to the following items whichever necessary for implementation of the Solar PV Project. All civil works should be carried out as per the relevant standards and guidelines.

1. MODULE MOUNTING STRUCTURE

1.1 SCOPE

This section covers activities related to design, manufacturing, testing, supply, insurance, transportation, delivery at project site, storage, erection, testing of module mounting structure as detailed hereunder.

Adequate number of mounting structure shall be provided for installation of the required number of PV module. The contractor shall provide the details of this item in the detailed design report.

1.2 TECHNICAL REQUIREMENTS

- The Module structure design shall be appropriate and innovative. It must follow the existing land profile.
- The structure shall be designed to allow easy replacement of any module and shall be in line with the site requirement.
- Design drawings with material selected and their standards shall be submitted for prior approval.
- The bidder 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) above highest flood level at the site and ii) 600 mm.
- There must be sufficient gaps between the rows of the panels and all precautions to be taken to avoid any shading on the panels.
- The module alignment and tilt angle shall be calculated to provide the maximum annual energy output. This shall be decided based on the location of array installation.
- The mounting structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation, absorb and transfer the mechanical loads to the base properly. Welding of structure at site shall not be allowed.
- The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels at the same time.
- All fasteners shall be of stainless steel of grade SS 316 and must sustain the adverse climatic conditions. Two numbers of anti-theft fasteners of stainless steel on two diagonally opposite corners for each module shall be provided. However if stainless steel (SS 304) fasteners are used they must have protective coating to ensure the life of 25 years. Clamps/bolts shall use EPDM rubber and shall be designed in such a way so as not to cast any shadow on the active part of the module.
- Nut & bolt, supporting structures including module mounting structures shall have to be adequately protected from atmosphere and weather prevailing in the area.
- The Mounting structure shall be grounded properly using maintenance free earthing kit.
- The support structure & foundation shall be designed with reference to the existing soil condition in order to withstand wind speed of the location as given in relevant Indian code for wind (IS 875 Part III, latest edition) or 200 kmph whichever is higher and seismic load (IS 1893, latest edition).
- The module mounting structure shall be designed as per prevailing IS 800 and IS 801 and Sections shall be as per IS 808 and IS 811 (Latest edition) and shall be safe against wind and seismic force. Detailed design including STAAD output file shall be submitted for final approval. However the minimum thickness of the

structural sections shall not be less than 3.0 mm. The members are to be designed taking into consideration the hot & humid nature of the area.

- The array structure shall be made hot dipped galvanized steel of suitable size. The specification of steel should be as per relevant IS 2062 (Latest Edition). The thickness of galvanization should be as per the relevant standards for galvanization but minimum 80 microns. It is to ensure that before galvanization the steel surface shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such foreign material as are likely to interfere with the galvanization process. The bidder should ensure that inner side should also be galvanized. All galvanized materials shall withstand tests as per IS 2633.
- Foundation is to be provided with piling if necessary. Foundation should be of minimum M20 grade of concrete (with provision of cube test as per relevant IS code) and minimum Fe500 reinforcing steel (conforming to IS 1786, latest edition). Design should be such that the foundation should be safe against the Soil Load Bearing Capacity as obtained at site. The work includes necessary excavation, concreting, curing, back filling, shoring & shuttering etc.
- For multiple module mounting structures located in a single row, the alignment of all modules shall be within an error limit of maximum 10 mm.
- The bidder/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagram and drawings.
- Bidder must submit all the quality test documents and test certificates complying with the requirement of the structure.

1.3 APPROVAL

- Proposed layout of the Module mounting structure fitted with equipments & other ancillaries as required over the proposed developed land profile shall be submitted with Detailed Design Report for approval.
- Design, drawings, specifications of all components with material selected & installation details shall also be included with Detailed Design Report.
- Approval of the Engineer in charge should be taken before execution of the work at site.

The contractor shall deliver the product to the site only after receipt of such approval against their prayer in writing from WBSEDCL.

2. OTHER CIVIL WORKS

2.1 DETAILED CONTOUR SURVEY & SOIL INVESTIGATION OF THE SITE

The turnkey contractor shall be responsible for detailed soil investigation and contour survey at required locations for the purposes of foundation design and other design/ planning required for the successful completion of the project. The contractor must submit the detailed soil investigation report, bore log records, ERT reports and contour survey to WSEDCL.

2.2 TOPOGRAPHICAL SURVEY

Topographical survey shall have to be done by the Successful Bidder of the proposed site at 5 m interval with the help of Total Station or any other suitable standard method of survey. All necessary Reduced Levels (RL) as entered in the Field Book have to be submitted along with pre contour layout of the total site. The formation levels of the proposed power plant have to be fixed with reference to High Flood Level

of the proposed site. The ground level and plinth level of structures shall be fixed taking into consideration the highest flood level and surrounding ground profiles.

2.3 SOIL TEST

The Contractor is advised to and is solely responsible to carry out detailed Geotechnical investigation to ascertain soil parameters of the proposed site for the use of planning / designing / construction / providing guarantee / warranty of all civil work including but not limited to foundations / piling for module mounting structures, HT lines, etc. The Contractor shall carry out soil investigation through any Govt. approved / certified soil consultant. These reports shall be furnished to the Employer prior to commencing work. All RCC works shall be provided of required grade of concrete as per relevant IS specifications as well as soil data considering appropriate earthquake seismic zone, wind velocity, whether effect, soil characteristics etc.

2.4 SOIL INVESTIGATIONS

The scope of soil investigation covers execution of complete soil exploration including boring, drilling, collection of undisturbed soil sample where possible, otherwise disturbed soil samples, conducting laboratory test of samples to find out the various parameters mainly related to load bearing capacity, ground water level, settlement, and soil condition and submission of detail reports along with recommendation regarding suitable type of foundations for each bore hole along with recommendation for soil improvement where necessary.

2.5 OTHER INVESTIGATIONS

Successful Bidder shall obtain and study earthquake and wind velocity data for design of module mounting structure, and considering all parameters related to the weathers conditions like Temperature, humidity, flood, rainfall, ambient air etc. The Successful Bidder shall carry out Shadow Analysis at the site and accordingly design strings and arrays layout considering optimal use of space, material and man-power and submit all the details / design to Employer for its review / suggestions / approval.

2.6 LAND DEVELOPMENT FOR SITE ACTIVITIES

The turnkey 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), leveling of ground (wherever required) etc. for commencing the project. It is to ensure that land must be graded and leveled properly for the flow of water. It is advisable to follow the natural flow of water at the ground. The Finished Ground Level shall be determined considering High Flood Level of the site area and accordingly, land development has to be done within the scope of this tender. WBSEDCL will assist in getting the High Flood Level from local authority.

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. In case the filled earth is brought out from outside the plant, the contractor shall provide the necessary challans. On the other hand, additional earth, if any, must be disposed of properly. Bidder shall take reasonable care to ensure that the plant is aesthetically designed with proper landscaping by covering open areas with grass turf. Site access from the local road is within the scope of tender. Site will be handed over with demarcation.

2.7 FOUNDATIONS

The contractor is responsible for the detailed soil investigation and subsequent foundation design of the structures in the plant. The foundation of the module mounting structures, buildings and other important structures must be approved by SECI prior to construction. The contractor must provide the detailed design and calculations of the foundation. The foundations should be designed considering the weight and distribution of the structure and assembly, and a wind speed of 200 km per hour. Seismic factors for the site have to be considered while making the design of the foundation. Successful Bidder shall also plan for transport and storage of materials at site

2.8 SWITCH YARD CIVIL WORKS

Switchyard civil work includes step up transformer plinth, HT Switchgear kiosk plinth, double pole, 4 pole or lattice structure foundation, earth pits, gravel/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 33 kV ground clearances. Earth pit construction shall be of brickwork covered with RCC (1:2:4) slabs. 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 will be provided. Area enclosed within this perimeter must be filled with gravel.

2.9 BUILDINGS

Buildings are required to be constructed for housing the electrical equipment/ panel and local control room, central control room with conference room, office cum store building for the operation & maintenance of Solar Photovoltaic Power Plant. Security houses/ cabins shall also be required at strategic locations to secure the plant from any theft. The building shall be constructed with conventional RCC framed structure with brick partition walls. Equipment room shall be designed as per the OEM recommendations to ensure desired life of equipment. Plinth level of all buildings shall generally be kept minimum 600 mm above the FGL. Bidder shall furnish the drawing of the proposed buildings to the Employer for approval, prior to construction. The construction of the same shall be as under-

2.9.1 RCC WORKS

All RCC works shall be as per IS 456 and the materials used viz. Cement, reinforcement steel etc. shall be as per relevant standards.

2.9.2 BRICK WORKS

Brick works in cement mortar (CM) 1:6 for 10" thick and 5" thick wall respectively. All brick works shall be using 1st class bricks of approved quality as per IS 3102.

2.9.3 DOORS & WINDOWS

Steel framed doors, Windows and ventilators shall conform to IS – 1081 with necessary glass panels including of all fixtures and painting etc. complete. Doors and windows shall be made of aluminum sections. All sections shall be 20 microns anodized. Sections of door frame and window frame shall be adopted as per industrial standards. Door shutters shall be made of aluminum sections and combination of compact sheet and clear float/ wired glass. The control room shall require a number of windows/ louvers to provide ventilation/ fresh air circulations.

2.9.4 PLASTERING

Plastering in cement mortar 1:4 and 1:6 shall be applied to all internal, external walls and ceiling of slab respectively as per IS 1542.

2.9.5 FLOORING

Flooring for stores shall be of cement flooring in concrete mix 1:2:4 using 10 mm aggregates as per IS 2571. Flooring for control building, equipment room and other places, if needed, shall be of vitrified tiles 8 mm. For toilet area, the floor shall be of ceramic tiles 8 mm thicknesses. The floor finishing must include skirting up to a suitable height. The wall tiles, if proposed, shall be glazed tiles of 6 mm thickness and provided up to lintel level.

2.9.6 ROOFING

The roof of the building shall be insulated and waterproofing shall be done as per relevant IS standard.

2.9.7 PLINTH PROTECTION

Plinth protection 1000mm wide shall be provided around all the buildings.

2.9.8 WHITE WASHING & COLOUR WASHING

White washing and colour washing work shall be conforming to IS 6278.

- Internal walls - Acrylic distempering as per IS 427.
- External walls – Heat reflective synthetic enamel as per IS 428.
- For cement painting IS 5410 shall be followed.
- For painting of steel doors, ventilators IS 2338, IS 1477 (Part I & II) shall be followed.

2.9.9 ROLLING SHUTTERS

Rolling shutters made of cold rolled strips shall conforming to IS 4030 with approved gauge thickness shall be provided with all fixtures, accessories, painting all etc. complete.

2.9.10 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.

2.9.11 PLUMBING AND SANITARY

Sanitary fittings, which include water closet (EWC/IWC), wash basins, sink, urinal fitting including flushing tank, and necessary plumbing lines shall be provided for office cum stores building and Security house.

2.9.12 ELECTRIFICATION OF BUILDING

Electrification of buildings shall be carried out as per IS 732 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. Supervisor room must be fitted with suitably sized HVAC system. It is encouraged that bidder shall use the latest energy efficient equipment for the electrification and illumination.

2.9.13 TOILET

Toilet shall be designed for 20 persons; and constructed with following finish

- Floor: Vitrified tiles/ ceramic tiles
- Door window: made out of aluminum sections, 6mm float glass
- Ventilators: Mechanical exhaust facility
- Plumbing fixtures: Repute make
- Sanitary ware: Repute make
- EWC: 390 mm high with health facet, toilet paper roll holder and all fittings Urinal (430 x 260 x 350 mm size) with all fittings.
- Wash basin (550 x 400 mm) with all fittings.
- Bathroom mirror (600 x 450 x 6 mm thick) hard board backing CP brass towel rail (600 x 20 mm) with C.P. brass brackets Soap holder and liquid soap dispenser.
- GI pipes (B class) of reputed makes
- Overhead water tank equivalent of 1,000 litre capacity

2.9.14 DRAINAGE FOR TOILETS

Drainage pipes shall be of PVC (6 kg/cm2) Supreme, Prince or equivalent make. Gully trap, inspection chambers, septic tank for 15 person and soak well to be constructed for abovementioned requirement.

2.10 WATER SUPPLY & CLEANING

Suitable arrangement of water shall be ensured to cater the day-to-day requirement of drinking water and needs of Solar Photovoltaic during entire O&M period. The Bidder shall estimate the water requirements for cleaning the photovoltaic modules at least once in every week in order to operate the plant at its guaranteed plant performance. All necessary arrangement for wet cleaning of the solar panels shall be in the scope of the bidders and accordingly the agency has to provide suitable water source along with all the necessary equipment, accessories, tool & tackles, pumps, tankers, tractors and water storage, piping arrangement which as may be required for the same..

2.11 ROADS WITHIN SOLAR POWER PLANT

Suitable approach road and internal Solar Photovoltaic roads to carry safe and easy transportation of equipment and material at the project site shall be made. The road should provide easy and fast approach to each location of the plant. These roads are to be designed optimally to carry the crane load with all necessary chambers, gradients, super elevation, and radius of curvatures for the easy movement of cranes, trucks and public transport. Roads are to be constructed with sufficient width (minimum 3.75m) followed by 0.5m well compacted shoulders on each side. The road must be well compacted as per the relevant IS standards and MORTH updated till date. All approach and internal roads shall be Bituminous Road with proper base development. Pathways would be either of concrete or brick soling with PCC of adequate thickness. Also, all cable crossings and other crossings shall be provided with GI/ Hume pipes.

2.12 PERIPHERAL BOUNDARY WALL AND FENCING:

The periphery of the project area shall be protected by means of boundary wall of about 2.4 meter height to avoid any unauthorized access to the plant. The Boundary wall shall comprise of cast-in–situ RCC Columns of minimum height upto 1.8 m from FGL with beams as per design and 125 mm thick 1^{ST} Class brick work. Top of the wall shall be provided with Zinc-Aluminium Concertina fitted & fixed with suitable sizes of MS angle/channel sections. The boundary wall must be provided with rugged main entry gate. The construction of peripheral wall and the main entry gate must confirm to relevant IS slandered and practice.

Switch Yard fencing may be of GI Chain Link of height about 1.8 m fitted & fixed with MS angle/flat with necessary nuts & bolts, welding and out of the total height 0.6 m from FGL and necessary foundations (Minimum 0.5 m below the original GL) shall be made with 1^{ST} Class brick work (1:6).

Wall and Fencing shall be with all necessary finish and colour/paint complete.

Details of wall/ fencing, material details along with design report and drawings are to be submitted for approval.

2.13 DRAINAGE

The storm water drainage shall be planned for the plant to ensure no water stagnation in the plant. The drains must be constructed with brickwork/ RCC/ RR masonry as suitable for the site conditions. The drains outfall must be connected to the nearest drain outside the plant premises. It is advised that the drainage for the plant must be designed keeping the natural flow of water to the nearest exit point. Bidder is to provide RCC hume pipe at the crossing of road and drains and at required locations. The peripheral drain shall be of brick pitching which is backed up by cement mortar bed and all joints are filled up with cement mortar in C.M. 1:4, no pointing and plastering is required. All other internal drains i.e. on both side of central road, pathways to inverter room, control room, switchyards are to be done by excavating the drain of required size and with required trapezoidal section.

