional Load Test (minimum 135 Kgs)
c. Concentrated Proof Load Test (minimum 135 Kgs)
d. Distributed Proof Load Test (minimum 200 Kgs)

e. Stability Under Vertical Load Test (minimum 55 Kgs)

Tests must be based on ANSI BIFMA X5.5 -2014 standards applied to the proposed product solution. Valid certificate of BIFMA X5.5 should be submitted along with the bid.

Seismic safety of user & control room equipment is a prime concern area. Control Desk shall be tested and qualified to sustain Seismic vibrations as per design spectrum IS 1893 for zone 4 vibrations with monitor mounted on monitor arms of the console. Seismic test report of bare control desk shall be deemed unacceptable. This test must be carried out by authorised government agency. Test report with images of control desk seismic test should be submitted along with the bid.

Monitor Arm: - The control desk shall feature ergonomic display mounting arms. It shall enable quick & easy replacement of VESA mounts & arm extensions as per the ergonomic requirement defined in ISO 11064. UL audit certified design feature of monitor arm assembly shall have auto lock, push & remove feature for quick release of VESA mounts and modular arm extensions for ease in maintenance and fixing of monitor by one technician within 30 seconds without using any tools. Valid UL audit certificate to be submitted along with the bid.

Cable Trays and Wiring: - The desks must be designed with vertical and horizontal cable trays to allow for continuous cable management between the cabinets. Wire shall be routed into the cabinet through gland plate. Proposed console should be RoHS Certified from UL/Intertek and the valid certificate shall be submitted along with the bid.

II. **Water Supply:** GI pipes of Medium quality conforming to IS: 1239 (Part I) and IS: 1795 for Mild Steel pipes shall be used for all water supply and plumbing works. The PVC storage water storage tank(s) conforming to IS: 12701 shall be provided over the roof of the main control room with adequate capacity to meet requirement, complete with all fitting including float valve, stop cock etc. Required water connection to service the main control room shall be in the scope of the Contractor.

III. **Plumbing And Sanitary:** Sanitary fittings, which includes water closet (EWC/IWC), Wash Basins, Sink, Urinal Fittings including Flushing Tank and necessary plumbing lines shall be provided for Office cum Stores, stores Building , security house.

IV. **Electrification of Building:** Electrification of building shall be carried out by the Contractor as per IS: 732, IS:4648 and other relevant standards. The lighting design of the buildings shall be carried out as per IS 3646. The building shall be provided with adequate quantity of light fittings, 5A/ 15A 1 phase sockets, fans etc., controlled by required ratings of MCBs and MCB, DBs. It is encouraged that Contractor shall use the latest energy efficient equipment for the electrification and illumination.

4.4.1.16 Cable Trenches

In Main Control room, Invertor rooms & Switchyard area cables shall be laid in concrete cable trenches. Cable trenches of suitable dimensions with GI cable trays shall be provided. The trench cover in Main Control room and Invertor rooms shall be of steel grating type. The trench cover in Switchyard area shall be of concrete.

All other cables in the project area shall be buried cables with a provision for culvert/Hume pipe for protection of cables under the motorable roads. The details of buried cables are provided in the Electrical Specifications in this contract and the same shall be followed

4.4.1.17 Switchyard Yard Civil Works

Switchyard civil work includes step up transformer plinth, HT Switchgear kiosk plinth, two pole 4 pole structure foundation, earth pits, metal spreading curb wall in and around switchyard and fencing. The transformer/ HT switchgear kiosk plinth shall be made of brickwork or Random Rubble masonry conforming to relevant standards. The height of transformer /HT Switchgear kiosk plinth shall be decided based on **Inverter Output Voltage/**33 KV ground clearance. Earth pit construction shall be of brickwork covered with RCC (1:2:4) heavy duty pre cast slabs. Cable Trench in Switchyard shall be RCC of M25grade concrete. Switchyard/ double pole area must be surrounded by chain link fencing with pre-cast RCC post/ galvanized MS angle of suitable size with double leaf gate as per CEIG Requirements. Earthing of Fencing shall be done through flexible wire of through GI Plates .Area enclosed within this perimeter must be filled with 100 mm thick gravel.

a) Switchyard foundations shall be RCC of Minimum M25 grade and structures shall be provided strictly as per CEIG/STU /CTU Norms/ requirements/design as applicable.

Transformer and equipment's foundations shall be designed based on the final geotechnical investigation report. 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. The individual oil pits shall be connected to an oil collection pit which shall be sized to accommodate oil volume of the transformer connected to it, without backflow. The oil pit shall be connected to oily water drainage system. Dimensions of the discharge pipe shall consider rainfall intensity also. The water shall be discharged into the nearest drain by gravity flow or pumping.

