



MAHARASHTRA STATE POWER GENERATION COMPANY LTD.

MAHARASHTRA STATE POWER GENERATION COMPANY LTD.

Renewable Energy (Projects & Planning)

EXPRESSION OF INTEREST

Maharashtra State Power Generation Co. Ltd. invites Expression of Interest (EOI) from **various EPC agencies having technical experience in developing solar power projects** for the remaining/balance work and supply of material for the development of a 62 MW solar power project at Paras. The EOI is invited for the remaining/balance scope of work and supply of material for the contracted 62 MW solar power project at Paras — for Design, Engineering, Supply, Erection, Testing, and Commissioning of a 62 MW AC cumulative capacity Crystalline Solar PV Technology Grid-Interactive Solar PV Power Plant with associated HT overhead transmission line/underground cable up to the point of interconnection, including 5 years' Operation & Maintenance on an EPC basis at Village: Paras, Taluka: Balapur, Dist.: Akola, Maharashtra

Interested applicants may submit their budgetary offer proposal for estimation purposes after visiting the site at their own cost.

The offer shall be submitted along with the following documents.

1. Specifying company profile along with Name of Directors.
 2. Experience as per Qualifying Requirements
 3. Site assessment report.
- Last date for submission of EoI/Application in soft copy through e-mail cespgd@mahagenco.in/dycespgd@mahagenco.in :--08/September/2025 till 11:00 Hrs.
 - Last date for submission of EoI/Application in hard copies in sealed envelope: --08/September/2025 till 17:00 Hrs.

Submit hard copy to:

O/o Chief Engineer (RE-P&P),

4th Floor, A- Wing, HDIL Towers, Bandra (East), Mumbai – 400 051.

Tel: 022-69415353/35/ Mob No. +918879770745/+917738070061.

Details of the EoI document is available on MAHAGENCO's website (www.mahagenco.in) for free download.

Note: This budgetary offer proposal is for estimation purposes only and does not create any right to receive a Letter of Award (LoA).

Date –

Sd/-

Chief Engineer- RE (P&P)

Annexure -I

EXPRESSION OF INTEREST (EOI)

For Execution of Balance of Work and Material Supply for 62 MW Solar-PV Power Project at Paras, District Akola, Maharashtra

Ref No.: CE/RE-P&P/62MWSPP/EOI/_____

Date: _____

1) Background

Maharashtra State Power Generation Company Ltd. (MAHAGENCO), a leading public sector utility in Maharashtra, initiated development of a 62 MW (AC) grid-connected Solar PV Power Plant at Paras (District Akola) under the Renewable Energy Bundling Scheme.

The project was awarded to M/s Gensol Engineering Ltd. through open tender competitive bidding and project commissioning originally scheduled for 14.11.2024. However, due to sustained lapses in performance, delays in material supply, and financial concerns of EPC contract or project work is stalled & contract is under termination as per applicable contractual clauses. To facilitate timely completion and safeguard project assets, MAHAGENCO is now inviting Expressions of Interest (EOI) and **budgetary offers** from technically and financially sound EPC agencies to take over and execute the **balance of work**, on an “as-is-where-is” basis, following a self-assessment of the site.

2) Objective

The objectives of this Expression of Interest are to:

- Identify EPC agencies with the requisite technical, managerial, and financial capabilities.
- Invite a thorough self-assessment visit to evaluate the project status and challenges on the project site.
- Shortlist capable agencies for subsequent participation in a detailed tender/RFP process for taking over the Balance of Work (BoW).
- Submitting budgetary offers and execution methodology for completing the remaining scope.
- Recommencing halted work efficiently to meet the revised commercial operation timelines.
- Ensuring grid synchronization and system commissioning as per MNRE/CEA/MERC guidelines.

3) Project Overview

- Project Name: 62 MW Paras Solar PV Project
- Location: Near Paras Thermal Power Station (TPS), District Akola, Maharashtra
- Project Capacity: 62 MW (AC)

- Project Status: Stalled; work in various stages of execution requiring take-over of BoW.

4) Scope of Work (Indicative)

The proposed balance-of-work under EPC mode shall include:

- **Design, Engineering, Supply, Erection, Testing & Commissioning** of the balance components of 62 MW (AC) Solar PV Plant based on crystalline technology.
- **Supply and Installation of HT Transmission Line/Cables**, evacuation infrastructure up to 220kV Paras TPS Substation as approved MSETCL Grid Connectivity.
- Completion of pending civil, structural, electrical works including MMS, SCADA, Inverters and substation equipment.
- Execution of 5-year comprehensive Operation & Maintenance (O&M).
- Rectification and integration of already supplied and installed material.
- All works shall be complied to original RfP technical specifications and standards.

5) Site Visit and Self-Assessment Protocol

Interested agencies are expected to visit the site at their own cost and assess:

- **Current Status:** Detailed on-ground status of completed versus pending work.
- **Material and Equipment Audit:** Condition, availability, and compliance of existing materials and equipment.
- **Logistics and Operations:** Infrastructure availability, workforce capacity, and logistical challenges affecting the balance work.
- **Risk and Remedial Analysis:** Identification of any risks or deficiencies that could impact the overall project completion.
- **MSPGCL Internal Committee Audited Report** of the stalled site (dated 26–28 May 2025) is available for reference during site assessment.
- **Site visits can be coordinated by contacting the project team at:**

Contact Person: Shri Ajit Gawade, Executive Engineer

Mobile: + 918879770745

Shri Shamkant Patil, Addl Executive Engineer.

Mobile: + 917738070061

Email: dycespgd@mahaengenco.in / ee4spgd@mahagenco.in

6) Submission Requirements

Interested EPC agencies shall submit the following:

- i. **Letter of Interest:** On official company letterhead, expressing intent and outlining capability.

- ii. **Company Profile** including organizational structure, directors' details, and relevant registrations.
- iii. **Project Experience** as per minimum qualifying requirements (detailed below).
- iv. **Site Assessment Report** highlighting current conditions, balance work needed, and recommended plan of action.
- v. **Budgetary Financial Offer** for execution of balance work in line with technical specification of enclosed RfP.
- vi. **Technical Proposal:** Detailing methodology for site assessment, proposed plan for takeover, schedule, risk management, and execution strategy.
- vii. **Execution Methodology** including work plan, resource mobilization strategy, risk mitigation, and timeline.
- viii. **Financial Documentation:** Certified copies of audited financial statements for the past three years, and details of financial arrangements to be mobilized for the project.
- ix. **Compliance Certificates:** Copies of GST registration, PAN, MOA, AOA and any other relevant statutory registrations or clearances.
- x. **O&M qualification:** Plant performance certificate of project commissioned by EPC & running successfully in last 7 years.
- xi. **Declaration:** EPC shall submit declaration of litigation status, financial standing, and compliance with statutory laws.

7) Minimum Qualifying Requirements

1. "Technical Experience:

Ground mounted solar PV plant having Cumulative installed capacity of 25 MW or higher capacity out of which single solar project of 12 MW or higher capacity is running successfully for at least six (6) months prior to the date of techno-commercial bid opening.

The reference plant of 12 MW(AC) capacity must have been in successful operation for at least six (6) months prior to the date of techno-commercial bid opening.

OR

The Bidder should have executed in last 10 years an industrial project either as developer or as EPC contractor in the area of Power / Steel / Oil / Gas / Petrochemical / Fertilizer cement/ coal / mining including coal handling plant and/or any other Process Industry, with HT power line connectivity for value of at least Rs. 125 Crs. or more in a single project or work respectively.

OR

The Bidder should have erected and commissioned Balance of System (BOS) of Solar Photo Voltaic (SPV) based ground mounted grid connected power plant(s) of cumulative installed capacity of 30% of quoted capacity and at least one plant should have been of 12 MW(AC)

capacity. The reference plant of 12 MW(AC) capacity must have been in successful operation for at least six (6) months prior to the date of techno-commercial bid opening.

Note BOS:

The Balance of Systems (BoS), under above QR refers to works related to following areas in a Solar PV Plant,

i. Erection of Solar PV Modules.

ii. Inverters (Power Conditioning Units) & Inverter Transformers.

- i. In case of a BIDDER / Member of Consortium seeking experience qualification on the basis of technical capability of its Parent Company, the Parent Company shall have minimum 51% stake in the Bidder / Member of Consortium for first 2 years and minimum 26% stake in the BIDDER / Member of Consortium for next 3 years of O&M.
- ii. Parent Company shall be construed as reference to any company or corporation of which the other company or corporation is a Subsidiary i.e. at least 51% stake in the subsidiary is held by the Parent Company.

2. Financial Criteria

A) Net worth

- i. The net worth of the tenderer/ bidder as on 31st March of previous financial year shall be minimum 15.5 Cr. If the tenderer does not meet the Net Worth criteria outlined here independently, tenderer must provide a letter of undertaking from their Holding Company along with their Bid. Such undertaking must pledge unconditional and irrevocable financial support for the contract execution up to Operations & Maintenance (O&M) period in case the contract is awarded. The Net Worth of the Holding Company as of 31st March of the previous financial year must be at least Rs 15.5Cr.
- ii. In case where audited results for the last preceding financial year are not available, certification of financial statement from a practicing Chartered Accountant shall also be considered acceptable as per format attached in tender along with UDIN
- iii. Please note that, Net Worth means sum of the paid up share capital and free reserves. Free reserves shall mean all reserves credit out of the profit and share premium account but not include reserves credited out of the revaluation of assets, write back of depreciation provision and amalgamation. Further, any debit balance of profit and loss account and miscellaneous expenses to the extent not adjusted or written off, if any, shall be reduced from reserves and surplus. Other income shall not be considered

for arriving at annual turnover.

- iv. *The Bidder should submit the documentary evidence in respect of above. In case audited results for the last preceding financial year are not available, certification of financial statement from practicing Chartered Accountant shall be acceptable as per format which will be provided later.*
- v. *For the purposes of meeting financial requirements only unconsolidated i.e. standalone audited annual accounts shall be considered.*
- vi. *If Bid is submitted by a Consortium, the Net worth requirement is to be met by Lead Member of the Consortium. The Bidder may seek qualification on the basis of financial capability of its Parent Company for the purpose of meeting the Qualification Requirements. In the case of the Bidder being a Bidding Consortium, Lead Member may seek qualification on the basis of financial capabilities of its Parent Company. In such an event, the Bidder would be required to furnish along with its bid, a Letter of Undertaking from the Parent Company, supported by Board Resolution, as per format which will be provided later, pledging unconditional and irrevocable financial support for the execution of the Contract by the Bidder in case of award.*
- vii. *Parent Company shall be construed as reference to any company or corporation of which the other company or corporation is a Subsidiary i.e. at least 51% stake in the subsidiary is held by the Parent Company. In case of a Bidder seeking qualification on the basis of financial capability of its Parent Company, the Parent Company shall have minimum 51% stake in the Bidder/Lead Member for construction period and also first 3 years of O&M and minimum 26% stake in the Bidder / Lead Member for next 2 years of O&M. To ensure shareholding, the shareholding certificate along with an undertaking regarding the shareholding shall be required to be submitted. Additionally, the undertaking shall be obtained from the EPC contractor before the start of each year of Operations and Maintenance (O&M).*

B) Turnover

- i. *The average annual turnover during preceding three consecutive financial years of the Bidder / consortium shall be at least Rs. **155 Crores** from the Bidder's business as an EPC Bidder / developer of Projects in India turnover will be considered exclusive of taxes. If Bid is submitted by a Consortium the Turnover requirement is to be met by Lead Member of the Consortium. The Bidder may seek qualification on the basis of financial capability*

of its Parent Company for the purpose of meeting the Qualification Requirements. In the case of the Bidder being a Bidding Consortium, Lead Member may seek qualification on the basis of financial capabilities of its Parent Company. In such an event, the Bidder would be required to furnish along with its bid, a Letter of Undertaking from the Parent Company, supported by Board Resolution, as per format which will be provided later, pledging unconditional and irrevocable financial support for the execution of the Contract by the Bidder in case of award. Parent Company shall be construed as reference to any company or corporation of which the other company or corporation is a Subsidiary i.e. at least 51% stake in the subsidiary is held by the Parent Company.” Other income shall not be considered for arriving at annual turnover. Standalone audited financial statement will be accepted for turnover assessment as specified for net worth.

8) Key Dates and Contact

- Last Date for Soft Copy Submission email cespgd@mahagenco.in / dycespgd@mahagenco.in: -- **08 /09/2025 up to 11:00 Hrs**
- Last Date for Hard Copy Submission (sealed envelope):-- **08 /09/2025 up to 17:00 Hrs**

9) Submission Address:

Office of Chief Engineer (RE-P&P)

4th Floor, A-Wing, HDIL Towers, Bandra (East), Mumbai – 400 051

Mob: +91-8879770745/+917738070061

Email: cespgd@mahagenco.in / dycespgd@mahagenco.in

10) Terms and Conditions

- **Non-binding Nature:** This EOI is not a tender, but a pre-bid EOI to collect budgetary offers and execution strategies. It does not constitute an offer or a guarantee of a contract award.
- **Confidentiality:** All submitted documents and information will be treated as confidential and will be used solely for the purpose of evaluating the responses.
- **Costs:** All costs incurred by the participating agencies for the site visit, self-assessment, and preparation of submissions shall remain the sole responsibility of the respective agency.
- **Clarifications:** Any queries or requests for clarifications regarding this EOI should be directed to the designated contact person as specified in

Section 9. Responses to all queries will be circulated to all prospective bidders.

- **Validity of Submission:** The offers/expressions of interest should remain valid for a minimum period of 180days from **the date of submission.**

11) Disclaimer

This document is an Expression of Interest (EOI) and does not represent a formal Request for Proposal (RFP) or a contract award. MSPGCL reserves the right to modify, cancel, or reject any or all submissions without assigning any reason. Shortlisted agencies may be invited for further evaluation and a detailed bidding process in due course.

Note: This budgetary offer proposal is for estimation purposes only and does not create any right to receive a Letter of Award (LoA).

Enclosure: RfP – II. SECTION II: TECHNICAL SPECIFICATIONS 62MW Solar Power Project.

Sd/-

Chief Engineer (RE-P&P)

MAHAGENCO

Date: 15 /08/2025

MAHARASHTRA STATE POWER GENERATION CO. LTD
62MW_{AC} CRYSTALLINE GRID INTERACTIVE SOLAR PV POWER PROJECT

BID SPECIFICATION FOR

Design, Engineering, Supply, Erection, Testing and Commissioning of 62MW_{AC} Cumulative Capacity Crystalline Solar PV Technology Grid Interactive Solar PV Power Plant with associated HT overhead transmission line / underground cable along with all required electrical equipment, construction of bays up to the point of interconnection at 220kV bays at Paras Substation including 5 years' Operation & Maintenance of Solar Power Plant and Evacuation System up to the point of interconnection on EPC basis at Village: Paras, Taluka: Balapur, Dist.- Akola, Maharashtra, India under Local Competitive Bidding from prospective Bidders.

Local Competitive Bidding Bid Specification No:

RFX No -3000036625



CHIEF ENGINEER (RE-P&P)
MAHARASHTRA STATE POWER GENERATION CO. LTD.
HDIL Tower, A-Wing, 4th Floor, Bandra (East), Mumbai - 400051
Email: cespgd@mahagenco.in, dycespgd@mahagenco.in
Phone No: 91-22-26582424 Extn:353/357



SECTION II:
TECHNICAL SPECIFICATION



II. SECTION II: TECHNICAL SPECIFICATIONS.A: -

GENERAL SCOPE OF WORK

1.0. OBJECTIVE

The main objective of this project is Design, Engineering, Supply, Erection, Testing and Commissioning of 62MW_{AC} Cumulative Capacity Crystalline Solar PV Technology Grid Interactive Solar PV Power Plant with associated HT overhead transmission line / underground cable along with all required electrical equipment, construction of bays up to the point of interconnection at 220kV bays at Paras Substation including 5 years' Operation & Maintenance of Solar Power Plant and Evacuation System up to the point of interconnection on EPC basis at Village: Paras, Taluka: Balapur, Dist.- Akola, Maharashtra, India.

1.1. DETAILS OF PROJECT SITES

62 MW_{AC} Solar PV Project Site is situated at Paras, Dist.- Akola, Maharashtra, India. The available land is 103 hectares, barren and firm soiled having Latitude 20.71 & Longitude 76.80. The land is in possession of MAHAGENCO and free from any litigation and encroachment. Bidders are requested to visit at site for actual assessment before quoting the bid.

The scope of work includes Design, Engineering, Supply, Erection, Testing and Commissioning of 62MW_{AC} Crystalline Solar PV Technology Grid Interactive Solar PV Power Plant with associated HT overhead transmission line / underground cable along with all required electrical equipment, construction of bays up to the point of interconnection at 220kV bays at Paras Substation including 5 years' Operation & Maintenance of Solar Power Plant and Evacuation System up to the point of interconnection on EPC basis at Village: Paras, Taluka: Balapur, Dist.- Akola, Maharashtra, India.

1.2. SCOPE OF WORK

It includes Design, engineering, supply, erection, testing and commissioning of 62MW_{AC} Crystalline Solar PV Technology Grid Interactive Solar PV Power Plant with associated HT overhead transmission line / underground cable along with all required electrical equipment, construction of bays up to the point of interconnection at 220kV bays at Paras Substation including 5 years' Operation & Maintenance of Solar Power Plant and Evacuation System up to the point of interconnection on turnkey basis.

- The Equipment and Materials for 62 MW_{AC} Crystalline Solar PV Technology and Grid Interactive Solar PV Power Plant with associated power evacuation system shall include but not limited to the supply, erection and testing & commissioning of the 62 MW_{AC} Cumulative capacity
- Array Junction boxes/string combiner box and Fuse boxes / circuit breakers of approved make.
- Power Conditioning Units (PCU) each of minimum capacity 1000 kW to 6847 kW shall be utilized in 62 MW_{AC} Crystalline Solar PV Technology. Total number of PCUs shall be as per the inverter capacity used.
- Capacity of each Transformers shall be in the range suitable for inverter capacity & as

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per applicable IS/IEC, oil filled/dry type, each of primary side voltage rating will be in accordance with AC output of Inverter & secondary voltage will be 33kV and Associated Switchgear of approved make shall be utilized. Total number of transformers shall be as per the designed numbers of units according to the inverter capacity.

- Metering and protection.
- Energy meter & cubicle.
- LT/HT Power and Control Cables including end terminations and other required accessories for both AC & DC power.
- 415 TPN Distribution Board for catering to lighting of the power station including power plug etc. Lighting fixtures, switches, receptacles and necessary wiring for control room building & area lighting (yard LED lighting).
- Earthing system for PV Array, DC power system, lightning protection system, AC power system for both LT & HT, equipment etc. for control room building, yard area, PCU, transformers and HT switch gear.
- Bidder has to construct a required capacity of switchyard inside the solar land parcel. The Power transformer inside the switchyard should be of adequate capacity and protection system.
- The Bidder has to do the power evacuation and integration it to 220 kV Paras MSETCL Thermal Plant substation via overhead line with the double pole structure / underground cable at 220 kV grid voltage with all necessary infrastructure such as protection switchgears and metering systems as per the requirement of the MSEDCL and MSETCL requirement.
- Monitoring at dual string level shall be provided as per standard practice, along with necessary details.
- Data acquisition system with remote monitoring facilities (SCADA).
- The items of civil erection work shall be performed with respect to the following but not limited to:
 - a. Solar PV array.
 - b. Power Cables.
 - c. Outside area of substation overhead transmission line and underground cable laid.
- Civil foundation work of transformers, switchgears, PV module mounting work, etc.
 - a. Entire cable tray inside control room building.
 - b. Fabrication, supply & erection of cable trays, support, brackets and accessories in case of site fabrication cable tray.
 - c. Galvanized steel rigid / flexible conduits and accessories, hume pipes, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts and bolts etc. as required.
 - d. Supply of necessary steel materials for field fabrication of cable trays, supports, brackets, grounding system etc.
 - e. Construction of pathways inside array and main approach road, entry gate, as required.
 - f. Outdoor cables installation shall be trenched or underground as per the site requirement & site conditions method for trenching and undergrounding cable shall comply applicable IS.

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- g. EPC Contractor shall arrange the water required for module cleaning, sufficient Bore wells along with pumps and piping system provision for project shall be made by Contractor to cater water requirement for module cleaning and other purpose.
- h. All relevant drawing, data sheets, technical catalogues on each piece of equipment / devices and type test certificates.
- i. Materials and accessories, which is necessary or usual for satisfactory and trouble-free operation and maintenance of the above equipment
- j. Furniture for office use as per requirement.
- k. Contractor has to make the required power supply arrangement for the construction purpose and auxiliary power supply for O&M of solar power project from MSEDCL & should bear the power charges for utilization of power for his construction work and 5 years of O&M of the solar plant.
- l. Adequate air Conditioner system along with required accessories shall be provided for each main control room.
- m. Air cooling system by employing ducting for each inverter and blower/suction fan along with required ventilation shall be provided as per requirement.
- n. Construction supply arrangement by Contractor from MSEDCL/MSETCL as per current industrials Supply Norm at Own Risk & cost.
- o. All statutory approval should be done by Contractor at their own cost like electrical, fire safety and CEIG etc.

1.3. SCOPE OF SERVICE

The item of work to be performed on all equipment and accessories shall include but not limited to the following:

- a. Transportation, unloading, receiving and properly storage at site.
- b. Arranging to repair and/or re-order all damaged or short-supply items
- c. Final check-up of equipment and commissioning and putting the system into successful function operation feeding power to the MSETCL grid from the output of the 33/220 kV Power transformer
- d. All statutory clearance (like Electrical, Fire, safety , environment, etc. as applicable)

B :- TECHNICAL SPECIFICATION

1.0. TECHNICAL REQUIREMENTS OF ARRAY YARD

1.0.1 Scope of Civil Work for 62 MW_{AC} SPV Plant Array Yard

1.0.1.1 Topographical Survey

Topographical survey shall have to be done of the proposed site at 5 m interval by Plain Table or any other suitable standard method of survey & according to the applicable standards. All necessary levels as entered in the Field Book have to be submitted along with pre contour layout of the total site. The formation level of the proposed power plant has to be fixed with reference to High Flood Level of the proposed site. The formation level shall be at least 1.5m above the highest flood level for efficient drainage of the plot area during rainy season. Based on the above survey work a general layout drawing with clear demarcation showing boundary pillars, grids of corners of the plot boundary, nalla locations, underground and over ground structures, if any in plot area, location and levels of reference benchmark fixed with reference to permanent benchmark available nearby proposed site, location of Array Yard, Main Control Room, sewage & drainage system and approach roads and general drainage etc. has to be prepared.

Set of drawings and survey reports along with all relevant documents in one soft copy (CAD and PDF formats) shall be submitted to MAHAGENCO for approval. Drawings of

complete plant capacity must be submitted for approval. Topographical survey drawings for complete 62 MW_{AC} for Paras, Dist. Akola in Maharashtra, along with drawing shall be submitted as per designed layout.

1.0.1.2 Soil Test

- i. The Contractor has to perform the soil test to ascertain soil parameters of the proposed site for construction of Main Control Room, Transformer foundation, Inverter room foundation, Watch tower foundation & Array Yard (minimum 6 bore holes). The EPC CONTRACTOR shall carry out sub soil investigation through certified soil consultant. These reports shall be furnished to MAHAGENCO. Based on sub-soil data collected during detailed soil investigation, Contractor shall prepare design parameters for foundation type to be provided suitable for the sub-soil conditions of the Site.
- ii. The scope of sub 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 sub soil condition. The soil resistivity tests and CBR tests are also included in the scope of soil investigation work.
- iii. Based on field soil investigation, bore log details and laboratory test reports, a detailed soil investigation report has to be prepared by the NABL accredited geo-technical agency. The report shall recommend foundation type, depth of foundation, safe bearing capacity of various founding strata based on shear and settlement criteria, cutting / filling, use of excavated soil for back filling, use of type of cement, type of concrete, admixtures, etc. The Contractor shall submit the reports in six hard copies and a soft copy.
- iv. The soil test shall also include analysis of water sample.
- v. Any variation in data furnished to the Contractor at the time of bid invitation and that during execution of work at Site or in detailed soil investigation carried out by the Contractor, shall not constitute any valid reason in affecting the terms and conditions of this Bid. Contractor shall not be entitled for any extension of time and nothing extra shall be payable on this account.

1.0.1.3 Planning and Designing

- (i) The Bidder shall carry out Shadow Analysis at the site and accordingly design strings & arrays layout considering optimal usage of space, material and labour. The Bidder shall submit the array layout drawings along with Shadow Analysis Report to Chief Engineer (RE-P&P), MAHAGENCO for approval.
- (ii) The Bidder has to plan and design the Array Yard in a proper manner considering the shadow analysis. Bidder has to develop general layout drawing of Array Yard, Internal Road & path ways, drainage system (ensuring no water logging in the Array Yard area). The work also includes landscaping of the entire array yard. All design & drawings have to be developed based on specification given in the tender, soil report, and relevant BIS unless otherwise specified. All details water supply for module cleaning and sewerage system shall be clearly shown in the drawings.



- (iii) The Bidder shall submit preliminary Design Basis Report (DBR) for planning, land development along with calculation of land cutting & filling areas, quantity as per design and drawing for approval. The Bidder shall submit six sets of final drawing and DBR to MAHAGENCO for approval to proceed with construction work.
- (iv) The buildings shall be with concrete construction in compliance with National Building Code and relevant BIS/International standards.

1.0.1.4 Land Development as per Design

Land development work of the entire area of the Project premises shall have to be done as per Design Basis Report & drawings developed by the Bidder and as approved by MAHAGENCO. The formation level of the land development shall be kept at least 1.5m above the high flood level of the nearby nalla/ pond, etc., where storm water is to be disposed off. Further, the formation level of the plot shall be decided matching the quantities of cutting and filling of the plot area. Any material required for filling for land development work shall be arranged by the bidder at his cost. Any excess material available from cutting of land development work shall be disposed off outside the plot boundary with a lead of 5 kms as directed by Project-In-Charge of MAHAGENCO.

1.0.1.5 Power Supply for Construction

Bidder has to make the required power HT/LT supply arrangement for the construction purpose from MSEDCL. Bidder shall make the required HT/LT arrangement for auxiliary power supply arrangement & shall bear the power charges for utilization of power for his construction work and 5 years of O&M of the solar plant.