2.14 PAINTING & FINISH

All metal surfaces and support structures shall be thoroughly cleaned of rust, scale, oil, grease, dirt etc. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking the finishing coat. After Phosphate treatment, two

(2) coats of yellow zinc chromate primer shall be applied followed by two (2) coats of epoxy based synthetic enameled paint. Shade shall be Siemens Grey RAL- 7032. Thickness of paint shall be not less than 75 micron. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

2.15 WATCHMEN / SECURITY CABIN

Contractor shall provide adequate numbers of prefabricated Watchman's portable cabin at strategic locations within of the plant. The Minimum size of watchmen's (Security Cabin) cabin is 1.2 meter x 1.8 meter size and height of 2.4m with appropriate roof at the top. Location of the watch Cabin (Security Cabin) will be as directed by the Employer. The Prefabricated Security Cabin of size 3 meter x 3 meter at the main entrance gate shall be designed and constructed by the Successful Bidder keeping in view the safety and security of the power plant.

2.16 CABLE TRENCH

For cabling purposes of the plant, cable trench shall be provided as per requirement. The trench shall be as straight as possible with a firm and smooth base. The trench should be made of RCC with adequate foundation and should be covered with concrete slab. Sufficient arrangement shall be provided to drain out accumulated water inside the cable trench.

Detailed design & layout of cable trench to be prepared as per project requirement.

TECHNICAL SPECIFICATION: ELECTRICAL

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1. SOLAR PV MODULE

1.1 SCOPE

This section covers activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of solar modules as detailed hereunder.

a. Solar Poly crystalline modules having capacity greater than 250 Wp may be used for the project for 10 MW Solar PV Power Plant in Patni (Khemasuli), Paschim Medinipur, West Bengal. However the make, capacity, technical specification and the model no. of each module connected with an individual inverter should be the same.

b. The proposed solar PV plant shall be of capacity 10 MW (AC) along with their associated equipment. The capacity of the Plant shall be determined to attain minimum of 10 MW (AC) at the point of evacuation and the net minimum guaranteed generation mentioned in the clause no. 11 of ITB of the tender document.

The scope of supply shall also include spare modules (at least 50 Nos.) required for any normal or breakdown maintenance and special tools & plants required for erection & maintenance. Corresponding parts of all the equipments & spares shall be of the same specification & workmanship and shall be interchangeable. All the material & workmanship shall be of reputed make as have proven successful in their respective uses in similar services & under similar condition.

1.2 STANDARDS

The PV modules must conform to the latest edition of any of the following IEC / equivalent BIS Standards for PV module design qualification and type approval:

Sl. No.	Standards	Description
1	IEC: 61215/IS: 14286	Crystalline silicon terrestrial photovoltaic modules – Design qualification and type approval.
2	IEC: 61730 – Part 1	Photovoltaic (PV) module safety qualification – Requirements for construction.
3	IEC: 61730 – Part 2	Photovoltaic (PV) module safety qualification – Requirements for testing.
4	IEC: 61701/IS: 61701	Salt Mist Corrosion Testing of the module.
5	IEC: 62804	Test method for detection of Potential Induced Degradation of photovoltaic (PV) modules.

The proposed PV Module must have the Test Certificate issued from accredited test laboratories of Ministry of New and Renewable Energy, Government of India under off grid programme.

The test certificates issued from IEC accredited laboratories shall also be acceptable.

The manufacturers should get their samples tested as per the new format/ procedure which are effective from 1st April 2013 onwards as per MNRE, Govt. of India Guideline.

1.3 IDENTIFICATION AND TRACEABILITY

Each PV module must use a RF identification tag (RFID), which must contain the following information:

i. Name of the manufacturer of PV Module
ii. Name of the Manufacturer of Solar cells
iii. Month and year of the manufacture (separately for solar cells and module)
iv. Country of origin (separately for solar cells and module)
v. I-V curve for the module
vi. Peak Wattage, I_m, V_m and Fill Factor for the module
vii. Unique Serial No and Model No of the module
viii. Date and year of obtaining IEC PV module qualification certificate
ix. Name of the test lab issuing IEC certificate
x. Other relevant information on traceability of solar cells andmodule as per ISO 9000 series.

RFID for each solar module shall be provided inside or outside of the module and must be able to withstand environmental conditions and last the lifetime of the solar module as per MNRE norms which is effective from 1st April 2013.

1.4 AUTHORIZED TESTING LABORATORIES/ CENTERS

PV modules must qualify (test reports/ certificate from IEC/NABL accredited laboratory should be enclosed) as per the relevant IEC standard. Additionally the performance of PV modules at STC conditions must be tested and approved by one of the IEC / NABL Accredited Testing Laboratories including Solar Energy Centre (SEC). However, qualification certificate from IEC/NABL accredited laboratory as per relevant standard for any of the higher wattage (greater than 50 kWp) regular module should be accompanied with the SEC report/certificate.

1.5 PERFORMANCE WARRANTY

A. Material Warranty: The manufacturer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than ten (10) years from the date of sale to the original customer (i.e. EPC Contractor).

i. Defects and/or failures due to manufacturing
ii. Defects and/or failures due to quality of materials
iii. Non conformity to specifications due to faulty manufacturing and/or inspection processes.

If the solar Module(s) fails to conform to this warranty, the manufacturer will repair or replace the solar module(s), at the Owner's sole option. The contractor shall be responsible to contact with the contractor if any of the above mentioned cases occurred.

B. Performance Warranty: The manufacturer should warrant the output of Solar Module(s) for at least 90% of its rated power after initial 10 years & 80% of its rated power after 25 years from the completion of trial run at site/date of final commissioning. The contractor shall collect the Warranty Certificate for performance of the modules from the manufacturer and submit the same to WBSEDCL prior to delivery of the products to the respective sites.

If, Module(s) fail(s) to exhibit such power output in prescribed time span, the Contractor will bound to either deliver additional PV Module(s) to replace the missing power output with no change in area of site used or replace the PV Module(s) with no extra cost claimed at Owner's sole option.

The manufacturer should warrant the output of Solar Module(s) for at least 90% of its rated power after initial 10 years & 80% of its rated power after 25 years from the completion of trial run at site/ date of final commissioning.

Manufacturer of proposed PV modules must have the ISO 9001:2008 or ISO 14001 Certification for their manufacturing unit for their said manufacturing item.

Note: Only indigenously manufactured PV modules should be used in Solar PV Power Plants under this scheme. However, other imported components can be used, subject to adequate disclosure and compliance to specified quality norms and standards.

1.6 PERFORMANCE RATIO OF THE PLANT

Performance Ratio of the plant calculated for any time period of measurement shall be minimum 75 %.

PR - Provisional Acceptance Test Verification Procedure

The Performance ratio test aims at the comparison of the actual PV plant energy production with the guaranteed value for a limited operation time of the PV plant of 30 consecutive days.

After Commissioning of the Plant and after receiving all the satisfactory results regarding the correct operation of the plant, there will be continuous monitoring of the performance for 30 days. This monitoring will be performed on the site under the supervision of the Employer / Employer's engineer.

The final tests to prove the guaranteed performance parameters shall be conducted at site by the Contractor in presence of the Employer. The Contractor's commissioning / start-up Engineer shall make the plant ready to conduct such tests. The Performance Guarantee Tests (PG tests) shall be commenced, within a period of one (1) month after successful Commissioning. Any extension of time beyond the above one (1) month shall be mutually agreed upon.

Performance Ratio of the plant will be calculated as per IS/IEC 61724: 1998 (Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis).

Performance Ratio (PR) = $Y_A / Y_R [1 – \alpha * (T_{Cellavg.} – T_{Cell})]$

Where;

Y_A = Final PV system yield (representing the number of hours that the system would need to operate at its rated output power P_{Nom} to contribute the same energy to the grid as was monitored)

Or, $Y_A = E_{ac} / P_{Nom}$

Y_R = Reference yield (representing the number of hours during which the solar radiation would need to be at STC irradiance levels in order to contribute the same incident energy as was monitored)

Or, $Y_R = I_{RSite} / I_{RSTC}$

E_{ac} = AC energy injected into the grid during a clearly specified amount of time (kWh)

P_{Nom} = Installed nominal peak power of modules (Flash test rating at STC) (kWp)

I_{RSite} = Irradiation on the module plane of array during a clearly specified amount of time (measured with a Pyranometer installed on the array plane) (kWh/sq. m)

I_{RSTC}	=	Irradiance at STC (kW/ sq. m)
$T_{cell\ avg}$	=	Average cell/ module temperature (^{0}C)
T_{cell}	=	STC cell/ module temperature (^{0}C)
α	=	temperature coefficient of power (negative in sign) corresponds to the installed module (%/^{0}C)

Monitoring System for PR Verification

The following instrumentation will be used to determine the Solar Plant Performance:

- Power Meter at the delivery point.
- Power Meter for each inverter for reference only.
- One nos. calibrated pyranometer to determine irradiance on the plane of array (with a target measurement uncertainty of ± 2).
- One nos. calibrated pyranometer to determine irradiance on horizontal plane (with a target measurement uncertainty of ± 2)
- Two nos. thermocouples to measure module temperature with a measurement uncertainty of ±1 °C.
- Shielded ventilated thermocouple with a measurement accuracy of ±1°C.
- An anemometer mounted on a 10m mast to measure wind speed (without additional shadowing on modules).

During the comprehensive O&M period after commissioning, PR shall be tested in yearly basis considering 100% grid availability. However, WBSEDCL may check the PR at any time of the year for a period of minimum 7 days.

1.7 TECHNICAL REQUIREMENTS

- Modules should be Poly crystalline type having capacity of minimum 250 Wp. Higher capacity Solar PV modules will be preferred (more than 250 Wp).
- 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, it is required to have provision for earthing to connect it to the earthing grid. Module frame thickness/Height should be minimum 40 mm, the anodization thickness shall not be less than 15 micron. Junction box of IP 67 rated with min 3 no. of bypass diode and MC4 connectors with 1 meter of TUV 2pfg 1169/09.07 certified Cu cable of 4 mm sq.
- Solar module shall be laminated using lamination technology using established polymer (EVA: Ethylene-vinyl acetate).
- The back sheet used in the crystalline silicon based modules shall be of 3 layered structures. 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 more than 1000 V.
- The EVA used for the modules should be of UV resistant in nature. No yellowing of the back sheet with prolonged exposure shall occur.
- 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.
- The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation shall be

compatible with the thermal expansion properties of the Silicon cells and the module framing arrangement/material. The encapsulation arrangement shall ensure complete moisture proofing during the whole life of the solar modules.

- The Module shall be made of high transmittance glass front surface giving high encapsulation gain. The glass used to make the crystalline silicon modules shall be toughened low iron glass with minimum thickness of 4.0 mm for 72 cell module and 3.2 mm for 60 cell module. The solar cell shall have surface antireflective coating to help to absorb more sunlight in all weather conditions. The glass used shall have transmittance of above 90% and with bending less than 0.3% to meet the specifications.
- Module rating is considered under standard test conditions, however Solar Modules shall be designed to operate and perform as per installation site condition.
- The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary by more than 2 % (two percent) from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
- All materials used shall be having a proven history of reliable, light weight and stable operation in external outdoor applications and shall have service life of 25 years.
- The modules should be 100% PID (Potential Induced Degradation) tolerant and should comply with IEC 62804.
- Solar PV Module design shall conform to following requirement:
    - Weather proof DC rated MC connector and a lead cable coming out as a part of the module, making connections easier and secure, not allowing for any loose connections.
    - Resistant of water, abrasion, hail impact, humidity & other environment factor for the worst situation at site. o The PV Junction Box shall confirm IP 67 and shall have sufficient bypass diodes to avoid shadowing effects.
- Modules shall perform satisfactorily in relative humidity up to 95% and temperature between -10^0C and 85^0C (module temperature).
- The PAN file of the solar module should be validated by Third party.
- The developer shall arrange for the details of the materials along with specifications sheets of from the manufacturers of the various components used in solar modules along with those used in the modules sent for certification. The Bill of materials (BOM) used for modules shall not differ in any case from the ones submitted for certification of modules.
- Proof of procurement of components like cell, back sheet, lamination material, frames, Glass, sealant etc), mentioning manufacturer name, manufacturing date and relevant test certificate shall be submitted at the time of pre-dispatch inspection and acceptance.
- No different quality/makes of back sheets shall be used in the single lot of supply of modules.
- The modules used in the Plant are to be freshly manufactured (not having manufactured before the last date of bid submission)
- 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.
- SPV module shall have module safety class-II and should be highly reliable, light weight and must have a service life of more than 25 years.

1.8 SPECIFICATION OF THE PV MODULES

Desired specification of the PV Module shall be as mentioned hereunder:

SI. No.	Item	Description
1	Type	Crystalline Silicon - Poly
2	Efficiency of module	Minimum 15.5 % at STC
3	Cell efficiency	Minimum 17 % at STC
4	Fill Factor	Minimum 73 %
5	No. of cells per module	60 / 72
6	Module Frame	Non-corrosive and electrolytically compatible with the structural material, preferably anodized Aluminium.
7	Termination box	Thermo-plastic, IP 65, UV resistant
8	Blocking diodes	Schottky type
9	Bypass Diode	Yes, as required
10	Power Rating	The nominal power of a single PV module shall be minimum 250 Wp
11	Power tolerance	upto +5 %
12	Temperature co-efficient of power	Not more than - 0.45% / °C
13	Glass	High transmittance glass with Anti Reflective Coating (ARC)
14	RF Identification tag for each solar module	Shall be provided inside or outside the module and must be able to withstand environmental conditions and last the lifetime of the solar module as per MNRE Norms.

1.9 APPROVAL

- The Detailed Design Report Submitted by the contractor to WBSEDCL must contain but not limited to the following details of the solar modules:

- Detailed specification
- Necessary Drawings
- Type Test Report and Necessary Certificates etc.

- Inspection of Electro Luminescence (EL) & Potential Induced Degradation (PID) tests during manufacturing of solar PV modules may be carried out by WBSEDCL.
- Joint inspections and testing will be done by WBSEDCL and the authorized representatives of the contractor at the manufacturer's workshop on regular basis for quality assurance and testing. Acceptance Tests as per relevant Indian Standard shall be carried out at the module manufacturer's workshop. Following tests as per relevant Indian Standard shall be carried out on certain number of modules from a lot (decided by WBSEDCL) as acceptance tests of Solar PV Modules:

- Visual Inspection
- Performance Test of the modules at STC and NOCT with Sun Simulator of Class B or better as per Indian Standard

- Performance Test of the modules at low irradiance (200 W/m^2) with Sun Simulator of Class B or better as per Indian Standard
- Dielectric withstand test
- Continuity and leakage current test
- Insulation Resistant test
- Wet leakage current test
- Mechanical load test
- Any other test as desired by WBSEDCL

Arrangements for the aforesaid testing and inspection at manufacturer's end are to be provided by the contractor.

- Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual Test reports for routine tests and acceptance tests etc.

- The contractor shall deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.
- WBSEDCL may select certain number of modules delivered at site by the contractor on random basis for conducting performance test of those modules from any accredited test laboratory of MNRE/NABL. If there are any discrepancy found in the test results and the values specified by the contractor, the contractor will be bound to accept the decision made by WBSEDCL in respect of taking further course of action.

2. PV ARRAY CONFIGURATIONS

2.1 SCOPE

This section covers activities related to PV array configurations and design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of array junction box as detailed hereunder.

The Solar array shall be configured in multiple numbers of sub-arrays, providing optimum DC power to auditable number of sub arrays. The Contractor shall submit their own design indicating configuration of PCU and respective sub arrays and associated bill of material.

- UV resistant Cable-ties (suitable for outdoor application shall be used to hold and guide the cables/wires from the modules to junction boxes or inverters. All the cables were aesthetically tied to module mounting structure.