Transformer track rails shall confirm to IS:3443. The requirement of fire barrier wall between transformers shall be as per Electricity Rules and IS:1646 recommendations.

4.4.2 DC Systems

4.4.2.1 SOLAR PHOTOVOLTAIC (SPV) MODULES

4.4.2.1.1 SPV Module

1) The Solar PV module comprises of PV cells connected in series combination to achieve the required module power output. PV cells directly produces DC power on receipt of solar irradiation. Solar Photovoltaic Module shall be made up of **crystalline silicon cells.**

2) Total DC Capacity of PV Module to be supplied for the **(125 MW (50 MW & 75 MW)) (AC)** project should be minimum **(40 %**) higher than the AC rating in MW, which is the cumulative rated capacity of all solar PV modules under supply as per relevant IEC standards under standard temperature condition (STC).

3) **For commissioning of the project, capacity of DC arrays installed shall be considered in multiple of 10MW per unit.**

4) The contractor shall guarantee net 110.98 MU for Package-1 and 166.48 MU for Package-2 at delivery point in the first year after **the Operation Acceptance.** The annexure indicating the minimum number of units to be generated in a particular year is mentioned in **Appendix A to Attachment 10.** However, as per the **Attachment 10** of this document, bidder shall quote the Net Guaranteed Million Units to be generated during the contract year but it shall not be less than the MUs provided by the employer. **As per industry practice/norms, the normative losses for Substation Transformer (33/132 kV) range form 0.2% to 0.5% and for 132 kV line it is 0.75%. Bidders may assume suitable loss percentage as per their practice. However, Bidders to demonstrate the net energy quoted at the delivery point irrespective of the loss percentage they considered.**

5) Further, the contractor shall make all efforts to add DC Capacity in order to achieve the above generation.

4.4.2.1.2 Rating & Functional Characteristics

1) Peak power rating of the individual module shall not be less than **325 Wp.** The allowable tolerance in STC Power rating for each individual module shall be 0 W to +5Wp. No negative tolerance is permitted. The value of positive power tolerance of each module shall not be added/considered in peak power rating of the individual module.

2) The cell should have minimum fill factor of 0.72.

3) Modules shall be designed for rugged design to with stand tough environmental conditions and Maximum static load, front & maximum static load, back shall be as per IEC-61730-2)

4) Electric Cables for photovoltaic systems with a voltage rating of 1.5kV $_{DC.}$

5) Maximum system voltage shall be 1000V DC or higher.

6) Power temperature Coefficient for modules shall be greater than (-) 0.43% per °C for better yield.

7) Nominal operating cell temperature (NOCT) shall be 45°C ± 2°C.

8) The current mismatch of the modules connected to an inverter should be less than 2%.

9) SPV module shall have module safety class-II and should be highly reliable and must have minimum operating life of 25 years.

10) The I-V characteristics of all modules as per specifications to be used in the systems are required to be submitted at the time of supply.

4.4.2.1.3 General requirements of Module

1) The materials used for manufacturing solar PV module shall have a proven history of reliability and stable operation in external applications. It shall perform satisfactorily in relative humidity up to 95% with ambient temperature between -10°C to +60°C and shall withstand adverse climatic conditions, such as high speed wind, blow with dust, sand particles, saline climatic / soil conditions and for wind 180 km/hr on the surface of the panel.

2) **Modules shall consist of 72 cells, connected in series using four (4) or more bus bars. The glass used to make the crystalline silicon modules shall be of toughened low iron glass with minimum thickness of 3.2 mm or more for 72 cell module. The glass used shall have transmittance of above 90% and bending less than 0.3% to meet the specifications**

3) The back sheet used in the crystalline silicon based modules shall be of 3 layered structure. Outer layer of fluoropolymer, middle layer of Polyester (PET) based and Inner layer of fluoropolymer or UV resistant polymer. Back sheet with additional layer of Aluminium also will be considered. The thickness of back sheet should be of minimum 300 microns with water vapour transmission rate less than 3g/m2/day. The Back sheet shall have voltage tolerance of minimum 1000 V.

4) The module frame shall be made of corrosion resistant materials, preferably having aluminium anodized finish. The anodizing thickness shall be 15 micron or better.