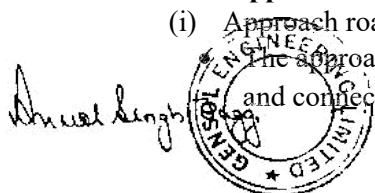
1.0.1.6 Module Structure Foundations

- (i) Modules structures foundations shall either be RCC foundations made of cement concrete as per applicable IS/ IEC or any other technically suitable design based on site soil condition after prior approval from MAHAGENCO. The minimum clearance between lower edge of the PV and Ground Level shall be 400 mm. A tolerance of +/- 50mm shall be allowed as per site conditions. While making foundations designs due consideration will be given to weight of module assembly and Minimum Wind speed shall be as per IS875, p3 & Seismic as per IS1893 with appropriate safety factor shall be considered. Minimum value of wind speed to be obtained from historical data with Meteorological department. Seismic factors for the site must be considered while making the design of the foundation. The design of array structure shall be based on soil test report of the site and shall be approved by MAHAGENCO.
- (ii) 5 Nos. of Pullout tests on prototype sample foundations at site shall be carried out by third party institution in presence of MAHAGENCO site authority and pullout test reports shall be submitted to MAHAGENCO for approval.
- (iii) Foundation drawings & designs shall be submitted to MAHAGENCO for approval before starting the work. Foundation excavation of Module Mounting Structure shall commence only after the proper leveling of the site.
- (iv) Aluminum Module mounting structures from Indian / internationally well-known company with hydraulic ramming installation procedure of structure according to the soil analysis can be acceptable after approval of MAHAGENCO.

1.0.1.7 Approach Road & Pathways

- (i) Approach road:

The approach road to the Solar Power Plant shall originate from the main approach road and connect to all Inverter rooms, main control room building and gates. Approach road



shall be asphalt road with top coat of bitumen 80/100 confirming to Grade S 90 of IS 73-1992. 3-meter- wide with 1-meter wide shoulder on both side.

(ii) Peripherals road:

- Peripheral road around the whole plot shall also be provided for easy access. The peripheral road shall be made WBM of minimum 250mm thick well compacted murrum, suitable for road construction. These roads shall be minimum 150mm above NGL. Peripheral road shall be min 3 meter wide. Suitable culverts with RCC slab at top shall be provided at crossing of water bodies. Peripheral road shall also be interconnected with all bituminous approach roads terminating at Invertor rooms and CMCS and all the gates.

(iii) Pathways:

- Pathways with the required width shall be provided between each row of MMS. The pathways shall be levelled and compacted for carrying panels, carrying materials, MMS washing, easy movement of O&M etc. Pathways shall be compacted manually/mechanically. Wherever the grass/roots are found in the pathways, same shall be removed upto depth of 200 mm & the ground shall be levelled and compacted. The finished pathways shall ensure easy movement of maintenance vehicle and avoid any growth of vegetation. Pathways surface shall be levelled by minimum 100mm thick PCC(1:3:6), wherever change in topography/ground slope is steeper than 1:6. The PCC/Concrete/brickwork masonry layer shall match the ground topography.

(iv) Concrete/Brick masonry drains shall be provided on either side of roads for proper drainage of rain water.

(v) The asphalt and WBM roads shall be designed as flexible pavements as per provision under IRC-37. The construction of roads shall be in accordance with MoRTH specifications and other relevant IRC/IS codes of practice. The minimum thickness of sub-base, base and wearing courses of asphalt and WBM roads shall be considered as below:

(vi) **Sub-grade:** the sub-grade shall be prepared with well compacted selected soil/ earth to achieve 95% of the standard density at optimum moisture content.

(vii) **Sub-base:** if sub-grade of road is of filled up soil or with natural soft soil, then sub-base shall be prepared with 300mm thick layer of murrum/ selected soil/ crushed stone(grading-1) on this layer 300mm rubble soling with 100mm thick cushion of murrum/ selected soil shall be provided with well compaction.

- If sub-grade is of hard natural soil/ rocky strata, then sub-base shall be of 150mm thick rubble soling with 100mm thick cushion of murrum/ selected soil with well compaction.
- **Base:** 150mm thick (consolidated thickness) water bound macadam course in two equal layers as per MORT&H specifications shall be provided.
- **Wearing course:** the wearing course shall be 75mm thick bituminous macadam binder course with 10 - 12 mm seal coat.
- Security Cabin at main gate shall be constructed by contractor in line with Industrial Safety & Security norms, standards & applicable IS. A hydraulic boom barrier of suitable size and design shall be provided for additional security.
- The drawings of approach road/pathways, gate, cabin and hydraulic boom shall be approved by MAHAGENCO.

1.0.1.8 Module Cleaning:

A. Water Arrangement for Modules Washing:



Contractor shall provide a permanent arrangement along with vehicle mounted mobile unit for module cleaning & washing in the Solar Power Plant.

- The permanent arrangement shall include installing tube wells or open wells or artificial water ponds along with rainwater harvesting arrangements for 62 MW_{AC} Project, with pump and motor and laying network of CPVC/HDPE pipe, confirming to applicable IS, in each row of SPV panels. Opening from the CPVC/HDPE pipe with manual isolating valves shall be provided at regular interval with at least one at each alternate row of SPV panels.
- The vehicle mounted module washing unit shall include minimum Two (2) nos. of suitable units purchased and permanently stationed at the site.
- The washing shall be with pressurized clean water and provision shall be made for water purification, softening and cleaning as the need be depending on the available water quality & requirements by the module suppliers for cleaning of module.
- A provision shall be made for overhead storage tank (confirming to IS 3370 (Parts 1 to 4) for storage and IS 11682-1985 (reaffirmed 1998) for staging) or underground RCC water tank with applicable IS or ground level water tank, confirming to IS 3370 (Parts 1 to 4) of adequate capacity at the site for use in module cleaning for entire year.

Contractor shall provide the water test report, water requirement calculations, cleaning schedule and single line diagram of water washing arrangement to MAHAGENCO for approval.

1.0.1.9 Storm Water Drainage System and rain water harvesting scheme

- As per State Pollution Control Board's Regulation, rain water harvesting shall be provided. The rain water harvesting scheme shall be executed as per the recommendations of the central ground water authority/ board obtaining the necessary statutory approvals for the rain water harvesting scheme to be implemented shall be in the scope of Contractor. Rain water harvesting scheme shall be designed for collection of rain water from storm water drains, for reuse of rain water and/ or for recharge of ground water by rain water collector. Further, the suitable outfall locations shall be provided for discharge of excess rain water to the nearby natural nalla/ drains during rainy season.
- The storm water drains shall be designed as network covering the plant area as per specifications and the drains shall be connected to rain water harvesting system to be implemented. The plant area storm water drainage shall be designed to cater to storm water runoff resulting from a three (3) hour storm or one hour rainfall intensity with a return period of 50 years, whichever is higher. The three (3) hour storm value and/ or one hour rainfall intensity value shall be based on the recommendations of Indian Meteorological Department (IMD).
- The drain shall be walled canal type & open brick masonry/ concrete/ Precast rectangular section shall be provided for all drains with minimum width as 450mm and minimum depth as 300mm. bed slope of the drains shall be milder than 1 in 1000.
- Care shall be taken to maintain slopes and to prevent water logging at the site. Proper water drainage shall be designed. The plan, design and drawing shall be submitted to MAHAGENCO for approval.

1.0.1.10 Fencing of 62 MW_{AC} Project

MAHAGENCO will provide fenced Land to the EPC contractor.



1.0.1.11 Watch Towers

Minimum Two Number of watch towers for 62 MW_{AC} Project, made of hot dip galvanized steel conforming IS 2062 and IS 4759:1996 with 85micron galvanization, shall be designed and constructed as per relevant IS/ IEC standards in view of the safety and security of the power plant. The height shall be decided with a view to cover the complete plant area and all its equipment for security purpose. Each Watch Tower shall be equipped with one (1) searchlight and one (1) floodlight along with two (2) PTZ night vision cameras and one (1) siren, which shall be operated locally and remotely from the control room. The design of the Watch Towers shall be submitted to MAHAGENCO for approval.

1.0.1.12 Others

Any civil work which is not mentioned or included here but necessary for the plant shall be borne by the Contractor.

1.0.1.13 Scope of Electrical Work for 62 MW_{AC} SPV Plant Array Yard

The manufacturers for all electrical and electronic components such as Meters, Protection Relays, AC Cables, Lightning Arrestors, Control Panels, Isolators, etc., and wherever no specific experience requirement is mentioned, must have manufacturing track record of at least ten (10) years.

1.1. SOLAR PV MODULES

1.1.1 PV modules should be from latest Approved List of Models and Manufacturers (ALMM) of Solar Photovoltaic Modules published by MNRE.

1.1.2 The Mono-Crystalline/Bifacial Silicon Solar Cell PV modules used must qualify to the latest edition of IEC-61215 or IS 14286: 2019 (Part -1 & 2) equivalent BIS standards.

1.1.3 In addition, Flat PV modules must qualify to IEC 61730 (Edition I and II) for safety qualification testing and all materials used shall have a proven history of reliability and stable operation in external applications.

1.1.4 It shall perform satisfactorily in relative humidity up to 85% with temperatures between -40° C to +80° C and shall have lowest temperature coefficient and shall withstand gust up to 200 km/h on the surface of the panel. Also, the PV modules to be used in a highly corrosive atmosphere throughout their lifetime, they must qualify to IEC 61701: 2011-12 (Edition 2). Each and every SPV module shall be checked for conformity with relevant standard and no negative tolerance shall be accepted for crystalline modules.

1.1.5 Modules shall be PID-free. Contractor shall submit the test certificate by recognized global laboratory to this effect for the model selected to be offered in this project. The Contractor shall also submit an IEC-62804:2015 certificate for the modules offered to this effect.

1.1.6 Experience and Performance:

1.1.6.1 Solar PV modules must have proven history of reliability and stable operation. Contractor shall provide the performance certificate from the owner or developer of any grid connected single solar power project of minimum capacity of 10 MW_{AC}, where these modules are working satisfactorily since last one year and where only the proposed manufacturer's modules are used.

1.1.6.2 Solar module manufacturer must have supplied modules at least cumulative installed capacity of 500 MW or above per year consecutively during the last five years. The Contractor shall provide documentary evidence for the same in the form of certificate from the same manufacturer as well as the invoice copies of supply for the year based



on which eligibility is sought.

1.1.7 Positive Power Tolerance:

- 1.1.7.1 All modules shall be with positive power tolerance only; i.e. all PV modules shall have 'higher than rated' power output report of flash test at the manufacturing factory, including all measuring and machine tolerance. Zero or Negative power tolerance shall not be accepted.
- 1.1.7.2 The Contractor shall provide the copy of publicly available/ published datasheet of technical specifications for modules for each of the vendors in addition to the information in the format prescribed in (Annexure 17). Contractor shall also provide GTP for modules from the manufacturer.
- 1.1.7.3 PV Peak power rating shall not be less than 500 Wp for Mono-crystalline/Bifacial module. The module efficiency should not be less than 20%.
- 1.1.7.4 The front surface of the module shall consist of impact resistant, low iron and high transmission toughened glass.
- 1.1.7.5 The Interconnected cells shall be laminated in vacuum to withstand adverse environmental conditions.
- 1.1.7.6 The module frame shall be made of corrosion resistant materials, preferably having aluminum anodized finish the anodizing thickness shall be 15 micron or better.
- 1.1.7.7 **Module(s) shall be provided with minimum three (03) bypass diode.**
- 1.1.7.8 The Contractor shall carefully design & accommodate requisite numbers of the modules to achieve the rated power in his bid. MAHAGENCO shall allow only minor changes at the time of execution.
- 1.1.7.9 The minimum design clearance (at the highest tilt angle) between the lower edge of the modules and the developed ground level shall be 400 mm. A tolerance of +/-50mm shall be allowed as per site conditions.
- 1.1.7.10 A maximum of two makes of modules shall be accepted. Contractor shall submit separate Table 1 in Annexure 17 for each make of modules proposed to be used in the Project.
- 1.1.7.11 **Manufacturing date of all modules used in the project shall not be more than 12 months prior to the date of transfer of ownership to MAHAGENCO. The representative of the Contractor must be present at the time of module manufacturing of entire capacity and / or flash testing of modules supplied for the Project. MAHAGENCO may also depute its Authorized Representative to be present at the time.** Contractor should coordinate with MAHAGENCO authorized representative for scheduling of inspection.

1.1.8 Warranties

1.1.8.1 Material Warranty:

- i. Material Warranty is defined as: The manufacturer shall warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than twelve (12) years from the date of sale to the Solar Power Company:
- ii. Defects and/or failures due to manufacturing defects and/or failures due to materials, including PID defect.
- iii. Non-conformity to specifications due to faulty manufacturing and/or inspection processes.

Warranty to be in the name of MAHAGENCO.

If the solar Modules fails to conform to this warranty, the Contractor & module manufacture will repair or replace the solar module(s), at MAHAGENCO's sole option.

1.1.8.2 Performance Warranty:



- i. The manufacturer shall warrant the output of Solar Module(s) for at least 90% of its rated power at the end of 12 years and 80% of its rated power at the end of 27 years from the date of receipt of modules on Site. The manufacturer shall warrant for the linear output of Solar Module(s) and degradation of the PV modules will be linear over 27 years from the date of receipt of modules at site.
- ii. If, Module(s) fail(s) to exhibit such power output in prescribed time span, the Contractor will either deliver additional PV Module(s) to replace the missing power output with no change in area of land used or repair or replace the PV Module(s) with no change in area of land used at MAHAGENCO's sole option. Total land available from MAHAGENCO is fixed and the Contractor shall design the plant so that in this case he has enough space within this land to accommodate additional capacity.

1.1.9 Insurance:

- 1.1.9.1 The Contractor shall bear the responsibility to arrange PV module insurance for entire contract period encompassing all the probable risks associated with the PV Modules. The insurance should also cover the product warranty & performance warranty. All the expenses in relation to such insurance of the project will have to be borne by the Contractor.
- 1.1.9.2 The insurance shall be in the name of MAHAGENCO and the policy shall be submitted to MAHAGENCO. The performance warranty shall be specifically a warrant and indemnity insurance against excessive loss of output of PV module. Draft of the insurance should be submitted to MAHAGENCO.
- 1.1.9.3 The Contractor shall provide the electrical characteristics, of typical solar PV module that is representative sample of proposed modules, including current-voltage (I-V) performance curves and temperature coefficients of power, voltage and current.
- 1.1.9.4 Modules shall be provided with a junction box, determined make and length of cable and connectors, as prescribed in the IEC certification for the selected module. These shall be approved by MAHAGENCO.

1.1.10 Module Testing:

PV modules must be tested and approved by one of the IEC authorized test centers. Factory test as well as third party testing of the random sample by the Solar Energy Centre is also mandatory. The cost of these testing shall be borne by Contractor.

The acceptance criteria for all these tests shall be as per the applicable IEC/IS. Standard Industry practice will be adopted with mutual understanding in case if no such guidelines are available in IEC for any of the test.

1.1.11 Factory Tests & Inspections:

1. Manufacturing date of all modules used in the project shall not be more than 12 months prior to the date of transfer of ownership to MAHAGENCO.
2. Contractor shall depute its representatives in the module manufacturer's factory for witnessing of QAP (Quality Assurance Plan) and flash tests of complete production of the modules. And daily production/inspection report shall be communicated to MAHAGENCO by email, same day. MAHAGENCO may also depute its Authorized Representative to be present at the time. Contractor should coordinate with MAHAGENCO authorized representative for scheduling of inspection & testing.

Contractor shall provide the electrical characteristics, of each solar PV module that is to be supplied these electrical characteristics includes current-voltage (I-V)



performance curves and temperature coefficients of power, voltage and current etc.

4. Modules deployed must use a RF identification tag. The RFID tag must be fixed only by the module manufacturer in the factory at the time of testing and before dispatch of modules. The following information must be mentioned in the RFID used on each module (This can be inside or outside the laminate, but must be able to withstand harsh environmental conditions).
 - i. Name of the manufacturer of the PV module
 - ii. Name of the manufacturer of Solar Cells.
 - iii. Month & year of the manufacture (separate for solar cells and modules)
 - iv. Country of origin (separately for solar cells and module)
 - v. I-V curve for the module
 - vi. Wattage, I_m , V_m and FF 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 and module as per ISO 9001 and ISO 14001.

1.1.12 Laboratory Tests:

Following inspections and testing shall be carried out by an independent internationally accredited testing laboratory as per the applicable IEC standards. The sampling will be carried out at factory in presence of MAHAGENCO representative. The IEC standards and norms of sample testing and acceptance shall be followed to compare the test results. In case where the tests show non conformity to tender document and / or has impact on plant performance and guaranteed generation of the plant, the Contractor shall compensate by replacing or adding the module capacity at the sole discretion of MAHAGENCO. Cost towards these tests shall be borne by the Contractor. Contractor should coordinate with MAHAGENCO Authorized Representative for scheduling of inspection & testing.

1. Determination of module efficiency under standard test conditions - A sample of 200 modules for 62 MW_{AC} shall be tested. The test shall be repeated on the same modules after the light soaking of modules i.e. to test LID.
2. Determination of modules peak power rating on STC condition under PID test-sample of 25 modules for 62 MW_{AC} shall be tested.
3. Low insolation tests with 200, 300, 400, 500 and 800 w/sqm. - A sample of 20 modules for 62 MW_{AC} shall be tested.
4. Determination of cell cracks snail trail and connection errors through electroluminescence testing and normative- actual value comparison of characteristic parameters. - A sample of 100 modules for 62 MW_{AC} shall be tested.
5. Determination of EVA cross-linking degree. - A sample of 25 modules for 62 MW_{AC} shall be tested.
6. Wet leakage test - A sample of 25 modules for 62 MW_{AC} shall be tested
7. Mechanical load test - A sample of 20 modules for 62 MW_{AC} shall be tested (half of the modules from previous tests and half new).
8. Dynamic load test - A sample of 25 modules for 62 MW_{AC} shall be tested (half of the modules from previous tests and half new).
9. Peel test. - A sample of 10 modules for 62 MW_{AC} shall be tested (one of the modules from previous tests and one new).



10. The Contractor shall provide the necessary testing reports to the MAHAGENCO as and when required.
11. Neither the waiving of inspection nor acceptance after inspection by MAHAGENCO shall, in any way, absolve the Contractor of the responsibility of supplying the plant and equipment strictly in accordance with specification and drawings etc.

1.1.13 On-Site Tests:

These tests shall be carried out as per the applicable IEC /IS standards before Final Acceptance Test at site by the third-party testing agency. Cost towards the on-site testing shall be borne by the Contractor.

1. Establishment of module capacity (shall be carried out in Third Party Lab) randomly selected 10 modules from project capacity of 10MW shall be sent to test lab.
2. A sample of 1/1000 modules shall be tested. The results of the measurements shall be compared to flasher protocols.
3. Establishment of string capacity (Shall be carried out at site by third party)
4. A sample of 5 strings /MW shall be tested.
5. Measurement temperature of the PV modules with thermal image camera with respect to the neighboring cells shall be carried out at site by third party A sample of 1/500 shall be tested. In case of failure rate > 10%, the sample shall be increased to 1/100.
6. Inspection of the MMS corrosion protection as per applicable IS/ASTM (Shall be carried out at site by third party). A sample of 6 stands per 5 MW shall be tested. In case of a failure rate > 10%, the sample shall be increased to 60 stands.

1.2. MODULES MOUNTING STRUCTURES

1.2.1 General

The PV modules shall be mounted on metallic structures called Module Mounting Structures (MMS) having adequate strength and appropriate design, which can withstand the load of the modules and design wind pressure.

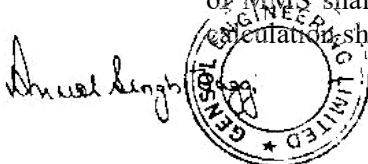
1.2.2 Codes and Standards

The applicable codes and standards are as mentioned below.

Sr. No.	Standards and Codes	Remark
1	IS 875: Part 1 & 2	Code of practice for the design loads for buildings and structures-
2	IS 875: Part 3	Code of practice for the design loads for buildings and structures-Wind Loads
3	IS 800: 2007	Code of practice for use of structural steel in general building construction
4	IS 4759	Hot-dip zinc coatings on structural steel and other allied products
5	IS 1868	Anodic Coatings on Aluminum and its Alloys

1.2.3 Design and Material Requirement

- 1.2.3.1 The structure design shall be appropriate with the factor of safety of not less than 1.5. Design of MMS shall be as per the design criteria specified under IS 800 and IS 801. Design calculation shall be submitted to MAHAGENCO.



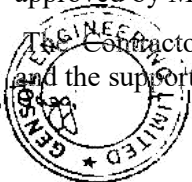
- 1.2.3.2 The Contractor shall provide Fixed type or Seasonal Tilt or Tracking type structure to hold modules in place at desired tilt and angle.
- 1.2.3.3 Design drawings with material selected shall be submitted for approval of MAHAGENCO. Modules shall be mounted on a non-corrosive support structures.
- 1.2.3.4 The foundations of module mounting structures shall be based on site related data, design calculations & drawings shall be submitted to MAHAGENCO for approval.
- 1.2.3.5 The frames assemblies (i.e. I channel, C channels, rafter, purlins, rails & bracings etc.) of the array structures shall be made of hot dip Galvanized steel per ASTM A123/ IS2062 (grade E350 or higher) and IS 4759:1996. Minimum thickness of galvanization shall be at least 80 microns.
- 1.2.3.6 Bidder can go for Hot-dip Aluminum-Zinc alloy metallic coated sheet steel strip and sheet sections for rafter, purlin only subject to following conditions.
 - a. The coating class shall be as per AZM150 (ASTM A792M) / (IS 15961)
 - b. The structure design shall be as per IS standard & shall comply with all basic terms & conditions mentioned above.
 - c. The concept of wind tunnel studies shall be considered in the design philosophy for fixed and seasonal module mounting structure. & it must be done from the reputed institutes(IIT in India).
 - d. If the study is done by any reputed international facility the study results must be vetted by any of the IITs in India.

OR

Aluminum Module mounting structures with hydraulic ramming installation from internationally reputed company can be acceptable after approval of MAHAGENCO.

- 1.2.3.7 All fasteners shall be of Stainless steel - SS 304 or higher grade. Nut & bolts, supporting structures including module Mounting Structures shall have to be adequately protected against all climatic condition. Hot dip Galvanized steel Nut & bolts can be used only for the structure foundation as per ASTM A123/ IS2062 and IS 4759:1996. Minimum thickness of galvanization shall be at least 80 microns.
- 1.2.3.8 The vendor credentials, base material test report, GTP & QAP shall be submitted to MAHAGENCO. Before dispatch of material MAHAGENCO will carry out required tests on random samples as per IS from the accredited testing lab the cost of this test shall be borne by Contractor.
- 1.2.3.9 The Module Mounting Structures shall be warranted up to 05 years by the manufacturer.
- 1.2.3.10 The structure shall be designed to allow easy replacement of any module and easy access to the O&M staff and P&P (Personnel and Protection).
- 1.2.3.11 The structure shall be designed for simple mechanical and electrical installation. It shall support Solar PV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. There shall be no requirement of welding or complex machinery at site.
- 1.2.3.12 The drawings along with detailed design shall be submitted in six sets to MAHAGENCO for approval before starting the erection work. The work will be carried out as per designs approved by MAHAGENCO
- 1.2.3.13 The Contractor/manufacturer shall specify installation details of the Solar PV modules and the support structures with appropriate diagrams and drawings

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- 1.2.3.14 The legs of the structures shall be MS Hot Dip galvanized I beams or C channels as per IS 2062 (grade E350 or higher) and IS 4759:1996. Minimum thickness of galvanization shall be at least 80 microns. Design and dimensions of the structure must confirm to withstand minimum wind speed of 150 km/h with appropriate safety factor of 1.5. The design calculations shall be submitted to MAHAGENCO and same shall be get approved from MAHAGENCO.

1.3. MODULE MOUNTING STRUCTURE (MMS) APPROVALS AND TESTS

- 1.3.1** The drawings along with detailed design & STAAD analysis with latest version shall be submitted in six sets to MAHAGENCO for approval before starting the erection work. The work will be carried out as per designs approved by MAHAGENCO.
- 1.3.2** Before finalization of MMS design, accredited third party Prototype load test of MMS structures (5 Nos. of load test) shall be carried out at site in presence of the MAHAGENCO representative & test report shall be submitted to MAHAGENCO for approval.
- 1.3.3** Vendor's credentials, base material test certificates, GTP (Guaranteed Technical Parameters) & QAP of MMS shall be submitted to MAHAGENCO for approval.
- 1.3.4** Vendor shall submit the certificate from the laboratory on testing the galvanized steel structure member for adherence of coat and for thickness of coating.
- 1.3.5** Vendor shall submit the report, from NABL accredited laboratory, Test to determine corrosion performance of module mounting structure as per the applicable IS/ASTM.

1.4. CABLE, WIRES & CABLE TRENCHES

1.4.1 AC LT cables:

All 1100 V AC cables shall be PVC insulated (heavy duty) confirming IEC 60189/ IS 1554-I & IEC 60502-1 with Aluminum conductor according to IEC 60228. All AC cables of size 4 sq mm and below shall be electrolyte tinned copper conductor type confirming the relevant IS/IEC. All AC cable should be rodent resistive/repellent.

The EPC CONTRACTOR shall submit the GTP (Guaranteed Technical Parameters) and QAP for the approval of MAHAGENCO.

1.4.2 PV wires and DC cables:

1.4.2.1 DC cables (Interconnecting SPV Modules and from SPV Modules to SMU)

Cables used for inter-connecting SPV modules as well as Modules to SCB's shall conform to the requirements of EN 50618:2014 applicable for DC cable for photovoltaic system. The connectors used for interconnecting the modules and connectors used for connecting the strings and/or to the String combiner Box, i.e. field connectors to be mated shall be of same make and model otherwise they shall be tested for Inter-compatibility.

- a. These cables shall meet the fire resistance requirement as per above standard and shall be electron beam cured at manufacturing facility.
- b. In case 1500 V modules are used, the module inter-connecting wires shall be as per TUV specification 2Pfg 1990/05.12. Conductor shall be Electrolytic tinned copper Class 5, according to EN60228 or IEC 60228. Core insulation & outer sheath of the cable shall be as per XLPO (Electron beam cross linked polyolefinco - polymer). All DC cable should be rodent resistive/repellent.
- c. In addition to manufacturer's identification on cables as per TUV, following marking shall also be provided over outer sheath



- i. Cable size and voltage grade
 - ii. Word 'FRNC' at every 5 meter
 - iii. Sequential marking of length of the cable in meters at every one meter.
 - iv. The Printing shall be progressive, automatic, in line and marking shall be legible and indelible.
 - v. Type test, routine, acceptance tests requirements for these cables shall be as per TUV specification 2pfg 1169/08.2007 or 2pfg 1190/05.12 as per requirement Charges of routine and acceptance tests shall be deemed to be included in the cable price. Sampling for acceptance tests will be as per IS 7098.
- d. A maximum of 8 Cables (4 Circuits) shall be laid in one HDPE Pipe for DC Cable from Module to string monitoring box (if applicable). The fill factor of the pipe should not be more than 40%.
 - e. However, in case of necessity to lay more than 8 cables (4 circuits) in one pipe, the same shall be allowed during detailed engineering and as per the derating factors recommended by the cable manufacturer. Fill factor criterion is still to be maintained.
 - f. Bidder to ensure that there is no gap and proper packing at the junction of two pipes, in which DC cable is laid, using proper method and accessories, like bell mouth.