- In case the string monitoring unit (SMU) is mounted on the module mounting structure, Contractor to take into consideration of the load thus added on the MMS. Accordingly, suitable supporting members for mounting the SMU must be designed and supplied. Separate structure for mounting of SMU can also be proposed.

- Every major Component of the Plant should be suitably named/ numbered & marked for ease of traceability, identification and maintenance.

2.2 ARRAY JUNCTION BOX/STRING COMBINER BOX

a. Adequate number of array junction boxes shall be provided for termination of array string with inverter.

b. The number and specification of PV Array Junction Box will be as per plant configuration.

The Array Junction Boxes shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

2.3 STANDARDS

The Array Junction Boxes shall conform to the latest edition of following Standards except where specified otherwise in this specification:

Sl. No.	Standards	Description
	IS 13703: Part 1 /IS 13703: Part 4	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC: General Requirements
	IEC 60269-4: Part 6	Low-voltage fuses: Supplementary requirements for fuse-links for the protection of semiconductor devices
	VDE 0636	Low-voltage fuses: Supplementary requirements for the protection of solar photovoltaic energy systems

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the bidder without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

2.4 TECHNICAL REQUIREMENTS

- The junction boxes shall have suitable arrangement for the followings (typical):
  - Combine groups of modules into independent charging sub-arrays that will be wired into the controller.
  - Provide arrangement for disconnection for each of the groups.
  - Provide a test point for each sub-group for quick fault location and to provide group array isolation.
  - SCADA Communication device with all necessary equipment for communicating with main SCADA Server.
  - Suitable space for workability and natural cooling.

- All junction boxes should be equipped with appropriate functionality, safety (including fuses, grounding, contacts etc.) and protection.
- The junction boxes shall be dust, vermin, and waterproof and made of thermoplastic/ metallic in compliance with IEC 62208, which should be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP65 (Outdoor) and Protection Class II.
- 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.
- 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.
- At outgoing side DC Disconnector switches Switch of suitable capacity shall be provided.
- The Array Junction Box will also have suitable surge protection. In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Device (SPD). The maintenance free earthing shall be done as per the relevant standards.

2.5 APPROVAL

The Detailed Design Report Submitted by the contractor to WBSEDCL must contain but not limited to the following details of the array junction boxes:

- Detailed specification
- Necessary drawings etc.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manuals
- Necessary test certificates

The contractor shall deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

3. SOLAR INVERTER

3.1 SCOPE

This section covers the activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at project site, storage, erection, testing, commissioning of Solar Inverters as detailed hereunder.

a. Adequate number of Solar Central Inverter of minimum capacity 500 kW having high quality, high efficiency and reliable operation. Total inverter capacity of the plant should be 10000 kW.

b. The rated power/name plate capacity of the inverters shall be the AC output of the inverter at 50°C.

c. The scope of supply shall also include necessary spares, if any, required for normal or any breakdown maintenance for at least 05 (five) years and special tools & plants required for erection & maintenance. Corresponding parts of all the equipments & spares shall be of the same specification & workmanship and shall be interchangeable.

All the material & workmanship shall be of reputed make as have proven successful in their respective uses in similar services & under similar condition.

The solar inverter/power conditioning unit shall be suitable for interfacing with SCADA system and all necessary transducers shall be included under the scope of supply.

3.2 STANDARDS

The equipments and materials covered by this specification shall conform to the latest edition of following Indian Standards or equivalent IEC standards except where specified otherwise in this specification:

Sl. No.	Standards	Description
IEC/IS: 61683		Photovoltaic systems – Power Conditioners – Procedure for measuring efficiency
IEC 62093		Balance-of-system components for photovoltaic systems – Design qualification natural environments
IEC 60068		Environmental Testing
Islanding Prevention Measurement	IEC 62116 / IEEE 1547/UL	1741/ equivalent IS standard IEC 61727
CERC regulation and grid		Relevant CEA/ Interfacing with utility grid code (amended up to date)
IEC 61000 series		EMC, harmonics, etc.
Electrical safety		IEC 62109 (1&2), EN 50178 or equivalent
		Recommended practice for

IEEE standard 929 – 2000 or equivalent
PV – Utility interconnections
IEC 62093 or equivalent Reliability test standard

Solar Inverters should have certificate and approval from VDE, IEC, UNE, RD, EDF, BDEW etc. The inverters should have CE conformity according to LVD (Low Voltage Directive) and EMC (Electro Magnetic Compatibility) Directive for safety purpose.
Type test certificate issuing authorities should be any NABL/IEC Accredited Testing Laboratories or MNRE approved test centres.

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out by the contractor.

3.3 TECHNICAL REQUIREMENTS

- The inverter should be 3-Φ static solid state type power conditioning unit.
- Inverter/PCU shall be centralized grid tied in nature, Maximum Power Point Tracker (MPPT) shall be integrated in the power conditioner unit to maximize energy drawn from the Solar PV array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism of MPPT to be submitted with the detailed design report. The MPPT unit shall confirm to IEC 62093 for design qualification.
- Degree of protection of the indoor Inverters shall confirm at least IP-42 and that of outdoor shall confirm at least IP-65.
- Nuts & bolts and the PCU enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.
- Only those PCUs/ Inverters which are commissioned for minimum 10 MW in aggregated capacity solar PV projects till date in India shall be considered for this project with individual Inverter capacity not less than 500 kW. Contractor has to provide sufficient information to the satisfaction of the Employer before placing the final order for PCUs/Inverters. Service centre of the PCU manufacturer must be in India
- All PCUs should consist of associated control, protection and data logging devices and remote monitoring hardware and compatible with software used for string level monitoring.
- The dimension, weight, foundation details etc. of the PCU shall be clearly indicated in the technical specification to be submitted with the detailed design report.
- The PCU shall be capable of complete automatic operation, including wake-up, synchronization & shut down independently & automatically. Inverters / PCU shall operate in sleeping mode when there will no power connected.
- The Inverter shall have internal protection arrangement against any sustained fault in output line and lightning in the grid. AC protection boxes shall be provided at the inverter output which shall include over current, under voltage protection etc.
- Both AC & DC lines shall have suitable fuses & surge arrestors and contactors to allow safe start up and shut down of the system.
- Inverters shall have the features like Power reduction, Low Voltage Ride through (LVRT), High Voltage Ride through (HVRT) etc. for grid support and connection.
- 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 and feeding this information to the feedback loop of the inverter. Thus control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation (PWM) technology.
- The PCU shall be able to withstand an unbalanced load conforming to related IEC standard (+/- 5% voltage). The PCU shall include appropriate self-protective and self-diagnostic features 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 feature, shall be cleared by the PCU protective devices and not by the existing site utility grid service circuit breaker.

- Operation outside the limits of power quality as described in the technical data sheet should cause the power conditioner to disconnect the grid. Additional parameters requiring automatic disconnection are over voltage, over current, earth fault, short circuit and reverse power.
- The inverter itself shall consist of one circuit breaker for isolation from the circuit during any fault or maintenance purpose.
- All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency.
- The PCU shall be capable of controlling power factor dynamically.
- The inverters shall operate satisfactorily within the operating ambient temperature range of -15°C to +60°C. The contractor shall assure that the inverter should not de-rate upto +50°C ambient temperature.
- To take care of PID (Potential Induced Degradation), the inverter should have active negative grounding kit. [Only PID free Solar PV modules shall be used for the proposed plant and necessary test certificates shall be submitted.]
- The PCU shall have the following main features for convenience of operation:
- Auto 'Wake up': The system shall automatically "wake up" in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.
- Stand – By Mode: The control system shall continuously monitor the output of the solar power Plant until pre-set value is exceeded & that value to be indicated.
- Sleep Mode: Automatic sleep mode shall be provided so that unnecessary losses are minimized at night. The power conditioner must also automatically re-enter standby mode when threshold of standby mode reached.
- Basic System Operation (Full Auto Mode): The control system shall continuously monitor the output of the solar power Plant until pre-set value is exceeded & that value to be indicated.
- Following protections shall be provided with the inverter.

o Over voltage both at input & output o Over current both at input & output o Over/under grid frequency o Synchronisation loss o Anti-islanding Protection (IEEE 1547/UL 1741/ equivalent BIS standard) o Heat sink over temperature o Short circuit

o Protection against lightening o Protection against unbalance phase voltage o Power regulation in the event of thermal overloading o Protection for each solid-state electronic device

o Surge arrestors to protect against Surge voltage induced at output due to external source

o Direct earth fault protection and body earthing o Set point pre-selection for VAR control o Insulation monitoring of the PV array with sequential fault location o Any other protections required

- Inverters should have user friendly LED/LCD or touch display for programming and view on line parameters such as:
  - Inverter per phase Voltage, current, kW, kVA, frequency and power factor o Grid Voltage, frequency and power factor o DC voltage and current o Inverter Import export kWh summation
  - Solar kWh summation o Inverter ON/OFF
  - Grid ON/OFF
  - Inverter under voltage/over voltage o Inverter over load o Inverter over temperature

- Any other if required

3.4 SPECIFICATION

Sl. No.	Operating Parameter	Desired specification
1	Input (DC)	
	PV array connectivity capacity	As per site requirement
	MPPT Voltage range	Compatible with the array voltage
	Number of MPPT Channel	Number of MPPT channel shall be minimum one. One spare MPPT channel shall be provided.
2	Output (AC)	
	Nominal AC Power output	500 kW (minimum)
	Number of Grid Phase	3
	Adjustable AC voltage range	+/- 10%
	Frequency range	+/- 5%
	AC wave form	Sine wave
	THD	Less than 3%
	Switching	H.F. transformer/transformer less
3	General Electrical data	
	Efficiency	98 % (minimum)
	VAR Control	Optional
	No load loss	< 1% of rated power
	Maximum loss in sleep mode	< 0.05% of rated power
SI. No.	Operating Parameter	Desired specification
4	Protection	
	DC Side	As mentioned in the Technical Requirement
	AC side	As mentioned in the Technical Requirement
	Isolation Switch	PV array Isolation switch (DC)
	Ground fault detection device (RCD)	To be provided
5	Display	
	Display type	LED/LCD or touch display

	Display parameter	
	DC	As mentioned in the Technical Requirement
	On grid connected mode	As mentioned in the Technical Requirement
9	Interface (Communication protocol)	Suitable port must be provided in the inverter for i. On site upgrade of Software ii. On site dumping data from the memory iii. Plant based remote monitoring system
10	Storage of Data	At least for 1 year. Separate data logger may be provided to meet the criteria.
11	Monitoring	Matched with the monitoring and data logging system (SCADA)
12	Mechanical Data	
	Protection Class	As mentioned in the Technical Requirement
	DC Switch	Integrated
	Operating ambient temperature	-15° C to +60° C
	Relative Humidity	15 to 95 %
	Noise Emission	Less than 80 dB (A) @ 1 meter
	Cooling	Forced cooling

3.5 APPROVAL

The Detailed Design Report Submitted by the contractor to WBSEDCL must contain but not limited to the following details of the Solar Inverter/Power conditioning Unit:

- Detailed technical description of the complete unit
- Necessary Drawings Type Test Report etc.

Joint inspections and testing will be done by WBSEDCL and the authorized representatives of the contractor at the manufacturer's workshop on regular basis for quality assurance and testing. Acceptance Tests as per relevant Standard shall be carried out at the module manufacturer's workshop. Following tests shall be carried out on certain number of Inverters from a lot (decided by WBSEDCL) as acceptance tests of Solar Inverters:

- Visual Inspection
- Performance Test and measurement of AC & DC parameters
- DC reverse polarity protection
- Islanding Protection
- Over Voltage & Under Voltage withstand
- Over Frequency & Under Frequency withstand
- Night consumption
- Any other test as desired by WBSEDCL

Arrangements for the aforesaid testing and inspection at manufacturer's end are to be provided by the contractor.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Safety precautions
- Test reports for routine tests and acceptance tests etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

4. THREE WINDING TRANSFORMER

4.1 SCOPE

This section covers the activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of step up transformers and associated equipments as detailed hereunder.

- Adequate number of 3-Φ, three winding, oil filled, ONAN type cooled transformers with suitable capacity shall be provided to step up voltage from 3-Φ, Grid tied Solar Inverter output to 33 kV voltage level for feeding the generated power to the 33 kV switchyard.
- Two LV winding of the three winding transformer will be connected to the outputs of two inverters and the HV sides will be connected to the 33 KV line through VCB, Isolator etc. Three winding transformer will be Oil Type and placed outside of each local control room (LCR).
- All the transformers shall be suitable for outdoor installation with 3 phase 50Hz in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 10% to minus 15%.

The scope of supply shall also include necessary spares required for normal operation & maintenance of transformers for a period of 5 (five) years & special tools & plants required for erection & maintenance. Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The transformers and associated equipment shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

4.2 STANDARDS

The equipments and materials covered by this specification shall conform to the latest edition of following Indian Standards or equivalent IEC standards except where specified otherwise in this specification:

Sl. No.	Standards	Description
1	IS: 2026 (Part I to IV)/ IEC 60076	Power Transformer
2	IS: 2099/IEC 137	Transformers bushings for alternating voltage above 1kV
3	IS: 2705/IEC 185	Current transformers
4	IS: 335	Transformer oil
5	IS: 3637	Gas and oil operated relay
6	IS: 3639	Fittings and accessories for power transformers
7	IS: 6088	Dimensions for porcelain transformer bushings
8	IS: 3347	Loading guide for oil-immersed transformers
9	CBIP No. 295	Manual on Transformers Publication

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the contractor without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

4.3 TECHNICAL REQUIREMENTS

The transformers shall be three winding, ONAN, oil filled, 3-Φ, Step Up transformers.

Sl. No.	Standards	Description
1	Type	Three Winding
2	No. of phases	Three (3)
3	Installation	Outdoor on rails
4	Rated continuous MVA at maximum ambient temperature of 40^0C	As required according to Solar Inverter capacity
5	% Impedance at 75°C, rated current & frequency	As per relevant Indian Standard
6	Type of cooling	ONAN
7	Winding material	Copper
8	Connection	
	HV	Delta
	LV	Star-Star
9	Vector group	Dy11y11
10	Voltage	
	HV	33 kV
	LV	As per Solar Inverter Output Voltage
11	Rated Frequency	50 Hz
12	Type of Bushing	
	HV Winding	Porcelain/ XLPE bushing
	LV Winding	Porcelain bushing
13	Insulation level (impulse withstand)	
	HV	170kV (Peak)
	LV	NA

14	Insulation level (Power freq. withstand)	
	HV	70 kV (rms)
	LV	3 kV (rms)
15	Tapping	OCTC
	Range	+5% to -5% @ 2.5%
16	Temperature rise of oil/ winding over design ambient temperature of 50°C	50ºC / 55ºC

Sl. No.	Standards	Description
17	Hot spot temperature over a maximum yearly weighted average ambient temperature of 32 ºC	105°C
18	Short circuit current for 1 sec. on HV side	25 kA
19	Short circuit withstand time	2 sec
20	Insulation	
	HV winding	Class B (Winding insulation shall be able to withstand 33 kV continuously)
	LV winding	Class B (Uniformly insulated)
21	Voltage withstand capacity during sudden disconnection of load	1.4 times the rated voltage for 5 sec. 1.25 times the rated voltage for 1 min. 1.1 times the rated voltage for continuous operation.
22	Noise level	< 90 dB As per NEMA TR-1 standard
23	Cooling medium	Mineral oil (as per IS 335)
24	Earthing	LV neutrals solidly earthed through neutral CT, HV side should also be earthed.
25	Minimum efficiency	98%
26	Only Type –Tested transformers shall be used	

4.4 DESIGN CRITERIA

- The rating of the Transformers shall be sufficient to evacuate generated power from the Solar Inverter under full load conditions. The Transformers shall be able to evacuate generated power under all conditions of ambient temperature, frequency and voltage variations.
- The transformers will have Off Circuit Tap Changer (OCTC) with tap ranging +5% to -5% in steps of 2.5 % at HV side. The transformers will operate without injurious heating at the rated capacity at any voltage within +/-10% of the rated voltage of that particular tap. The transformer will be designed to deliver rated MVA continuously even at the lowest tap without exceeding specified temperature rise.
- HV line terminals shall be brought out through 33 kV class weather proof, shaded porcelain bushing.