5) The module frame shall be made of anodized Aluminium or corrosion resistant material, which shall be electrically & chemically compatible with the structural material used for mounting the modules. In case of metal frames for modules, with sufficient number of grounding installation points. Module frame thickness/Height should be minimum 40 mm, the anodization thickness shall not be less than 15 micron. The adhesion strength with encapsulant shall be greater than 70 N/cm.

6) Each module should have two 4 sq.mm stranded UV resistant cables as per of TUV specification **2 Pfg 1169/08.2007/EN 50618** and terminated with connectors adaptive to MC4 type connector directly. MC4 type connector should be **TUV/EN 50618** certified.

7) The EVA used for the modules should be of UV resistant in nature. No yellowing with prolonged exposure in the filed shall occur. The modules shall be uniformly laminated without any lamination defects.

8) The solar cell shall have surface anti-reflective coating to help to absorb more light in all weather conditions.

9) The sealant used for edge sealing of PV modules shall have excellent moisture ingress protection with good electrical insulation (Break down voltage >15 kV/mm) and with good adhesion strength.

10) Each PV module **deployed must use a Radio Frequency Identification (RFID) tag for traceability. RFID shall either be placed behind name plate**

sticker or behind bar code label pasted on the back glass of PV module and must be able to withstand harsh environmental conditions during the module lifetime. One number RFID reader has to be supplied by the bidder which has to be compatible to read the data from the RFID Tag & download the data to Computer. All associated Software & Cables are to be provided along with the RFID reader. The following information must be mentioned in the RFID used on each module :

i. Name of the manufacturer - PV Module & PV Cells
ii. Month and year of the manufacture (separately for solar cells and module)
iii. Country of origin (separately for solar cells and module)
iv. I-V curve for the module at Standard Test Condition (1000 W/m2, AM1.5, 25 deg.C)
v. Wattage, Im, Vm and FF for the module
vi. Unique Serial No and Model No of the module
vii. Date and year of obtaining IEC PV module qualification certificate
viii. Name of the test lab issuing IEC certificate
ix. Other relevant information on traceability of solar cells and module as per ISO 9000

Note: Contractor would be required to maintain accessibility to the list of Module IDs along with above parametric data for each module.

11) The crystalline silicon based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided.

12) The modules must qualify to the latest edition of the following IEC PV Module qualification test or equivalent BIS standards as specified in the RfS (Page 99 to 100):-

i. IEC 61215 2nd Edition or latest: Design qualification and type approval for Crystalline Si modules).

ii. IEC61730 Part 1 &2 : PV module safety qualification testing @ 1000 V DC or higher)

iii. IEC 61701: Salt Mist corrosion testing of PV Module for highly corrosive environment, (Severity-6)

iv. IEC 62716: Ammonia Resistant certified, if applicable

v. IEC 62804 (draft std.) or equivalent TUV Rhineland std.: PID (Potential Induced Degradation) free Module.

vi. The PV modules deployed must have valid test certificates as per above specified IEC Standards by one of the NABL Accredited Test Centres in India. In case of module types/ equipment for which such Test facilities may not exist in India at present, test certificates from reputed ILAC Member body accredited Labs abroad will be acceptable.

The contractor shall submit the above compliance certifications for approval of RECPDCL.

13) The junction box used in the modules shall have suitable numbers of bypass diodes to prevent hot spots in case of cell mismatch or shading. The material used for junction box shall be made with UV resistant material to avoid degradation during module life and the Junction Box shall comply IP 67degree of protection or higher protection class. The Junction Box shall consist of semi permeable membrane to allow entry /escape of air in /from the Junction Box, but block the entry of moisture in module. Junction Box shall be weather proof.

14) Modules of same rating and manufacturer shall be connected to any single inverter.

15) The Contractor shall maintain the list of Module IDs along with performance characteristic data for each module. This data shall be submitted to UPNEDA/IMPLEMENTING AGENCY/MNRE/RECPDCL.

16) It is the responsibility of the Contractor to maintain a RFID reader at the site and submit the data stored in RFID to Employer after the work of installation of modules is completed.

17) The Contractor shall submit the Data sheet, Drawings, Flash reports and compliance certificates of the offered modules for review/approval of RECPDCL/Implementing Agency/UPNEDA and supply should start thereafter. Also CDF (Construction Data Form) for the SPV Module, approved by any reputed agency shall be submitted as per Engineering Information Schedule.

18) **Only valid type tested as per clause no 4.4.2.1.5 crystalline modules with Peak power rating of the individual module not less than 325 Wp** shall be considered for this Project. On this account, the Contractor shall provide full information, to the satisfaction of RECPDCL.