1.4.2.2 DC cables (SMU to Inverters)

- a. Cables used between SMU's and Inverters shall be of min. 1.5 kV (DC) grade. In case Contractor offers 1500V DC system 3.3 kV (E) grade cables shall be provided. These Power cables shall have compacted Aluminum/copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), Armoured/Unarmoured, FRLS PVC outer sheathed conforming to IS: 7098 (Part-I). All DC cable should be rodent resistive/repellent.
- b. The DC cables shall be TUV/UL/equivalent certified.
- c. Manufacturer shall have in house electron beam cross link facility and shall have successfully supplied cable for Solar Power Plants for at least 25 MW_{AC} single capacity solar project.
- d. The DC cable manufacturer shall have proven experience of having supplied successfully to Solar PV grid connected projects of at least 200MW cumulative capacity.
- e. Vendor credentials, manufacturing facilities, Guaranteed Technical Parameters, Type test reports, IEC certificates & reports, Cable & wiring design, calculations, QAP and detailed explanations along with drawing shall be provided to MAHAGENCO for approval.

1.5. CABLE LAYING, TRENCHES & SEALING

- 1.5.1 Contractor shall design the array yard such that Module mismatch loss shall be less than 1.5% loss in system power.
- 1.5.2 Only terminal cable joints shall be accepted. No cable joint of two cable ends shall be accepted. All cable plugs provided shall be as per IEC/IS standards.
- 1.5.3 The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All opening in floor/roof/wall/cable tunnel/cable tranches



made for conduit installation shall be sealed and made water proof by the Contractor with modular multi-dimensional cable system consisting of frames, blocks, compression wedge and its accessories. The cable sealing system shall have been tested for fire insulation for minimum 2 hrs. as per BS 476/UL 1479/EN 1364 and shall provide water sealing for continuous pressure of 0.3 bars the system shall be rodent proof and shall have valid enclosure protection as per IEC 60529.

- 1.5.4 All cable/wires shall be marked with good quality letter and number ferrules of proper sizes so that the cables can be identified easily. The IS 5578:1984 (First revision-2011)/ IEC 60391-1972 shall be adhered to for guidelines for marking.
- 1.5.5 AC and DC cables shall be laid underground according to the applicable IS / IEC.
- 1.5.6 Wherever cables are carried underground through trenches, these trenches shall be excavated to a suitable depth and of suitable width as per the applicable IEC/ IS standard depending on runs of cables passing through. These trenches shall be refilled with sand, bricks and backfilled excavated soil, wherein cables are bedded in clean sand. There shall be cable pulling pits at inspection and maintenance points at intervals. The bare cables, wherever necessary, shall pass through these trenches in PVC conduits.
- 1.5.7 Cables used in the project, whether underground or above, shall be marked clearly with identification useful for repairs and maintenance.

1.6. STRING COMBINER BOX & STRING MONITORING SYSTEM

1.6.1 String Combiner Box:

- 1.6.1.1 **The string combiner boxes shall be dust, vermin, waterproof and sunlight/ UV resistive as well as fire retardant** & must have minimum protection to IP 65 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 cable ferrules will be fitted at the cable termination points for identification.
- 1.6.1.2 String Combiner Boxes Specification shall be as per EN 61439-2, class-II.
- 1.6.1.3 SCB shall be designed for ambient temperature in summer up to 60 deg C and humidity up to 90% non-condensing before monsoon. DC System Voltage 1500 V DC (VOC), On Load DC Voltage: 1000 to 1500 V DC (based on Inverter MPPT settings), IP protection: IP65
- 1.6.1.4 Enclosure of SCB shall be FRP cabinet with hinged door(s)
- 1.6.1.5 SCB shall be have designed Inputs of 8 /14/16 /24, with suitable current rating (Isc) & fuses holder as per applicable IS standard for each input. This rating (Isc) shall be finalized during engineering & design review phase.
- 1.6.1.6 In each SCB 5% spare terminals along with cable glands and fuse rounded off to next higher integer shall be provided to connect the PV strings.
- 1.6.1.7 In order to provide protection to all cables and modules, string fuses shall be provided with strings. String fuses shall be of PV category and dedicated to solar applications and conform to IEC 60269-6 or UL-2579 standards and fuse base shall comply with IEC 60269-1. String fuses should be so designed that it should protect the modules from reverse current overload. Fuses or Isolation Link shall be mounted in pull out type fuse holders. Fuse holders shall be suitable for DIN rail mounting. PCB mounted fuses are not acceptable. Fuse rating for single and combined input (limited to two) shall be 15 A and 30 A respectively suitable for 1000/1500 Volt for crystalline module. The fuse rating shall be decided during detail engineering. In case of negative grounded system, requirement of string fuses as well as inverter input fuses on negative side shall be

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decided based on the recommendation of Inverter (PCU) manufacturer.

- 1.6.1.8 Surge arrestors: Minimum 2 Nos. per box needed as per the requirements of class II and III according to the IEC 61643-1:2008 standard, whereas type (1+2) and type 3 are according to EN 61643-111 class C and D as well as DIN VDE 0675, T.6, class C and D, T6, A2 10/96. Surge Protection Device (SPD) shall be provided for data / communication circuit.
- 1.6.1.9 DC-DC control power supply unit confirming the relevant IEC standard shall be provided in SCB.
- 1.6.1.10 Output: 1500V DC, Solar Connectors: Push in Type no need to crimp the connections, Output Cable compatibility: copper DC Rated cable up to 300 sq. mm x 1 run and need out Stud Type Terminals with protective cover as per Rated impulse withstand voltage / Pollution severity Gauge to IEC 60947-1 / Flammability class UL94.
- 1.6.1.11 DC Disconnect switch needed: ONLOAD Disconnecter type switch for required DC voltage & design current as per IEC 60947-1, braking capacity DC21B or better.
- 1.6.1.12 Earthing: floating DC system, compatible with negative earthing.
- 1.6.1.13 SCB shall be finger touch proof & adequate safety labels of instructions.
- 1.6.1.14 In addition to suitable surge protection, the string combiner box will have over-voltage and over current and lightning protection. Adequate capacity solar DC fuses & isolating Miniature Circuit Breakers or manual isolator shall be provided if required.
- 1.6.1.15 Codes and Standards

Codes	Description
UL 94 V	Fire Resistant/ flammability for Enclosure
UL 746C	UV Resistant for Enclosure
IEC 62262/EN 50102	Mechanical Impact Resistance for Enclosure
IS 2147/IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 61643-12	Surge Protection
IEC 62208	Enclosure for low voltage Switchgear and control gear assemblies

Vendor shall submit the suitable Test Certificate/Report from accredited lab(s) indicating compliance of mentioned codes and standard if asked for the offered component or assembly.

1.6.2 String Monitoring System:

- 1.6.2.1 Monitoring of various parameters at dual string level with Y type of connector shall be made possible in the Main Control Room at site by installing the suitable string monitoring system any fault at string level could be recognizable by that system.
 - a. Each of these input strings to be monitored for string current.
 - b. Monitoring Device: Shunt type as per IEC61010-1 and IEC 61326-1 certified
 - c. Output Total voltage and current to be monitored
 - d. Communication: RS485 / MODBUS RTU/ Wireless or any other compatible.
 - e. Maximum Error: $\pm 1\%$
 - f. Power Supply: the power supply or data acquisition and monitoring systems Input (V)85...264 V AC (De-rating @ 100 V AC: 2.5 % / V) as per EN61000- 4-2 (ESD), EN61000-4-3 und EN61000-4-8 (Fields), EN61000-4-4 (Burst), EN61000-4-5 (Surge), EN610004-6 (conducted), EN61000-4-1 (Dips) standards

System shall be able to operate on error free and trouble free mode, at the ambient 60 deg temperature (and internal combiner box temp of 70°C).



- h. String Combiner Box & String Monitoring System (SCB& SM) shall be able to withstand the harsh climatic conditions without active cooling or heating.
- i. A string monitoring system shall be able to monitor inside and outside temperature string combiner box
- j. Memory mapping of the communication devices shall be submitted for SCADA integration.
- k. Makes and specifications, Certifications of all components (especially the data acquisition devices and communication devices, Monitoring Device, fuses, terminal blocks, surge arrestors, DC isolator switches) shall be provide to MAHAGENCO for approval.
- l. Mounting arrangements, installation manual and operation and maintenance manual shall be shared.
- m. SCB & SM system shall be warranted for minimum 5 years.
- n. String Combiner Box & String Monitoring System shall be IEC certified system andshall have proven track record. The system shall use precision accuracy sensors for current. The system shall use precision accuracy sensors for current. Accordingly, the Contractor has to submit the hard copy in physical support document for authentication of experience by past PO of supply for String Combiner Box & String Monitoring System while submitting the Bid, failure of which may be lead to rejection of the bid.
- o. Accordingly, the Contractor has to submit the hard copy in physical support document for authentication of experience by past PO of supply for String Combiner Box & String Monitoring System while submitting the Bid, failure of which may be lead to rejection of the bid.
- p. Contractor shall submit the GTP, QAP, TUV/UL/equivalent certifications, performance/experience certificate, detailed datasheet, heat load calculations of String Combiner Box and string monitoring system to MAHAGENCO for approval.

1.6.3 Type Test

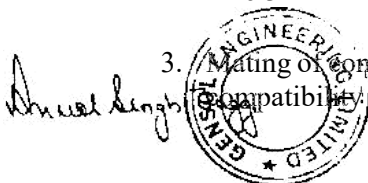
Vendor shall submit the following Type Test/ Product Certification from any National /International accredited lab for approval.

- i. Temperature rise test on complete assembled box as per acceptable limit mentioned in relevant clause.
- ii. Type test for enclosure as per code and standard mentioned irrelevant clause.
- iii. Thermal ageing at 70 °C for 96 hours as per IEC 60068-2
- iv. HV Test

1.7. DC Plug-in Connectors for Field Cabling

1.7.1 General Requirement

- 1. Field connectors are electrical connectors/coupler used for connecting solar panels and also strings of panels to String combiners box. Cable connector to be used for connecting SPV modules and String monitoring boxes shall be in accordance with IEC 62852: 2014.
- 2. Connector shall be of plug and socket design to be plugged together by hand but can be separated again using a tool only. Contractor shall ensure that field connectors to be mated shall always be of same make and model or shall be tested Inter-compatible as per clause no.6.3.11 of IEC 62852: 2014 for offered make(s).
- 3. Mating of connectors of different makes/model shall not be acceptable if not tested for inter-compatibility by any accredited lab.



1.7.2 Technical Requirements for DC connectors

Particular	Description
Rated Current, IEC (85°C)	30 A (4 mm ² , 6 mm ²), 40 A (10 mm ²)
Rated Voltage	Min1000/1500 Volts as per system requirement
Connector Design	Snap-In locking Type
Protection Degree	IP68 (Mated)
Ambient Temperature	(-) 40 ⁰ C to (+) 85 ⁰ C
Protection/Safety Class	Class II
Contact material	Cu
Contact surface material	Silver/Tin
Contact resistance for plug connector	≤ 0.5 milli-ohms
Stripping length	10 mm
Inflammability class	UL 94-V0
Insulating Material	PPE / PPO/Polyamide
Pollution degree	3
Certification	UL/TUV/CSA/EAC or Equivalent

1.7.3 Type Test for DC Plug-In Connectors

1. Protection Degree (IP)
2. Operating Temperature
3. Inflammability
4. Pollution Degree
5. Voltage Withstand (Rated Voltage/Test Voltage)
6. Product Certification

1.8. ARRAY YARD LIGHTING

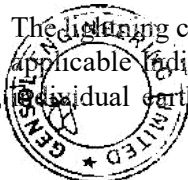
Adequate Array Yard LED based energy efficient lighting including erection of poles, fixtures & cables as per IS standards, keeping the general security in the mind using auxiliary power supply at location. Array yard LED based energy efficient lighting theoretical design, calculations and detailed explanations along with drawing shall be provided and approved by MAHAGENCO.

1.9. LIGHTNING PROTECTION

1.9.1 The Complete Solar PV Power plant shall be provided with Lightning and over voltage protection. The "Lightning Protection System" must be completed prior to start-up of commissioning activities of the project. The main aim of over voltage protection is to reduce the over voltage to a tolerable level before it reaches the PV or other sub-system components. The source of over voltage can be lightning or other atmospheric disturbance.

1.9.2 The Lightning Conductors shall be made to protect the entire Array Yard from Lightning stroke. Necessary concrete foundation for holding the lightning conductor in position to be made after giving due consideration to maximum wind speed and maintenance requirement at site in future.

1.9.3 The lightning conductor shall be earthed through flats and connected to the Earth mats as per applicable Indian Standards with earth pits. Each Lightning Conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing

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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.

1.9.4 Direct Stroke lightning protection shall be used. The system shall have following features:

- 1.9.4.1 Active Lightning Rod OLP-214 shall be based on Early Streamer Emission principle, complying NFC 17-102 and UNE 21186 Standards. The Device shall create an upward propagating streamer into the air 60 microseconds earlier than conventional air terminals or other objects on the earth, The device selected shall give 107 meter radius of protection in level IV when mounted on 5 meter effective height mast. Along with Mast (G.I. pipe of suitable height) for mounting The device & adaptor along with supporting stray wires, etc. The device shall be in compliance to CE. The device shall be tested & certified by CPRI (Central Power Research Institute- Bangalore) Govt. of India. The device shall be tested from International lab / University in compliance with NFC17-102 standard for Lightning catching head (ESE) impulse voltage streamer time Lag. Gain measurement. The ESE device shall have Warranty of 30 years.
- 1.9.4.2 High voltage insulated (HVI) cable shall be used as a down conductor to overcome the separation distance which is essential to avoid creep age flashovers. The HVI shall have high voltage resistant of the inner Cu conductor. Safe injection of lightning voltage at the entry thus preventing creeping flashovers (voltage flashovers) along the surface between the first Earthing point and the entry. The diameter of cable shall be 27mm, inner conductor size 25sqmm. And Separation distance: S 90 cm in air or S 1.8 meter in solid
- 1.9.4.3 Tripod C- Bar Maintenance Free Chemical Earthing for Lightning Protection consists of 3 Nos. of Copper bonded rod of 5/8" dia 10' length (The electrode shall be a solid steel rod made of high tensile low carbon steel and coated with molecularly bonded copper on the outside as per UL 467. The thickness of the copper coating shall be at least 250 microns. The electrode shall carry UL marking.) With two clamps (Clamp shall be suitable to terminate the earth rod and strip. The clamp shall be of Brass/Gunmetal), supported with 3 bags of 22.6 Kg Ground Enhancement Material (GEM) {The GEM shall have a low resistivity for faster transient/fault current dissipation. The GEM shall be Performed in all soil conditions even during dry periods. The GEM shall maintain constant resistance for the life of the system, temperature variation effects less than 1.0%. The GEM shall be non-toxic, environment friendly and does not adversely affect soil or ground water. The GEM shall lower the contact resistance to earth by up to 63%. The GEM shall have a resistivity of less than 0.2 ohmmeter. The GEM shall be CE & ROHS certified.} Joined by using 25x3mm copper flexible strip of 3 mtr length each (total 9 mtr.) and one number of poly plastic pit cover no mason work needed.
- 1.9.4.4 The Contractor shall ensure adequate lightning protection to provide an acceptable degree of protection as per IS for the array yard. If necessary, more numbers of Lightning conductors may be provided. Theoretical design calculations and detailed explanations along with drawings shall be provided and approved by MAHAGENCO.

1.10. EARTHING SYSTEM FOR ARRAY YARD

1.10.1 General requirements

This specification is intended to outline the requirement of earthing (grounding) for Solar array (DC) side and AC Power block side of Solar PV Project. It is not the intent of the specification to specify all details of design and construction since the bidder has full responsibility for engineering and implementation of earthing system meeting the intent of the specification and functional requirement. Any additional equipment, material, services



which are not specifically mentioned herein but are required for successful installation, testing and commissioning of earthing system for safe and satisfactory operation of the plant shall be included under scope of the bidder.

1.10.2 Earthing design requirements

The object of protective earthing system is to provide as nearly as possible a surface under and around a station which shall be at a uniform potential and as nearly zero or absolute earth potential as possible. The purpose of this is to ensure that, in general, all parts of apparatus other than live parts, shall be at earth potential, as well as to ensure that operators and attendants shall always be at earth potential. Also, by providing such an earth surface of uniform potential under and surrounding the station, there can exist no difference of potential in a short distance big enough to shock or injure an attendant when short-circuits or other abnormal occurrences take place. Care must be taken for equipment with functional earthing that its service is not disrupted due to undesired disturbances in protective earthing system.

1.10.3 Codes and standard

IEEE: 80	IEEE guide grounding for safety in AC Substation
IEEE: 837	Standard for qualifying permanent connections used in substation grounding
IS: 2309	Code of Practice for the protection of building and allied structures against lightning.
IS: 802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS: 2629	Recommended practice for hot dip galvanizing of iron & steel
IS: 2633	Method for testing uniformity of coating on zinc coated articles
IS: 513	Cold rolled low carbon steel sheets and strips
IS: 6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS 2062	hot rolled medium and high tensile structural steel — specification
IS: 4736	Hot-dip Zinc coating for MS Tubes.
IS: 458	Precast Concrete Pipes (With and Without Reinforcement)
UL-467	Grounding and Bonding Equipment
IEC62561 -7	Requirements for earthing enhancing Compounds
	CEA regulations for electrical safety-2010
	Indian Electricity Rules/ Indian Electricity Act.

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (codes and standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the above standards/ codes as applicable.



The earthing system includes earth electrode, installation of earth electrode in suitable pit size, construction of earth pit with cover for the installation, connection of earth electrode with equipotential earth bus and connection of equipment to equipotential earth bus.

1.10.4 Earth electrode

The earth electrode is in direct contact with the ground provides means for conducting earth current with ground. Earth Electrode material should have good electrical conductivity and mechanical strength and should not corrode in wide variety of soil conditions. For an effective earthing system, following type of vertical earth electrodes can be used.

- a) MS Rods: Hot rolled, Medium or High Tensile Steel Rod as per IS 2062 of length not less than 3000 mm.
- b) Copper Bonded Rods: High tensile-low carbon steel rod having diameter not less than 14/17 mm of Length 3000 mm to be selected based on earth fault current. The Rod shall comply with requirements of BS 4360 Grade 43A or EN10025:2-004 S275JR, molecularly bonded by 99.99% pure high conductivity copper on outer surface with copper coating thickness 250 micron or more in conformity to UL-467. Its surface shall be clean, free from mechanical defect and any visible oxide layer or foreign material.

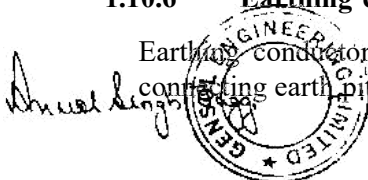
1.10.5 Earthing Enhancement Compound

A low resistance earth electrode system is important to provide a low impedance path for the better dissipation of lightning/fault currents, and to protect personnel and equipment by minimizing and equalizing voltage potential differences. Earthing (ground) enhancement materials shall be used to improve the ground electrode resistance. Earth enhancement material shall be a superior conductive material which improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.). It shall be tested and should conform to the requirements of IEC 62561-7. It shall have the following characteristics: -

- a) High conductivity improves earth's absorbing power and humidity retention capability, non-corrosive in nature having low water solubility but highly hygroscopic.
- b) Carbon based with min 95% of fixed carbon content premixed with corrosion resistant cement to have set properties. Cement shall not mix separately & shall not have Bentonite.
- c) Resistivity of less than 0.2 ohms -meter.
- d) It shall not depend on the continuous presence of water to maintain its conductivity and shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.
- e) It shall not dissolve, decompose, or leach out with time and shall be environmentally friendly, suitable for soils of different resistivity and any kind of earth electrode.
- f) The Earth enhancement material shall be supplied in sealed, moisture proof bags, marked with Manufacturer's name or trade name, quantity etc. The minimum quantity of earth enhancement compound to be used with each earth-pit shall be 25 Kg.

1.10.6 Earthing conductor

Earthing conductor is the conductor for buried below the ground at the depth of 600 mm connecting earth pits to make interconnection of earth pit. To interconnect earth pits, following



type of conductor can be used. Application of specific conductor and its size has been mentioned in relevant clause

- a) Galvanized Steel Flat (GS) Flat GS/GI Flat (Strip) conductor shall comply to IS 2026 with Galvanization of 85 Micron as per IS. Material shall be clean and free from mechanical defects.
- b) Copper Clad Steel (CCS) Earthing Conductor. The Copper Bonded Steel Grounding Conductor shall be made of steel with the coating of 99.99% pure copper complying to ASTM B 869-96 and ASTM B 452-93 standards.
- c) Each strand of CCS shall have continuous, uniform coating and the conductor surface shall be smooth and free from mechanical defects.
- d) MS Rod Hot rolled, Medium or High Tensile Steel Rod as per IS 2062 of length not less than 3000 mm and diameter of 40 mm.

1.10.7 Earthing Technical and Installation Requirement

Careful consideration should be given to installing an earthing system that meet or exceed statutory requirements. Contractor shall select certified product and ensure good workmanship for installation for satisfactory performance to fulfill the designed parameters all the times. Following care shall be taken while installation of earthing.

- Metallic frame/ structure of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of handrails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic sheaths and armour of single core cables shall be earthed as per requirement mentioned elsewhere in the specification. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable. Metallic column for Inverter/Switchgear shelter/E-house shall be earthed with two distinct connections at minimum two column. All the wall cladding section shall be earthed at minimum two location with flexible copper cable of not less than 50 sq. mm.
- Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meters. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground.
- Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.
- The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.
- Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti-corrosive paint/compound.
- Connections between equipment earthing leads and between main earthing conductors

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shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding. Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

- Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.
- Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover
- Earth pit shall be constructed as per IS:3043. Electrodes shall be embedded preferably below permanent moisture level. Minimum spacing between electrodes shall be 600mm.
- Contractor shall obtain all necessary statutory approvals for the earthing system before charging of the plant and electrical equipment's

1.10.8 Technical detail solar array for DC earthing

1. This section outlines the earthing requirement for discharging DC fault current to earth of Solar PV plant and provide equipotential bonding for Module Mounting Structure (MMS), SCB Mounting structure, Module Frames etc.

System Requirement for the solar array DC earthing: System fault level--5 KA for 1 Sec
Min. Steel corrosion --As per IS 3043 Life Expectancy - 25 years

2. Each Module mounting structure (MMS), SPV Module frames, mounting arrangement for String Monitoring Boxes, Metallic Junction Boxes, Metal frames/Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system.
3. Earthing conductor for connection to structure and equipment may be kept on the ground below MMS. However, these conductors shall be laid 300 mm below the ground along the pathway and/or crossing the pathway.
4. Contractor shall seek MSPGCL's approval for connecting solar array earth mesh with any other earth mat/earth grid of the solar PV plant.
5. Inverter functional earthing (Negative earthing, Anti PID Earthing) shall be carried out as per guideline of OEM. Contractor shall submit complete detail of such earthing from OEM and implement the earthing accordingly.

1.10.9 Technical details for AC earthing system

1. This section outlines the requirements of protective and functional earthing system to discharge AC fault current to earth and provide equipotential bonding for Transformer, HT and LT Switchgear Panel and other similar electrical equipment, Transformer neutral and shield.
2. The Contractor shall furnish the detailed design and calculations as per IEEE 80/IS 3043 for Employer's approval for equipment earthing.



1.10.10 Earthing System requirement for AC Earthing

Conductors above ground level and in built up trenches -Galvanized steel

- Conductors buried in earth -Mild steel rod of 40 mm diameter
 - Earth electrodes - Mild steel rod of diameter 40mm or Copper bonded steel rod of diameter not less than 17 mm
 - Life Expectancy - 25 years
 - Min. Steel corrosion - As per IS 3043
 - Soil Resistivity -Actual as per site condition
-
- For functional earthing of electronic component such as SCADA, contractor shall provide 1 no. (Min) isolated earth electrode near to the equipment connected with 2 run of copper cable of size not less than 25 sq. mm. Contractor shall comply to the recommendation of OEM (Original Equipment Manufacturer) for electronic earthing and electrode can be connected with other earth electrode as per recommendation of OEM.
 - Each inverter duty transformer having shield between HV and LV winding shall be provided with 2 nos. Isolated earth electrode connected with each other for functional earthing of transformer shield. Each electrode shall be connected with transformer shield with separate 25x6 Cu flat.
 - Contractor shall ensure there at least two earth pits each dedicated for earthing of each Transformer, HT/LT Switchgear panel, transformer neutral,Battery Charger/UPS/Control Panel etc. shall be provided. Earth electrode shall be located near to the equipment and all earth electrodes shall be interconnected with parallel conductor buried in earth surrounding the equipment.
 - **Earthing system of different locations such as Inverter room/Pooling Switchgear/Sub pooling switchgear/Inverter shelter etc. shall be interconnected in single network with buried conductor of the size 65x8 GS Flat laid at 600 mm depth.** Contractor shall submit the calculation based on the system of earth conductor and electrode connected in single network. Location and manner of interconnection shall be approved during detail engineering.
 - Bidder shall also interconnect the earthing system of Solar PV plant with MSPGCL existing earthing system wherever available.
 - For functional earthing of electronic component such as SCADA, contractor shall provide 1 no. (Min) isolated earth electrode near to the equipment connected with 2 run of copper cable of size not less than 25 sq.mm. Contractor shall comply to the recommendation of OEM for electronic earthing and electrode can be connected to other earth electrode as per recommendation of OEM.

1.10.11 Water Arrangement for Earthing

The EPC Contractor shall make water arrangement for continuous requirement of earth pits in switchyard as per applicable IS/IEC.

1.11. OTHERS

Any Electrical work which is not mentioned or included here but necessary for the plant shall be borne by Contractor.



1.12. SCOPE FOR CONTROL ROOM

A. SCOPE OF CIVIL WORK FOR UNIT CONTROL ROOM(INVERTER ROOM) MAIN CONTROL ROOM

1.12.1 Planning & Design

1.12.1.1 **Main control room:** The Contractor has to plan and design the RCC type building/ container type/ prefabricated building for 62 MW_{AC} Main Control Room in a proper manner. Contractor has to develop general layout drawing of Control Room including landscaping of the entire Control room area should accommodate inverter and all the required equipment & panels, switchgears, SCADA, battery & charger battery & charger, firefighting equipment's etc. All design & drawing/s have to be developed based on specification given in the tender, soil report, and relevant IS unless otherwise specified. All details should be clearly shown in the drawings. MAHAGENCO reserves the right to modify the main control room design as per local site conditions/requirements.