- Ambient air temperature for the transformer o Maximum ambient air temperature: 50^0 C o Maximum daily average ambient air temperature: 40^0 C o Maximum yearly weighted average ambient air temperature: 32^0 C o Minimum ambient air temperature: - 5^0 C
- The transformers shall be designed to withstand short circuit current of 25 KA for 2 seconds without any damage. This capability shall be demonstrated by type test report.
- The transformers will be capable of being loaded in accordance with IS 3347 - loading guide for oil immersed power transformers. The transformers shall also be designed for operation at unbalanced loading conditions.
- The transformers shall be suitable for co-ordination and integration with SCADA System and necessary contacts and/or ports for the purpose shall be provided.
- Earthing arrangement of the transformers shall be provided as per the relevant Indian Standard.
- Necessary protection arrangement should be provided in the transformer.
- Marshaling 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 65. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. 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 Marshaling Box door.
- The 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.
- Construction of different parts of the transformer shall conform to the latest edition of IS 2026.
- Fittings and accessories as per relevant Indian Standard shall be provided within the scope of the work.

4.5 TYPE TSET

All the transformers used for the plant must be type tested. The contractor must ensure the type tests are to be conducted separately at no extra cost for the transformers. These tests should be conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an CPRI/NABL accredited Laboratory/ Govt. Recognized test house. The type tests shall be performed are furnished below:

Sl.No.	TYPE TESTS
1.	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)
2.	Measurement of harmonics of no load current (special test)
3.	Short Circuit Test as per IEC76/IS202
3.	Measurement of acoustic noise level as per NEMA TR-1 (special test)
5.	Tank Vacuum & Pressure Test (as per CBIP norms)

Sl.No.	TYPE TESTS
5.	Impulse Voltage Withstand Test, including Full Waves and Chopped Waves as listed below as per IEC76/IS2026: • One full wave at 50% BIL; • One full wave at100% BIL; • One chopped wave at 50% BIL • Two chopped waves at100%BIL and • Two full waves at100% BIL.

4.6 APPROVAL

The Detailed Design Report Submitted by the contractor to WBSEDCL must contain but not limited to the following details of the transformers:

- Detailed specification including Fittings and Accessories
- Necessary Drawings shall contain but not limited to the following:

o Outline dimension drawings of transformers and fittings/accessories o Assembly drawings and weight of main components.
o Transport drawings, showing main dimensions and weight of each package.
o Foundation details o Tap-changing equipment o Name-plate diagrams

- Necessary test certificates and type test reports.

A joint inspection and testing will be done by WBSEDCL and the authorized representatives of the contractor at the manufacturer's workshop. Testing and inspection of the transformers will be carried out as per relevant Indian Standard. Arrangements for the aforesaid testing and inspection at manufacturer's end are to be provided by the contractor.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Safety precautions
- Test reports for routine tests and acceptance tests etc
- Detailed schematics of all power instrumentation and control equipment and subsystems along with their interconnection diagrams. Schematics shall indicate wiring diagrams, their numbers and quantities, type and ratings of all components and subsystems etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

5. 33 kV INDOOR C&R PANEL AND POWER EVACUATION

5.1 SCOPE

This specification covers the design, manufacture, testing at manufacturer's works before dispatch, supply, delivery at site, transit insurance, storage at site, erection, testing & commissioning of 33 kV Indoor Switchgear & Power Evacuation System with all necessary equipments and accessories

required for satisfactory operation of 10 MW (AC) Solar PV Power Plant in Patni (Khemasuli), Paschim Medinipur, West Bengal.

The scope of supply shall also include necessary spares required for normal operation & maintenance of switchgear equipments & Power Evacuation System for a period of 5 (five) years & special tools & plants required for erection & maintenance.

Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

5.2 STANDARDS

The equipments covered under this chapter shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

Sl. No.	Standards	Description
1	IS: 5	Colors for ready mixed paints & enamels
2	IEC: 60298/IS: 3427	AC metal enclosed switchgear & control gear for rated voltages above 1 kV & up to & including 52 kV.
3	IS: 13947	Degree of protection provided by enclosures for switchgear.
4	IS: 1901	Specification for visual indication lamps
5	IS: 13118/IEC-56	High Voltage Alternating current circuit breakers
6	IS: 2705 - (Part I-IV)	Current Transformers
7	IS: 3156 - (Part I-IV)	Voltage Transformers
8	IEC: 60694	Common clauses for high voltage switchgear & control gear
9	IS: 1248	Indicating Electrical measuring instruments
10	IS: 8084	Inter connecting Bus bars for AC voltage between above 1 kV up to and including 36 kV
11	IS-5578 & 11353	Making and arrangement for switchgear bus bar main connections and auxiliary wiring.
12	IEC: 62271-102	Alternating current disconnectors and earthing switches
13	IEC-99-4	Metal oxide surge arresters without gates for A.C. systems

Sl. No.	Standards	Description
15	IS: 3231	Electrical relays for Power Systems
16	IS-8686	Static Protection Relays
17	IEC-60255 & IEC- 61330	Numerical Relays
18	IEC-137	Bushing for AC Voltages
19	IS-3347	Porcelain Transformer Bushings.
20	IS-2099	High Voltage Porcelain Bushings.

21	IS-5561	Terminal Connectors
22	IS-13779	Static Energy Meters
23	IS 14697/1999	HT Static Tri-vector TOD Energy meter
24	IS-1248	Electrical measuring instruments 25 IS-10118 Minimum clearances for Outdoor Switchgear.
26	IEC-694	Common Clauses for High Voltage Switchgear and Control gear
27	IS 6875 amended upto date	Control switches

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the contractor without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

5.3 SPECIFIC TECHNICAL REQUIREMENTS/PARAMETERS:

All indoor switchgear panels shall have minimum technical parameters for design consideration as mentioned hereunder:

5.3.1 C & R PANEL:

- Each C & R Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof for tropical use. The enclosure shall provide a degree of protection not less than IP-41 in accordance with IS-2147. Type test report in this respect shall be furnished with offer Separate C&R panel shall be provided for each VCB.
- Panels shall be free standing, floor mounting type and shall comprise structural frames enclosed completely with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of panels such as base frame, front sheets and door frames and not less than 2mm for sides, door, top & bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.
- Control Cable entries to the panel shall be from the bottom. Bottom plates of the panels shall be fitted with detachable gland plates to allow cable entries from the bottom. Gland plates shall be suitable for fixing the cable glands at an elevated height of at least 100 mm above the ground level. Terminal Connectors and Test terminal blocks for cables shall be fixed at an elevated height of at least 200 mm above the Bottom plate. Side blocks cut out to be arranged at the top of both sides of panel for inter panel bus wires. Dimensions of the cut out will be 300 mm X 50 mm, 255 mm from the top.
- The Control and Relay Panel shall be of Simplex type and the access door shall be provided at the back of each Panel where no instruments or relays shall be mounted. The indicating and signaling devices and relays etc. shall be mounted on the front side and the auxiliaries which shall be inside the Panel. The access door shall be at the back side and of double door type of height at least 1900 mm.
- The individual panel shall be of at least 2250 mm. in height with Channel base, 610 mm. in depth and of suitable width limited to 1000mm to accommodate the equipment at a suitable height, suitable gaps to facilitate easy workability as specified hereafter. Individual piece of

Channel base of C&R Panel is to be provided to obtain the flexibility of inter-changing the Panel, if any.

- The complete panel shall incorporate all necessary instruments, meters, relays, auxiliary relays, control switches, indicating lamps, mimic, annunciator, audible alarms, horizontal and vertical wiring trough, wiring supports, interior lighting system, terminal blocks , fuses and links etc.

0.415/33 KV individual control transformer panel having HV side control and protection shall consist of the following mentioned items meeting the IEC/IS mentioned above:

Sl. No.	Items
1	Circuit label engraved suitably at front and inner side
2	Section of painted and overlaid mimic diagram
3	Circuit breaker control switch.
4	Local/Remote switch
5	Indicating lamps for circuit breaker ON/OFF, spring charged, trip circuit 1 & 2 healthy and auto trip indication.
6	Trip circuit supervision relay to supervise the TC 1 & 2 both under pre-close and post-close condition.
7	PT supply Indicating lamps, red-yellow-blue for each PT.
8	96 mm x 96 mm ammeter scaled suitably.
9	Voltmeter of 96 mm x 96 mm
10	Voltmeter selector switch, 4-position, RY—YB—BR—OFF.
11	Suitable space and wiring for non-tariff TVM for energy management.
12	Three phase 4 wire test terminal block for above.
Sl. No.	Items
13	Auxiliary relay with test push button for panel DC supervision relay.
14	12 window type Fascia annunciator complete with accept reset and test PB but without audible bell.
15	Triple pole, IDMTL, non-directional over current relay with setting range 50%-200% for IDMTL units and 500% - 2000% for high set unit.
16	Restricted Earth Fault Relay current operated having setting range 10% to 40% both for HV & LV side of the Transformer.

17	High speed master tripping relay with contacts as required with lockout and coil supervision scheme complete.
18	PT selector switch, two position PT-1/PT-2 switch, stay put type(16A)
19	Space heater with On/OFF switch and thermostat.
20	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Buchholz trip and Buchholz alarm function. Each element
21	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer winding temp. trip and alarm function. Each element with 4NO+2NC Contact.
22	Two elements DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Low Oil Level (Main Tank) and OSR (OLTC) alarm function.
23	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Oil Temp. trip and alarm function. Each element with 4NO+2NC Contact.
24	Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for transformer Main tank PRV trip and OLTC PRV Trip function. Each
25	elem ent with 4NO+2NC Contact. Two element DC operated auxiliary relay having hand reset type contact with hand reset operating flag for OLTC Buchholz trip and spare. Each element with 4NO+2NC Contact.
26	DC operated emergency lamp with switch.
27	Cubicle illumination lamp operated from door switch.
28	Audible bell and hooter for trip and non-trip fascia annunciation.
29	15A, 3 phase plug & socket with switch.
30	Other Panel accessories & equipment relays etc. as required to fulfil the scheme Requirement.

33KV Line Control C&R Panel with Directional O/C & E/F protection shall consist of the following mentioned items meeting the IEC/IS mentioned above:

Sl. No.	Items
1	Circuit label engraved suitably at front and inner side
2	Section of painted and overlaid mimic diagram

3	Circuit breaker control switch.
4	Local/Remote switch
5	Indicating lamps for circuit breaker ON/OFF, spring charged, trip circuit 1 & 2 healthy and auto trip indication.
6	Trip circuit supervision relay to supervise the TC 1 & 2 both under pre-close and post-close condition.
7	PT supply Indicating lamps, red-yellow-blue for each PT.
8	96 mm x 96 mm ammeter scaled suitably.
9	Voltmeter of 96 mm x 96 mm
10	Voltmeter selector switch, 4-position, RY—YB—BR—OFF.
11	Suitable space and wiring for non-tariff TVM for energy management.
12	Three phase 4 wire test terminal block for above.
13	Auxiliary relay with test push button for panel DC supervision relay.
14	12 window type Fascia annunciator complete with accept reset and test PB but without audible bell.
15	Triple pole, IDMTL, non-directional over current relay
16	Triple pole, IDMTL, directional over current relay with setting range 50% - 200% for IDMTL units and instantaneous high set unit -500% - 2000% applicable for parallel line feeder as per schedule
17	Single pole definite time sensitive E/F relay current operated having wide setting range for single circuit line.
18	Single pole directional definite time sensitive E/F relay current operated having wide setting range for single circuit line

Sl. No.	Items
19	High speed master tripping relay with contacts as required with lockout and coil supervision scheme complete.

20	PT selector switch, two position PT-1/PT-2 switch, stay put type(16A)
21	Space heater with On/OFF switch and thermostat.
22	AC operated single element, auxiliary relay having only self reset contacts and with reverse flag for incoming AC supply supervision with test push button.
23	DC operated, two element, auxiliary relay having only self reset contact and with reverse flag for incoming DC and alarm bus DC fail supervision with test push button.
24	Single element AC operated auxiliary relay having self reset contact only for incoming DC and alarm bus DC fail alarm cancellation.
25	Push button for incoming DC and alarm bus DC fail alarm accept.
26	Indicating lamp for incoming DC and Alarm bus DC fail indication.
27	AC operated buzzer for incoming DC and Alarm bus DC fail audible alarm.
28	DC operated emergency lamp with switch.
29	Cubicle illumination lamp operated from door switch.
30	Audible bell and hooter for trip and non-trip fascia annunciation.
31	15A, 3 phase plug & socket with switch.
32	Other Panel accessories & equipment relays etc. as required to fulfil the scheme Requirement.

5.3.2 CIRCUIT BREAKERS

SI. No.	Description	Requirement
1	Type	Vaccum
2	No. of Poles	3
3	Nominal/Highest System Voltage	33 kV/36 kV
4	Type of Installation	Outdoor
5	Duty Cycle	O- 0.3 sec-CO-3 min-CO
6	Operating cycles	Min. 10000
7	Control Voltage	110/220 V DC (10% to -15%)
SI. No.	Description	Requirement

8	Short Time Current Rating for 3 sec	25 kA
9	Continuous current rating	As per system design
10	Symmetrical Breaking Current Capacity	25 kA (rms)
11	Short Circuit Making Current	62.5 kA
12	Degree of protection	IP 65
13	Operating mechanism	Spring Charged
14	Auxiliary contacts	As required plus 6NO and 6NC contacts per pole as spare.
15	Noise level	Maximum 140dB at 50m distance from base of circuit breaker
16	Seismic acceleration	0.4 g horizontal

5.3.3 CURRENT TRANSFORMER

SI. No.	Description	Requirement
1	Type	Outdoor
2	Nominal/Highest System Voltage	33 kV/36 kV
3	Short Time Current Rating for 1 sec	25 kA
4	No. of Phases	Single
5	Insulation Class	Class A
6	Rated Power Frequency withstand voltage (Primary/secondary)	70 kV (rms)/3 kV (rms)
7	Rated Lightning Impulse Withstand Voltage	170 kV (peak)
8	Degree of protection	IP 65
9	Partial discharge level	10 Pico coulomb max.
10	Temperature rise	As per IEC 60044
11	Number of cores	Two (2) with One (1) protection core and one (1)metering core of accuracy 5P20 and 0.5 class respectively
12	CT secondary current	Protection cores – 1 Amp Metering Core – 1 Amp

5.3.4 POTENTIAL TRANSFORMER

SI. No.	Description	Requirement
1	Type	Outdoor
2	Nominal/Highest System Voltage	33 kV/36 kV
3	Short Time Current Rating for 1 sec	25 kA
4	No. of Phases	Single
5	Insulation Class	Class A
6	Rated Power Frequency withstand voltage (Primary/secondary)	70 kV (rms)/3 kV (rms)

7	Rated Lightning Impulse Withstand Voltage	170 kV (peak)
8	Rated voltage factor	1.2 continuous & 1.5 for 30 sec
SI. No.	Description	Requirement
9	Class of Accuracy	0.5/3P
10	Degree of protection	IP 65
11	Partial discharge level	10 Pico coulomb max.
12	Temperature rise	As per IEC 60044

5.3.5 ISOLATOR/DISCONNECTING SWITCH

The isolators and accessories shall conform in general to IEC 62271-102. Each isolating switch should have the following particulars under the site conditions for the system under design:

- Isolators shall comply with routine tests as per IEC 606181
- Isolator shall be gang operated for main blades and earth switches. The operation of the three poles shall be well synchronised and interlocked.
- The design of linkages and gears shall be such so as to allow one man to operate the handle with ease for isolator and earth switch.