19) The Modules must mandatorily meet the requirements laid by UPNEDA/MNRE/IMPLEMENTING AGENCY as mentioned in RFS Document.

20) The Contractor has to ensure that all the Solar PV MODULES after their " END of Life" (When they become defective/non-operational/no reparable) are disposed in accordance with the " E-Waste (Management & Handling) Rules, 2011" notified by the Government and as revised and amend from time to time.

21) As per the Solar Photovoltaics, Systems, Devices and Components Goods (Requirements for Compulsory Registration) Order, 2017, PV Modules used in the grid connected solar power projects shall be registered with BIS and bear the Standard Mark as notified by the Bureau of Indian Standards.

22) Transportation, handling, storage and installation of modules shall be in accordance with the manufacturer manual so as not to breach warranty conditions. The Standard Operating Procedure (SOP) for the same shall be shared by the Contractor prior to dispatch for review.

23) The Employer shall perform material inspection at the Manufacturer's factory before the start of proposed manufacturing schedule. Proof of procurement of components

as per the approved BOM mentioning manufacturer name, manufacturing date and relevant test certificate shall be submitted during material inspection for verification.

4.4.2.1.4 Routine Testing & Inspection

All the acceptance tests and Routine Tests, inspection at manufacturer's works as well as at site shall be carried out strictly as per specifications, relevant standards and in accordance with the Final Quality Assurance Plan and reports shall be submitted to Employer.

The Employer reserves the right to inspect the modules at the manufacturer's site prior to dispatch.

4.4.2.1.5 Type Test:

SPV modules supplied must be of type tested design and certified by any of the accredited certifying agencies according to International standards mentioned at Clause No. 4.4.2.1.3 (12) above and the type test reports shall be submitted to the Employer for approval.

Further, Bidder shall submit the following:

i) Third Party verified PAN files for any one module, if bidder is offering three wattage bins or less. In case the bidder is offering more than three wattage bins, additional wattage bin need to be submitted.

ii) Self-certified Electro-Luminescence (EL) Test Report of all the Crystalline Silicon based PV modules being offered to RECPDCL.

4.4.2.1.6 Warranty for Modules

a) **Performance Warranty**: Power output at STC for modules shall not be less than 97% rated power output at STC during the first year after year of completion.

b) PV modules must be warranted for their output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years from the date of successful completion of **COD.**

c) **Product Warranty**: The modules shall be warranted for at least 10 years for failures due to material and workmanship.

4.4.2.1.7 Insurance for Warranty/Guarantee/Performance of PV Modules

Contractor shall submit Third Party Insurance towards Warranty for Modules before the dispatch of first lot of PV Modules. This insurance shall cover the PV module warranty in case of insolvency or bankruptcy of the PV module manufacturer. The Premium Charges, recurring charges, any expenditure for the Insurance shall be in the scope of Contractor.

4.4.2.2 MODULE MOUNTING STRUCTURES (MMS)

4.4.2.2.1 Module Mounting Structures (MMS)

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. Modules shall be mounted on non-corrosive support structures.

The Contractor shall provide the following type of mounting arrangement:

Fixed Tilt Mounting Arrangement

4.4.2.2.2 Technical Requirements

1. The MMS Structure and foundation shall be designed considering total project life of at least 25 years. The structure design shall be appropriate and innovative. It must follow the existing land profile. The foundation system for MMS shall be designed as per geo technical investigation report.
2. The structure shall be designed to allow easy replacement of any modules and easy access for safe and trouble free operation & maintenance of the plant.
3. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels at the same time.
4. The design calculations shall be as the codes & standards as mentioned in relevant sections in this document. The Contractor shall submit to the employer the detailed foundation & structural design drawings along with calculations and bases/ standard, Bill of Materials, entire specifications, STAAD PRO Analysis Report, Shadow analysis report showing the effect of shadow of various structures and buildings on the energy output of PV Array as per the Engineering Information Schedule.
5. The structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation & tilt, absorb and transfer the mechanical loads to the ground properly.
6. Design shall be in such a manner that, there are minimum requirements of child parts/sub-parts. Further, all the sub-parts used in the Module Mounting Structure like purlins, rafters, bracings, C-clits etc. shall be designed to ensure easy replacement. The contractor shall ensure that, the design of the mounting holes of MMS structure is in accordance with the dimensions of the SPV Module to be used in the project.
7. The thickness of the members shall be arrived by structural analysis after considering combination of all possible loads.
8. The primary loads and load combinations for design of MMS structure shall be as specified as under:

i. **Primary Loads:**

- Dead Load (DL)
- Live Load (LL)