1.12.1.2 **Unit Control Room (Inverter Room):**
The contractor has to plan & design 1-12.5 MW (AC) Unit Control Room (Inverter Room) as per design layout of 62 MW_{AC} Solar plant. Unit Control Room shall be RCC type/ container type/ prefabricated building. The Unit control room should accommodate inverter and all the required equipment & panels, switchgears, SCADA, battery & charger, firefighting equipment's etc. The Unit control room should be designed as per global industry best practices and local conditions. The design of Main Control Room Buildings shall also incorporate the outlet openings for ventilation ducting from inverter. The Contractor shall submit the detailed design with relevant certifications and approvals for MAHAGENCO approval.

1.12.2 Container type solution for Unit Control Room (Inverter Room):

The manufacturer of container / enclosure for inverter and other equipment shall have experience of supplying minimum of 50 MW_{AC} capacity in similar type. The container solution if used for inverter shall be approved by the inverter manufacturer and the Contractor shall submit the certificate from the inverter manufacturer to such effect, without changes in any performance or product warranties.

1.12.3 Construction of Unit control room using Pre-fabricated material:

The Contractor can use pre-fabricated material designed to meet required functionality of the room. All designs and details shall be according to the latest versions of relevant global / Indian standards. Wind and other loads on structure shall be transmitted to the foundations through moment resistant frames in one direction and vertical X braced or K braced frames in other direction. Structure that resists lateral loads with rigid frame shall be avoided.

The structure shall be designed for all types of loads as given below.

1. Dead load: Self weight of structure including purlins, sheeting, girts, bracings, etc.
2. Live load: Live loads shall be as per IS 875.
3. Collateral loads: All frames shall be designed for additional collateral load of 0.2 kN/m² on purlins and runners.
4. Wind loads: Wind loads shall be as per IS 875.
5. Earthquake load: Seismic forces shall be as per IS 1893.



6. All materials for sheet and accessories shall strictly confirm to IS/BS/ASTM/AS specifications as applicable.

1.12.4 Concrete Structure Unit Control Room:

The Contractor also has the option to construct Unit Control Room in concrete structure. In such case all the specifications as mentioned in this document shall be applicable.

1.12.5 Main Control Room:

- 1.12.5.1 The Main Control Room has to plan & design the RCC type building/ container type/ prefabricated building adhering to relevant standards. It shall have an inverter room. The Contractor has to submit the proposed drawing of control room during construction phase to MAHAGENCO for approval. The building shall be designed to meet National Building Code requirement.
- 1.12.5.2 Main Control design should be developed considering optimal usage of space, material and labour without compromising the effect of shadow, cooling, ventilation, accessibility, losses during electrical interconnections, etc.
- 1.12.5.3 Main control room construction should be in compliance with National Building Code and relevant BIS/International standards.
- 1.12.5.4 The Main control room buildings shall have to be designed based on topological survey report & soil testing report, relevant BIS code, National Building Code of India, unless otherwise mentioned in the general scope of work & technical specification in consultation with Project Manager/Site-in-Charge.
- 1.12.5.5 The Main Control Room building shall be equipped with Toilets, Washbasin, and Overhead tank for water storage, with proper fresh water and sewage arrangement and septic tank. Relevant standards have to be maintained for construction.
- 1.12.5.6 Main Control Room shall have, all the required equipment & panels, switchgears, SCADA, battery & charger battery & charger, firefighting equipment's etc.
- Office Room for staff.
 - Air conditioned SCADA room
 - Store Room
 - Lobby
 - Pantry
- 1.12.5.7 Office room for staff:
- Office space for MAHAGENCO representative of minimum size of 20 X 15 Feet shall be into the Main control.

1.12.5.8 Toilet and urinal:

The Contractor shall submit the proposed drawing of control room building along with the bid to MAHAGENCO for approval. The following specifications are applicable for control room buildings; the main control room, if proposed to be civil constructed room.

RCC WORK - All RCC works shall be of M25 grade as per IS 456-2000 and the materials used viz. Cement reinforcement, steel etc. shall be as per relevant IS/ IEC standards. In addition IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must be complied. Reinforcement shall be high strength TMTFe 415 or Fe 500 conforming to "IS: 1786-1985".

MASONRY WORK - All brick works shall be of atleast class II approved quality as per IS: 2212 and IS: 3495. The cement mortar for brick masonry shall be in the ratio 1



cement and 5 sand, by weight. The cement mortar shall be machine mixed. Bricks required for masonry work shall be thoroughly soaked in clean water tank for approximately two hours. Brick shall be laid in English bond style. Green masonry work shall be protected from rain. Masonry work shall be kept moist on all the faces for a period of seven days.

1.12.5.9 Doors & windows:

Doors, windows and ventilators of air-conditioned areas, entrance lobby of buildings (wherever provided), and all windows and ventilators of main plant and service shall have, electro colour dyed (anodized with 15-micron coating thickness) aluminum framework with glazing. All doors of toilet areas shall be of steel framed solid core flush shutter.

The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS: 4351. Steel windows and ventilators shall be as per IS: 1361 and IS:1038. All windows and ventilators on ground floor of main control room shall be provided with suitable grill.

Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However, for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20m.

The main entrance shall include Mild Steel single leaf door. The structural steel shall conform to IS:7452 and IS: 2062. The holdfasts shall be made from steel flats (50 mm and 5 mm thick). The fixtures, fastenings and door latch are to be made with same materials. Each window shall have a solid bronze polished, cam locking handle and strike. All steel windows shall be suitably painted after fabrication in accordance with the relevant Indian Standard(s).

Fixing of metal doors and windows shall be done in accordance to IS: 1081 and IS 7452.

Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings except for main entrance door to the control room where the projection shall be 1500mm.

1.12.5.10 Glazing:

All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, plain or tinted for preventing solar radiations, unless otherwise specified.

For single glazed aluminum partitions and doors, float glass of 8mm or 10 mm thickness shall be used. All glazing work shall conform to IS:1083 and IS:3548. 6 mm reflective toughened glass, with following minimum technical characteristics: Solar factor 45% or less, U-value less than 5.7 W/SQMK, VLT min 35%: The glass to be used shall be from the manufacturers of glass like Asahi Intecc, Gujrat Guardian, Borosil, La oppla, Hindustan nirmal glass, Saint Gobain (France) Or equivalent. The glass shall be free from distortion and thermal stress.

1.12.5.11 Plastering:

All external surfaces shall have 20mm cement plaster in two coats, under layer 12 mm



thick cement plaster 1:4 and finished with a top layer 8mm thick cement plaster 1:4 with water proofing compound. White cement primer shall be used as per manufacturer's recommendation.

At least one coat of plaster shall be applied to interior walls by hand or mechanically, to a total thickness of 12 mm using 1:4, 1 cement and 4 sand. Plastering shall comply to IS: 1542, IS:1661, IS:1630. Oil bound washable distemper on smooth surface of internal walls shall be applied with 2 mm thick Plaster of Paris putty for control room.

Plaster of Paris (Gypsum Anhydrous) conforming to IS:2547 shall be used for plaster of Paris punning.

1.12.5.12 Flooring:

The Cement shall be ordinary Portland cement as per IS:269. Flooring for stores shall be of cement concrete flooring as per IS 2571-1970. Flooring for office building, security cabin & control room shall be vitrified tiles.

1.12.5.13 Roofing:

Roof of the control room building shall consist of Cast-in-situ RCC slab treated with a water proofing system which shall be an integral cement based treatment conforming to CPWD specification (item no. 25.8 of DSR 1997). The roof of the building shall be water proof with tarfelt 5 layer over screeding. The roof shall be designed for minimum superimposed load to 150 kg/m².

For efficient disposal of rainwater, the runoff gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made watertight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.

1.12.5.14 Painting of walls & ceilings:

The paint shall be anti-fungal quality of reputed brand suitable for masonry surfaces for high rainfall zone. All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush, then same shall be finished off with roller. For painting on concrete, masonry and plastered surface IS:2395 shall be followed. All paints shall be of approved make including chemical resistant paint. Minimum 2 finishing coats of paint shall be applied over a coat of primer.

For painting on steel work and ferrous metals, BS: 5493 and IS:1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.

The cement paint as per as per IS: 5410 shall be of approved brand and manufacturer. All external surfaces of walls shall be painted with water-proof cement base paint. Ceiling of all rooms except Battery room shall be whitewashed. The ceiling of Battery room (if provided) shall be acid resistant paint.

1.12.5.15 Plinth protection:

Plinth protection shall be provided around the buildings with Brickbats and PCC 1:2:4 & smoothly finish of top surface.

1.12.5.16 Water supply:

Pipes of Medium quality conforming to IS 1239 (Part I-1990) and IS 1795-1982 (reaffirmed, 1990) for Mild Steel pipes shall be used for all water supply and plumbing



works. The Sintex or equivalent make PVC storage water storage tank conforming to IS:12701 shall be provided over the roof of the Main control room with adequate capacity for 10 No person and 8 hours' requirement completes with all fitting including float valve, stop cock etc. The capacity of the tank shall be minimum 500 liters.

1.12.5.17 Plumbing & Sanitary:

Toilet shall have the following minimum fittings. WC (Western type) 390 mm high with toilet paper roll holder and all fittings or WC (Indian Type) with all fittings (both types of WCs shall be provided at alternate locations).

- 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.
- All fittings, fastener, grating shall be chromium plated. Necessary plumbing lines shall be provided for office cum control room building and Security cabin

The floor finish for washroom, pantry and toilet shall be vitrified ceramic anti-slip tiles and Dado glaze ceramic tiles up to 2.1m shall be used. The normal size of Ceramic tiles shall be 300 mm X 300 mm X 9 mm and shall comply IS:15622.

The Contractor shall design & provide underground one septic tank and two soak pits and assuming that a total of 10 persons shall be working for O&M in combined three shift.

The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with trap, with inlet and outlet connections and CPVC concealed water supply pipe of minimum 12 mm dia of medium class, sanitary pipe of minimum 75 mm diameter, floor trap with Stainless Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)

1.12.5.18 Stairs:

Contractor to provide service ladder made up of access the roof for maintenance of communication equipment and water tank.

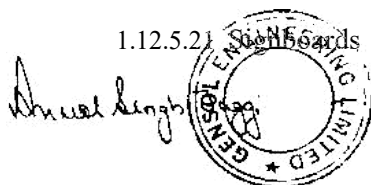
1.12.5.19 False ceiling:

Main control room shall be provided with false ceiling of 15 mm thick mineral fiber board, in tile form of size 600mm x 600mm, along with galvanized light gauge rolled form supporting system in double web construction pre painted with steel capping, of approved shade and colour, to give grid of maximum size of 1200x600 mm as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts(if required), return air grills(if required), light fixtures, etc., all complete.

1.12.5.20 Office furniture:

Adequate and appropriate ergonomically designed furniture of approved make for the control room shall be included in the Price bid. The furniture shall be chosen in such a way that it matches with the decor of the control room. Furniture shall be of reputed approved manufacturer.

1.12.5.21



The Signboard will contain brief description of the Power Plant. The Signboard will be made of steel plate of not less than 3 mm. Aluminum strip of 2 mm thickness, 18mm width and length equal to the length of sign board shall be provided with the board for clamping the board on to the RC Poles. Letters on the board have to be with proper illumination arrangement. The design & size of the signboard shall have to be befitting the Control Room.

1.12.5.22 Security cabin & boom barrier

Security cabin containing CCTV terminals shall be designed and constructed by the Contractor keeping in view the safety and security of the power plant as a whole and as per requirements in consultation with Project Manager. The design of the Gate shall be submitted to MAHAGENCO for approval.

1.12.5.23 Others

Any Civil work which is not mentioned or included here but necessary for the plant shall be borne by Contractor.

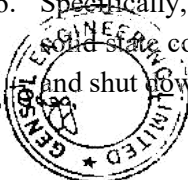
1.13. SCOPE OF ELECTRICAL WORK FOR UNIT CONTROL ROOM (Inverter Room)

1.13.1 General Requirement

There will be necessary numbers of Power Control Units (PCU) which will consist of an electronic Inverter along with associated control, protection and data logging devices. The system shall incorporate a unidirectional inverter and should be designed to supply the AC power to the grid at load end. The power conditioning unit shall adjust the voltage & frequency levels to suit the Grid. All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency. PCU shall conform to IEC 60068-2 standards for Environmental Testing.

1.13.2 Power Control Unit (Inverter Room) :

1. Central inverters of minimum capacity of 1000-6847kW shall be used in the project. The central inverters can be with modular built-up design.
2. The Bidder/its Sub-vendor should have designed, manufactured and supplied grid connected solar Inverters of cumulative capacity of 200 MW out of which at least one such supply order for a single plant should be of 10 MW or above capacity.
The reference plant in which 10 MW or above capacity solar Inverters (consisting of one or more) were supplied must have been in successful operation for at least six (6) months prior to the date of issue of LoA by Mahagenco to bidder.
3. The efficiency of the PCU inverter shall be equal to or more than 98% at 75%load as per IEC 61683. The Contractor shall specify the conversion efficiency at different loads say 25%, 50%, 75% and 100% in his offer. The Contractor should specify the overload capacity in the bid Inverter should be warranted up to 20 years
4. The output power factor of the PCU inverter should be of suitable range to supply or sink reactive power. The PCU shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line.
5. The PCU inverter shall have the required protection arrangements against earth-leakage faults. Inverters shall be suitable for floated or negative earthing.
6. Specifically, the PCU inverter should be three phase power conditioning unit using static solid state components. DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. Circuit breakers used in the DC lines must be rated suitably.

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7. Each solid state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter.
8. The PCU inverter shall have anti islanding protection.
9. The system shall tend to balance unequal phase voltage (with 3-phase systems) with reference to the red phase (line-1)
10. The PCU inverter front panel shall be provided with a display (LCD or equivalent) of all important Parameters such as DC input voltage, DC input current, AC input voltage, AC input Current, AC output power, power factor, frequency etc.
11. If the Contractor is not able to provide PCU with display, the same has to be made available at the SCADA monitoring & controlling desk installed in Main Control Room.
12. Nuts, bolts and the PCU enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.
13. Dimensions and weight of the PCU shall be indicated by the Contractor in the offer. The PCU shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of PCU component failure or from parameters beyond the PCU's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices.
14. It should have Local LCD (Liquid crystal display) and keypad for system control, monitoring instantaneous system data, event logs, data logs and changing set points. Control and read-out should be provided on an indicating panel integral to the Inverter. Display should be simple and self-explanatory display to show all the relevant parameter relating to PCU operational data and fault condition in form of front Panel meters / LED's or two line LCD Display.
15. PCU shall have arrangement for adjusting DC input current and should trip against sustainable fault downstream and shall not start till the fault is rectified.
16. Operation & maintenance manual should be furnished by the Contractor before dispatch of PCU's.
17. The bill of materials associated with PCU's should be clearly indicated while delivering the equipment.
18. Standby 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.
19. Basic System Operation (Full Auto Mode)
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.
20. Maximum Power Point Tracker (MPPT)
MPPT control algorithm shall adjust the voltage of the SPV array to optimize solar energy fed into the grid.
21. 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.

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22. Maximum Power Tracking

Maximum power point tracker 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 shall be mentioned by the Contractor in his offer. The MPPT must have provision for constant voltage operation. The MPPT unit shall conform to IEC 62093 for design qualification.

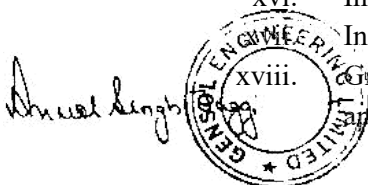
23. Technical specifications –

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 technology.

- i. Nominal AC Output Power : Contractor can use inverter of Nominal AC Output Power from 1000KW to 6874KW as per their design.
- ii. Nominal Output voltage : 240 – 800 Volts
- iii. Minimum Efficiency at : 75% load : $\geq$ 98%
- iv. Output frequency : 50 Hz +/- 0.5% Hz (Inverter to follow grid frequency up to +/- 3Hz of the nominal output frequency during normal operation)
- v. Maximum Input voltage : 1200 V DC
- vi. THD Less than : 3%
- vii. Ambient temperature : 0 to 50 degree C
- viii. Humidity : 85% Non-Condensing Enclosure
- ix. Minimum IP20 (Indoor Rated)

24. The Inverter shall have following features:

- i. No load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%
- ii. Sinusoidal current modulation with excellent dynamic response.
- iii. VAR control with +/- 0.9 power factor
- iv. Unit wise & integrated Data logging.
- v. Dedicated Prefabs / Ethernet for networking
- vi. Protection against
- vii. Over current
- viii. Sync loss
- ix. Over temp.
- x. DC bus over voltage
- xi. Cooling Fan failure (If provided)
- xii. Power regulation in the event of thermal overloading
- xiii. Set point pre-selection for VAR control
- xiv. Bus communication via -interface for integration
- xv. Remote control via telephone modem or mini web server
- xvi. Integrated protection in the DC and three phase system
- xviii. Insulation monitoring of the PV array with sequential fault location
- xviii. Ground fault detector - which is essential for large PV generators in view of appreciable discharge current with respect to ground.



- xix. In case of any fault in grid the inverter shall protect itself before any damage to inverter or grid.
- xx. Vendor's credentials, base material test certificates, GTP (Guaranteed Technical Parameters) & QAP for Inverter shall be submitted for approval from MAHAGENCO.

The Power Conditioners/Inverters of the SPV power plants must conform to the latest edition of IEC/ equivalent BIS Standards as specified below:

Efficiency Measurements	IEC 61683
Environmental Testing	IEC 60068-2/ IEC 62093
Electromagnetic Compatibility (EMC)	IEC 61000-6-2, IEC 61000-6-4
Electrical Safety	IEC 62103/62109-1 &2
Protection against Islanding of Grid	IEEE1547/IEC 62116/ UL1741 or equivalent EN/BIS Standards
Grid Connectivity	Relevant CERC Regulations and Grid Code as amended and revised from time to time.
Rated capacity	Nominal/Rated output power of the inverter (if different power ratings are mentioned at different temperatures, then power rating at 50° C shall be considered) in kW will be considered as inverter rated capacity.

1.13.2.1 DC Bus & Panel (If necessary)

DC generated by the Solar modules is transmitted through the appropriate cables from Array Yard to Inverters in control room. DC bus & Panel should be provided for the incoming DC supply from Array Yard. The Panel should consist of adequate size DC Bus/Cable which can handle the current and the voltage safely as per the relevant IS/ IEC standards. DC panel should be equipped with an adequate capacity indoor DC circuit breaker along with control circuit, Protection Relays, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

Theoretical design calculations and detailed explanations along with drawings, vendor's credentials, GTP (Guaranteed Technical Parameters) & QAP shall be submitted to and approved by MAHAGENCO.

1.13.2.2 AC Bus & Panel

AC converted by the inverter is transmitted through the appropriate cables from Inverter to Inverter transformers. AC bus & Panel should be provided for the outgoing AC supply from inverter to inverter transformer Switchyard, the Panel should consist of adequate size indoor AC Bus/Cable which can handle the current and the voltage safely as per IS 8623(Part 2):1993 / IEC 60439-2. AC panel should be equipped with an adequate Protection Relays, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

AC Bus & Panel housed in the control room shall be provided in between PCU and 415V/33 kV (or of suitable primary voltage) transformer. It shall have MCB/MCCB or



Circuit Breaker of Suitable rating for connection and disconnection of PCU from Grid. The connection between ACDB and Transformer shall be busbar. It shall have provision to measure bus voltage, current and power feeding the transformer.

Bus-bars shall be of high conductivity aluminum alloy or copper of adequate size. The bus-bars shall be adequately supported by non-hygroscopic, noncombustible track resistant and high strength type polyester fiber glass moulded insulators. Separate supports shall be provided for each phase and neutral busbar. The bus-bars joints shall be provided with high tensile steel bolts, belleville washers and nuts, so as to ensure good contacts at the joints. The bus-bars shall be colour coded as per IS 375.

Theoretical design calculations and detailed explanations along with drawings, vendor's credentials, GTP (Guaranteed Technical Parameters) & QAP shall be submitted to and approved by MAHAGENCO.

1.13.2.3 Circuit Breaker

Appropriate & adequate Capacity 240V / 380V / 415V AC indoor air Circuit Breaker as per IS 60947 (Part 2):2003 / IEC 60947-2 along with control circuit, protection relay circuit, fuses, annunciations and remote operating and controlling facility from the Main Control Room is necessary.

Theoretical design calculations and detailed explanations along with drawings, vendor's credentials, GTP (Guaranteed Technical Parameters) & QAP shall be submitted to and approved by MAHAGENCO.

1.13.2.4 UPS, DC Battery & Charger

An uninterrupted power supply along with adequate capacity maintenance-free type DC battery Bank should be provided for emergency control supply of control / protection system & emergency lighting. The DC voltage shall be as per requirement of and suitable to design of the system (220/110/96/60/48/24VDC).

A appropriate capacity Battery charger with relevant IS/IEC standards & protection and automatic change over system should be provided to charge the battery bank along with relay circuit, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

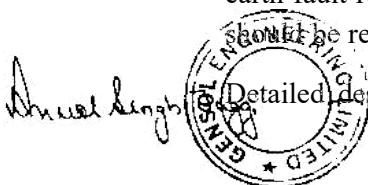
A DC power supply Distribution panel/board should be supplied along with the Charger as per relevant IS/ IEC standards.

Control room DC Battery Bank & DC supply system theoretical design, calculations, QAP, GTP and detailed explanations along with drawing shall be provided and approved by MAHAGENCO.

1.13.2.5 Protective Relays

The SPP and the associated power evacuation system shall be protected as per Indian Standards. Over current relays, reverse power relays, differential protection relays and earth fault relays have to be essentially provided. All relay should be numerical type & should be remote operating and controlling facility from the Main Control Room.

Detailed design calculations shall be provided on fault power computations and the



philosophy of protective relaying with respect to short circuit kVA calculations. These shall be provided in the software and its version as required by MAHAGENCO. Design & Drawing of protection relay should be approved by MAHAGENCO.

1.13.2.6 Auxiliary Power Supply

A supply point connection for LT supply required to provide essential and peripheral loads on 24x7 basis shall be provided by Mahagenco. However, necessary separate transformer and its accessories, control & protections for auxiliary power supply shall be in the scope of contractor.

These shall be designed depending on the plant auxiliary power requirement. Design and drawings shall be submitted to MAHAGENCO for its approval.

1.13.2.7 String Monitoring System

Monitoring of various parameters at string level should be made possible in the Main Control Room at site by installing the suitable string monitoring system so that any fault at string level could be recognizable by that system.

String Monitoring System theoretical design, calculations and detailed explanations along with drawing shall be provided and approved by MAHAGENCO.

Additionally necessary facility shall be installed at the Main Control Room to enable remote monitoring of the plant performance from MAHAGENCO's Mumbai office facility.

1.13.2.8 Air Ventilation System

The control room shall be equipped with appropriate air ventilation system suitable for heat dissipation. The calculations for air flow, heat dissipation and other shall be submitted to MAHAGENCO for approval.

1.13.2.9 Lighting Fixtures

All lighting fixtures shall be indoor type & pre-wired comprising of Lamp(s) as indicated with lamp holder(s) and Electronic Ballast(s) with metal reflector(s). The lamp fitting shall be covered by Glass or Perspex material. The Lamp Fixture shall be fitted on wall as per direction of Site -In-charge. Alternatively, LEDs may be used after submitting detailed descriptions of illumination computations and test certificates from reputed test centers.

The number of lighting fixtures should be such that it should give sufficient luminance level for daily operation as per BEE standards.

Load calculations and detailed explanations along with drawing shall be provided and approved by MAHAGENCO.

1.14. MAIN CONTROL ROOM PANELS & MONITORING DESK

1.14.1 The Panel shall have adequate inputs to take in from the centralized Push Button



Switching Unit having Suitable Mimic with Power flow Indicator & Status Indicator of different PCUs.

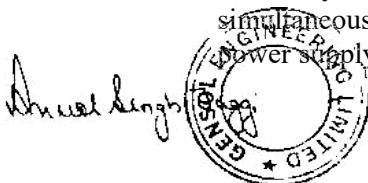
- 1.14.2 The Panel shall be floor mounted type. All the measuring instruments such as feeder voltmeter, ammeter, frequency meter, Electronic Energy Meter (for measuring the deliverable units (kWh) for sale), selector switches, Mimic etc. shall be in the front panel.
- 1.14.3 All the Power cables shall be taken through backside of the Panel.
- 1.14.4 The Panel shall be fitted with suitable rating & size, HRC fuses/circuit breaker/isolator indicators for all incomer and outgoing terminals, Voltmeter & Ammeter with suitable selector switches to monitor & measure the power to be evacuated.
- 1.14.5 Nut & bolts including metallic cubicle shall have to be adequately protected against atmosphere and weather prevailing in the area.
- 1.14.6 The overall dimensions of the panel shall be suitable with other power conditioning units of the power plant. However, dimensions, weight, sheet thickness, painting etc. should be indicated by the Contractor . The bill of material associated with the equipment should be clearly indicated while delivering the equipment.
- 1.14.7 Drawings, vendor's credentials, GTP (Guaranteed Technical Parameters) & QAP along with makes of components shall be submitted to and approved by MAHAGENCO.

1.15. MAIN CONTROL ROOM CABLES & WIRES FOR LIGHTING FIXTURES

- 1.15.1 All cables shall be PVC insulated grade conforming to relevant IS/ IEC standards shall also confirm to IEC standards for test and measuring. Methods of testing & make of cable should be approved by MAHAGENCO.
- 1.15.2 The wiring for modules inter connection shall be with hard PVC conduit of approved make. All Tees, Bends etc. shall be approved make. Before procurement, approval for materials should be obtained from MAHAGENCO.
- 1.15.3 Only terminal cable joints shall be accepted. If the length of cable increases significantly, straight-through joints can be accepted.
- 1.15.4 Cables inside the control room shall be laid in suitable Cable Trays of approved type.
- 1.15.5 All wires used on the LT side shall conform to IS/ IEC and should be of appropriate voltage grade. Copper or Aluminium conductor wires of reputed make shall be used.
- 1.15.6 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 panels' bottoms should be properly sealed to prevent entry of snakes/lizard etc. inside the panel.
- 1.15.7 All cable/wires shall be marked with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.
- 1.15.8 Control room panel wiring theoretical design, calculations and detailed explanations along with drawing shall be provided and approved by MAHAGENCO.

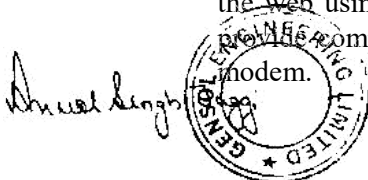
1.16. MAIN CONTROL ROOM SCADA AND REMOTE MONITORING SYSTEM

- 1.16.1 The plant shall be automatically operated and shall be controlled by microprocessor based control system SCADA. Computer Aided Data Acquisition Unit shall have features for simultaneous monitoring and recording of various parameters of different sub-systems, power supply of the Power Plant at DC side and AC side. The drawings of



Plant Monitoring Desk should be approved by MAHAGENCO.