SI. No.	Description	Requirement
1	Type	Outdoor
2	Nominal/Highest System Voltage	33 kV/36 kV
3	Short Time Current Rating for 1 sec	25 kA
4	No. of Poles	3
5	Continuous current rating	As per requirement
6	Short Time Current Rating for 3 sec	25 kA
7	Rated Power Frequency withstand voltage	
	a. To earth & between poles	70 kV (rms)
	b. Across isolating distance	80 kV (rms)
8	Rated Lightning Impulse Withstand Voltage	
	a. To earth & between poles	170 kV (peak)
	b. Across isolating distance	195 kV (peak)
9	Temperature rise	As per Table-IV of IS: 9921
10	Operating mechanism of Isolator and Earth Switch	Motor operated

5.3.6 SURGE ARRESTOR

SI. No.	Description	Requirement
1	Type	Metal Oxide Gapless
2	Rated Voltage	30 kV
3	Nominal Discharge Current	10 kA (8x20 micro impulse shape)

4	Installation	Indoor
5	Degree of protection	IP 67
6	Rated Power Frequency withstand voltage	70 kV (rms)
7	Rated Lightning Impulse Withstand Voltage	170 kV (peak)
8	RIV/Partial Discharge when energised at 1.05 times its continuous operating voltage shall not exceed b	250 microvolt/ less than 50 pico-coulomb

5.4 GENERAL REQUIREMENTS

The 33 kV Indoor Switchgear shall be designed considering the minimum general requirements as mentioned hereunder:

- The Switchgear shall confirm IP 52 or higher degree of protection.
- Each panel shall be equipped with space heaters to prevent moisture condensation within the enclosure and shall be complete with MCB, thermostats and auxiliary relay (if required).
- C&R Panel design shall comprise of fully compartmentalized execution having separate vertical sections for each circuit.
- Structure and control wiring shall be designed and arranged in such a manner so that future extension of the switchboard would readily be feasible.
- The circuit breaker shall be suitable for remote electrical and local electrical/manual operation. The closing coil shall operate correctly between 85% to 110% of its rated voltage and shunt trip shall operate correctly under all operating conditions of the circuit breaker between 70% to 110% of its rated voltage.
- The disconnecting switches shall be provided with local electrical/manual control from the panel. The disconnecting switches shall be fitted with earthing link wherever required. The disconnecting switch shall be connected between the transformer and circuit breaker for the power incoming from solar PV and for synchronization between the bus bar and transmission line through breaker, at 33 kV.
- The supplier shall ensure that the current transformers shall have adequate VA output for the type of protection & metering offered. The supplier shall also ensure that the current transformers quoted by him have adequate output for prescribed accuracy class and accuracy limit factor for the type of relays and instruments connected in their circuits. PS class CTs shall have low secondary resistance and high knee point voltage so as to avoid any possibility of CT saturation under through fault conditions.
- Three single phase voltage transformers shall be suitable for connecting in a bank of three phase voltage transformers for protection and measurement purpose for each incomer and outgoing feeders. Separate and dedicated voltage transformers shall be provided for synchronization.
- Each cubicle shall be equipped with space heaters, thermostats, illumination lamps & 240 V AC, 5A receptacle.
- Suitable single compression type, heavy duty brass cable glands with check nuts, rubber sealing ring and brass washers mounted on a removable gland plate shall be supplied with the switchgear to support all power and control cables entering the C&R Panel.
- Cables for each equipment must be tagged with permanent metal tag of impregnated cable number as per drawings at C&R Panel end and equipment terminal end as well as in the mid portion of the cables at certain distances as instructed by the owner or his authorized representative.
- The accuracy class of indicating instruments shall be 1 or better as per IS. The accuracy class of meters for commercial metering shall be 0.2 All instruments shall have means for calibration, testing and adjustment at site.

- Three phase watt hour meters conforming to latest issue of relevant Indian standard shall be provided with test link for CTs & PTs. Meters shall be compensated for temperature errors and factory calibrated to directly read the primary quantities.
- Following equipments at 33 kV C&R Panel shall be monitored from SCADA:

1) Circuit breaker - On/Off status & Control
2) Transformer - Winding temperature & Oil temperature Alarm status
3) Energy meters
4) Numerical Relays
5) Voltmeters
6) Ammeters

- Suitable earthing arrangement must be designed for the system.
- Finishing work like painting etc. for C&R Panel should be as per relevant IS.

5.5 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the Ring Main Unit/Switchgear:

- Detailed specification of all the items.
- Necessary Drawings
- All necessary test certificates and approvals etc.

The successful bidder required to produce all necessary test certificates and approvals of the product as per relevant standard with the Detailed Design Report.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Electrical diagrams
- Safety precautions
- Detailed schematics of all power instrumentation and control equipment and subsystems along with their interconnection diagrams. Schematics shall indicate wiring diagrams, their numbers and quantities, type and ratings of all components and subsystems etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

6. CABLES & CONDUCTOR

6.1 SCOPE

The scope of work under these specification covers the Design, Manufacture, Assembly, Shop Testing, Delivery at site, transit insurance, Storage, Erection, Testing & Commissioning of power, control and instrumentation cables (complete with cable terminals and all accessories for making the systems complete and for warranting a trouble free and safe operation).

The scope shall also include supply of all material, fabrication and erection of cable supporting structure, cable racks & trays as well as laying of cables on cable racks.

The scope of supply shall also include necessary spares required for a period of 5 (five) years & special tools & plants required for erection & maintenance.

The contractor shall assess the quantity of various sizes of the power, control, instrumentation and communication cables & its accessories along with cable racks & trays including the mandatory

spares required for the project and shall furnish same in the bid. He shall also furnish the unit price for each item.

6.2 STANDARDS

The equipments covered under this chapter shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

Sl. No.	Standards	Description
1	Part 1	IS: 7098 – Cross linked polyethylene insulated PVC sheathed cables for working voltage up to and including 1.1kV
2	Part 2	IS: 7098 – Cross linked polyethylene insulated PVC sheathed cables for working voltage from 3.3kV up to and including 33kV
3	IS 10418	Drums for cables
4	IS 8130	Conductors for insulated electric cables and flexible cords
5	IS 8308	Compression type tubular inline connectors for aluminium conductors
6	IS 8309	Compression type tubular terminals for aluminium conductors
7	IS 8438	Moulds of cast resin based straight joints of cable up to including 1.1kV
8	IS 11967	Specifications for co-axial cables
9	IS : 2062	Structural Steel (Standard Quality)
10	IS : 513	Cold rolled low carbon steel sheets & strips
11	IS : 277	Galvanized sheet steel
12	IS : 808	Rolled Steel Beam, Channels and Angle section
13	IS : 2629	Recommended practice for hot dip galvanizing of iron and steel.
14	IS : 2633	Method of testing uniformity of coating on zinc coated articles.
15	IS : 800	Specification for use of structural steel in general building construction.

Cables and other accessories complying with other internationally accepted standards such as IEC, IEEE, BS, etc. will also be accepted if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case the Contractor shall clearly indicate the standard/standards adopted and furnish a copy of English version of the latest revision of the standard(s) along with the Bid and the salient features of comparison shall be brought out.

6.3 GENERAL REQUIREMENTS

Minimum requirements are mentioned hereunder.

- The cables shall be of type and design with proven record of similar power station installations.

- The colours of the cables (both AC & DC) should be so selected that there should not be any problem for identification of cables used for various circuits during inspection & testing.
- To facilitate easy identification of cores, multi-core control and instrumentation cables shall be colour coded by using PVC insulation of red, black, yellow, blue and grey colours in accordance with IS 1554 (Part I).
- Cable lengths shall be considered in such a way that straight through cable joint is avoided.
- Cable terminations shall be made with suitable cable lugs & sockets etc, crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles.
- The contractor shall ensure that no bimetallic action takes place between the Aluminium conductor of the cable and the cable connecting lugs by filling the lugs with suitable compound.
- For the main cable ways, a system of cable racks and trays as well as cable ducts and trenches shall be provided. The power and the control cables will run on separate trays. The cables for emergency lighting, fire alarm systems, etc., shall run on separate trays. The power cables shall be laid on the uppermost rack to prevent spread of fire.
- In indoor installations, the cables must be laid through PVC conduit or GI pipe. In case of using metallic pipe as conduit proper grounding of the conduit must be done.
- Exposed cables, wherever, used, shall preferable have UV resistant jacket besides being water resistant.
- Cables for each equipment must be tagged with permanent metal tag of impregnated cable number as per drawings at MCC/switchgear end and equipment terminal end as well as in the mid portion of the cables at certain distances as instructed by the owner or his authorized representative.
- The loop length shall be provided for various cables as per the relevant Indian Standard.
- Cables shall be properly clamped at regular intervals with the help of non magnetic/molded fiber glass strip clamps/PVC sleeved clamps, of suitable size.
- When power cables are laid in the proximity of communication cables, the minimum horizontal and vertical separation between them may be 300 mm.

6.4 TECHNICAL REQUIREMENTS FOR CABLES AND CONDUCTOR

Minimum Technical requirements are mentioned below:

- All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. (Note: IEC standards for DC cables for PV systems is under development, the cables of 600 – 1800 volts DC for outdoor installations should comply with the draft EN 50618/ TUV 2PfG 1169/09.07 for service life expectancy of 25 years)
- All cables shall be Fire Retardant Low Smoke (FRLS) type. The cables shall be sized based on the following considerations:
  - Rated current of the equipment
  - The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during running condition, shall be limited to 3% of the rated Voltage
  - Short circuit withstand capability De-rating factor for various conditions of installations shall be considered while selecting the cable size
  - Variation in ambient temperature for cables laid in air o Grouping of cable
  - Variation in ground temperature and soil resistivity for buried cables
- HT cable shall be designed based on the short circuit conditions and LT cable shall be sized based on the voltage drop.

- Size of aluminium power cable shall in no case be less than 16 mm^2 and copper power cable shall not be less than 6 mm^2. Where there is requirement of cables less than the above mentioned values, copper cable of appropriate size but not less than 4 mm^2 may be used.
- Minimum size of the control cable for CT circuit shall be 4 mm^2 and that for potential circuit shall be 2.5 mm^2.
- The cables shall be capable of satisfactory operation under a power supply system voltage variation of ± 10% and frequency variation of ± 5% and a combined frequency voltage variation of 10% (absolute sum). The cables shall have heat and moisture resistant properties.
- Conductor size of cables and wires shall be selected based on efficient design criteria. The wiring size of shall be designed such that maximum voltage drop at full power from the PV Array to Inverter(s) should be less than 1.5%. From Inverter to AC Grid interfacing panel should be less than 2.5%.
- The continuous withstand temperature shall be $90^{O}C$ and $70^{O}C$ for XLPE and PVC cables respectively and the short circuit withstand temperature shall be $250^{0}C$ and $160^{O}C$ for XLPE and PVC cables respectively.
- The Jointing Boxes shall comply in all aspects with the provision of the latest issue of relevant standards.
- The control cables shall be multi-core, colour coded, annealed, stranded high conductivity copper, single conductor, insulated with HR-PVC insulation, PVC sheathed, unarmoured FRLS type conforming to IS 1554 (part I & II)/relevant IEC. The outer sheath is of specially formulated PVC compound.
- The instrumentation cables in addition to meeting the requirements of control cables shall be provided with electrostatic shielding by aluminium tape and screening by annealed tinned copper wire.
- For connecting solar modules with solar inverter via array junction box (1.1 kV), solar inverter output with three winding transformer input (1.1 kV), three winding transformer output with 33 kV Indoor Switchgear (33 kV) and 33 kV Indoor Switchgear (33 kV) with the 33 kV Switchyard (33 kV), cables of suitable size shall be provided.
- Number of Local Control Rooms with 33 kV Indoor Switchgear shall be as per plant design. One number Main Control Room shall be provided adjacent to the 33 kV Switchyard. Cable Trench of suitable size as per relevant standard shall be a part of the scope of work.

6.5 TECHNICAL REQUIREMENTS OF CABLE LAYING

Minimum technical requirements for cable racks and trays are mentioned below:

- The contractor shall fabricate and supply the mounting arrangement for the support and installation of all the cable trays on galvanized steel structure including channels, angles, rods etc at requisite spacing in the suspended cable trays, cable trenches. Supporting structures wherever necessary, shall be provided by the contractor.
- The contractor shall provide embedment/anchor fasteners for fixing the supporting structures.
- These supporting structures shall be fabricated from structural steel members (channels, angles and rods) of the required size.
- The vertical member of the support will be of ISRO12 threaded rod or ISMC100 channel. The horizontal member of the support will be of angle ISA 50X50X6. For the threaded rod support configuration the horizontal member shall be fixed by bolting whereas for channel configuration the horizontal member shall be fixed by welding to the channel.
- Trays shall be of ladder type. The trays shall be fabricated from Hot Rolled Carbon Mild Steel (conforming to IS 1079, Grade “O”, of chemical composition (C, Si, Mn, S, Ph) sheet of proper thickness as per IS.

- Cable trays shall be fixed with support by hold-down clamps. The clamps shall be fabricated from MS sheet of appropriate thickness and Hot Dip Galvanized.
- The contractor shall supply various tray fittings and accessories like coupler plate with fasteners, horizontal tees, vertical and horizontal elbows, vertical and horizontal adjustable connectors required for the mentioned trays. All accessories, fittings, elbows and tees shall be Hot Dip Galvanized. The nuts, bolts and washers shall be cadmium plated or electrolytically galvanized.
- Proper earthing of the trays and continuity between tray components must be ensured by the contractor.
- The contractor shall install the cable trays in accordance with relevant standards.
- 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 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.
- Cables shall be laid on cable trays strictly in line with cable schedule
- Power and control cables shall be laid on separate tiers in RCC cable trench with slab cover 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.
- Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255. Directly Buried Cables.
- 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. Cable shall be laid in such a systematic manner, so that in case of occurrence of fault the faulty cable can be identified in shortest possible time.
- 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.

- 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.
- Inspection pit at suitable places to be provided for the purpose of maintenance.
- Adequate no. of spare DC cables shall be laid for the purpose of better reliability and minimize interruption period.
- For each Transformer at both Incoming and outgoing side minimum one no. spare cable shall be laid for the purpose of better reliability and minimize interruption period.

6.6 APPROVAL

The Detailed Design Report Submitted by the contractor to WBSEDCL must contain but not limited to the following details of the Cables and conductor and the accessories for their installation:

- Detailed design and specification of all the items.
- All necessary drawings
- Calculations for choosing cable size
- Type test reports and necessary certificates etc.

Before dispatch, sample pieces of the cable shall be subjected to type, routine, acceptance and FRLS tests at the manufacturer's works as stipulated in IS 1554 (Part I)/IEC in the presence of owner or his representative. Routine tests and acceptance tests as per relevant standards shall be carried out on each type of cable in presence of the owner or his representative.