- Wind Load (WL) – Both along X&Z directions
- Seismic Load (EL)- Both along X&Z directions

ii. **Wind Load (WL) for MMS design**

9. Load due to fair (positive pressure) wind direction on design tilt angles of MMS members.
10. Load due to adverse (negative pressure) wind direction on design tilt angles of MMS members.
11. Load due to wind on side face of MMS members.
12. In case, String Combiner Box (SCB) is mounted on the Module Mounting structures, the contractor shall to take into consideration the load of SCB during design of MMS. Further suitable supporting members for mounting the SCB on the MMS shall also be in the scope of the Contractor. Separate structure for the mounting of SCB can also be proposed.
13. The contractor shall design the structure height considering highest flood level at the site. The minimum clearance between the lower edge of the module and the ground shall be the higher of (i) highest flood level at the site + 100 mm and (ii) 500 mm.
14. The support structure design & foundation shall be designed with reference to the existing soil conditions in order to withstand wind speed applicable for the zone (Site Location), whichever is higher, using relevant Indian wind load codes. The structures and foundations shall also conform to the seismic conditions pertaining to the zone using relevant Standards and codes.
15. Modules shall be mounted on a non-corrosive support structures. Mounting structures shall be designed to withstand the extreme weather conditions in the area. The terrain factor K2 and topography factor K3 shall be as per IS 875 (Part 3).
16. MMS frames, post, base plate, assembly of the array structures, etc. shall conform to IS-Standards mentioned in this document. The MMS structure shall be made of hot dipped galvanized steel with minimum GSM 610 kg/sqm and/or minimum coating thickness of 80 microns. It is to be ensured that galvanization process is done as per relevant standards. Galvanization shall confirm to IS-2629, 4759 & 4736 as applicable. The galvanization shall be done after fabrication of members and cutting of holes to ensure galvanization of all cut/exposed edges. Purity of Zinc to be used for galvanizing shall be 99.5% as per the IS: 209. Before the galvanizing the steel section shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or other foreign matters. The galvanized steel member shall withstand minimum four (4) dips of one (1) minute duration each in copper sulphate solution as per IS: 2633.
17. All fasteners (nuts, bolts and washers) shall be of Stainless steel of grade SS316 and must sustain the adverse climatic conditions. If stainless steel (SS304) fasteners are used they must have protective coating to insure the life of 25 years. All bolts shall be tighten with designed torque mechanically.

18. Welding of the structure at site shall not be allowed and only bolted connections shall be used.
19. For multiple module mounting structures located in a single row, the alignment of all modules shall be within an error limit of maximum 10mm.
20. Cable should pass from Pipes and Cable-ties shall be used to hold and guide the Pipes (cables/wires) from the modules to inverters or junction boxes. All the cables were aesthetically tied to module mounting structure.
21. **The Structure must be designed considering 1.5 times factor of safety.**
22. Modules shall be clamped/bolted with the structure properly. The material of construction shall be AL/S.S. Clamps/Bolts with or without EPDM rubber shall be designed in such a way so as not to cast any shadow on the active part of a Modules.
23. Cutting, welding, drilling etc. at site is not allowed for MMS. Contractor shall carry out all correction in structure (if required) at his works.
24. Contractor must submit all the quality test documents and test certificates complying with requirement of the structure.
25. **Mounting of PV Modules**: -PV Modules will be supplied in the palates each arranged with colour coding to minimize module mismatch losses. Contractor should select the modules from a single palate for mount them in the same array so as to minimize module mismatch loss.

4.4.2.2.3 Standards & Codes

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Standards	Description
IS 800: 2007	Code of Practice for use of structural steel in general building construction of steel
IS 875:Part 1 & 2	Code of Practice for Design Loads for Buildings and Structure.
IS 875: Part 3	Code of Practice for the Design Loads for Building and Structures –Wind Loads
IS 1893: 2002	Criteria for earthquake resistant design of structures -General provisions and buildings
IS 513: 1994	Cold-rolled low carbon steel sheets and strips
IS 814	Covered electrodes for manual metal arc welding
IS 3043 - 1987	Grounding of mounting structures
IS 4759	Hot Dip Zinc coating on Structural Steel and other allied products
IS 4736	Hot Dip Zinc coating on mild steel tubes
IS 2062	Hot Rolled Medium and High Tensile Structural Steel
IS 811	Cold Formed Light Gauge Structural Steel Sections

IS 1161	Steel Tubes for Structural Purpose
IS 4923	Hollow Steel Sections for Steel Structural use

4.4.2.2.4 Routine Testing & Inspection

All the acceptance tests and Routine Tests, inspection at manufacturers works as well as at site shall be carried out strictly as per specifications, relevant standards and in accordance with the Final Quality Assurance Plan and reports shall be submitted to Employer. The Employer or its authorized representative reserves the right to inspect the MMS at the manufacturer's site prior to dispatch.