- 1.16.2** Computer Aided Data Acquisition Unit (in the form of personal computer (PC)) shall be a separate and individual system comprising of different transducers to read the different variable parameters, A/D converter, Multiplexer, De-multiplexer, Interfacing Hardware & Software, Industrial Type PC, which will be robust & rugged suitable to operate in the Control Room Environment.
- 1.16.3** Two sets of reliable sensors (one for horizontal and one for tilted surface) for Solar Radiation, Temperature & other Electrical Parameters are to be supplied with the data logger unit.
- 1.16.4** **The computer shall be of Server grade, rugged & robust in nature to operate in a hostile environment with latest specifications. The computer shall have 52" LED Color monitor, latest generation Intel Core i7 processor having SSD of at least 1 GB & 1TB HDD with 32 GB RAM & 4 GB dedicated graphic memory card, web camera, speaker, mic, USB drive, scroll mouse and UPS for 4 hours power back up.** The printer shall be of industrial type, rugged & robust in nature and of reputed make. The printer shall be equipped for printing, scanning, copying.
- 1.16.5** The Data Acquisition System shall perform the following operations: Measurement and continuous recording of:
- Power at 220 kV Terminal
 - Power at 33kV terminal.
 - Ambient temperature near array field
 - Control room temperature.
 - Wind speed
 - AC and DC side power of each inverter
 - Solar irradiation / insolation.
 - Voltage of HT side.
 - Any other parameters considered necessary by supplier based on current practice.
- 1.16.6** SCADA shall record data for each 30 seconds and provide every 15 Minutes data averages for daily, monthly and annual average of following parameters
- Radiation
 - Temperature
 - Exported energy
 - Energy of each inverter
 - Current and voltage on string at SCB end.
- 1.16.7** All data shall be recorded chronologically date wise. The data file should be MS Excel compatible. The data logger shall have internal reliable battery backup and data storage capacity to record all sorts of data simultaneously round the clock. All data shall be stored in a common work sheet chronologically. Representation of monitored data shall also be in graphics mode or in tabulation form. All instantaneous data can be shown in the Computer Screen.
- 1.16.8** SCADA shall have feature to be integrated with the local system as well remotely via the web using either a standard modem or a GSM/WIFI modem. The Contractor shall provide compatible software and hardware so that data can be transmitted via standard modem.



- 1.16.9** The Bill of Materials associated with the equipment must clearly indicate especially the details about the PC and Printers, etc.
- 1.16.10** SCADA shall be provided with reliable power supply along with backup supply for at least four hours to cater to outage of grid.
- 1.16.11** The Data Acquisition System should be housed in a desk made of steel sheet.
- 1.16.12** If needed SCADA system upgradation shall be done by bidder as per requirement of owner at his own cost.
- 1.16.13** For the purpose of Remote Monitoring a necessary facility should be installed to enable remote monitoring of plant performance including all parameters. There shall be dedicated communication link from MAHAGENCO's Mumbai office and the SLDC (Maharashtra State Load Dispatch Center) at Kalwa facility in Thane district. All blocks in the Project need to be brought in common network with appropriate protocol conversion so that through the single link of SLDC and MAHAGENCO's Mumbai office the data shall flow.
- 1.16.14** For MAHAGENCO's Mumbai office facility the data is required on OPC protocol.
- 1.16.15** The data requirement for SLDC is on IEC-104 protocol. This arrangement shall be as per protocols, specifications and other requirements of the SLDC. The architecture must be approved by SLDC Kalwa.
- 1.16.16** Cost of equipment, internet facility and all rentals for the facility of remote monitoring shall be borne by the Contractor for the complete project period.
- 1.16.17** The drawings, designs, protocols and complete Bill of Material relating to SCADA and remote monitoring shall be submitted to MAHAGENCO for approval.

1.17. MAIN CONTROL ROOM ELECTRICAL WIRING

- 1.17.1** Electrification of building shall be carried out as per IS 732-1989, IS 46481968 and other relevant standards. Suitable AC Distribution Board should be designed to Supply AC power in Control room.
- 1.17.2** Control room AC distribution Board theoretical design, calculations and detailed explanations along with drawing shall be provided and approved by MAHAGENCO.

1.18. MAIN CONTROL ROOM AUXILIARY POWER SUPPLY

L.T. Power supply as required to provide essential and peripheral loads on a 24 x 7 basis shall be provided by the Contractor initiating necessary action with MSEDCL/MSETCL through MAHAGENCO.

1.19. MAIN CONTROL ROOM DC BATTERY & CHARGER

- 1.19.1** Adequate capacity DC battery Bank should be provided for emergency control supply of control / protection system & emergency lighting.
- 1.19.2** A Battery charger of appropriate capacity with relevant IS/IEC standards & protection and automatic change over system should be provided to charge the battery bank along with relay circuit, fuses, annunciations.
- 1.19.3** A DC power supply Distribution panel/board should be supplied along with the Charger as per relevant IS/ IEC standards.
- 1.19.4** Control room DC Battery Bank & DC supply system theoretical design, calculations, GTP, QAP and detailed explanations along with drawing shall be provided and approved by MAHAGENCO.

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1.20. ENERGY METERS

1.20.1 Energy meters shall be provided AT 33 kV side of the inverter Transformer and AT 220 kV Side of the Power Transformer i.e. Delivery Point at the 220 kV MSETCL substation adjacent to the project site and shall be as per the applicable Grid Code and recommendations of MSEDCL/ MSETCL.

1.20.2 The Contractor shall be responsible for installation, operation and maintenance of the Main Meters and Back-Up Meters as per the provisions of MSEDCL / MSETCL. The Contractor shall comply with arranging for installation, sealing, inspection, calibration, maintenance and testing of Main Meters and Back-Up Meters as per the applicable Grid Code and recommendations and provisions of MSEDCL / MSETCL and shall also conform to the Central Electricity Authority (Installation and Operation Meters) Regulation, 2006 as amended from time to time.

1.21. SEALING AND MAINTENANCE OF METERS

1.21.1 The Main Meters and the Back-Up Meters shall be sealed in the presence of representatives of MAHAGENCO, Contractor and MSEDCL/MSETCL.

1.21.2 When a Main Meter and/or a Backup Meter and/or any component thereof is found to be outside the acceptable limits of accuracy or otherwise not functioning properly, it shall be repaired, re-calibrated or replaced by the Contractor and/or the MSEDCL/MSETCL at the Contractor's cost, as soon as possible.

1.21.3 Any seal(s) of Main Meter or Backup Meter shall be broken only by MSEDCL/MSETCL's representative in the presence of the Contractor's representative whenever such Main Meter or the Backup Meter is to be inspected, tested, adjusted, repaired or replaced.

1.21.4 The Main Meters and Back-Up Meters shall be calibrated once in a period of one (1) year.

1.21.5 In case, both the Main Meter and the Back Up Meter are found to be beyond permissible limit of error, both shall be calibrated immediately and the correction applicable to such Main Meter shall be applied to the electricity registered by the Main Meter at the correct energy for the purpose of energy accounting/ billing for the actual period during which inaccurate measurements were made, if such period can be determined. If this period is not readily determinable, it shall be the shorter of:

- The period since the immediately preceding test of such Main Meter, or
- Forty five (45) days immediately preceding the test at which such Main Meter was determined to be defective or inaccurate.

1.21.6 Further, if the quantum of error in the meters is not determinable or where both the Main Meter and the Back Up Meter have failed to function as per specifications, then in such event, the assessment of the electricity supplied shall be equivalent to the electricity registered at the Main Meter during an equivalent generation period of 45 days in the previous calendar year.

1.22. MAIN CONTROL ROOM LIGHTING FIXTURES

All LED Lighting fixtures shall be indoor type & pre-wired comprising of Lamp(s) as indicated with lamp holder(s) and Electronic Ballast(s) with metal reflector(s). The lamp fitting shall be covered by Glass or Perspex material. The Lamp Fixture shall be fitted on wall as per direction of Site - In-charge. Alternatively,



LEDs may be used after submitting detailed descriptions of illumination computations and Test certificates from reputed test centers. The number of lighting fixtures shall be such that it shall give sufficient luminance level for daily operation as per BEE standards.

1.23. MAIN CONTROL ROOM AIR CONDITIONERS

The control room shall be equipped with appropriate energy efficient (as per BEE standards 5 star) split Inverter type air conditioning system suitable for heat dissipation.

1.24. SURVEILLANCE CAMERA MONITORING DESK

Surveillance CCTV system is required to ensure effective surveillance of solar power plant area (array yard, Main control room, switchyard etc.) as well as create a tamperproof record for post event analysis. The System shall provide an online display of video images on Large LCD/LED monitors located in Main Control Room as well as at Security cabin in the site. System should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users present in the LAN. System should provide interoperability of hardware, OS, software, networking, printing, database connectivity, reporting, and communication protocols. System expansion should be possible through off-the-shelf available hardware.

There shall be cameras installed inside and outside the control rooms, main gate, security cabin, switch yard, all weather stations and all watch tower, providing round the clock surveillance. The location and type of cameras are mentioned as here:

1.24.1 Location of Surveillance Cameras:

Following table states location wise types of cameras to be used in CCTV system.

Sr. No	Location	Type of Cameras
1	Inside - Main Control Room	Dome Type
2	Outside - Main Control Room	Bullet Type
3	Main Gate	Bullet Type
4	Inside – Security Cabin	Dome Type
5	Outside – Security Cabin	Bullet Type
6	Main Switchyard & Pooling Substation	Bullet Type
7	Weather Station	Bullet Type
8	Each Watch Tower	PTZ

Cameras shall cover the entire inside & outside area of all units & main control rooms, main gates, security cabin, switch yards, all weather stations and all watch towers, providing round the clock surveillance considering the safety point of view. No. of cameras will depend on the design of Surveillance & vigilance CCTV system.

Design & drawing for the Surveillance & vigilance CCTV system shall be submitted for approval to MAHAGENCO.

1.24.1 Equipment with better specifications shall be accepted.



- a. CCTV Cameras should have low lux so that the same can operate in minimum illumination also. Cameras should have both auto/manual focus mode and control should also be both manual/auto.
- b. The system should be based on Stand Alone Integrated DVR (Digital Video Recording). Specifications of Stand Alone Integrated DVR:
 - i. Ability to connect Cameras as per requirement,
 - ii. Facility to store 90 days of Video,
 - iii. Capability to set the frame rate, contrast, brightness of each individual camera,
 - iv. Shall have facility to view live video (with audio) images in a monitor, in a PC and web browser.
 - v. Remote Administration: Should be fully administrable/programmable remotely through client software and web browser.
 - vi. Recording rate per channel - NTSC/30 fps per channel, PAL/25 per channel.
 - vii. Configurable/adjustable recording rate.
 - viii. Full recording and playback facilities on remote machine.
 - ix. Smart monitoring (Motion Detection).
 - x. Adjustable motion detection (motion detection sensitivity should be adjustable).
 - xi. Ability to convert H.264 video into AVI files.
 - xii. Date and time stamping of video files.
 - xiii. Viewing for all cameras.
 - xiv. Shall support backup devices like USB drive, DVD writer DVR Software must be able to take backup in DVD writer, USB drive etc.
 - xv. Shall have live display, playback, record facilities.
 - xvi. Shall have minimum 1 USB port.
- c. System should have the capability of increasing the storage capacity as and when required.
- d. It shall have low maintenance cost and should be upgradeable to inputs for more cameras, as and when required, with minimum cost.
- e. It shall be compatible with alarm system.
- f. Cameras should be C-mount type.
- g. The firm installing the system should have adequate infrastructure for providing aftersales/installation service.
- h. Cameras of CCTV system must at least cover the following areas:

1.24.2 PTZ Cameras (IP base)

- 36x optical zoom and 16x digital zoom, up to 432x total zoom
- High resolution of 540TVL (color) and 570TVL (B/W)
- Wide Dynamic Range (WDR)
- True Day/Night (IR-cut filter)
- IP66 rate and surge protector
- Pan speed up to 300°/sec and tilt speed up to 120°/sec
- High-performance memory with 128 preset positions, 24 privacy mask zones



and 3 self-learning auto tracks

- Advanced security functions and network administration, such as encryption.
- HTTPS preserved performance, IPv4 and IPv6 and Quality of Service.

1.24.3 Integrated IR Bullet camera (IP base)

- Ultra-high resolution: 700TVL
- Min. illumination: 0 Lux (IR ON)
- 2 IR LED array lights; 30 – 40m IR range
- 5 - 50mm lens
- True Day/Night (with IR-cut filter)
- AES, BLC, White Balance, digital spot compensation, lens shaded control, horizontal mirror
- Motion detection, privacy masking
- Lens shaded control, horizontal mirror, OSD
- Defog function
- IP66, aluminum casing – vandal-proof, lightening-proof
- UTC (Up-the-Coax) function optional
- HTTPS preserved performance, IPv4 and IPv6 and Quality of Service.

Operating Temperature	-20°C to 50°C
Storage Temperature	-30°C to 70°C
Operating Humidity	90%RH (non-condensing)
Casing Material	Aluminum Alloy
Rating	IP66, vandal proof, lightening proof

1.24.4 Dome camera (IP base)

- Ultra-high resolution: 700TVL
- 5 - 50mm lens
- True Day/Night (with IR-cut filter)
- White Balance, electronic Shutter adjustable, BLC
- Lens shaded control, horizontal mirror
- Defog function
- Motion detection, privacy masking, OSD
- Up-the-Coax (UTC) function (optional) for controlling OSD remotely
- 24V AC / 12V DC
- HTTPS preserved performance, IPv4 and IPv6 and Quality of Service.
- Video Cable: RG59U video cable (with heavy gauge PVC conduit)
- Power Cable with heavy Gauge
- Other technical requirements:
- The DVR system shall have CE certification with certificates
- All Cameras must be provided with suitable mounts/housings Wall, Dome etc.
- All cameras must be connected with DVR system with RG59 (with heavy gauge PVC conduits) cables and vendor must perform the necessary cabling to connect DVR with cameras.
- The DVR system offered must be an integrated DVR system and shall not be a DVR system assembled using third party Personal Computers and DVR cards.



- 16 channel DVR shall be able to support D1 resolution for all camera's with 16 TB HDD facility & they shall have a central management software & joystick keyboard shall be there for PTZ Controlling.
- Training Aspect: At the time of installation of equipment, the vendor shall offer free training specific to CCTV system.
- CCTV vendor shall be reputed and have relevant experience of similar solutions in any of Private/ PSU/ State Govt . Supporting documents in form of customer completion letter shall be submitted at vendor approval stage to Mahagenco.
- The CCTV system shall be warranted for 5 years from the date of commissioning. Circuit diagram for the Surveillance & vigilance CCTV system shall be submitted for approval to MAHAGENCO

1.24.5 Fire Protection System

The SPP shall be equipped with suitable fire protection & firefighting systems for protection of entire equipment including SPV, Inverter room, Main Control Room, main switchyard & Pooling Substation and Security Cabins as per CEIG requirements. Contractor shall comply with **recommendation** of Tariff Advisory Committee to incurring minimal premium for insurance. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.

1.24.6 Fire Extinguishers

Liquefied CO₂ fire extinguisher shall be Upright type of capacity 10 kg having IS: 2171. 7 IS: 10658 marked. The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes, Electrical Wiring, Live Machinery Fires, and All Flammable Liquid & Gas.

Contractor to provide following number of portable fire extinguisher

Particular	DCP Type (ABC type) (10 Kg. Cap)	CO2 Type Hand held (9 kg)	Foam Type Hand held (9 kg)
Main Control Rooms	3 each	3 each	3 each

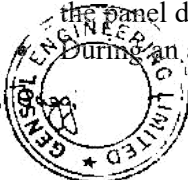
1.24.7 Fire Detection & Alarm

Contractor to provide intelligent microprocessor based main fire alarm panel of modular construction complete with central processing unit, input and output modules, power supply module, supervision control and isolator modules with 10% spare provisions.

Fire detection alarm system shall include alarm initiating devices e.g. multisensor type smoke detectors and alarm notification Appliances (Audio device). Multisensor type smoke detectors shall be provided for below false ceiling areas of Main Control Room. One (01) sensor shall be provided for each 25 sqm. of area in Main Control Room.

1.24.8 Fire Alarm Control Panel:

- Alarm conditions shall be immediately displayed on the control panel of Main Control Room. Alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged the LED shall remain lit. A subsequent alarm received from another zone after acknowledgement shall illuminate the alarm LED and the panel display shall show the new alarm information.
- During an alarm condition, an alarm tone shall sound within the control panel until the

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alarm is acknowledged.

- If the audible alarm signals are silenced for any reason, they shall automatically resound if another zone is activated.
- All alarm signals shall be automatically “locked in” at the control panel until the operated device is returned to its normal condition and the control panel is manually reset.

1.25. OTHERS

Any Electrical work which is not mentioned or included here but necessary for the plant shall be borne by Contractor.

1.26. TECHNICAL REQUIREMENTS OF POWER EVACUATION SYSTEM:

1.26.1 Scope of Civil Work for 33/220 kV Main Switchyard (Pooling Substation)

Indoor/outdoor Inverter Room switchyards of capacity 1-12.5MW of 240-800V/33kV for each Unit Control Room (Inverter Room) as per design of suitable primary side voltage and current in accordance with inverter AC output. Solar power from these Inverter Room Switchyard will be pooled in main switchyard of 62 MW_{AC} project through underground 33kv XLPE cables from Inverter Room Switchyard. Main Switch yard will consist one numbers of Power Transformer of 33/220 kV and other required equipment's as per MSETCL requirement. Solar power at 220kV will be transmitted through transmission line/underground cable to interconnection point which is situated in adjacent MSETCL 220kV substation of Paras.

Contractor shall be responsible to construct 220kV bay/s and interconnection points at MSETCL 220 kV at Paras substation.

a) Main Switchyard (Pooling Substation):

For 62 MW_{AC} Capacity separate Switchyard will be situated at the pre-decided suitable area. It shall consist a 33 kV and 220 kV Circuit Breaker, Metering, Protection CTs, PTs, LAs, Isolators & any other associated equipments etc. All these equipments shall be outdoor type.

Construction of the 220kV bay at the plant end and MSETCL substation end (If required) is in scope of the Contractor. Total evacuation arrangement and testing commissioning cost of the same shall borne by the EPC.

O&M of the evacuation lines (i.e. underground/ overhead line) is in scope of EPC. Construction of the Meter room is in scope of the contractor.

Supply and installation of the ABT meter/ summation meter by approval of MSETCL/MSEDCL requirement with Automated meter reading (AMR) is in scope of the EPC Contractor.

b) The underground cables of 33 kV between Inverter room till switchyard is in the scope of the Contractor. This line shall be XLPE Aluminum cable confirming to IEC60502 and IS7098-II.

c) The Contractor has to do the power evacuation up to interconnection point i.e. 220 kV bus level of nearest MSETCL Paras substation via 220 kV overhead transmission line/ underground cable with the all necessary infrastructure such as protection switchgears and metering systems as per the requirement of the MSEDCL and MSETCL.

The 220 kV line shall be constructed as per state grid code and MSETCL norms.



Site wise nearest substation details are as follow-

- a. Construction of 220 kV switchyard with associated electrical works required for interfacing with grid (i.e. transformer, breakers, isolators panels, protection system, earthing and metering).
- b. The Contractor has to do the power evacuation and integration to at 33/220KV substation via overhead line with the double pole structure / underground cable at 220 kV grid voltage with all necessary infrastructuresuch as protection switchgears and metering systems as per the requirement of the MSEDCL and MSETCL requirement. Contractor shall be liable for approvals, permissions and NOC from MSEDCL & MSETCL at its own cost.
- c. Construction of the 220kV bay at the plant end side is in scope of the Contractor.
- d. Total evacuation arrangement and testing commissioning cost of the same shall borne by the EPC Contractor.
- e. O&M of the evacuation lines (i.e. underground/overhead line) is in scope of EPC Contractor.
- f. Construction of the Bays should have done by the EPC Contractor at the plant end side.
- g. Construction of the Meter room is in scope of the Contractor.
- h. Supply and installation of the ABT meter with Automated meter reading (AMR) is in scope of the EPC Contractor.

1.26.2 Land Developing & Leveling

Land developing work of the entire switchyard area of the plant premises shall have to be done as per drawing developed by Contractor and as approved by MAHAGENCO. Leveling must be carried out as per requirement.

1.26.3 Water Arrangement for Earthing:

Contractor shall make water arrangement for continuous requirement of earth pits in switchyard.

1.26.4 Earthing System

The 415–600V, 33kV, 220kV (or with suitable primary side voltage and current in accordance with inverter AC output) equipment and parts shall be earthed as required as per provisions of IS.

The intent of this specification is to define the requirements for the supply wherever applicable, installation, testing and commissioning of the Earthing System Standards

The work shall be carried out in the best workmanship in conformity with this specification, the relevant specifications/codes of practice of Indian Standard Institution, approved drawings and instructions of the Engineer-in-charge or his authorized representative issued from time to time. For earthing installation work details' along with all Drawings/Data Sheets have to be approved by MAHAGENCO. In case of any conflict between the standards, the instructions of Engineer-in- Charge of MAHAGENCO shall be final and binding.

In addition to the standards all works shall also conform to the requirements of the



following Rules & Regulations.

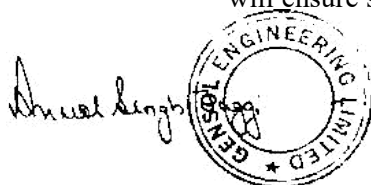
- Indian Electricity act and rules framed there under.
- Fire insurance regulations.
- Regulation laid down by Chief Electrical Inspector of State, State Electricity Board.
- Regulations laid down by the Chief Inspector of Explosives.
- Regulations laid down by the Factory Inspector of state.
- Any other regulations as may be laid down by the Central/Local authorities.

1.26.5 Grounding and lightning protection system

- 1.26.5.1 The station earthing system shall be as designed that actual step and touch voltage are well within the maximum safe values at the site. The design shall be done in compliance of IEEE guide and shall be subject to approval.
- 1.26.5.2 Grounding system shall consist of a ground grid formed by a number of M.S. Rods placed in a mesh foundation by all welded joints, riser connections from ground grid and ground G.S. flat for grounding of equipment. Ground electrodes shall also be provided at intervals and driven into solid earth.
- 1.26.5.3 Size of below ground conductor shall be selected based on unrestricted ground fault current and maximum duration of fault closing time shall be 1 second. Connection to individual equipment shall be sized based on fault clearing time.
- 1.26.5.4 Metal body of all electrical items of motors, transformers, switchgears shall have duplicate ground connection. All exposed conductive parts of plant and equipment; control cubicles, valves actuators, cable glands and armors etc. shall be effectively earthed.
- 1.26.5.5 All extraneous conductive parts such as structural steel work, cable support steel work, steel tanks and pipe works compound and station perimeter, fences gates etc. shall be effectively bonded to the earthing system.
- 1.26.5.6 A separate instrument earth network shall be provided, single point connected to the main earth system, to which all alarm, control computer, instrument etc. earth connection shall be made. Instrumentation cable screens shall be single point bonded to the instrument earth network to minimize the effects of electrical interference.
- 1.26.5.7 The Lightning protection of Power station, other buildings, chimney etc. shall be designed and executed as per code of practice for lightning protection and connected directly to main ground grid. The main earthing grid conductor shall be of M.S. Rod. Sizes for main conductors shall be selected by the Contractor to suit the system requirement. Earth electrodes shall be as per IS 3043.

1.26.6 Earthing network

- 1.26.6.1 The earthing installation shall be done in accordance with the earthing drawings, specifications and the standard drawings of reference. The entire earthing system shall fully comply with the Indian Electricity Act and Rules framed there under. The Contractor shall carry out any changes desired by the Electrical Inspector or MAHAGENCO, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location of earth conductors, earth electrodes and earthing points on the equipment shall be determined in field, in consultation with the Engineer-in-charge or his authorized representative. Any changes in the methods, routing, size etc. MAHAGENCO/Engineer-in-charge approval shall be obtained before execution.
- 1.26.6.2 Excavation and refilling of earth, necessary for laying underground earth loops shall be the responsibility of the Contractor.
- 1.26.6.3 The earth loop impedance to any point in the electrical system shall have a value which will ensure satisfactory operation of protective devices.



- 1.26.6.4 The main earth loop shall be laid at a depth of 1000 mm below grade level. Wherever cable trenches are available, the earth lead shall be laid in the trenches. The earthing strip shall be protected against mechanical damage.
- 1.26.6.5 In process unit areas, the earthing cable/strip shall be run along cable trays wherever specified in the layout drawings. The earthing strip/cable shall be suitably cleaved and electrically bonded to the cable tray at regular intervals.
- 1.26.6.6 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covering with Hessian tape. All joints above ground shall be made by means of connectors/lugs as far as practicable. Tee connectors shall be used for tapping earth leads from the main earth loop wherever it is installed above ground. Earthing plates shall be provided for earthings of two or more equipment at a place from earth grid.
- 1.26.6.7 Where aluminum cable risers are to be connected to the underground MS earth bus, the aluminum cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable, then a MS riser shall be brought above grade and a bolted joint shall be made between this MS riser and the aluminum cable riser just above grade. Aluminum lugs shall be used for cable termination. This MS Riser shall be protected by applying two coats of bituminous paint/bitumen on the exposed portion.
- 1.26.6.8 Conduits in which cables have been installed shall be effectively bonded and earthed. Cable armours shall be earthed at both ends.
- 1.26.6.9 HV and LV earthing system shall not be mixed and to be kept separately.
- 1.26.6.10 Contractor shall submit Theoretical design calculations and detailed explanations along with drawings shall be provided and approved by MAHAGENCO.
- 1.26.6.11 Earth electrodes : Earth pipe electrodes shall be installed as shown in the earthing layout drawings and in accordance with the standard drawings of reference and IS: 3043. Their location shall be marked to enable accurate location by permanent markers.

1.26.7 Foundations for Various Structures

Foundation of all Switchyard equipment transformers, L.A. C.T., P.T. Isolators, Gang operated isolators etc. should be RCC works of M25 grade as per IS 456-2000 and the materials used viz. Cement reinforcement, steel etc. shall be as per relevant IS/ IEC standards. In addition IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must be complied. Reinforcement shall be high strength TMT Fe 415 or Fe 500 conforming to "IS: 1786-1985".

1.26.8 Stone Metal Spread

Suitable size stone metal as per IS/ IEC standards should be spread in switchyard area as per requirement.

1.26.9 Cable Trench

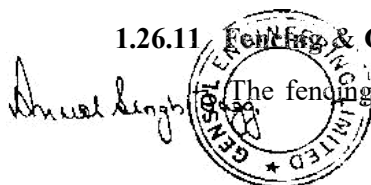
Suitable size cable trenches as per IS/ IEC standards should be constructed in switchyard as per requirement.