Before commissioning of complete system all cabling system shall be checked as per cable schedule and complete report shall be prepared by Contractor and shall be submitted.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Cable routing and layout drawings
- Detailed procedure adopted for the earthing of the trays Type test certificates for cable trays etc.

The contractor can deliver the product to the site only after receipt of such approval against their prayer in writing from WBSEDCL.

7. STATION AUXILIARY TRANSFORMER

7.1 SCOPE

This section covers the activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of 33 / 0.415 kV oil fill type station auxiliary transformers and associated equipments as detailed hereunder.

The scope of supply shall also include necessary spares required for normal operation & maintenance of transformers for a period of 5 (five) years & special tools & plants required for erection & maintenance. Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The transformers and associated equipment shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

7.2 STANDARDS

The equipments and materials covered by this specification shall conform to the latest edition of following Indian Standards or equivalent IEC standards except where specified otherwise in this specification:

Sl. No. Standards	Description
IS: 2026 (Part I to IV) /IEC 76	Power Transformer
IS: 2099/IEC 137	Transformers bushings
IS: 2705/IEC 185	Current transformers
IS: 1180	Three phase distribution transformer
IS: 6088	Dimensions for porcelain transformer bushings
IS: 3347	Loading guide for oil-immersed transformers
IS: 335	Transformer oil
CBIP No. 295	CBIP Manual on Transformers Publication

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the bidder without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

7.3 TECHNICAL REQUIREMENTS

- Capacity of the Station Auxiliary Transformer (SAT) shall be calculated based on the total auxiliary load of the plant.
- HT side of the transformer shall be connected to the 33 kV Bus through Isolator with earth switch of required rating and LT side shall be terminated to the Station Service Board (SSB)/ 415 V LT Switchgear.
- SAT shall be installed at the switchyard of the plant.
- The transformer shall be able to perform satisfactorily under voltage variation limit of +/- 10 % and frequency variation limit of +/- 5 %.
- Vector group of the transformer shall be Dyn11
- Off Circuit Tap changer (-10% to +10% @1.25% steps) shall be provided with the transformer. Owner will take final decision regarding this based on the proposal submitted by the contractor.
- % Impedance, type of bushing, class of insulation, temperature rise etc. shall be as per relevant Indian Standard.

- The transformers shall be suitable for co-ordination and integration with SCADA System and necessary contacts and/or ports for the purpose shall be provided.
- Earthing arrangement of the transformers shall be provided as per the relevant Indian Standard.
- Necessary protection arrangement like should be provided in the transformer.
- Construction of different parts of the transformer shall conform to the latest edition of relevant Indian Standard.
- Fittings and accessories shall be provided as per relevant Indian Standard code.
- Transformer oil shall conform to latest edition of IS 335.

7.4 APPROVAL

The Detailed Design Report Submitted by the contractor to WBSEDCL must contain but not limited to the following details of the transformers:

- Detailed specification
- Fittings and Accessories
- Necessary Drawings shall contain but not limited to the following:

o Outline dimension drawings of transformers and fittings/accessories o Assembly drawings and weight of main components.
o Transport drawings, showing main dimensions and weight of each package.
o Foundation details o Tap-changing equipment o Name-plate diagrams o Schematic control and wiring diagrams for all aux. equipment etc.

- Tools and spare parts etc.
- Type Test Reports and certificates etc.

A joint inspection and testing will be done by owner and the authorized representatives of the contractor at the manufacturer's workshop, if desired so by the owner. Testing will be done as per relevant IS Code.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual Test Reports for routine and acceptance tests etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

8. LT SWITCHGEAR

8.1 SCOPE

The scope of work under this specification covers the design, manufacture, assembly, testing at manufacturer's works, transportation, transit insurance, delivery at site, storage, installation, testing, and commissioning of indoor type following 415V LT Switchgear complete with all accessories and spares.

The Scope shall include supply of 415 V (3 phase, 1 neutral and single phase for lighting etc.) transmission line (all Al conductor) for the entire area from the LT switchgear at both location with necessary breaker, switch fuse unit as and when required, Boards as above along with gland plates for all power and control cables, base frames, special tools i.e. operating handles, trolley necessary

for removing the circuit breakers for maintenance etc. Isolators should be provided in the line to connect or isolate the connection from both the station auxiliary transformer.

The scope shall include all associated devices, components, relays, contactors, switches etc. required for satisfactory operation of the switch boards as per the proposed logic control scheme. The scope of supply shall also include necessary spares required for operation & maintenance of switchgear equipments for a period of 5 (five) years & special tools & plants required for erection & maintenance.

Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

8.2 STANDARDS

The equipments covered under this chapter shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

Sl. No.	Standards	Description
1	IS: 13947 (Part 1 to 5)	Specification for Low-Voltage Switchgear and Control gear.
2	IS: 10118 (Part 1 to 4)	Code of practice for selection, installation and maintenance of switchgear & control gear.
3	IS: 1248	Specifications for Electrical Indicating Instruments
4	IS: 2633	Hot dip Galvanizing
5	IS: 2705	Current Transformers
6	IS: 3156	Voltage Transformers
7	IS: 3231	Electrical Relays for Power System Protection
8	IS: 5082	Wrought Aluminium and Aluminium Alloy bars, tubes and sections for electrical purposes.
9	IS: 8623	General requirement for factory built assemblies up to 1000V.
10	IS: 8828	Circuit breakers for over current protection for household and similar installations
11	IS: 13703	Low Voltage fuses for voltages not exceeding 1000V AC
12	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.

Equipment meeting any other authoritative national or international standards that ensure equal or better quality than the standards mentioned above are also acceptable. Where the equipment conforms to any other standards than those mentioned above, salient points of difference between the standards adopted and standards mentioned above shall be brought out in the tender.

The electrical installation shall meet the requirement of Indian Electricity rules and other statutory regulations as amended up to date and relevant BIS code of practice.

8.3 TECHNICAL REQUIREMENTS

- Main Incoming A.C. circuits on Station service Board shall be controlled through microprocessor based draw out type circuit breaker. Type and capacity of the breakers shall be proposed by the bidders in their bid considering the total auxiliary load of the plant.
- The LT switchgears shall be suitable for indoor installation in the control room.
- LT switchgears shall be placed in each control room and shall be connected to each other by means of 415 V (3 phase, neutral) transmission line along the whole area. LT switchgear at main control room shall be connected with Station Auxiliary Transformer 1 (as mentioned in the chapter "Station Auxiliary Transformer") and LT switchgear of a local control room placed at a suitable distance away from the Main Control Room shall be connected with Station Auxiliary Transformer 1 (as mentioned in the chapter "Station Auxiliary Transformer").
- The Station Service Board (SSB) shall be sectionalized in two parts through sectionalizing breakers on the bus to ensure continuity of supply to the auxiliaries in case of failure/fault on one section.
- For interconnection with various boards and all outgoing feeder circuits, 25 kA, 3 pole draw-out type MCCBs with adjustable current setting shall be provided.
- The Circuit Breakers, Boards etc. shall have at least the following ratings: o No. of phases : Three o Rated voltage : 1.1 kV o Service voltage : 415 V ± 10%
  - o Frequency : 50 Hz. ± 5%
  - o Rated short time current rating : 25 kA for 1 sec. for bus & switchgear o Normal control voltage : 110V / 220V DC o Degree of Protection : IP 42 or higher
- The following equipments at LT switchgear shall be monitored from SCADA.

1) Circuit breaker - On/Off status & Control
2) Auxiliary Transformer - Winding temperature Alarm status
3) Energy meters
4) Voltmeters
5) Ammeters
6) Numerical Relays should also be integrated with SCADA.

- The 415V switchboards shall be metal-enclosed fixed type, free standing, selfsupporting, floor mounted, indoor type, totally enclosed and compartmentalized to house the switchgear. Circuit breakers and other switchgear components shall be arranged in compartments, vertically in a multi-tier formation. All metering and protection equipment associated with a particular circuit shall be housed in separate and independent compartment earmarked for particular circuit and in the fixed portion of the vertical panel in case of breaker panels.
- Construction of all the switchboards and equipments shall conform to the latest edition of relevant IS codes.
- All cable glands and aluminum crimping type cable lugs for all power and control cables shall be in the bidder's scope of supply. Panels shall be suitable for bottom entry of cable unless otherwise specified.
- The bidder shall indicate clearly the de-rating factors, if any, employed for each component and furnish the basis for arriving at these de-rating factors duly considering the specified current ratings, ambient temperature etc.
- The equipment shall comply with all safety requirements during erection and operation as per relevant standards.

- The neutral of the incoming transformer secondary shall be connected to the neutral bus of the auxiliary boards. The neutral shall be connected to the common earthing system of the switchyard/control room.
- All auxiliary devices for control, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, Power monitors, kWh meters and protective relays shall be mounted on the front side of the respective compartment. The design shall be such that unless required for maintenance / inspection purposes, all power ON/OFF or START / STOP and relay reset operations shall be performed without opening the panel door.
- The switchboard panels shall be provided with thermostatically controlled space heaters to prevent moisture condensation.
- Tube light / CFL lamp fittings along with necessary isolating switches shall be provided for illumination inside the panels. Each panel shall be provided with an industrial grade power socket as well.
- The 415V bus shall be of suitable cross-section so as to be able to carry the required continuous and short circuit currents within the limits of temperature rise for the site conditions.
- Control and selector switches shall be rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front.
- AC Distribution Board is to be provided in the main switchgear room and in the particular local control room having auxiliary transformer as per requirements.
- Instrument transformers shall be provided and shall conform to the relevant standard.
- All relays shown in the drawing and others required for operation of the system as per the specification shall be included in the scope of supply. The relays shall be of electromagnetic/ static/numerical type/ microprocessor based conforming to the requirements of IS: 8686 or IEC: 255.
- All instruments and meters shall be suitable for operation under the climatic conditions prevailing at site. The instrument cases shall be dust-proof, water tight, vermin proof, specially constructed to adequately protect the instruments against damage or deterioration due to high ambient temperature and humidity.
- The VA burden of instrument coils/elements shall be as low as possible, consistent with the best modern design.
- Watt hour meter shall be suitable for 3-Phase, 4-wire unbalanced system and shall comply generally with the requirements of relevant IS code and shall be of first grade for the purpose of accuracy classification. Watt hour meters shall be provided in each LT switchgears as well as each 33 kV switchgears.
- Panels shall be supplied completely wired internally to equipment and terminal blocks for connection to external cables entering the panel from the bottom. Terminal blocks shall be complete and provided with necessary terminal accessories for cable ends.
- Engraved PVC labels shall be provided on incoming and all outgoing breaker compartments, the exact details of legend to be engraved shall be furnished later to the contractor.
- All vertical cubicles shall be connected to earth bus bar running throughout the length of the switchboard. All doors and movable parts shall be connected to the earth-bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the main earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Earthing bolts shall be provided to ground cable armours.
- Finishing work like painting etc. for switchgears should be as per relevant IS.

8.4 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the LT Switchgear:

- Detailed specification of all the items.
- All necessary drawings
- All necessary test certificates and approvals etc.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Electrical diagrams
- Safety precautions
- Detailed schematics of all power instrumentation and control equipment and subsystems along with their interconnection diagrams. Schematics shall indicate wiring diagrams, their numbers and quantities, type and ratings of all components and subsystems etc

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

9. DC BATTERY, BATTERY CHARGING EQUIPMENT & DCDB

9.1 SCOPE

The scope of work under this specification covers the design, manufacture, assembly, testing at manufacturer's works, transportation, transit insurance, delivery at site, storage, installation, testing, and commissioning of D.C equipment comprising of 110/220 V D.C Battery Bank of suitable designed capacity complete with battery charging equipment, D.C. Distribution Board and other auxiliary equipments.

The scope shall include all associated devices, components, relays, contactors, switches etc. required for satisfactory operation of the DC equipment as per the proposed logic control scheme.

The scope of supply shall also include necessary spares required for normal operation & maintenance of DC equipments for a period of 5 (five) years and special tools & plants required for erection & maintenance.

Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

9.2 STANDARDS

The equipments covered under this chapter shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

Sl. No.	Standards	Description
1	IS: 1651	Stationary cells & batteries, lead acid type (with tubular positive plates)
2	IS: 266	Battery grade Sulphuric Acid. (Battery electrolyte)

3	IS: 1069	Water for storage batteries
4	IS: 1146	Rubber & Plastic containers for lead Acid storage batteries
5	IS: 1248	Electrical Indicating Instruments
6	IS: 13947	Low voltage switchgear and control gear
7	IS: 3895	Mono-crystalline semi-conductor rectifier cells & stacks
8	IS: 8320	General requirement and methods of tests for lead acid storage batteries
9	IS : 6071	Synthetic separators for lead acid batteries
10	IS : 8623	Factory built assemblies of switchyard and control gear for voltage up to including 1000 V AC and 1200 V DC (Part 1 to 3)
11	IS : 4540	Non-crystalline semi-conductor rectifier assemblies & equipment

Equipment meeting any other authoritative national or international standards that ensure equal or better quality than the standards mentioned above are also acceptable. Where the equipment conforms to any other standards than those mentioned above, salient points of difference between the standards adopted and standards mentioned above shall be brought out in the tender.

9.3 GENERAL REQUIREMENTS

Minimum general requirements for the DC Battery, Battery charger and DC Distribution Board are mentioned below.

- Lead acid tubular type battery of required rating shall be provided at Main Control Room and each Local Control room. Battery Bank at Main Control Room shall be 110/220 V and Battery Bank at Local Control Rooms shall be selected based on the Control Voltage required for closing and tripping of 33 kV Indoor type VCBs. 10 hours continuous discharge shall be considered for sizing the battery.
- One float charger and one float cum boost chargers shall be provided to maintain constant voltage at D.C. bus bars while supplying the continuous load in addition to keeping the battery on float charge.
- In case of sudden D.C. requirements due to failure of A.C. supply or charger itself, the battery shall be capable of meeting the system load demand. In case of failure of float charger supplying the continuous DC load, the affected battery charger shall get disconnected automatically from the DCDB and the complete D.C. load requirements shall be met by the float charger of float cum boost charger unit.
- The charger shall be protected against overloads by having suitable characteristics so that all loads in excess of the capacity of the charger would be transferred to the battery.
- In the event of failure of A.C. supply, the battery shall meet the complete D.C. requirements. After the discharge of battery to a considerable extent, the boost charger on restoration of A.C. supply shall recharge the battery in a short period. During the period of boost charging, the D.C. load requirements of power station shall also continue to be met.
- The distribution board with necessary switch and interlock, if any, shall be provided for distributing the D.C. power for the control & protection circuits, emergency D.C. supply for essential lighting etc.