4.4.2.3 STRING COMBINER BOX (SCB)

4.4.2.3.1 String Combiner Box (SCB)

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 be equipped with appropriate functionality, safety (including fuses, grounding, contacts etc), protection and String Monitoring Unit (SMU). The SMU shall be capable to monitor each input current, string voltage and total current of all the strings connected to SMU. PV array showing the location of each SMU shall be displayed as a screen shot on the SCADA screen so that operator can identify the faulty SMU and the string from the SCADA screen

4.4.2.3.2 General Requirement

1. SCB shall be corrosive resistant and should not be sensitive to the salty/ foggy weather condition.
2. The maximum voltage of the PV Plant is in open circuit and the lowest ambient temperature of the PV modules. SCB shall support minimum 1000 V DC /as per system requirement in open circuit without deterioration.
3. The maximum input current is in short circuit condition and the highest sun irradiance. Regardless the number of inputs, each input shall be rated accordingly during the highest irradiance conditions. The reverse-current resistance of the PV modules must be taken into account for solar PV rated fuse sizing.
4. The rating of all component of SCB's shall be suitable with adequate factor of safety to inter connect the Solar PV array. There shall be suitable space for workability and natural cooling.
5. Array Junction Box should have adequate ratings of solar DC fuses & isolating miniature circuit breakers at both the terminals (+ve as well as –ve), provided in recommendation with the inverter manufacturer. The fuses should be so designed that it should protect the modules from the reverse current overload.
6. Cable connectors to be used for connecting Solar PV Modules and SCB shall be in accordance with DIN EN 50521. Connectors shall be of Plug in socket design to be plugged together by hand but can be separated again using a tool only.

4.4.2.3.3 SCB Enclosure

1. The junction boxes shall be dust, vermin, and waterproof and made of polycarbonate or equivalent material, which should be sunlight/ UV resistive , fire retardant & must have minimum protection to IP65 (Outdoor) and Protection Class II. The enclosure shall be fire retardant with self-extinguishing property and free from Halogen. The enclosure shall be UV protected.
2. Degree of protection for enclosure shall be at least IP 65. The mechanical impact resistance of enclosure shall be IK 07 or better.
3. SCB shall have terminals blocks rated for minimum 1000 V DC and rated continuously to carry maximum expected current.
4. The size of the enclosure shall be designed in such a way that the temperature rise of the enclosure should not more than 30 deg C above the ambient temp of 50 deg C. The components mounted inside the SMU shall have higher temperature withstand capability and shall continuously operate under such conditions.
5. The terminals will be connected to copper bus-bar arrangement of proper sizes to be provided. The junction boxes will have suitable cable entry points fitted with

cable glands of appropriate sizes for both incoming and outgoing cables. Suitable markings shall be provided on the bus-bars for easy identification and weather resistant cable ferrules will be fitted at the cable termination points for identification.

6. In each SMU, 5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided to connect the PV strings.
7. Cables used in SCB shall be suitable for system voltage-1500V DC. 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 shall not fall off when the wire is disconnected from terminal blocks.
8. All PV inputs shall be protected with fuses and both polarities shall be protected. The fuses shall be gPV type and dedicated to solar applications and confirm to IEC 60269-6 or UL-2579 standards. String fuses should be so designed that it should protect the modules from reverse current overload.
9. Each SCB shall be provided with properly rated surge protection device (SPD). SPD shall be provided with Metal Oxide Varistors (MOV) type surge arrestors, which shall be connected from positive and negative bus to the earth. The discharge capability of the SPD shall be at least as per IEC 61643-12. During Earth fault and failure of MOV, the SPD shall safely disconnect the healthy system. SPD shall have thermal disconnector 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 disconnector, the SPD shall be able to extinguish the arc.
10. Resistance Temperature Detector (RTD) type or semiconductor type temperature sensor shall be provided to monitor the cabinet temperature.
11. MC4 connector conforming to IEC 62852 or EN 50521 shall be provided at each SCB input. Cable gland (double compression metallic) of suitable size for DC cables shall be provided at the SCB output.
12. Provision shall be made for disconnection for each of the groups/incomers. A test point shall be provided for each-sub group for quick fault location and to provide group array isolation.
13. At outgoing side DC Disconnector switches Switch of suitable capacity shall be provided.
14. Two (2) pole ON LOAD disconnector switches (s) shall be installed at the output of the SCB to secure any intervention in the SCB or in the field as per IEC60947-3.
15. Short-circuit Withstand capacity of the PV-SPD has to be properly selected with respect to the total String current at Combiner Box (SCB) output plus the reverse (back) current from the Inverter side.
16. Overvoltage protection shall be ensured in DC and AC circuits using type II surge arrester.