1.26.10 Sand Buckets

Sand bucket should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546

1.26.11 Fencing & Gates

The fencing work required for electrical switchyard shall be of barbed wire / twisted



G.I. fencing wire in accordance to IS: 278 and CEIG requirement. It shall be of commercial type and conforming to “IS: 226- 1969”. M.S. angle posts shall conform to “IS: 226-1969 and IS 800- 1984”. Suitable Gates should be provided

Fencing & gate drawing shall be provided by the Contractor and the same shall be got approved from MAHAGENCO.

1.26.12 Others

Any Civil work for Main Switchyard which is not mentioned or included here but necessary for the plant shall be borne by Contractor.

1.27. SCOPE OF ELECTRICAL WORK FOR 33kV SWITCHYARD (Outdoor)

The manufacturers for all electrical and electronic components such as Meters, Protection Relays, AC Cables, Lightning Arrestors, Control Panels, Isolators, etc., and wherever no specific experience requirement is mentioned, must have manufacturing track record of at least ten (10) years.

1.27.1 Transformers 240-800V/33kV (or suitable voltage)

Each step up transformer shall be 3 phase, 240-800V/33kV (or with suitable primary side voltage and current in accordance with inverter AC output), 1250 / 6874 kVA, 50 Hz. “Two primary and One secondary” type three windings transformers can be used in case required as per design. The noise level shall be in accordance to NEMA TR-1. Transformer shall have Off Circuit Tap Changer with tapings of at least +/- 15% with individual steps of 2.5%. The vector group, impedance, bushing rating, HV/LV termination & neutral earthing shall also meet the system requirement & shall also be in line with standards as mentioned in this specification. Air clearance shall be in line with CBIP norms. Suitable Bushing CTs shall be provided to meet the system protection requirement. Transformer shall be in accordance to IS:2026 or equivalent to any other international standard. The designs and specifications must be submitted to MAHAGENCO for approval.

The Bidder/its Sub-vendor should have designed, manufactured and supplied transformers of 33 kV or higher voltage class of cumulative capacity of 40 MVA or above, out of which at least one such supply order for a single plant should be of 10 MVA or above capacity.

The reference plant in which transformers of 10 MVA or above capacity (consisting of one or more) were supplied, must have been in successful operation for at least six (6) months prior to the date of award of contract by MSPGCL to the bidder

1.27.1.1 General Construction

- Transformer shall be constructed in accordance to IS:2026 and IS:3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect and shall be in scope of supplier. The other important construction particulars shall be as below.
- The Transformer tank and cover shall be fabricated from high grade low carbon plate



steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane.

- A double float type Buchholz relay conforming to IS: 3637 shall be provided. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation.
- Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
- All bolted connections to the tank shall be fitted with suitable oil tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at site.
- The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through a transparent type silica gel breather. Silica gel is isolated from atmosphere by an oil seal.
- Transformer shall have adequate capacity Conservator tank to accommodate oil preservation system and volumetric expansion of total transformer oil. The conservator shall be bolted into position so that it can be removed for cleaning purposes.
- Transformer shall have Oil Temperature Indicator and Winding temperature Indicator with accuracy class of ± 2 deg.
- The radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, along with drain valve at the bottom and relief valve at the top.
- The new insulating oil before pouring into the transformer shall conform to the requirement of IS: 335. No inhibitors shall be used in the oil. The oil samples taken from the transformer at site shall conform to the requirements of IS: 1866.
- A sheet steel, weather, vermin and dust proof marshaling box shall be furnished with each transformer to accommodate temperature indicators & terminal boards for incoming and outgoing cables.

1.27.1.2 Windings

- The Contractor shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.
- The Contractor shall furnish details of the facilities available at works along with the bid.
- The conductors shall be of electrolytic grade copper free from scales & burrs.
- All windings of the transformers shall be fully insulated.

1.27.1.3 Core

- The core shall be constructed from high-grade non-aging, cold rolled, super grain oriented silicon steel laminations.
- Core isolation level shall be 2 kV (rms.) for 1 minute in air.
- Adequate lifting lugs will be provided to enable the core & windings to be lifted.

1.27.1.4 Fittings

The following fittings shall be provided with transformer:

- Breather for conservators shall be mounted not more than 1400 mm above rail top.



- Minimum two Nos. of spring operated pressure relief devices with alarm/trip contacts. Discharge of PRD shall be properly taken through pipes & directed away from the transformer /other equipment.
- Air release plug.
- Inspection openings and covers.
- Bushing with metal parts and gaskets to suit the termination arrangement.
- Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.
- Protected type Mercury or alcohol in glass thermometer.
- Bottom and top filter valves with threaded male adapters, bottom Sampling valve & drain valve.
- Rating and diagram plates on transformers and auxiliary apparatus.
- Prismatic/toughened glass oil gauge for transformers and Tap Changer chamber
- 150 mm dial type oil temp indicator with alarm and trip contacts, maximum reading pointer & resetting device.
- 150-mm dial type Winding temp indicator with alarm and trip contacts, maximum reading pointer & resetting device.
- Flanged bi-directional wheels. (as applicable)
- Marshaling Box.
- Bushing current transformers.
- Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently. Sludge valve at bottom most point of tank to be provided for easy flush out/removal of sludge during maintenance.
- Terminal marking plates.
- Valves schedule plates.
- Equipment earthing.
- The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformer, are deemed to be included.

1.27.1.5 Performance

- The maximum flux density in any part of the core & yoke at the rated MVA, voltage & frequency shall be such that under 110% continuous voltage condition it does not exceed 1.9 Tesla.
- The transformer & all its accessories including CTs etc., shall be designed to withstand without injury the thermal & mechanical effects of any external short circuit to earth & of short circuits at the terminal of any winding for a period of 2 sec. Contractor shall submit the short circuit withstand calculations.
- Transformers shall withstand, without injurious heating, combined voltage & frequency fluctuations, which produce the following over fluxing condition:

110%	Continuous
125%	For One Second
140%	For Five Seconds

Contractor s to provide 150% voltage withstand capacity in time/cycle.

The transformers shall be capable of being operated continuously without danger at



the rated MVA with voltage variation of $\pm 10\%$.

- The transformers shall be capable of being loaded in accordance with IS: 6600 / IEC: 60354 up to load of 150%. There shall be no limitation imposed by bushings etc. or any other associated equipment.

1.27.1.6 Tests and Inspection

The Type Test & Routine test of the transformer shall be carried out in accordance with IS: 2026 or as specified elsewhere in the specification. In addition to this tank Vacuum test and tank pressure test shall also be carried out as a type test in line with CBIP norms. Oil leakage test shall also be performed as routine test as per the clause no. 1.27.1.9 below.

In case the Contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit the type test reports to MAHAGENCO for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

In case the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Employer and submit the reports for approval.

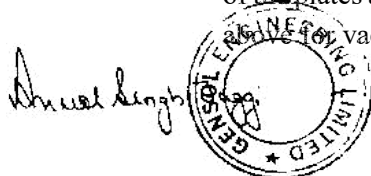
1.27.1.7 Vacuum Test –

Each type of transformer tank shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/sq. m absolute (25 torr) for one hour. The permanent deflection of the plate after the vacuum has been released shall not exceed the values specified below:

Horizontal length of flat plate (mm)	Permanent deflection (mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

1.27.1.8 Tank pressure Test –

Transformer tank of each type shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN / sq. m whichever is lower, measured at the base of the tank & maintained for one hour. The permanent deflection of the plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.



1.27.1.9 Oil leakage test on assembled transformer –

All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 24 hours during which time no sweating shall occur.

1.27.2 Lightning Arrestor

- The surge arrestors (SAs) shall conform in general to IEC 60099-4 or IS: 3070 except to the extent modified in the specification. Arresters shall be of hermetically sealed units, self-supporting construction, suitable for mounting on lattice type support structures. Contractor shall furnish the technical particulars of Surge arrester.
- The SAS shall be of heavy duty station class and gapless Metal Oxide type without any series or shunt gaps. The SAs shall be capable of discharging over-voltages occurring during switching of unloaded transformers, and long lines.
- Arrestors shall be complete with insulating base for mounting on structure. Self-contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit with necessary connection. Suitable leakage current meters should also be supplied within the same enclosure. The reading of millimeter and counters shall be visible through an inspection glass panel
- The surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4

Rate System Voltage	36kV
Rate Arrester Voltage	30kV
Nominal Discharge Current	10 kA of 8/20 micro sec wave
Minimum Discharge Capability	5 kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics)
Maximum Continuous Operating	24 kV rms
Maximum Residual Voltage (1kA)	70 kVp
Maximum Residual Voltage at 10kA nominal discharge current (8/20 micro sec wave)	85 kVp
Maximum Switching Impulse Residual Voltage at 500A Peak	70 kVp
Maximum Steep Current Residual Voltage	93 kVp at 10 kA
High Current short duration test value (4/10 micro sec wave)	100 kAp
Current for Pressure Relief Test	25 kA rms



One Minute Power Frequency Withstand voltage of Arrester Housing (dry and wet)	70 kV (rms)
Impulse Withstand Voltage of Arrester Housing with 1.2/50 microsec wave	170 kV (Peak)
Radio Interference Voltage at 156 kV	< 1000 micro volt
Partial Discharge at 1.05 MCOV (continuous operating voltage)	< 50%

1.27.3 Isolators

The isolators and accessories shall conform in general to IEC 62271-102 (or equivalent Indian standard) except to the extent explicitly modified in specifications. Earth switches shall be provided on isolators wherever mentioned.

Operating Mechanism of Isolator and Earth	Motor operated
Nominal System Voltage	36kV
Highest System Voltage	30kV
Type	
Rated short time current of isolator and earth switch	25 kA (rms) for 1 sec
Rated dynamic short time withstand current of isolator and earth switch	62.5kA (peak)
Impulse withstand voltage with 1.2/50 micro sec wave	170kVp to earth 195 kVp across isolating distance
One minute power frequency withstand voltage	70 kV (rms) to earth & 80 kV (rms) across isolating distance
Temperature Rise	As per Table-IV of IS: 9921
Rated mechanical terminal load	As per 62271-102
Creepage Distance (Total)	900 mm
Line charging breaking capacity	6.3 A
Transformer off-load breaking	6.3 A

- Isolator shall be gang operated for main blades and earth switches. The operation of the three poles shall be well synchronized 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.
- They shall be constructed such that they do not open under influence of short circuit current and wind pressure together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa.

- In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other

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interlocking conditions are met. All these interlocks shall be of failsafe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in relevant section. The interlock coil shall be provided with adequate contacts for facilitating permissive logic for “DC” control scheme of the isolator as well as for AC circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energized.

1.27.4 Circuit Breaker for Inverter Transformer

1.27.4.1 Circuit Breakers shall be outdoor/indoor type, comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to IEC- 62271-100 or equivalent Indian Standard.

Duty Requirements

- Circuit breaker shall be C2/M1 class under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 33 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.
- The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 33 kV transformers. It shall also be capable of breaking line charging currents as per IEC- 62271-100 with a voltage factor of 1.4.
- The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC: 62271-100.
- Contractor shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.
- The Contractor may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the tripcoil voltage, pneumatic pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the Contractor may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.
- While furnishing particulars regarding the D.C. component of the circuit breaker, the Contractor shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation.
- The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated.
- All the duty requirements specified above shall be provided with the support of adequate test reports to be furnished along with the bid.

1.27.4.2 Operating Mechanism

- Circuit Breaker shall be vacuum or SF6 type with electrically spring charged mechanism
- The operating mechanism shall be anti-pumping and trip free (as per IEC definition) electrically and either mechanically or pneumatically under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the leakage of operating media and/or gas. The circuit breaker



shall be able to perform the duty cycle without any interruption.

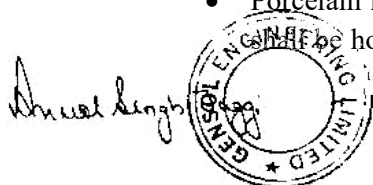
- Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. „Local / remote“ selector switch and close & trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided.
- Operating mechanism and all accessories shall be in local control cabinet. A central control cabinet for the three poles of the breaker shall be provided along with supply of necessary tubing, cables, etc.

1.27.4.3 General Parameters

Type of circuit breaker	Vacuum type or SF6 type
Highest system Voltage	36 kV
Rated frequency	50 Hz (+3% to -5%)
Number of poles	Three (3)
Rated/minim po frequency 70 kV voltage Withstand	
Rated lightning impulse voltage	170 kV
Minimum Creepage distance	25 of system voltage
Rated operating duty cycle	0 - 0.3 sec. - CO - 3min. - CO
Rated line charging breaking	As per IEC Current (voltage factor of 1.4)
Reclosing	Single and three phase high speed auto reclosing
Maximum fault level	25 kA (rms) for 1 sec
Total closing time	Not more than 150 ms
Auxiliary contacts	As required plus 4NO and 4NC contacts per pole as spare.
Noise level	Maximum 140dB at 50m distance from base of circuit breaker
Seismic acceleration	0.3 g horizontal

1.27.5 Conductors & Insulators

- All switchyard overhead conductors should be designed as per IS/ IEC standards & should have adequate size and current carrying capacity.
- Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137. Hollow column insulators shall be manufactured and tested in accordance with IEC: 60233/IS: 5261. The support insulators shall be manufactured and tested as per IS: 2544 / IEC: 600168/IEC: 600273. The insulators shall also conform to IEC 815 as applicable. Contractor shall furnish the technical particulars of all type of insulators used.
- Porcelain insulator shall comply IS: 731-1976 or equivalent international standard and shall be homogenous, free from laminations, cavities and other flaws or imperfections



that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage

- Contractor may offer silicone rubber housed composite type insulator as an alternative to the above porcelain insulator with equivalent creepage distance.

1.27.6 Instrument Transformers

1.27.6.1 General Requirement:

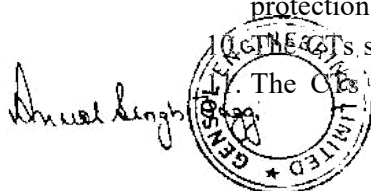
1. The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units. The tank as well as top metallic shall be hot dip galvanized or painted Grey color as per RAL 9002.
2. The instrument transformers shall be oil filled hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.
3. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block. The insulators shall have cantilever strength of more than 500 kg.
4. Manufacturers of Current Transformers and Voltage Transformers shall have experience of having supplied similar CTs and VTs in power plants having a cumulative capacity of at least 1000 MW.

1.27.6.2 Current Transformers (CTs)

1. The CTs shall have single primary of either ring type or hair pin type or bar type. In case of "Bar Primary" inverted type CTs, the following requirements shall be met:
2. The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.
3. The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.
4. The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome.
5. The CT shall be provided with oil sight glass.
6. Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.
7. The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
8. The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box.
9. The secondary terminals shall be terminated on stud type suitable no's of non-disconnecting and disconnecting terminal blocks inside the terminal box of degree of protection IP: 55 at the bottom of CT.

10. The CTs shall be suitable for horizontal transportation.

11. The CTs shall have provision for taking oil samples from bottom of CT without



exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT.

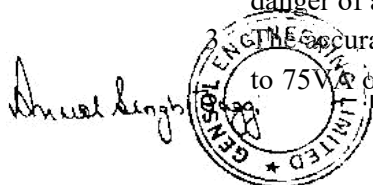
12. The CT shall have provision for measurement of capacitance and tan delta as erected at site.

General Parameters for Current Transformers

Highest system Voltage(Um)	36 kV
Rated frequency	50 Hz
System neutral earthing	effective earthed
Installation	Outdoor
Rated short time thermal current	25 kA for 1 sec
Rated dynamic current	63 kA (Peak)
Rated min power frequency withstand voltage (rms value)	70kV
Rated lightning impulse withstand	170kV
Partial discharge level	10 pico Coulombs max
Minimum Creepage distance	25 mm/kV of highest system Voltage
Temperature rise	As per IEC 60044
Type of insulation	Class A
Number of cores	Three (3) with 2 protection cores and one metering core of accuracy 0.2s class.
Number of terminals in marshalling box	All terminals of control circuits wired up to marshalling box plus 20 terminals spare

1.27.6.3 Voltage Transformers (VTs)

1. Voltage transformers shall be electro-magnetic(EMU) type and shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.
 2. The secondaries shall be protected by 3A HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP: 55. The access to secondary terminals shall be without the danger of access to high voltage circuit.
- The accuracy of metering core shall be maintained through the entire burden range up to 75VA on all three windings without any adjustments during operations.

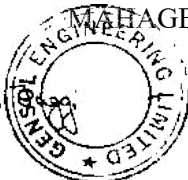


System neutral earthing	Effectively earthed
Installation	Outdoor
System fault level	25 kA
Rated min power frequency withstand voltage(rms value)	70 kV
Rated lightning impulse withstand voltage (peakvalue)	170 kV
Standard reference range of frequencies for which accuracy is valid	96% to 102% for protection and 99% to 101% for measurement
Rated voltage factor	1.2 continuous & 1.5 for 30 sec
Class of accuracy	0.2/3P
Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC 358
One Minute Power frequency withstand voltage – for secondary winding	2 kV rms
Temperature rise over ambient temp of 50degrees C	As per IEC 60044
Number of Terminals in control spare	All terminals of control circuits wired Cabinet up to marshaling box plus 10 terminals
Rated total Thermal burden	350 VA
Partial Discharge level	10 Pico Coulombs max
Number of Cores	Two (2); one for protection and one for metering with 0.2 class accuracy

1.27.7 Marshaling Box / Connector Box

1. The connector box shall be made of stainless steel, Dust & Vermin Proof, which is to be recessed at the base of each Yard LED Lighting system. The connector box shall have suitable brass or copper made connector terminal.
2. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box in such a manner so that it is visible and it does not deteriorate with time. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals.
3. Detail Drawing for Marshaling box should be submitted for approval of MHA GENCO.

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1.28. SCOPE OF ELECTRICAL WORK FOR SWITCHYARD (INDOOR)

Instead of 33kV out door switchyard mentioned in above clause no. 1.27, contractor can also offer the indoor composite type VCB panel of 33 KV, 1250 A, 25 KA, Multi panel, shunt trip, Indoor Type, motor operated, spring closing Vacuum Circuit Breaker having SCADA compatible facilities and complete with all required accessories under a shed.

Vendor details, design & drawing for 33kV composite VCB panel & installation shed should be submitted for approval of MAHAGENCO.

33kV composite VCB panel should be as per following specifications & standards

Unit Of Measurement And Language :

In all correspondence, in all technical schedules and on all drawings prepared by the manufacturer, the metric units of measurement shall be used. On drawings or printed pamphlets where other units have been used, the equivalent metric measurements shall be added. All documents, correspondence, drawings, reports, operating and maintenance instructions/manuals and nameplate details of the equipment shall be in English language.

Service Conditions:-

In choosing materials and their finishes, due regard shall be given to the environmental and climatic conditions under which the switchgear panels shall be called upon to work.

The switchgear panels shall be installed in a room or under sheds without air conditioning but with ventilation to allow natural cooling. Therefore all the protection and control devices employed shall be capable of operating in this environment without failure for their designed life time. Design & drawing of Room/shed should be submitted to Mahagenco for approval. Following climatic parameters as per site location and applicable IS should be considered while design of materials.

- a) Max. Ambient temperature
- b) Reference Ambient Temperature for design
- c) Min. Ambient temperature
- d) Relative humidity
- e) Average number of rainy days
- f) Max. Annual rainfall
- g) Max. Wind pressure
- h) max. Wind velocity
- i) Max. Altitude
- j) Seismic level
- k) average thunder storm
- l) Climatic condition

All equipment must be designed for operations in the severe climate conditions and fully comply with climatic aging tests as per IEC 60932-class 2.

System Parameters :

- a) System voltage : 33 KV
- b) Highest system voltage : 36 KV c) Number of phase : Three
- d) Power frequency : 50 Hz.
- e) System earthing : Impedance earth. f) Fault level : 25 KA
- g) Voltage level : 11 KV / 36 KV / 170 KV (P)



Technical specifications:

Metals:

Iron and Steel are generally to be painted or galvanized as appropriate. Indoor parts may alternatively have chromium or copper-nickel plates or other approved protective finish. Small iron and steel parts (other than rustless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts of relays and mechanisms shall be treated in an appropriate manner to prevent rusting.

Screws, Nuts, Springs, etc.:

The use of iron and steels shall be avoided in instruments and electrical relays wherever possible. Steel screws shall be zinc, cadmium or chromium plated or where plating is not possible owing to tolerance limitations, shall be of corrosion resisting steel. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Springs shall be of non-rusting material, e.g., phosphor-bronze or nickel silver, as far as possible.

Rubbers:

Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, shall be used for gaskets, sealing rings, diaphragms, etc.

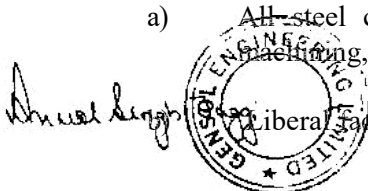
Working Stress and Equipment/Apparatus Design

1.28.3.1 General

- a) The design, dimensions and materials of all parts shall be such that they will not suffer damage under the most adverse conditions nor result in deflections and vibrations, which might adversely affect the operation of the equipment. Mechanisms shall be constructed to avoid sticking due to rust or corrosion.
- b) The equipment and apparatus shall be designed and manufactured in the best and most substantial and workmanlike manner with materials best suited to their respective purpose and generally in accordance with up-to-date recognized standards of good practice.
- c) Whenever possible, all similar parts, including spare parts, shall be made interchangeable. Such parts shall be of the same materials and workmanship and shall be constructed to such tolerances as to enable substitution or replacement by spare parts easily and quickly.
- d) All equipment shall be designed to minimize the risk of fire and consequential damage, to prevent ingress of vermin and dust and accidental contact with electrically energized or moving parts. The switchgear panels shall be capable of continuous operation with minimum attention and maintenance in the exceptionally severe conditions likely to be obtained in a tropical climate and where the switchgear is called upon to frequently interrupt fault currents on the system and also where the duty of operation is high.
- e) Suitable lifting hooks needs to be provided for lifting of the equipment.

1.28.3.2 Strength and quality

- a) All steel castings and welding shall be stress-relieved by heat treatment before machining, and castings shall be stress-relieved again after repair by welding.



Liberal factors of safety shall be used throughout, especially in the design of all parts

subject to alternating stresses or shocks.

1.28.3.3 Designed data for low voltage equipment

Low voltage equipment and installation shall be designed in accordance with EMC (Electromagnetic Compatibility, IEC 61000) directives. The rating and design criteria for low voltage equipment shall be as follows:

1.28.3.4 AC Supply Rating system

- i. Rated voltage between phase 415 V AC
- ii. Connection type 3ph 4wire
- iii. Rated voltage between phase to earth 240 V AC
- iv. Grounding system PME
- v. Frequency 50 HZ
- vi. Voltage variation $\pm 10 \%$
- vii. Frequency variation $\pm 5 \%$
- viii. Power frequency 1 min, Test Voltage 3 kV
- ix. Thermal rating of conductors 120 % of load

The AC supply shall be used for power circuit and for lighting, indication, motor controls and similar small power circuits. Unless otherwise specified, the equipment provided under this tender is to be capable of reliable operation at voltages as low as 85% of the rated voltage, and to withstand continuously up to 110% supply voltage above the rated value of 240V or 415V AC.

1.28.3.5 DC Auxiliary Supply Rating

Equipment/Device Rated voltage 30V DC

Connection type 2 wire.

Voltage variation 24 to 40 V DC

The auxiliary dc supply shall be used for controls, indication, alarm and circuit breaker tripping and closing circuit, etc. All equipment and apparatus including the circuit breakers, control devices and accessories, measuring and indicating instruments and electronic equipment shall be capable of satisfactory operation at 80% to 130% of the rated dc supply voltage. However, in case of VCB, for tripping the range should be 70% to 110% and for closing that should be 85% to 110%.

1.28.3.6 Electrical controls, auxiliaries and power supplies

- a) Responsibility for electrical control and auxiliaries.

The manufacturer shall provide all control, indication and alarm and all auxiliary equipment with wiring and interconnecting cable which are integral parts of or are directly associated with or mounted on the switchgear panels to be supplied under this tender. The design of protection and control schemes for the switchgear panels shall be subject to approval of MAHAGENCO.



b) Operation and control.

Interlocking devices shall be incorporated in the control circuit to ensure safety, and proper sequence and correct operation of the equipment. The scheme will be finalised during detailed engineering and drawing approval.

1.28.3.7 Corona and radio interference

- i. Switchgear shall electrically be designed to avoid local corona formation and discharge likely to cause radio interference.
- ii. The design of jointing of adjacent metal parts and surfaces shall be such as to prevent corrosion of the contact surfaces and to maintain good electrical contact under service conditions.
- iii. Particular care shall be taken during manufacture of bus bar and fittings and during subsequent handling to ensure smooth surface free from abrasion. All joints on the bus bar and the circuit within the switchgear board shall be silver or tin-plated to ensure good electrical connection.

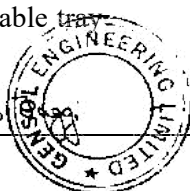
Panel construction

Enclosure type	Dead front, floor-standing, rigid welded/bolted/rebated steel frames fully compartmentalized, Metal clad, Vermin Proof, suitable for indoor installation and provision for bolting to the floor.
Degree of protection of enclosure	IP55
Material of enclosure	CRCA Steel/Alu-Zinc
Metal sheet thickness	Load bearing member : 2.5 mm Doors & covers : 2.0 mm Gland plate : 3.0 mm
Compartment	Bus-bar, VCB, Power cable, PT, LV Instrument
VCB Compartment door	Separate with lockable handle.
Breaker to bus compartment	Through seal off bushing
Breaker to cable compartment	Through seal off bushing
Pressure relief device	To be provided for each HV Compartment. Each compartment shall be separated from adjacent one by sheet steel barrier.
Bus support insulator	Non hygroscopic, track-resistant, high strength, epoxy insulators (calculation for validating dynamic force withstand capability to be submitted during detailed engineering)



Power cable termination	Cable entry from rear bottom side for Incomer and Outgoing feeders, suitable for 3 Core XLPE, 33 KV grade , Aluminum, 300mm².The cable termination height shall be at least 750 mm in the cable compartment. Double cable termination arrangement to be provided with two sets of nut and bolts. Copper terminator strip of adequate size shall be provided for termination of cables and shall have adequate height inside to accommodate the heat shrinkable type indoor cable termination.
Isolator panel	Draw out type Isolator trolley will be required for tapping 33 KV Power cable for 100 KVA, 33/0.4 KV Station Service Transformer. Necessary phase to phase & phase to earth clearance will have to be maintained as per VCB particulars. The isolating contact should have inductive current breaking capacity of the Station Service Transformer. The said Trolley will have link instead of Vacuum Bottle and will be without tripping and closing mechanism. Only draw out facility will be required.
Bus Section Panel	Bus Section Panel to be provided beside the Bus Coupler Panel for front bus connection purpose.
Prevention of internal arc	Shall be type tested against internal arc as per provision in IEC 62271-200. The Circuit Breaker, bus bars and cable compartments shall be provided with arc venting outlet. The doors for the compartment shall be capable of withstanding the effects of maximum internal arcing fault without being blown off and causing danger to personnel and other equipment. This should be proven by successful testing for 25 KA with duration 0.1second as per relevant IEC standard.
Multi way terminal block and low voltage wiring	Delinking type, Rail/Channel mounted, Terminal Connector to be used in CT Circuit & Screw type for other Circuit. The Terminal Blocks should be suitable for 2.5 sq.mm wire and covered with insulated transparent cover. Pitch should be minimum 8mm & 10mm for Screw type & Delinkingtype connectors respectively. The low voltage cable shall be enclosed in grounded metal conduit when routed through a high voltage compartment. Control wiring shall be neatly bundled and tie wrapped where applicable. Wiring shall be protected from rubbing against door flanges or other parts of the enclosure. Minimum 100 mm clearance to be maintained between two rows of TB. 20% spare terminal block to be provided in each row.
Cable tray	Netted Metal cable Tray of suitable size at the rear side of Switchgear, preferably running at the top along the panel for carrying the signal cables for SCADA interface to be provided.