- The bidder may give his recommendation on the scheme of operation of battery, battery chargers as described in the specifications. However, the decision of the owner in this regard shall be final and bound to the bidder/contractor.
- The battery shall be capable of delivering the rated output at the minimum temperature of -3°C and maximum temperature of +40°C.
- The battery shall be mounted on the two tier wooden racks supplied along with the battery. Each cell as well as its locations shall be numbered for proper record of maintenance operations. Battery should be placed on the porcelain base kept on the wooden rack.
- The battery shall be connected to D.C. distribution board by single core cables laid above ground. Suitable terminal arrangement with glands shall be provided for this purpose.
- Battery room shall be painted with acid proof paint. Exhaust fans should be provided in the battery room. Contractor shall submit the details of the same to the owner.
- The ripple content in the D.C. current shall be less than 1%.
- The float charger unit shall be capable of supplying continuous D.C. load and trickle charge the battery.
- Necessary alarm and indication shall be provided with the DC System and also in the annunciation window of the Battery Charger.
- Necessary terminals with lugs for earthing the charger panels with two distinct separate earthing for each panel shall be provided. In addition, separate terminals for earthing of equipment shall be provided. The charger panels shall have space heaters.
- Compression type cable glands of suitable rating for PVC unarmoured cable, suitably mounted in the panel for cable entry from the bottom for A.C. & D.C. supplies shall be provided.
- Type of cell, cell terminal, containers and installation of battery, chargers, inverter, DC Distribution Board, cables etc. should conform to the latest edition of relevant Indian Standard.
- During installation of battery, charging & discharging and charging is to be done proper installation procedure.

9.4 TECHNICAL REQUIREMENTS

Minimum technical requirements for the DC Battery, Battery charger and DC Distribution Board are as following.

- The battery shall be made of lead-acid cells with tubular type plates conforming to latest issue of IS 1651. The battery cells shall be high discharge performance (HDP) type.
- The capacity of 110/220 V D.C. batteries based on 10 hours discharge rate shall be selected to fulfill the plant's requirement. The contractor shall propose the same to the owner and decision of the owner will be final and bound to the contractor.
- The battery shall normally remain under floating condition with the charger supplying the normal continuous load. However, the battery shall be capable of supplying the load without fall of terminal voltage per cell below 1.85V (92.5% of rated voltage).
- The number of cells of the 110/220 volt battery bank at Main Control Room and required voltage at Local Control Room shall be chosen to suit the following conditions. o Nominal floating voltage per cell shall be between 2.15 and 2.21 V.

o The voltage of each cell under floating conditions shall be of optimum value for its performance and maintenance in a healthy condition.

- The voltage of the battery after meeting the D.C. load cycle shall not be less than 90% of the rated voltage. The manufacturer shall ensure safe operation of the battery after the aforementioned end voltage.
- The voltage across the load shall not exceed 110% of rated value under charging conditions of the battery. To achieve this condition under quick charging, a blocking diode may be incorporated by the supplier in the charging equipment.
    - The bidder shall clearly justify the choice of number of cells in the tender on the above lines and furnish any clarifications required by the owner.
    - All cell terminals shall have adequate current carrying capacity and shall be of lead-alloy or lead-alloy reinforced with copper core inserts. Cell terminal posts shall be equipped with acid resisting connector bolts and nuts.
    - The electrolyte shall be of battery grade sulphuric acid. The battery shall be transported dry.
    - The charging equipment shall preferably employ solid state full wave rectifier in a 3 phase full wave bridge circuit with suitable filter circuit of AC ripples, suitable for operation in conjunction with static voltage regulator. A.C. and D.C. Circuit breakers with thermal overload and instantaneous short circuit releases shall be provided on input and output sides of chargers respectively.
    - Capacity of the float charger and the boost charger in the float cum boost charger shall be sufficient to meet the system requirement. Contractor shall submit the details to the owner.
    - The charger shall be capable of providing the floating voltage between 2.15 V to 2.21 V per cell with the variation of not more than +1% irrespective of input supply voltage fluctuations within +/-10%, frequency fluctuation within +/-5 % throughout its ampere rating with ambient air temperature range of -3^0C to 40^0C.
    - The DC Distribution Board (DCDB) shall be free standing, self-supporting and floor mounting type. It shall be totally enclosed and compartmentalized. DCDB shall be made as per relevant Indian Standard.
    - The Emergency Lighting Board supplying the emergency lighting requirement of the power house at A.C shall have an arrangement so that automatic changeover to emergency lighting in case of A.C. failure, is achieved through an inverter of suitable capacity. Normally, the inverter shall run on AC. supply. In the event of failure of AC, the inverter shall automatically switch-over to DC supply and feed the selected emergency loads (lighting loads) at 230 V AC. On restoration of AC supply, the inverters load will automatically return to AC.
    - The DC system shall have necessary control & protection arrangement which include but not limited to the following.

- Auto/Manual selector switch o Digital D.C. voltmeter, ammeter o A.C. failure alarm
- Ground fault relay and its annunciation
- Double pole D.C. contactor of suitable capacity for annunciation o Triple pole A.C. contactor of suitable capacity for ON/OFF operation o MCCB and DC contactor of suitable capacity in output circuit of each charger to suit the operation requirements.
- Indicating lamps, as required
- Triple pole, A.C. circuit breaker of sufficient capacity to meet system requirements & capacity with overload and short circuit release for incoming

  A.C. supply to charger panel o MCB/MCCBs for A.C. supply to individual chargers o A.C. under voltage relay o A.C. voltmeter, ammeter etc.

    - Nearest local control room from the main control room should be connected with 110/220 V DC from Battery Bank DCDB.

- 110/220 V AC/DC converter is to be provided in each isolated switchgear for operation of circuit breaker/isolator as and where required. Power required in ACDB/DCDB for illumination, control system etc. for each control room should

  be collected from 415 V (3phase+N) transmission line with necessary cables and protection.

9.5 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the DC system:

- Detailed specification of all the items.
- Necessary Drawings
- Test Certificates etc.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Detailed schematic, connection and control wiring diagrams etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

10. PROTECTION SYSTEM

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10.1 SCOPE

The scheme shall consist of design, engineering, quality surveillance, manufacture, tests at manufacturer's works before dispatch, transport, transit insurance, supply, delivery to site, storage at site, erection, testing, trial run and commissioning, handing over to the purchaser of protection system for o PV Array yard o Solar Inverter o Three winding Step up Transformer o Incomer feeder for 33 kV Switchyard o Station Auxiliary Transformer o 33 kV outgoing feeder

The protection system shall include protection relays, trip relays, relay contacts, trip & alarm circuits, Annunciation system, diagnostic system, other necessary equipment with all accessories, wiring and cubicles for making the protection system complete for 10 MW Solar PV Power Plant in Patni (Khemasuli), Paschim Medinipur, West Bengal.

10.2 STANDARDS

All materials and equipments shall conform to latest edition of relevant Indian/IEC Standards unless otherwise specified. Equipment conforming to any other authoritative standard ensuring equal or better quality than the standards indicated below will also be acceptable. However, in such eventuality, the salient points of difference between the standards adopted and the standards mentioned below shall be brought out by the bidder. The list of reference standards is given below:

Sl. No.	Standards	Description
IS: 2705	Current Transformers	
IS: 3156	Voltage Transformer s	
IEC: 60255 (Part 1 to 23)	Electric Relays	
IEC: 60337		Control switches and low voltage switching devices for control and auxiliary circuits
IS: 1885	Electric Power System Protection and Switchgear	Electro-technical vocabulary on Electrical relays, & Control
IS:13947		Degree of protection provided by enclosures for low voltage switchgear and control gear
IS: 3231	Electric relays for Power System protection	
IS: 5834	Electric Timer relays	
IS: 8686	Static Protective relays	

10.3 TECHNICAL REQUIREMENTS

The technical requirements of the protection system shall be but not limited to the following.

- Protection shall be designed to ensure reliability, sensitivity and stability under through fault conditions of the system.
- The protection system shall be fully integrated with SCADA system.

- The protection scheme shall be coordinated with control & protection of solar modules, solar inverters and generator transformers etc. All protection, though not specified but which are recommended for this capacity of the machine as per relevant IEC / other Standards shall be provided.
- The protective relays shall be of the numerical, fully tropicalised, plug in type, arranged in protection cubicles including all ancillary devices, such as interposing transformers, tripping matrix and relays, test facilities, power supply units, etc. with all circuits complying to latest editions of IEC 60255-4 recommendation or British Standard 142 and 5992, parts 1, 2 and 3 or relevant Indian Standard.
- The relays/protection system shall be of state of the art of technology and only latest proven versions of the relay series shall be offered. If the protection system mentioned in the awarded Contract become obsolete at the time of supply, the Supplier shall offer the latest model with the approval of Employer, without any extra cost.
- Protection system shall be provided to prevent operation of protective equipment due to, magnetizing current inrush during switching-in of the transformer from the high voltage side.
- Precaution shall also be taken so that the unavoidable inductive and capacitive couplings from the power circuits do not cause disturbances.
- Protection relay shall have features but not limited to the following:
    - Man machine communication interface with alarm and trip value setting, displaying of alarm/trip set values, alarmed/tripped values, fault current and disturbance values etc.
    - Self-supervision and indication of any failure.
    - Continuous monitoring of external and internal auxiliary voltages o Easiness of replacing a set in case of failure.
    - Communication interfaces or ports. o Indication of alarm and trip condition. o Test facilities etc.
- All devices shall remain inoperative during external faults and transient phenomenon. They shall be insensitive to mechanical shocks, vibration and external magnetic fields.
- The protection relays, shall be located in conventional panels and shall be flush mounted in dust and moisture proof cases with protection class IP 54 and of the draw out type with rear connections. The protection class of the cover for all relays or protection systems, in which the modules are mounted, shall not be inferior to IP 54.
- The protection systems shall be fed by the battery banks installed in the main control room and local control rooms. Relay shall be suitable for operation on DC systems without the use of voltage dropping resistors.
- The supplier has to supply the equipments for protection of best quality. The supplier has to maintain control and quality assurance during the manufacture, installation, testing and commissioning of equipments as per approved quality assurance plan.

10.4 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the protection system:

- Detailed specification of all the items.
- All required drawing etc.

Prior to the delivery of the products, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation
- Instruction O&M manual Testing & commissioning manuals

- Detailed BOQ covering protection relays, CTs /PTs, DC Sources and all other devices.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

11. EARTHING SYSTEM

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11.1 SCOPE

The scope of work under this specification covers the design, supply, transportation, delivery at project site, transit insurance, storage at site, erection, testing & commissioning of earthing system along with necessary materials

11.2 STANDARDS

The grounding system shall conform to the requirement of following standards.

Sl. No.	Standards	Description
1	ANSI/IEEE: 80 –2000	Guide for safety in AC Substation Grounding
2	CBIP Publication: 223 substation	Design of Earthing Mat for High Voltage
3	IS: 3043	Code of Practice for Earthing Indian Electricity Rules

11.3 OBJECTIVE

The grounding system shall be designed with the following objectives:

- To provide low impedance path to fault currents, during ground faults, to ensure prompt and consistent operation of protective devices to effect isolation
- To keep the maximum voltage gradient during ground faults along the surface inside and around the switchyard, PV array yard, control rooms etc. within safe limits
- To protect the life and property from electrical shocks due to over voltage
- To stabilize circuit potentials with respect to ground and limit the overall potential rise

11.4 TECHNICAL REQUIREMENTS

Minimum technical requirement of the earthing system is mentioned below.

- The earth resistance should be less than 1 Ω.
- Suitable number of earthing pit shall be provided at the array field.
- Design and installation of the earth mat and other associated system shall confirm IS: 3043 and shall be followed by modern practice.
- The earthing for solar field and power distribution system shall be made with GI pipe of suitable size including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS: 3043. The Mounting structure shall be grounded properly using GI strips and maintenance free earthing kit.
- Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.
- The earth conduction shall run through GI pipe partly buried and partly on the surface of the control room building.
- The complete earthing system shall be mechanically & electrically connected to provide independent return to earth.
- All three phase equipment shall have two distinct earth connections.

- Along the cable trays suitable size of GI Flat shall be provided inside the control room.
- For each earth pit, necessary Test Point shall have to be provided.
- The earthing system shall be connected to the following. o Solar modules with suitable number of earthing pit at the solar array field o The neutral point of each system/equipment o Equipment framework and other non-current carrying parts o Frames of panels & cubicles o Metallic structures of switchgear, cable racks, casing of cable boxes o Equipment supporting Steel structures o All extraneous metallic frame work not associated with equipment o The earth point of lightning arrestors; voltage transformers and lightning conductors through their permanent independent earth electrodes.
  o Fence
- For equipment connection to mat/riser, 50 mm x 6 mm or higher size GS flat shall be used.
- The conductor shall be of adequate cross-section to safely withstand the system fault current for time duration of fault clearance by the remotest/back up protective system.
- Sufficient allowance needs to be provided for corrosion of the embedded conductor on account of chemical properties of soil and also due to galvanic action with other embedded systems.
- For determination of the size of the conductor, the value of fault current may be taken as 40 kA; duration of fault current may be considered as 1 second. The extra allowance of 20% to take care of corrosion shall be added to arrive at final conductor size.
- For designing of the earth mat for 33kV switchyard, the material of ground mat conductor shall be MS Flat and that of risers emanating from ground mat shall be GS flats. Soil resistance of the site is available in the soil report.

11.5 APPROVAL

The successful bidder shall carry out the earth resistance measurement at the site and they need to submit the measurement report to WBSEDCL.

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the earthing system:

- Detailed specification of all the items.
- Soil resistivity measurement data
- Necessary calculations and drawings etc.

The successful bidder required to produce schematic diagram of the earthing system and the proposed locations for earth mat as per relevant standard with the Detailed Design Report.

All drawings and calculations submitted by the contractor will be subjected to approval of the WBSEDCL.

12. CONTROL, MONITORING AND DATA ACQUISITION SYSTEM

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12.1 SCOPE

The scope of work under this specification covers the design, engineering, manufacture, testing at manufacturer's works, transportation, transit insurance, delivery at project site, storage at site, erection, testing at site and commissioning of Control, monitoring & Data Acquisition system comprising of computers, VDU, key board/mouse, PLC’s, input and output relays, meters, fields

sensors, panels/cubicles for housing above equipment/devices, power supplies, transducers, converters, wiring etc to make the system complete.

12.2 REQUIREMENTS

- The automatic control panels shall be located in each control room. The control panels shall be provided with local automatic selection. On local automatic selection, control will be transferred to control panels located in local control rooms from where unit can be started by single push button control.
- The SCADA work station and push button control panel shall be interlocked by means of hardwired and software (Logic) to ensure smooth and safe operation of the plant.
- All pre-synchronisation checks shall be made to ensure normal and safe operation of the machine. Detailed philosophy shall be submitted by the contractor.
- PTZ (Pan-Tilt-Zoom) outdoor camera covering the whole plant to be deployed with night vision and central monitoring through 40" LED monitor/TV.
- System shall acquire on continuous basis the parameters of PV array, like DC current of string, DC voltage of each combiner box etc., Parameters of Solar Inverter like Power at the input of each inverter, Power at the input of each inverter, phase current, voltage, PF, MVAR, MW, Frequency etc., similar parameters of Generator Step-up and auxiliary Transformers etc.
- The Monitoring system shall perform String level monitoring for trouble free operation and maintenance of the plant. System shall indicate these on VDU Mimic alongside relevant device.
- System shall monitor and indicate on VDU status of all electrical devices including 33 kV switchgear.
- Shall provide mimics of main single line diagram, Auxiliary SLD and DC SLD in colour. The parameters as above shall be displayed by the side of respective device in proper units of measurement.
- The control & monitoring system for the generating units shall be microprocessor based digital control.
- The data logger shall have reliable battery backup and data storage capacity to record all sorts of data simultaneously round the clock.
- Inverters should be integrated with SCADA and provision of Data logging should be there. Logger should have the provision of recording the data of solar insolation, PV Module temperature and ambient temperature and associated electrical parameters at different stages to study performance of system as well as to study status of the system at a particular instant. The data logger should have required transducer to monitor and record the required system data. The data logger should be provided with an insolation sensor and a module temperature sensor, ambient temperature sensor matched with the system.
- Plant based Remote Monitoring system must be compatible with data logger. The other required accessories, hardware and compatible software shall have to be provided as an integrated part of the system to monitor the real time data through the server. The Data logger shall continuously send data to the server. Plant based Data logging system may be provided with special software (minimum 10 users). Upgradation of the software, if any, shall be done by the contractor. The server shall not be provided by WBSEDCL or end-user.
- In case the data cable to be laid in the array field, SPD (surge protection device) suitable for communication network, as much number at suitable location are required must be provided with the system.
- The Plant based monitoring system should have the provision of graphical representation of the data shall include but not limited to the following:

SI. No.	Operating Parameter	Desired specification
1	Input data	PV Power PV Energy
2	Meteorological data	Insolation (inclined on the plane of module as well as horizontal) Module Temperature Ambient Temperature Wind Velocity
3	Output data	Inverter Export Power Inverter Export energy

- All data shall be recorded chronologically date wise. The data file should be MS Excel/XML/any readable form compatible and should have the facility of easy downloads.
- IT grade server may be installed including provision for back up data at least for 02 years.