4.4.2.3.4 String Monitoring Unit (SMU)

1. SMU shall communicate over RS485 or any other compatible networking system. The protocol and speed of the communication line shall allow the Monitoring system of the plant to collect all data. Shunt Characteristic shall be employed for sensing current & voltage of string.
2. At least following parameters shall be available at SCADA for monitoring the health of SCB:
   a. String(s) Current
   b. Voltage of SMU
   c. Total Current of SMU
   d. Total Power of SMU
   e. Status of Disconnector Switches
   f. Cabinet Temperature
   g. SPD operating status

4.4.2.3.5 Standards and Codes

Connectors, Junction Boxes, Surge Protection Devices, etc. must also conform to the relevant international/ national Standards. The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards

Standard	Description
IEC/EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical
IEC/EN61439- 1 & 2	Low-voltage switchgear and control gear
IEC/EN 60529/IS 2147	Enclosure protection
UL-94V	Fire Resistant/Flammability
UL-746C	UV Resistant
EN50539-IEC 61643-12	Surge protection
IEC 60269- 6/UL- 2579	Solar PV application string fuses
IEC 62208	Enclosure for Low Voltage Switchgear and Controlgear assemblies
IEC 60695-2-11	Fire Hazard Testing

4.4.2.3.6 Routine Testing & Inspection

All the acceptance tests and Routine Tests, inspection at manufacturer's works as well as at site shall be carried out strictly as per specifications, relevant standards and in accordance with the Final Quality Assurance Plan and reports shall be submitted to Employer. The Employer or its authorized representative reserves the right to inspect the SCBs at the manufacturer's site prior to dispatch.

4.4.2.4 POWER CONDITIONING UNIT (PCU)

4.4.2.4.1 Power Conditioning Units (PCU)

Power Conditioning Unit (PCU) shall consist of an electronic inverter along with associated control, protection and data logging devices. The system shall incorporate a uni-directional inverter designed to supply the AC power to the grid at load without any disturbance. The power-conditioning unit shall automatically adjust the voltage & frequency levels to suit the Grid. All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency. The model offered should have operating capability to operate under the existing environmental conditions in India. Only indoor/**Outdoor** type PCU shall be accepted.

4.4.2.4.2 General Requirements

1. PCU shall confirm to IEC 61000 or equivalent international standard for compliance to requirements for Electromagnetic compatibility and to IEC60068-2 or equivalent international standard for requirement of environmental testing. The rating of PCU/Inverter shall not be less than 1 MW. Block wise installation should have to be adopted.
2. The inverter supplied shall have minimum of **40%** additional DC input Capacity. (E.g. Inverter is supplied with rated capacity of 1000 kW (AC) shall accept at least **1400 k**W of DC power). Contractor shall also submit maximum overloading capacity of the PCU at ambient temperature of 50 deg C along with the PCU data sheet. In case, the rated capacity is mentioned in KVA, the certificate of OEM declaring the power factor of the Inverter/PCU at 50 deg Cel has to be submitted and the power factor shall be multiplied by the KVA rating to achieve the rated capacity of the Inverter in KW.
3. PCU shall also confirm to IEC 62109 or IEC 62103 or equivalent international standard for compliance to requirement for the design and manufacture of PCU for protection against electric shock, energy, fire, mechanical and other hazards.
4. Only those PCU's/Inverters models/capacity which are supplied and installed (as on the original date of submission of Bid) for more than 50 MW capacity Solar PV projects in India shall be considered for this project. The Contractor must provide all the relevant data sufficing the above requirement to the Employer.
5. All the PCUs shall consist of associated control, protection and data logging devices and remote monitoring hardware and compatible with software used for string level monitoring.
6. The rated power /name plate capacity of Inverter shall be AC Output of the Inverter at 50°C ambient temperature. Hence, the maximum AC Power Output at 50°C ambient temperature should not be less than the rated capacity of the Inverter.
7. **Grid Connectivity**: Relevant CERC regulations and grid code as amended and revised from time to time shall be complied. The system shall incorporate a uni - directional inverter and should be designed to supply the AC power to the grid at load end. The power conditioning unit shall adjust the voltage & frequency levels to suit the grid. The inverter output shall always follow the grid in terms of voltage and frequency. This shall be achieved by sensing the grid voltage and phase by the feedback control loop of the inverter and the inverter shall always remain synchronized with the grid