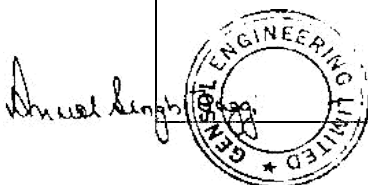
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Space heater	Thermostat control space heater with switch for isolation to be provided in Breaker, HT Cable & Instrument compartments.
Illuminating lamp	15 Watt, CFL type.
Power Switch & Socket	5Amp rated Power Socket & Switch to be provided in Instrument compartment.
Surface cleaning	Seven tank process or Sand blasting
Painting	Powder coating with texture finish
Paint shed	RAL 7032

Circuit Breaker

Mounting	On withdrawable truck or trolley, horizontally draw out & horizontal isolation with locking facility in service position. Switchgear truck/trolley should be floor mounted. Racking-in and Racking-out should be such that one person can do it easily.
Arc quenching medium	Vacuum
Switching duty	Oil filled transformer and UG Cable up to 20 Km.
Breaker operation	Three separate identical single pole units operated through the common shaft and shall be fully interchangeable both electrically and mechanically. Circuit breaker poles between the interrupters and primary plug-in contacts shall be fully insulated with durable material. Each breaker shall be provided with Mechanical 'ON' and 'OFF' facility by operating suitable closing and opening devices. Each breaker shall be provided with Mechanical 'ON' and 'OFF' indicators. Each breaker shall have three positions - service, test and isolated/withdrawal marked. Mechanical safety interlocks shall be provided so that it is not possible for a circuit breaker - To be put into the cubicle unless the truck is secured in position. - To be either draw out or draw in from and to the service position unless its contacts are safely open. - To be withdrawn or inserted in the fixed housing unless it is at the withdrawable position. - To be operated in service position unless its primary and secondary isolating contacts are fully engaged. - The circuit breaker racking equipment can be padlocked in closed position. - Electrical close/trip operation should be dependent on Local/Remote switch. However, protection trip and emergency trip circuit should be independent of

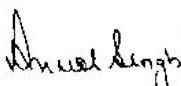
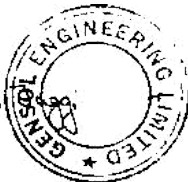


	Local/Remote Switch.
Inter changeability	The Circuit Breakers of Incomer, Bus Coupler & Feeder Panels should be interchangeable both for electrically & mechanically.
Operating mechanism	a) Re-strike free, trip free both electrically and mechanically, with electrical anti-pumping feature. b) One O-C-O operation possible after failure of power supply to the spring charging motor. c) Motor wound, spring, charged, stored energy type with manual charging facility. One no. Breaker Truck operating handle for every three panels needs to supply.
Tripping & Closing coil	To be rated for substation DC voltage. Suitable for operation at minimum operating voltage of 70% for tripping and 85% for closing operation. Burden shall be about 200 watt for each coil.
L/R Switch	To be provided for breaker operation from Local & Remote
Provision of Push Button on breaker panel front	a) Manual close & Open operation b) Emergency electrical Trip operation
Mechanical indication	CB ON, CB OFF, Spring Charged / Discharged.
Electrical indication	CB ON, CB OFF, Spring Charged, CB in Test / Service Position, Flush mounted type high intensity, clustered LED lamps to be used. Colour of the lamps will be as follows : a) Breaker ON : Red b) Breaker OFF : Green c) Spring charged : Blue d) Auto trip : Amber e) Test / Service position : White.
TNC Switch with pistol grip	To be provided for electrical ON / OFF operation and other purpose. It should be lockable and spring return to normal position.
Operating handle	Breaker shall be provided with handles for easy handling, rack in-out operation and manual spring charging as applicable.
Safety shutter	Automatic safety shutter to be provided cover contacts fully when breaker is withdrawn to test. Independent operating mechanism for bus bar & cable side shutters, separately padlock able in closed position.

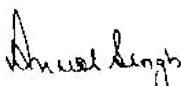
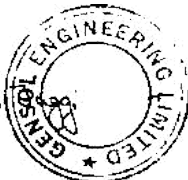
Interlocking arrangements	a) Breaker compartment door cannot be opened unless breaker is OFF and racked out to TEST / ISOLATED position. b) Breaker compartment door cannot be closed unless breaker is in ISOLATED position. c) Racking in or out of breaker inhibited when the breaker is CLOSED. d) Racking in the circuit breaker inhibited unless the control plug is gully engaged. f) Disconnection of control plug inhibited as long as the breaker is in service position. g) Other interlocks as per Standard.
Breaker operation	a) Local closing : Only when L/R switch in Local position and CB in either Service or Test position. b) Local tripping : Only when L/R switch in Local position and CB in either Service or Test position. c) Remote closing : Only when L/R switch in Remote position and CB in Service position. d) Remote tripping : Only when L/R switch in Remote position and CB in either Service or Test position. e) Protection tripping : Irrespective of L/R switch position and CB in Service condition.
Trip coil supervision	To be given for CB close & open condition.
Anti pumping	Anti Pumping Relay (94) to be provided in the Breaker panel. PLA type relay / Contactor is not acceptable.
Aux. AC & DC control supply in all panels	Fed by single AC & DC incoming source in Bus Coupler Panel as well as Incomer Panels for entire Switch Board.
Spring charge limit switch	The circuit breaker shall be provided with motor operated spring charged closing. Spring charging by motor should be smooth and hassle free and there should be nominal sound during spring charging. Motor should be 230 Volt AC operated, Tripping of the circuit breakers shall be through "Shunt trip" coils rated for 30V DC auxiliary supply. It shall be possible to trip the breaker manually in case of necessity. 2 NC : For Motor circuit 1 NO : For Breaker Closing Circuit 1 NO : For Breaker Closing permissive to be used in IED/Relay. 1 NO : For panel spring charged indication AC operated contactor may be used for contact multiplication of Limit Switch, if required, for indication and spare contacts.
Local Remote Switch	Switch should be 4 Pole 2 Ways lockable and stay put type.



Operation counter	Suitable mechanical operation counter to be provided in the breaker trolley with count range 0 to 9999.
Current Transformer	Shall be cast resin type with insulation class of E or better. Contact tips on primary side shall be silver plated. Correct polarity shall be invariably marked on each primary and secondary terminal. Primary shall be wound or bar type, rigid, high conductivity grade copper conductor. Unavoidable joints on the primary conductor shall be welded type, preferably lap type. Current density at any point shall not exceed 1.6 A/sq.mm. Suitable insulated copper wire of electrolytic grade shall be used for CT secondary winding. Multi ratio in CT shall be achieved by reconnection of secondary winding tapping. The secondary terminals shall have screw type terminals. The screw should have sufficient length for connection of at least two nos wires with plain and spring washers and minimum 10 mm clearance between the adjacent screws.
C T Mounting	To facilitate easy replacement of 33 KV CT afterwards, fixing of CT in hanging condition/CT baseplate fixed at the upper covering of the CT Chamber may not be acceptable. Fixing in horizontal upright condition over a base channel is preferable. CT Secondary connection terminals should be clearly visible and accessible from the back side of the breaker assembly just after opening the rear cover plate. P1 side of CT will be at Bus side for both Line & Transformer panel.

Potential Transformer	Potential Transformer should be three no Single Phase PT housed in a withdrawable carriage, Shall be cast resin type with insulation class of E or better. Service position locking mechanism shall be provided and indicated by bidder in relevant drawing. Rigidity of primary stud point with earth bus in service position shall be confirmed. Contact tips of primary/secondary contacts shall be silver plated. Correct polarity shall be distinctly marked on primary and secondary terminal. Secondary terminal studs shall be provided with at least three nuts, two plain and two spring washers for fixing leads. The stud, nuts and washers shall be of brass, duly nickel plated. The minimum outside diameter of the studs shall be 6 mm. the length of at least 15 mm shall be available on the studs for inserting the leads. The space clearance between nuts on adjacent studs when fitted shall be at least 10 mm. Trolley mounted and connected on bus side. It can be plugged into and withdraw from service by pulling or pushing the PT by the handle provided on the PT. This action traverses the PT shall automatically operate the spout shutters. The shutter drive also forms a latch which holds the PT in the service position and this latch shall be required to be released before PT can be isolated.
Earth bus	A ground bus rated to carry maximum fault current shall be furnished along the full length of the panel board. Each stationary unit shall be grounded directly to ground bus. All bolted joints in the bus will be effected by connection of two bolts.
	The earth bus shall be of copper and shall have adequate cross sectional area. Earthing conductors shall be of annealed high conductivity stranded Copper

Internal wiring	a) 750 V grade PVC insulated stranded flexible copper wire to be used. b) Size of wire will be as follows : CT & PT circuit : 2.5 sq. mm Main AC & DC circuit : 4.0 sq. mm Other circuit : 1.5 sq. mm. c) A suitable wiring duct system firmly fixed on the panel and having covers shall be installed for front to rear and inter panel wiring to provide easy access for inspection and replacement of the wires. d) Wiring between terminals of the various devices shall be point to point. Splices or tee connection will not be acceptable. e) Wires shall be suitably bunched adequately supported to prevent sagging and it shall have sufficient clearance from High voltage system. f) Colour of wires will be as follows : For CT & PT circuit: R Phase : Red, Y Phase : Yellow, B Phase : Blue, Neutral : Black For DC circuit : Grey For AC circuit : Black For Earth circuit : Green.
Ferrules	a) Plastic ferrules conforming to IS to be used. Same marking to be used at both ends of wires. b) Ferrule markings will be as follows : AC Circuit : H1,H2,H3 - - - - - Metering circuit : D11, D31, D51 - - Protn. Circuit : C11, C31, C51 - -REF Circuit : A11, A31, A51 - - MainDC Ckt : J1, J2, J3 - - - - - DC Control ckt : K1, K2, K3 - - - - Indication ckt : L1, L2,L3 - - - - - Motor ckt : M1,M2,M3 - - - - PT Circuit : E11,E31,E51 - - - Spare circuit : U1,U2,U3 - - - - - c) Plastic channels, inter panel wiring through PVC sleeves or suitable grommets
Guarantee of the complete equipment	5 (five) years from the date of last dispatch of any integral part of the equipment.



Mandatory particulars of Panel

Type	Metal clad, air insulated with VCB type indoor circuit breaker
Reference Standard	IEC : 62271-100 & 200, IS 13118, IS 3427
Rated voltage	33 KV
Rated current	1600 Amps
Highest system voltage	36 KV
Insulation level	36 KV/70 KV/170 KV(P)
Frequency	50 Hz.
Enclosure degree of protection	IP55
Thickness of metal sheet (min)	Load bearing : 2.5 mm Doors & covers : 2 mm
Bus bar & Earth bus material	Electrolytic Copper with Tin / Silver plated
Shape of Bus bar	Rectangular/Tubular
Bus identification	Colour coded (R-Y-B)
Bus clearance	Phase to phase : As per type test report Phase to ground : As per type test report
Position of Mechanical & Electrical Emergency Trip Arrangement	Front side of the Panel
Separate Bus Section Panel at the side of Bus Coupler	To be provided
Paint type	Powder coated
Paint shade	RAL 7032 (both external & internal)
Paint thickness	50 microns (min)

Mandatory particulars of Current Transformer

Type	Cast resin, Bar primary, Indoor type . Marking on primary and secondary terminal as per requirement of IEC 60044-1, IS 2705 and shall be indelibly marked. The secondary terminals shall have screw type terminals.
Reference Standard	IEC : 60044-1, IS : 2705
Make	To be approved from Mahagenco
Rated voltage	33 KV
Highest system voltage	36 KV
Insulation level	36 KV/70 KV/170 KV(P)
STC	25 KA for 1 Sec
Class of insulation	A
Continuous over load capacity	120 % of rated primary current
Core identification	Core 1 : Metering, Core 2 : Protection Core 3 : Protection Special
Accuracy class	0.2s class.

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Mandatory particulars of Potential Transformer

Type	Resin cast, draw out, single phase unit
Reference Standard	IEC : 60044-2, IS : 3156
Make	To be approved from Mahagenco.
Rated voltage	33 KV
Highest system voltage	36 KV
Frequency	50 Hz.
Class of insulation	A
Core identification	Core 1 : Metering, Core 2 : Protection
Accuracy class	0.2 / 3P
Rated voltage factor	1.2 Continuous, 1.9 for 30 sec.

Mandatory particulars of Vacuum Circuit Breaker

Type	Metal clad, air insulated with VCB type indoor circuit breaker
Reference Standard	IEC : 62271-100, IS : 13118
Make	To be approved from Mahagenco
Rated voltage	33 KV
Highest system voltage	36 KV
Insulation level	36 KV/70 KV/170 KV(P)
Frequency	50 Hz.
STC	25 KA for 3 sec.
Duty cycle	O -0.3 Sec-CO-3 Min-CO
Sym. Breaking current	25 KA
Short circuit making current	62.5 KA (P)
Closing time	< 100 ms
Opening time	< 60 ms

Mandatory particulars of Vacuum Bottle

Make	OEM
Rated voltage	33 KV
Highest system voltage	36 KV
Rated current	1600 Amps
Insulation level	36 KV/ 70 KV / 170 KV(P)
Frequency	50 Hz
STC	25 KA for 3 Sec
Short circuit breaking capacity	25 KA
Making capacity	62.5 KA (P)
Mechanical Endurance capacity	30000 operation
Electrical Endurance capacity	20000 operation
Minimum electrical life	100 no at rated short circuit current



Type Test : - Following Type Test reports are should be submitted to Mahagenco for approval.

Switchgear panel (with circuit breaker installed)	a) Lightning Impulse Voltage withstand test b) H.V. dry power frequency voltage withstand test c) Short time and peak withstand current test d) Short circuit test with basic duties e) Single phase breaking capacity test. f) Cable charging breaking current test g) Temperature Rise test h) IP Test i) Internal Arc Test as per IEC 62271-200 j) Horizontal Acceleration due to seismic force (if available)
Circuit Breaker	a) Mechanical Endurance Test as per M2 Class of IEC
Current Transformer	a) Short Time Current Test b) H.V. dry power frequency voltage withstand test c) Impulse Voltage Withstand Test d) Temperature Rise Test
Potential Transformer	a) Impulse Voltage Withstand Test b) H.V. dry power frequency voltage withstand test c) Temperature Rise Test

Copies of test certificates in respect of following bought out items:-

- Vacuum Interrupter.
- Insulators
- Bus Bar Material
- Terminal connectors

Note: All the type test report on Switchgear Panel & Circuit Breaker to be conducted with offered Vacuum Interrupter.

Submission of drawings & documents:

Contractor should submit vendor credentials of HT panel, Circuit Breaker, CT, PT, LA and other equipments to Mahagenco for approval the qualifying requirements for vendors shall be as per RFP terms and conditions.

Contractor should submit following drawing/documents along with all calculations and Design Basis Report, GTP and QAP to Mahagenco for approval.

- GA of indoor composite panel Switchgear showing constructional features and space required in the front for withdrawal of breaker truck and in back, other accessories, power and control cable entry with plan elevation and views.
- Sectional view of incomer, bus coupler & transformer panels with parts list.
- GA of Circuit Breaker truck.
- GA of Current Transformer
- GA of Potential Transformer.
- Technical particulars of Switchgears and brochures for technical data sheet of vacuum interrupter.
- Details, design, drawing and calculations of shed.

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Six copies of drawing, data and manuals containing above shall be submitted for approval and afterwards for final distribution.

Contractor shall submit all above drawings and following additional drawings along with design basis calculations to Mahagenco for approval before commencement of supply:-

- i. Drawing of the shed.
- ii. Foundation details for Panel Switchgear.
- iii. Equipment door layout for incomer, bus coupler & transformer panels.
- iv. Schematic Diagram for incomer bus coupler & transformer section of Switchgear
- v. CT Circuit, PT circuit & DC control circuit for incomer bus coupler & transformer section of Switchgear
- vi. Name Plate CT & PT.
- vii. Rating Plate details of the Panel
- viii. Manual for installation, operation and maintenance procedure.

Routine & Acceptance test :

- a) All the switchgear panels shall be tested in accordance with the requirement of IEC 62271-200. Tests shall be carried out on the circuit breakers as per the requirement of IEC 62271-100.
- b) Current transformers and Voltage transformers shall be tested in accordance with the requirement of IEC 60044-1, IS 2705 and IEC 60044-2, IS 3156 respectively.

All routine tests at manufacturer's works shall be carried out as per the RFP terms and conditions.

All Acceptance tests shall be carried out at manufacturer's works on every lot offered for inspection as per relevant IS & IEC in presence of the Mahagenco representatives. The entire cost of acceptance and routine test that to be carried out shall be borne by Contractor.

Six copies of test reports duly signed by the inspecting officers, shall be submitted to the Chief Engineer, RE-P&P, Mahagenco

1.29. 33/220KV MAIN SWITCHYARD (POOLING SUBSTATION).

1.29.1 Scope of work

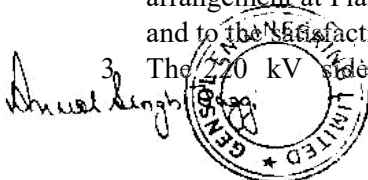
Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Owner's personnel, handing over to employer and guarantee for two years of outdoor Switchyard for Solar Photovoltaic (SPV) Power Plant and as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system covering all supply and services for completeness of the system including but not be limited to following.

1.29.2 Outdoor Switchyard Equipment

1. The switchyard shall be 33/ 220 kV of the outdoor type power transformer. The power transformers are however covered elsewhere in the specification.
2. Supply, installation and commissioning of switchyard equipment and necessary protection arrangement at Plant end shall be as per the CEA & CEIG Regulation/ requirement and norms and to the satisfaction of employer including statutory inspection.

3. The 220 kV side equipments rating, bus bar arrangement, conductor sizing, control,



protection, telemetry etc. shall also be as per the requirement and norms of CEA and the drawings/documents of the same shall be got approved through MSETCL by contractor before submitting to MSPGCL.

4. Bidder's scope shall be termination at 220 kV line take-off gantry. All equipment/hardware including take-off gantry required for termination of 220 kV lines as well as equipment support structure and civil works shall be under scope of bidder. The Contractor shall identify all interface issues with MSPGCL and shall be responsible for such interfacing, coordination and exchange of all necessary information for completeness of the system.

1.29.3 Power Transformer

Technical Requirement

Sr. No.	Description	Unit	Technical Parameters
1	Voltage ratio (Line-to-Line)	kV	220/33
2	Rated Capacity (HV & LV)	MVA	100
3	No of phases		3 (Three)
4	No of secondary windings		One winding
5	Vector Group		YNyn0
6	Type of transformer		Power transformer
7	Applicable Standard		IEC 60076 / IS 2026
8	Cooling type		ONAN / ONAF
9	Rating at different cooling	%	70 / 100
10	Frequency	Hz	50
11	Cooler Bank Arrangement		2 X 50%
12	Tap Changer		
i)	Type		On-load tap changer /OCTC
ii)	Tap range and steps		-5% to +5% in steps of 1.25% for HV variation
iii)	Location of tap changer		On HV neutral end
13	Impedance at 75°C, at highest MVA base		
i)	Max. Voltage tap	%	16.2
ii)	Principal tap	%	15
iii)	Min. Voltage tap	%	14
iv)	Tolerance on Impedance		As per IEC
14	Service		Outdoor
15	Duty		Cyclic
16	Overload Capacity		IEC-60076-7
17	Temperature rise over 50°C ambient Temp		
i)	Top oil measured by thermometer	°C	45
ii)	Average winding measured by resistance method	°C	50

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18	Winding hot spot rise over yearly weighted temperature of 32°C	°C	61
19	Tank Hotspot Temperature	°C	110
20	Maximum design ambient temperature	°C	50
21	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kV _p	950
	LV	kV _p	170
	HV Neutral	kV _p	95
	LV neutral	kV _p	170
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kV _p	1045
	LV	kV _p	187
iii)	Switching Impulse withstand Voltage		
	HV	kV _p	750
iv)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	395
	LV	kV _{rms}	70
	HV Neutral	kV _{rms}	38
	LV neutral	kV _{rms}	70
v)	Neutral Grounding (HV & LV)		Solidly grounded
vi)	Insulation		
	HV		Graded
	LV		Uniform
vii)	Tan delta of winding	%	≤ 0.5
22	Bushing		
i)	Rated voltage		
	HV	kV	245
	LV	kV	36
	HV Neutral	kV	36
	LV Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	LV	A	3150
	HV Neutral	A	3150
	LV neutral	A	3150
iii)	Lightning Impulse withstand Voltage		
	HV	kV _p	1050



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iv)	Switching Impulse withstand Voltage		
	HV	kVp	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	505
	LV	kVrms	77
	HV Neutral	kVrms	77
	LV Neutral	kVrms	77
vi)	Tan delta of bushing at ambient Temperature	%	<0.5
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV bushing	mm	7595
	LV bushing	mm	1116
	HV neutral / LV neutral	mm	1116
viii)	Maximum Partial discharge level at Um		
	HV	pC	10
23	Maximum Partial discharge level at $1.58 * U_r / \sqrt{3}$	pC	100
24	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	80
25	Termination details		To be provided by the purchaser as per its requirement
26	Maximum Permissible Losses of Transformers		100
i)	Max. No Load Loss at rated voltage and frequency	kW	Losses based on maximum flux density of 1.7 T at rated MVA, voltage & frequency and maximum current density of 3.5 A/mm ² at all taps may be provided by the Manufacturers.
ii)	Max. Load Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	
iii)	Max. Auxiliary Loss at rated voltage and frequency	kW	

1.29.4 Structure Accessories and Auxiliaries

1. One (1) lot of conductor as required to complete the system with bus bar arrangement (as per norms & requirement) in the switchyard,
2. One (1) lot of galvanized gantry structures and supporting structures required to complete the switchyard system,

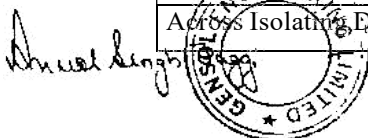


3. One (1) lot of insulators, hardware fittings, fasteners, lightning masts, earthing risers for equipment and gantry structures, earth wire including arrangement for screening of switchyard for protection against lightning,
4. Necessary quantity of Marshalling Kiosks for ease of construction and operation,
5. One name plate and two danger plates of more than 300 X 300mm size for each bay,
6. Continuous on-line monitoring for operating parameters such as current, voltage, temperature etc. complete with sensors, control/processor units, wiring/cabling in all respect and coordination & provision of necessary contacts and/or ports for integration with plant SCADA system,
7. All necessary auxiliaries for control & supervisory circuits, local control switches and other relays as required,
8. All secondary wiring, terminal blocks, labelling, nameplates, sockets etc.
9. Transformer and Line Control & Relay Panel
10. Complete Fire Fighting System
11. PLCC/OPGW and/or any other means as per system requirement, STU norms / requirements for speech transmission, line protection, data channels etc.
12. Spare parts,
13. Tools & instruments
14. Any other item(s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

1.29.5 Rating and Functional Characteristics

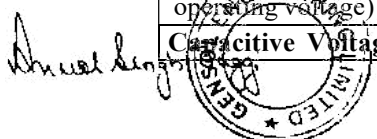
Outdoor Switchyard Equipment

System Parameters	HV system
Installation	Outdoor
Type of Busbar Arrangement	As per requirement
Total No. of Bays	As above
Nominal Voltage , kV, RMS	220
Highest System Voltage, kV	245
Rated Frequency, Hz	50 + 5%
Rated Continuous Current, A, RMS	As per the system requirement
Rated Short Time Withstand Current (RMS) for 1 sec.	As per relevant IS/IEC standard
Rated Peak Withstand Current, k A	
Rated Duration of Short Circuit (SC)	
Rated Insulation Level	
One Minute Power Frequency Withstand Voltage	As per relevant IS/IEC standard
Dry (kVrms)	
Wet (kVrms)	
Rated Lightning Impulse Withstand Voltage ((1.2/50 micro sec.) (kVpeak)	
Line To Earth (kVp)	
Across Isolating Distance (kVp)	



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Minimum Creepage Distance , mm	
Rated Control Voltage DC, V	
Auxiliary AC supply, 3 Phase, V	
Partial discharge at 1.05 MCOV (Continuous operating voltage)	
Maximum Radio Interference Voltage for any frequency between 0.5 MHz to 2.0 MHz in all positions (micro volts)	
Degree of Protection	IP 55
Circuit Breaker	
Type	SF6
Description	Three Phase
Rated SC Symmetrical Breaking Current kA (r.m.s)	As per relevant IS/IEC standard
Rated SC Making Current, kA (peak)	
Rated Line Charging Breaking Current Capacity, A	
Rated Cable Charging Breaking Current Capacity, A	
First-Pole-to Clear Factor	1.3
Closing Time	Maximum 150 ms.
Total Break Time for any current up to the Rated Breaking Current	Not more than 60 ms.
Rated Operating Duty Cycle	O-0.3Sec-CO-3 Min- CO
No of Trip Coils	2
Isolators	
Type	3 Phase Double Break
Operation	Motorised as well as Manual
Total Operating Time of isolator along with its operating mechanism	<12 s
Current Transformers	
Current Ratio Line Bay	As per system requirement
Current Ratio Power Tr. Bay (incoming)	As per system requirement
Accuracy Class For Protection	PS
Accuracy Class For Metering	0.2
Surge Arrestors	
Rated Arrestor Voltage	As per system requirement
Rated Nominal Discharge Current (8/20 μ s wave)	10 kA
Continuous Operating Voltage (COV) at 50 Deg C	As per system requirement
Energy Dissipation Capability	Not less than 5 KJ/kV
Partial discharge at 1.05 MCOV (Continuous operating voltage)	<10 pC
Capacitive Voltage Transformers for HV Bus	



Purpose	Metering & Protection,
Voltage Ratio	As per system requirement
Accuracy Class for Metering & Protection	0.2 (1-core) & 3P (2core) respectively
Number of Cores in Secondary side	3
Rated Voltage Factor	1.5 for 30 s & 1.2 Continuous
Partial Discharge at Highest Voltage	<10 pC
Insulation Class	A

1.29.6 Current Transformers (CT)

1. The CTs shall have single primary of either ring type or hair pin type or bar type. In case of "Bar Primary" inverted type CTs, the following requirements shall be met:
2. The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.
3. The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses. The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome.
4. The insulator shall be one piece without any metallic flange joint. The CT shall be provided with oil sight glass/oil level indicator.
5. The core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores shall produce undistorted secondary current under transient conditions at all ratios with specified parameters.
6. Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.
7. The guaranteed burdens and accuracy class are to be intended simultaneously for all cores.
8. The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT.
9. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box.
10. The secondary terminals shall be terminated on stud type suitable no's of non-disconnecting and disconnecting terminal blocks inside the terminal box of degree of protection IP:55 at the bottom of CT.
11. The CTs shall be suitable for horizontal transportation.
12. The CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT.