12.3 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the data acquisition and monitoring system:

- Detailed scheme
- Details of panels, metering system Necessary drawings for the scheme etc.

Drawings and scheme submitted by the contractor will be subjected to approval of the owner.

13. MISCELLANEOUS

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13.1 GENERAL SCOPE

The scope of work under this specification covers the following systems.

- Illumination system
- Fire protection system
- Ventilation system
- Air conditioning system
- Drinking water
- Weather station
- Communication system
- Signage
- Surveillance System

13.2 ILLUMINATION SYSTEM

13.2.1 SCOPE

The scope of work under this specification covers design, manufacture, assembly, shop testing, delivery, site erection, testing & commissioning of Illumination system comprising of main Illumination switchboards, distribution boards, sub distribution boards, switchboards, lighting fixtures, convenience and power outlets, conduits & fittings, cabling, outdoor lighting including mounting structures & poles, LED etc. for control rooms, security cabin, watch tower, access road, across the fence (maximum 15 m between two adjacent lamps).

The illumination system shall be designed as per relevant Indian Standard / Guideline for different location of the plant. The lighting arrangement should be LED Based.

The scope of supply shall also include necessary spares required for normal operation & maintenance of illumination equipment for a period of 5 (five) years & special tools & plants required for erection & maintenance. Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable.

13.2.2 STANDARDS

The material, equipment and its installation under the scope shall comply with all applicable provisions of the latest Indian standards and codes of practice. Some of the relevant standards are given below:

Sl. No.	Standards	Description
1	IS: 3646	Code of practice for interior Illumination (Part I, II, III)
2	IS: 6665	Code of Practice for Industrial Lighting
3	IS: 732	Code of Practice for Electrical wiring installations
4	IS: 9537	Conduits for Electric installations
5	IS: 2418	Tubular fluorescent lamps for general lighting service
6	EN 61347-2-13	Particular requirements for D.C. or A.C. supplied electronic control gear for LED modules
7	EN 62384	D.C. or A.C. supplied electronic control gear for LED modules
8	EN 61000-3-2	Electromagnetic compatibility (EMC). Limits for harmonic current emissions (Equipment input current < 16 A per phase)
9	EN 61000-3-3	Limitation of voltage fluctuation and flicker in low voltage supply systems for equipment with rated current < = 16 A

The installation shall generally be carried out in conformity with the requirements of Indian Electricity Act 1910 (latest Amendment) & Indian Electricity Rules.

13.2.3 REQUIREMENT

The lighting system for outdoor and indoor areas of Solar Power Plant shall be designed in such a way that uniform illumination is achieved.

In outdoor yard equipment / bus bar areas and the peripheral wall are to be illuminated and luminaires shall be aimed for clear view.

13.2.4 LIGHTING LEVELS

The complete switchyard shall be lightened with an average illumination level of 100 lux.

Lighting in other areas such as control room, office rooms and battery room & other areas (i.e. street light) shall be such that the average LUX level to be maintained shall be as under:

Sl No.	Area	LUX
1	Control Room and equipment rooms	500
2	Office	300
3	Communication Room	300

4	Battery & other rooms	150
5	Other areas including periphery wall	20
6	H – pole and metering point	20
7	Outdoor switchyard including road	30
8	Road within campus including colony area	30
9	Auxiliary Buildings like Pump room and other houses	150
10	ACDB- DCDB room/Store / Store Office	150
11	Conference room	300
12	Dining room/Kitchen	150
13	Maintenance room	150
14	Stairs	100
15	Toilet	100
16	Corridor	100
17	Any other spot where high level of illumination required	150

13.2.5 EMERGENCY LIGHT POINTS

Light points using LED lamps of 15-20 W (at 240 V) shall also be provided as given below:

- Control room and equipment room – 4 Nos. Battery room – 1 No
- Office – 1 No
- Corridor – 1 No
- Local Control Room – 2 Nos.

These lights shall operate on AC/DC changeover supply from the DC distribution Board. Separate wiring and distribution board shall be provided from these lights.

13.2.6 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the illumination system:

- Detailed scheme and specification
- Illumination calculations for arriving at the number of lighting fixtures for different areas & rooms considering the required lux level as per relevant IS Code.
- Necessary drawings etc.

Drawings and scheme submitted by the contractor will be subjected to approval of the owner.

The contractor can deliver the product to the site only after receipt of such approval against their prayer in writing from WBSEDCL.

13.3 FIRE PROTECTION SYSTEM

13.3.1 SCOPE

The scope of work under this specification covers design, engineering, quality assurance, manufacture, shop testing, transport, transit insurance, delivery to site, storage at site, site erection,

testing & commissioning of fire protection system (fire extinguisher (type shall be selected as per requirement), fire buckets, fire alarms at all control rooms etc.) complete with all accessories.

The scope of supply shall also include necessary spares required for normal operation & maintenance of illumination equipment for a period of 5 (five) years & special tools & plants required for erection & maintenance. Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable.

13.3.2 STANDARDS

All equipment covered under this section will conform to the latest edition of following Indian Standards:

Sl. No.	Standards	Description
1	IS: 3034	Code of Practice for Fire Safety of Industrial buildings: Electrical generating and distributing stations.
2	IS: 3844	Code of Practice for installation of internal fire hydrants in multi-storied buildings
3	IS: 1646	Code of Practice for fire safety of buildings (General) Electrical Installations
4	IS: 2878	Specification for fire Extinguishers – Carbon dioxide type
5	IS: 2171	Specification for fire Extinguishers – Dry Powder type
6	IS: 933	Specification for fire Extinguishers – Foam type
7	IS: 2175	Specification for heat sensitive fire detectors for use in automatic electrical fire alarm system
8	IS: 2189	Code of Practice for installation of automatic fire alarm system using heat sensitive type fire detectors

13.3.3 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the fire protection system:

- Detailed scheme and technical specification
- Placing and type of fire extinguisher with justification Necessary drawings related to the system etc.

Drawings and scheme submitted by the contractor will be subjected to approval of the owner.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

13.4 VENTILATION SYSTEM

13.4.1 SCOPE

The scope of work under this specification covers design, manufacture, shop testing, supply, transportation, delivery, storage at site, erection, testing and commissioning of ventilation system complete with all accessories at each control rooms, store room etc.

The Scope shall include supply of all blower fans, GS ducting, air plenum, exhaust fans air dampers etc as required to make the ventilation system complete in all respects for satisfactory operation.

The scope of supply shall also include necessary spares required for normal operation & maintenance of ventilating equipments for a period of 5 (five) years and special tools & plants required for erection & maintenance.

Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

13.4.2 STANDARDS

The ventilating equipment shall comply with the requirement of the latest edition of relevant Indian standards or equivalent British Standards. Some of the relevant standards are given below:

Sl. No.	Standards	Description
1	IS : 3103	Code of Practice for industrial ventilation
2	IS : 2312	Specifications for propeller type A.C. Ventilating fans.
3	IS: 4894	Centrifugal fans

13.4.3 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the fire protection system:

- Detailed scheme and technical specification
- Calculations showing air requirements at various locations Necessary drawings etc.

The successful bidder required to produce all necessary test certificates and approvals of the product as per relevant standard with the Detailed Design Report.

Drawings and scheme submitted by the contractor will be subjected to approval of the owner. The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

13.5 AIR CONDITIONING SYSTEM

13.5.1 SCOPE

The scope of work under this specification covers design, manufacture, testing, supply, transportation, transit insurance, delivery, storage at site, erection, testing and commissioning of Air conditioning system with control and accessories at the operator's work station, SCADA room and Conference/seminar room at main control room building.

13.5.2 STANDARDS

Equipment shall conform to the latest Indian standards or equivalent British Standards.

Sl. No.	Standards	Description
1	IS: 659	Safety code for Air conditioning
2	IS: 660	Safety code for Mechanical Refrigeration
3	IS: 655	Metal Air ducts

13.5.3 APPROVAL

The successful bidder required to produce all necessary test certificates and approvals of the product as per relevant standard with the Detailed Design Report.

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the Air Conditioning system:

- Detailed scheme and technical specification
- Necessary drawings etc.

Drawings and scheme submitted by the contractor will be subjected to approval of the owner. The contractor can deliver the product to the site only after receipt of such approval against their prayer in writing from WBSEDCL.

13.6 DRINKING WATER

13.6.1 SCOPE

The scope of supply under this section shall cover the design, manufacture, shop testing, supply, transportation, delivery, storage at site, erection, testing and commissioning of deep tube well, pump, water purifier unit and other related plumbing arrangement and accessories etc. for drinking water supply for the personnel at the power house.

13.6.2 STANDARDS

The whole system shall conform to the latest edition of relevant Indian Standard.

13.6.3 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the water purification unit:

- Detailed Technical specification
- Necessary drawings etc.

Specification submitted by the contractor will be subjected to approval of the owner. The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

13.7 WEATHER STATION

13.7.1 SCOPE

The scope of supply under this section shall cover the design, manufacture, shop testing, supply, transportation, delivery, storage at site, erection, testing and commissioning of weather station comprising of o Temperature sensor with radiation protection o Temperature sensor in the module o Solar radiation sensor (Inclined on the plane of module as well as horizontal) o Sensor which indicates the speed and direction of the wind etc.

The monitoring system shall be linked to the weather station by means of its digital/analogue inputs, allowing the datas collected by the sensors stored through software.

13.7.2 STANDARDS

The equipments shall conform to the latest edition of relevant Indian Standard.

13.7.3 APPROVAL

The Detailed Design Report submitted by the contractor to WBSEDCL must contain but not limited to the following details of the equipments of weather station:

- Detailed Technical specification
- Necessary drawings etc.

Specification submitted by the contractor will be subjected to approval of the owner. The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBSEDCL.

13.8 COMMUNICATION SYSTEM

Communication system at the Main Control Room (telephone sets) and required number of walkie talkies for security personnel and main control room shall be provided by the contractor.

13.9 SIGNAGE

Project information Signage:

- The Signage shall be provided with details of the project as approved by WBSEDCL.
- The font size on the signage has to be big enough so that everyone can read it easily.
- This signage will be outdoor type.
- The Signage shall be installed two (02) prominent place of each project location.

Safety Signage:

Safety Signage must be provided mentioning the level and type of voltage and symbols as per IE Rule at different position as may be required.

13.10 SURVEILLANCE SYSTEM

The specification covers design, supply, erection, testing and commissioning of the complete surveillance system including cameras, Network Digital video recorder, computer with peripherals, mounting arrangement for cameras, cables etc. for effective visual monitoring of total power plant premises.

The number of cameras and their locations shall be decided to monitor at least:

- All the Transformers.
- The operation of each and every isolator of the complete yard.
- All other Major Equipments (such as CB, CT, PT, SA etc.)
- Key areas of control room cum administrative building, Indoor C&R panel room etc.
- All the Entrance doors of Control Room Building, Pump House, Sub-Station main gate, gates of switchyard, colony entrance gate etc.

The cameras can be mounted on structures, buildings or any other suitable arrangement to be provided by the contractor.

13.10.1 TECHNICAL REQUIREMENTS

The system shall use video signals from various types of indoor/outdoor CCD colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using MPEG 4 or better standard and streamed over the IP network. Mouse-Keyboard controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras. The System shall provide sufficient storage of all the camera recordings for a period of 30 days or more @ 25 FPS, at 4 CIF or better quality using necessary compression techniques. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable. The provision for transfer of recorded data to separate external media shall be ensured.

The surveillance CCTV System shall operate on 230 V, 50 Hz single-phase power supply.

13.10.2 SYSTEM REQUIREMENTS

- Camera with external encoder shall be used for image capture.

- Indoor cameras shall be either with fixed focal length lens or with Pan/Tilt & Zoom lens as per site requirement. All outdoor Cameras shall be Day/Night PTZ Dome type cameras.
- Housing of cameras meant for indoor use shall be of IP 42 rating whereas outdoor camera housing shall be of IP 66 or better rating.
- All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.
- System to have facility of additional camera installation beyond the originally planned capacity.
- System shall be triplex i.e. it should provide facility of simultaneous recording, playback & network operation.
- The offered system shall have facility to export the desired portion of clipping (from a desired date/time to another desired date/time) on CD or DVD.

  Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.
- System shall have provision for remote monitoring.

The equipment should generally conform to Electromagnetic compatibility requirements for outdoor equipment in EHV switchyards. Type test reports to establish compliance with this requirement shall be submitted during detailed engineering.

13.10.3 VIDEO SURVEILLANCE APPLICATION SOFTWARE

- Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, video encoder, Servers, NAS boxes/Raid backup device etc.
- Surveillance control software should be compatible with MS Windows operating system.
- The software should have inbuilt facility to store configuration of encoders and cameras.
- The software should Support flexible 1/2/4/8 Windows Split screen display mode or scroll mode on the PC monitor.
- The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.
- There must be a single encoder for each camera.
- The software should have user access authority configurable on per device or per device group basis. The user shall have the facility to request the access and control of any camera for a pre determined time period. Control of camera shall be released automatically after expiry of the pre determined time period.
- The system shall provide user activity log with user ID, time stamp, action performed, etc.
- The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user.
- It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.
- The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

- Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 30 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.

13.10.4 DIGITAL VIDEO RECORDER

The Personal Computer based network digital Video recorder is to be provided. The Personal computer shall include the PC (min intel core i5 processor, 4GB DDR3 RAM, 1 TB hard disk) with latest configuration available in the market along with:

- Coloured LED monitor of minimum 40", coloured Laser printer, and External USB DVD writer.
- Windows operating system latest version with license.

Sl. No.	Items	Specifications Requirement
1	Recording & Display Frame Rate	Real time 240 frames per second total, 30 frames per second per camera
2	Recording Resolution	(NTSC): 704(H) x 480(V) / (PAL): 704(H) x 586(V) It should be possible to select lower resolutions
3	Operating System	MPEG4 Hardware RTOS (Real time operating system)
4	Compression Method	MPEG-4
5	Video Motion Detection Capable	Standard and built-in (selectable in menu)
6	Video Motion Detection Options	Masking, sensitivity adjustment
7	Monitoring Options	Split screen 1,2, 4 or 8 cameras
8	Playback Options	Search, still image capture
9	Network Operation Capable	To be provided by using WAN or LAN router
10	Ethernet/Modem Built-in	Ethernet standard and built-in
11	HDD Storage Consumption	80 ~ 350 MB per hour / channel variable based on frame speed and
12	HDD Speed	7200 R.P.M + 8 MB buffer
13	Operation	Triplex operation (simultaneous recording, playback, network operation)