8. PCU must have provision to be isolated from grid through Circuit Breakers, which shall be inbuilt with the inverter or located in separate standalone panel. In case of grid failure, the PCU shall be re-synchronized with grid after revival of power supply. Vendor to furnish the time taken by PCU to be re-synchronized after restoration of grid supply during detailed engineering. PCU and its components shall be designed accordingly and parallel operation equipped with advanced/dynamic grid support & monitoring features. Suitable synchronizing methodology shall be provided for synchronizing the AC output from the inverters.
9. The PCU must have the feature to work in tandem with other similar PCU's and be able to be successively switched "ON" and "OFF" automatically based on solar radiation variations during the day. The PCU shall be capable of controlling the power factor dynamically.
10. The minimum euro efficiency of the PCU as per IEC 61683 shall be 98% at 100 % load. The Contractor shall specify the conversion efficiency at following load conditions i.e. 25%, 50%, 75% and 100% during detail engineering, which shall be confirmed by type test reports.
11. The PCU shall have protection against any sustained fault in the feeder line and against lightning discharge in the feeder line. PCU should be equipped with space heater in each cabinet to control through hygrostat and thermostat.
12. The PCU shall also have the adequate protection against earth leakage faults. The incoming DC feeder of PCU shall have suitably rated isolators to allow safe start up and shut down of the system and its terminals should be shrouded. The DC feeder shall terminate in the fuse box through a suitable fuse rating. The PCU fuse box shall have one spare terminal with fuse and holder for the future use. The connection between the fuse box and inverter shall be through copper bus bars or copper cable.
13. Internal Surge Protection Device (SPD) shall be provided in the PCU on DC and AC side. It shall consist of Metal Oxide Varister (MOV) type arrestors. The discharge capability of the SPD shall be as per IEC 61643-12. During earth fault and failure of MOV, the SPD shall safely disconnect the healthy system. SPD shall have thermal disconnector 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 disconnector, the SPD shall extinguish the arc.
14. The PCU inverter shall be Transformer-less. However, adequate grounding for the DC side shall be provided.
15. Each solid state electronic device shall have to be protected to ensure long life as well as smooth functioning of the inverter.
16. The PCU shall have anti-islanding protection as per IEC 62116 or equivalent international standard.
17. The PCU shall have required protection arrangements against reverse polarity of DC connection and remains in standby mode.
18. PCU shall have arrangement for adjusting DC input current and should trip against sustainable fault downstream and shall not start till the fault is rectified.
19. The PCU shall be tropicalized and design shall be compatible with conditions prevailing at site. Provision of exhaust fan with proper ducting for cooling of PCU's

should be incorporated in the PCU's, keeping in mind the extreme climatic condition of the site.

20. It should have local display with keypad for system control including start & stop, monitoring instantaneous system data, event logs, data logs with date & time and configuration settings. Control and readout should be provided on an indicating panel integral to the inverter.
21. **Display**: The PCU shall have local LCD (Liquid crystal display) and keypad for system control, monitoring instantaneous system data, event logs, data logs and changing set points. PCU front panel shall be provided with display (LCD or equivalent) to monitor the following Instantaneous DC power input
    a. DC input voltage
    b. DC Current
    c. Instantaneous active AC power output
    d. Instantaneous reactive AC power output
    e. AC voltage (all the 3 phases and line
    f. AC current (all the 3 phases and line)
    g. Power Factor
    h. KWh produced during entire day
    i. Total kWh produced during its life time
    j. Thermal loading (percentage)

22. 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 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.
23. All the cables from the array strings to the solar grid inverters shall be connected/terminated in the DC Distribution Box with suitable rated GPV type fuse conforming to IEC 60269-6 or UL- 2579 Standards.
24. In case external auxiliary power supply is required, Standalone UPS shall be used to meet auxiliary power requirement of PCU, it shall have a backup storage capacity of at least 120 minutes.
25. 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 station shall be adequately ventilated. The Ventilation plant capacity and air quality of inverter room shall be as per inverter and other auxiliaries manufacturer's recommendations. Filter banks at the air inlet of the inverter room shall be provided to prevent dust ingress.
26. 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