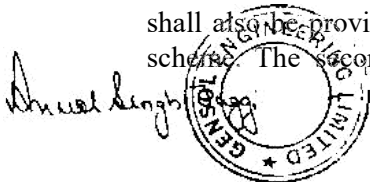
13. The CT shall have provision for measurement of capacitance and tan delta as erected at site

1.29.7 Parameters for Current Transformers

Highest system Voltage(Um)	245 kV
Rated frequency	50 Hz
System neutral earthing	effective earthed
Installation	Outdoor
Rated min power frequency withstand voltage (rms value)	70 kV
Rated lightning impulse withstand voltage (peak value)	170 kV
Partial discharge level	10 pico Coulombs max.
Minimum Creepage distance	As per Clause 1.05
Temperature rise	As per IEC 60044
Type of insulation	Class A
Number of cores	Tariff CTs shall be single metering core with 0.2S accuracy class.
Number of terminals in marshalling box	All terminals of control circuits wired upto marshalling box plus 20 terminals spare

1.29.8 Voltage Transformers (VTs)

1. Voltage transformers shall be of Outdoor type, Oil filled, bottom and dead Tank type electromagnetic, with sealing arrangement as per IS-316-1992. It is also to be equipped with protective and damping devices Oil level indicator with danger level marking is also to be provided.
2. They shall be of the oil immersed, self-cooled type and provided alternatively with an inert gas cushion or with metallic bellows above the- insulating oil level. A pressure relief device valve type may also be provided if permitted to design.
3. The VTs may be built up of high-grade non ageing cold rolled grain oriented silicon steel lamination, conforming to IS: 3024, of low hysteresis losses and high permeability to ensure high accuracy at both normal rated and above rated voltages.
4. The limits of temperature rise shall not exceed the values specified in Table 3 of IS: 3156 (Part-1) 1998. However, if the voltage transformers has an inert gas cushion above the oil at the top of the tank or housing shall not exceed 50° C. The oil shall be mineral insulating oil conforming to IS: 335- 1983.
5. The HV neutral end terminal shall not be earthed directly to the metal body of the VT but shall be brought out through a porcelain 2 kV class bushing. A tinned copper link of the bolted type shall be provided to connect the HV neutral end terminal and the earth bushing. Both the HV neutral end bushing and the earth bushing shall be housed in a dust tight, vermin proof box with a front access bolted type gasketed cover.
6. The secondaries shall be protected by HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-



disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP55. The access to secondary terminals shall be without the danger of access to high voltage circuit.

7. The accuracy of metering core shall be maintained through the entire burden range upto 50VA on all three windings without any adjustments during operations.

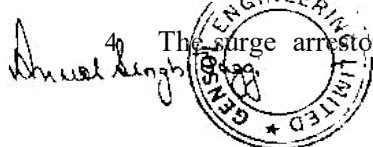
1.29.9 Parameters for Voltage Transformers

Highest System Voltage(Um)	245 kV
System neutral earthing	effective earthed
Installation	Outdoor
Rated min power frequency withstand voltage (rms value)	70 kV
Rated lightning impulse withstand voltage (peak value)	170 kV
Standard reference range of frequencies for which the accuracy are valid	96% to 102% for protection and 99% to 101% for measurement
Rated voltage factor	1.2 continuous & 1.5 for 30 sec
Class of Accuracy	For tariff metering VT - 0.2 Other VTs – 0.2
Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:358
One Minute Power frequency Withstand voltage for secondary winding	2 kV rms
Temp. rise over an ambient temp.of 50 deg. C	As per IEC 60044
Number of terminals in controls pare.	All terminals of control circuits wired Cabinet upto marshalling box plus 10 terminals
Rated total thermal burden	350 VA
Partial discharge level	10 pC max.

1.29.10 Surge Arrestor

1. The surge arrestors (SAs) shall conform in general to IEC 60099-4 or IS: 3070 except to the extent modified in the specification. Arresters shall be of hermetically sealed units, self-supporting construction, suitable for mounting on lattice type support structures. Bidder shall furnish the technical particulars of Surge arrester.
2. The SAs shall be of heavy-duty station class and gapless Metal Oxide type without any series or shunt gaps. The SAs shall be capable of discharging over-voltages occurring during switching of unloaded transformers, and long lines.
3. Arrestors shall be complete with insulating base for mounting on structure. Self-contained discharge counters suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit with necessary connection. Suitable leakage current meters should also be supplied within the same enclosure. The reading of millimeter and counters shall be visible through an inspection glass panel

4. The surge arrestors shall conform to type tests and shall be subjected to routine and



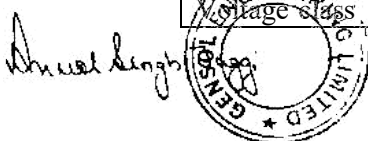
acceptance tests in accordance with IEC-60099-4. The cantilever strength of the insulator shall be min. 350 kg for 33 kV level.

Rate System Voltage	
Rate Arrester Voltage	
Nominal discharge current	10 kA of 8/20 micro-sec wave
Minimum discharge capability	5 kilo joule/kV(referred to rated arrester voltage corresponding to minimum discharge characteristics)
Maximum continuous operating voltage	24 kV rms
Max. residual voltage (1 kA)	70 kVp
Max. residual voltage at 10 kA nominal discharge current (8/20 micro sec wave)	85 kVp
Max. switching impulse residual voltage at 500A peak	70 kVp
Max. steep current residual voltage	93 kVp at 10 kA
Long duration discharge class	2
High current short duration test value (4/10 micro-sec-wave)	100 kAp
Low current long duration test value (2000 micro sec.)	As per IEC
Pressure relief class	Class A
One minute power frequency withstand voltage of arrester housing (dry and wet)	70 kV (rms)
Impulse withstand voltage of arrester housing with 1.2/50 micro sec. Wave	170 kVp
Partial discharge at 1.05 MCOV (continuous operating voltage)	Not more than 50 pc

1.29.11 Post Insulator

1. The post insulators shall conform in general to latest IS:2544 and IEC – 60815, 60168.
2. Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators shall be accepted. Height of post insulator shall be preferably as given under parameters of this part.
3. Other requirements of insulator as given under auxiliary requirements shall also be applicable.
4. In accordance with the stipulations elsewhere the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS:2544, IEC-60168 shall be carried out.

Type	Solid core
Voltage class	36 kV



Rated one minute power frequency withstand Voltage	70 kV (rms)
Rated Lightning Impulse withstand voltage with 1.2/50 micro sec. wave	170kVp
Total min. cantilever strength	350 kg
Min. torsional moment (Nm)	As per IEC 60273
i) Top p.c.d (mm)	76
ii) Bottom p.c.d (mm)	76
No. of bolts: Top :	4
Bottom :	4
Diameter of bolt holes (mm)	
Top :	M12
Bottom :	M12

1.29.12 Switch Yard LED Lighting System

Adequate Switchyard LED lighting for both Switchyards shall be provided keeping the general security in mind using the auxiliary power supply (conventional) available at the location.

Contractor should submit Theoretical design calculations and detailed explanations along with drawings shall be provided and approved by MAHAGENCO.

1.29.13 Danger Plates

Size of each Danger Notice plates will be 200 mm x 150 mm made of mild steel sheet and at least 2 mm thick, and vitreous enameled white on both sides and with inscription in signal red colors on front side as required. The inscriptions shall be in Hindi and English.

1.29.14 Others

Any Electrical work for switchyard which is not mentioned or included here but necessary for the plant shall be borne by Contractor.

1.29.15 Warranty / Guarantee

The Contractor must ensure that the goods supplied under the contract are new, unused and of most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the contract.

1. Solar PV Modules: Material/product Warranty should be at least 12 years and Performance / power output warranty of Solar Module(s) shall be for at least 90% of its rated power at the end of 12 years and 80% of its rated power at the end of 27 years from the date of receipt of modules on Site. The manufacturer should warrant for the linear output of Solar Module(s) and degradation of the PV modules will be linear over 27 years from the date of receipt of modules at site. The Manufacturer Detailed Warranty / Guarantee clause shall be furnished.
2. Module mounting structures should be warranted for a minimum period of 5 Years.
3. Inverter should be warranted up to 10 years (standard warranty 5 years + 5 years extended warranty)
4. Transformers, associated switch gear and others: Manufacture shall furnish in

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details their warranties / guarantees for these items. Transformers, CT, PT & switch gears, DC Cables, HT cables, SCB & SMS, SCADA, CCTV System should be warranted for minimum period of 5 Years.

5. Before finalizing the purchase order all warranty/guarantees agreements of equipments & material should be approved from MAHAGENCO. During the period of Warranty / Guarantee the Contractor shall remain liable to replace any defective parts, that becomes defective in the plant, of his own manufacture or that of his sub- Contractors under the conditions provided for by the contract under and arising solely from faulty design, materials or workmanship, provided such defective parts are not repairable at site. After replacement, the defective parts shall be returned to the Contractors works at the expense of the Contractor unless otherwise arranged.
6. If any defects not remedied within a reasonable time, the Owner may proceed to do work at the Contractor's risk and cost, but without o other rights, which the Owner may have against the Contractor in respect of such defects.
7. At the end of guarantee period, the Contractor's liability shall cease. In respect of goods not covered by the first paragraph of this clause, the Owner shall be entitled to the benefit of such guarantee given to the Contractor by the original Contractor or manufacturer of such goods.
8. During the operation & maintenance and guarantee period, the Contractor shall be responsible for any defects in the work due to faulty workmanship or due to use of sub-standard materials in the work. Any defects in the work during the guarantee period shall therefore, be rectified by the Contractor without any extra cost to MAHAGENCO within a reasonable time as may be considered from the date of receipt of such intimation from MAHAGENCO failing which MAHAGENCO shall take up rectification work at the risk and cost of the Contractor.

1.29.16 Technical Data Sheet

Detailed technical specification of the proposed Solar PV Grid interactive system in response to section II of RfP shall be provided as part B. In addition to the description of the system, the Contractor shall furnish Technical Data Sheet as per the format given in Annexure 17.

C:- OPERATION AND MAINTENANCE SCOPE

1.0. GENERAL

- 1.0.1 The Contractor shall operate the Solar PV Power Plant including its associated HT line and all civil structures, Control Room building, Array Yard, Garden etc. for a period of 5 years from the date of handing over of the plant for O&M after completion of successful PG test & Final Acceptance Test.
- 1.0.2 Zero date of operation and maintenance of the solar plant shall begin on the date of handing over to O&M after successful completion of PG test & Final Acceptance Test of the Solar PV Power Plant.
- 1.0.3 Operation work includes day to day operation of Solar Power Plant including, maintenance of LT lines, HT lines and maintenance of all Civil Works.
- 1.0.4 The Contractor will furnish necessary details regarding technical competence, qualification

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and number of different grades of personnel to be posted at site along with proposed maintenance (preventive) schedule from the date of commissioning.

- 1.0.5 The maintenance staff of the Contractor shall be available in the Power Plant for 24 hours every day irrespective of whether the plant is in operation or not unless otherwise instructed by MAHAGENCO in writing.
- 1.0.6 The Contractor's representatives/employees shall conform to all general regulations in force at site and to any special conditions affecting by local administration issued by MAHAGENCO or duly authorized representative of MAHAGENCO. All employees of the Contractor living at site shall be deemed to be aware of dangers and risks incidental to the conditions of MAHAGENCO's land and works from time to time and MAHAGENCO shall not be responsible for any injury arising there from.
- 1.0.7 MAHAGENCO reserves the right to ask the Contractor to remove/transfer any staff of the Contractor from site without assigning any reason whatsoever. Instructions issued in writing to the Contractor in this matter shall be binding and the Contractor shall replace the transferred/removed person with a suitable person immediately.
- 1.0.8 All persons deployed by the Contractor for regular operation and maintenance must remain in proper uniform while on duty. The Contractor shall supply uniforms, raincoats, toolset, gloves, gumboots and other items required for carrying out the services.
- 1.0.9 MAHAGENCO shall have power to disallow any maintenance personnel, if found unsuitable. The Contractor shall have to replace such persons within 24 hours.
- 1.0.10 The Contractor shall maintain attendance register for all their staff deployed for carrying out jobs on regular basis and shall be produced for verification on demand by authorized personal of MAHAGENCO.
- 1.0.11 The Contractor shall ensure that all safety measures are taken at the site to avoid the accidents to his employees or his co-Contractor's employees.
- 1.0.12 The Contractor shall comply with the provision of all relevant Acts of Central or State Governments including payment of Wages Act 1936, Minimum Wages Act 1948, Employer's Liability Act 1938, Workmen's Compensation Act 1923, Industrial Dispute Act 1947, Maturity Benefit Act 1961, Employees State Insurance Act 1948, Contract Labor (Regulations & Abolishment) Act 1970 or any modification thereof or any other law relating whereto and rules made there under from time to time.
- 1.0.13 In order to ensure longevity, safety of the core equipment and optimum performance of the system the Contractor should use only genuine spares of high quality standards.
- 1.0.14 The Contractor shall immediately report the accidents, if any, to the Engineer In charge & to all the concerned authorities as per prevailing laws of the state. A detailed Emergency Response Plan shall be submitted by the Contractor at the beginning of the O&M period.
- 1.0.15 The Contractor shall provide his maintenance staff at the power Plant for day-to-day operation and maintenance. The maintenance personnel shall be qualified, certified by competent authorities and well trained so that they can handle any type of operational hazards quickly and timely. The responsibility of providing suitable Personal Protection Equipments rests solely with the Contractor.
- 1.0.16 The Contractor shall arrange to provide proper and elaborate O&M training of Solar Power Plant and associated power evacuation arrangement to the MAHAGENCO's staff for successful takeover of the plant in due course of time.
- 1.0.17 All electricity charges for auxiliary power of plant shall be borne by Contractor during the



complete O&M period (5 years).

- 1.0.18 The security of the Power Plant will rest with the Contractor for entire contract period.
- 1.0.19 The maintenance personnel shall be in a position to check and test all the equipment regularly, so that, preventive maintenance, could be taken well in advance to save any equipment from damage. Abnormal behavior of any equipment shall be brought to the notice of MAHAGENCO not later than 2 hours for taking appropriate action.
- 1.0.20 All repairing & replacement works are to be completed by the Contractor within 24 hours from the time of occurrence of fault or defect. If it is not possible to set right the equipment within this time, the Contractor shall notify the MAHAGENCO indicating nature of fault & cause of damage etc. within 12 hours from the time of occurrence of the fault.
- 1.0.21 During operation and maintenance if there is any loss or damage to any component of the power plant due to miss-management/ miss-handling or due to any other reasons, what so ever, the Contractor shall be responsible for immediate replacement / rectification of the same. The damaged component may be repaired, if it is understood after examination that after repairing performance of the components shall not be degraded, otherwise the defective components shall have to be replaced by new one without any extra cost to the MAHAGENCO.
- 1.0.22 The scope of maintenance work shall include the following:

Regular operation and maintenance of the Solar PV Power Plant including water supply pump, if any, for a period of 5 years and submission of daily performance data of the power plant. The Contractor shall keep a Record Book in this respect clearly indicating date of checking & comments for action etc.

- i. The scope of operation includes injecting power to the 220 kV MSEDCL/MSETCL Grid. Proper records of operation of Power Plant System are to be kept as per direction of MAHAGENCO.
- ii. Cleaning of the Power Plant including array yard on regular basis. (Module cleaning cycle should not less than twice per month)
- iii. Normal and preventive maintenance of the Power Plant such as cleaning of module surface, tightening of all electrical connections, Line accessories, Transformers and associated switch gear on the HT side.
- iv. Keeping & recording daily log sheet as per approved format for the Power Plant to be supplied after commissioning of the Power Plant.
- v. Operation of the Power Plant has to be in accordance with the availability of Solar Energy and feeding to the grid. Under no circumstances, the operator shall run the power plant damaging the substation grid.
- vi. Contractor's employees shall use no part of the power plant building for residential or any other purpose except for running the plant.
- vii. The Contractor shall submit monthly Performance report of Solar PV Power Plant indicating cumulative energy generation data as per approved format within 15 days of the following month.
- viii. The Contractor shall preserve all recorded data in either manual or through computer format and shall submit to MAHAGENCO quarterly.
- ix. The Contractor shall develop & maintain the garden on the nearby area of Main Control room, Administrative building cum rest house which will be

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developed by the Contractor himself as per aesthetic requirement including daily watering and manuring as and when necessary and on regular basis.

- x. During 5 year's maintenance period, the Contractor have pay all broad band / wifi/satellite internet & communication charges/bills for web box system & Scada monitoring also
- xi. Contractor shall pay all statutory fees/charges for renewal of required certificates during O&M period. Contractor shall pay the borneall the charges/fees/taxes local Govt. bodies, regulatory & statutory bodies.
- xii. During 5 year's maintenance period, the Contractor shall refill the Liquefied CO2 Extinguisher as per manufacturer's recommendation before expiry.

1.1. PERFORMANCE MONITORING

As part of the performance monitoring, the following shall be carried out:

- a) The EPC Contractor shall maintain the list of Module IDs along with performance characteristic data for each module. This data shall be submitted to MAHAGENCO as and when required.
- b) The EPC Contractors shall provide access to MAHAGENCO or their authorized representatives for installing any additional monitoring equipment to facilitate on-line transfer of data/ Generation data.
- c) Web-based monitoring should be available, which should not be machine dependent. The web- based monitoring should provide the same screens as available in the plant. Also it should be possible to download reports from a remote web-client in PDF or Excel format.
- d) The EPC Contractor shall follow the Maharashtra Electricity Regulatory Commission guidelines for Forecasting, Scheduling and Deviation settlement process for Solar Generation. The regulations in this regard by the CERC/MERC as per the Indian Electricity Grid Code (IEGC) is abided to EPC Contractor.
 - EPC Contractor shall appoint QCA (Qualified Coordinating Agency) as per regulation for Forecasting, Scheduling and Deviation settlement process for Solar Generation at own cost for 5 years of contract period.
 - Forecasting, Scheduling & Deviation settlement process charges / fees applicable should be paid by EPC Contractor.
- e) As per requirement of SLDC, EPC Contractor shall establish the required SCADA system & communication facility from project to SLDC. EPC Contractor shall be responsible for the O&M of SCADA & communication system thereof for entire contract period at its own cost.
- f) Contractor shall ensure that the facility at all times.
 - Have SCADA installation/any other continuous communication facility for transferring the data of Solar Energy generated from the Facility's switchyard / Nearest Substation of MSEDCL/MSETCL to the State Grid's Sub-Station(SLDC)/ Control room;
 - Have installed Special Energy Meter (SEM) with telecommunication facility with



availability based tariff (ABT) feature as per relevant CEA specifications / regulations as maybe applicable.

- **Moreover, it shall be mandatory to provide real time visibility of electricity generation to Maharashtra State Load Dispatch Center (MSLDC) at Airoli, Navi Mumbai, Maharashtra or MSETCL through RTU-DC, V-SAT or any other standard protocol decided by MSETCL.**

Contractor should provide the day ahead schedule, forecasting, availability & performance of the solar power project as per the rules & regulations applicable.

1.2. MANDATORY SPARES & CONSUMABLES

Contractor shall maintain the mandatory spares, consumables and various components of SPP for smooth running during O&M period. Contractor shall also replenish the consumed mandatory spares during the O&M period to maintain the stock as mentioned in Bid Proposal Sheet. The Contractor shall mention the source of supply for each consumable, spares and components with all contact details. The Contractor shall submit the list of spares and consumables planned to be kept at site at the time of submission of final bid.

EPC contractor shall maintain sufficient spare for any failure restoration of plant & power evacuation line.

1.3. INSTRUMENTS FOR METEOROLOGICAL MEASUREMENTS (WEATHER MONITORING STATION)

- 1.3.1 Contractor shall provide at least following measuring instruments with all necessary software & hardware required to make it compatible with SCADA. The weather stations must be capable of recording and reporting all the parameters like air temperature, module temperature, relative humidity, wind speed, wind direction, rain accumulated, barometric pressure, Global Horizontal Irradiation and Tilted Surface Irradiation. Specifications of some instruments are as given below.

- 1.3.2 **Pyranometer:** Contractor shall provide pyranometer for measuring incident global solar radiation. The specifications are as follows:

- Spectral Response- 0.31 to 2.8 micron.
- Sensitivity - 9 micro-volt / w / m²
- Time response (95%): Max 15 s
- Non linearity: $\pm 0.5\%$
- Temperature Response: $\pm 2\%$
- Temperature Response= Max $\pm 2\%$
- Tilt error: $\pm 0.5\%$.
- Zero offset thermal radiation: ± 7 w/m²
- Zero offset temperature change ± 2 w/m²
- Operating temperature range: - 40 deg to +80 deg.
- Uncertainty (95% confidence Level): Hourly- Max-3%; Daily- Max-2%
- Non stability: Max $\pm 0.8\%$
- Resolution: Min + / - 1 W/m²
- Input Power for Instrument & Peripherals: 230 VAC (If required)
- Output Signal: Analogue form which is compatible with the data



- 1.3.3 Each instrument shall be supplied with necessary cables. Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the equipment. The signal cable length shall not exceed 20m. Contractor shall provide Instrument manual in hard and soft form.
- 1.3.4 **Thermometer:** Contractor shall also provide at least one RTD type ambient temperature measuring instrument at suitable place in PV array. Instrument shall have a range of -5°C to 60°C.

1.4. TESTING INSTRUMENTS FOR ELECTRICAL & ELECTRONICS

Contractor shall also provide required set of onsite testing instruments/equipments viz. Thermo graphic cameras, earth resistance tester, rheostats, insulation tester, multi-meter, CRO, Function Generator, Transformer oil BDV kit, Relay testing kit, infrared thermal hand held temp. meter, inverter testing kit, SF6 gas filling Kit etc.

1.5. SYSTEM DOCUMENTATION

- 1.5.1 The Contractor shall submit & maintain all the Engineering drawings, data, design and engineering information in both soft copy (CD) and hard copy to MAHAGENCO along with a "Master Drawing List":
- SPV array and cable layout.
 - Module foundation
 - Main & service road with general drainage
 - Main Control Room.
 - 33/220 kV Pooling Substation.
 - Earthing system

Any other Engineering drawings, data, design and engineering information (whether specifically mentioned in the document or not) required to fulfill the stated scope of work shall be deemed to be included.

1.6. SCOPE OF CIVIL MAINTENANCE

- 1.6.1. Cleaning of surface drain, sewerage line, septic tank, drainage outfall, down pipes, soil pipes, water pipe lines and also mention pre monsoon cleaning activity.
- 1.6.2. Repairing or replacement, whatever necessary, and cleaning of all joineries as and when necessary.
- 1.6.3. Repairing or replacement, whatever necessary, of door, window fixtures, toilet accessories as and when necessary.
- 1.6.4. Cleaning & maintaining of power plant area.
- 1.6.5. Painting of fencing once in two year.
- 1.6.6. Painting of iron parts of array structures posts once in a year.
- 1.6.7. All tit bit repair maintenance in case of building and all other structures as and when required as per instruction of Project of CE (RE-P&P).



1.7. OTHERS

Any Electrical work which is not mentioned or included here but necessary for the plant shall be borne by Contract.

D:- COMPREHENSIVE OPERATION & MAINTENANCE

1.0. GENERAL

- 1.0.1. The Operation and Maintenance shall be comprehensive. The maintenance service provided shall ensure project functioning of the Solar PV system as a whole and Power Evacuation System to the extent covered in the contract. All preventive / routine maintenance and breakdown / corrective maintenance required for ensuring maximum uptime shall have to be provided. Accordingly, the Comprehensive Operation & Maintenance shall have two distinct components as described below:

Preventive / predictive Maintenance: This shall be done by the Contractor regularly and shall include activities such as cleaning and checking the health of the Solar PV system, cleaning of module surface, tightening of all electrical connections, and any other activity that may be required for proper functioning of the Solar PV system as a whole. Necessary maintenance activities, Preventive and predictive for Transformers and associated switch gears also shall be included.

Breakdown / Corrective maintenance: Whenever a fault has occurred, the Contractor has to attend to rectify the fault & the fault must be rectified within 24 hrs time from the time of occurrence.

- 1.0.2. The Contractor may ensure adequate insurance of Solar PV systems against robbery, theft and acts of God such as natural calamities, flood etc.
- 1.0.3. Detailed scope of comprehensive operation & maintenance has been described in Section II - C of this document. However, operation of the Power Plant means operation of system as per bidding schedule and workmanship in order to keep the project trouble free covering the guarantee period.
- 1.0.4. Contact period shall be after the completion of commissioning, PG test, FAT test and thereafter up to 5 Years of Operation and Maintenance.
- 1.0.5. Terms of contract may be extended beyond the period of 5 years of Operation and Maintenance on mutually agreed terms and conditions between contractor and MAHAGENCO at least ninety (90) days prior to the expiry of the first term if contact.
- 1.0.6. EPC Contractor shall appoint QCA for Forecasting and Scheduling generation reports as per extant regulations (MERC Regulation -2018) for Forecasting, Scheduling, Deviation Settlement Mechanism and related matters at his own cost. The scope under this Clause shall also include establishing and maintaining forecasting tools. As well as preparation and submission of report to SLDC Kalwa as per regulations is in scope of QCA/Aggregator. If Charges (Penalties) in case of any deviation shall be borne by the EPC Contractor. Also, the service charges of QCA and any other applicable deviation settlement charges shall be in scope of EPC Contractor.

