

VOLUME - II



**EPC PACKAGE WITH LAND FOR DEVELOPMENT OF UP
TO 500 MW (AC) SOLAR PV PROJECT ANYWHERE IN
THE STATE OF GUJARAT**

SCOPE OF WORK & TECHNICAL SPECIFICATIONS

PART – 2 (C)
SHEET 1 of 95

VOLUME – II

PART – 2

SCOPE OF WORK & TECHNICAL SPECIFICATIONS


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SCHEDULE – III EPC TECHNICAL SPECIFICATION
GENERAL SYSTEM
C1 - CABLING SYSTEM
1.0 Cabling System

This section covers various types cabling system to be followed for the proposed PV Solar plant. Cable laying, installation, testing and commissioning of cables shall comply with all currently applicable statutes, regulations and safety codes in the locality where the system will be adopted. The system shall also conform to the latest applicable standards mentioned in Codes & Standards.

2.0 Codes & Standards

Codes	Description
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 kV rating
NEC 300.5	Cabling and wiring methodology

3.0 Cable Installation Notes – General

- 3.1 These notes in general apply to installation of cables up to and including 33 kV grade.
- 3.2 Electrical installation work shall comply with all currently applicable statutes, regulations, and safety codes in the locality/country where the installation is to be carried out.
- 3.3 Installation of cables shall be carried out generally as per IS: 1255 or relevant applicable standards.
- 3.4 Installation of cables shall include unloading, storing, shifting from place of storage to place of installation, laying, fixing, jointing, termination and all other work necessary for completing the job. Supply of glands and lugs whenever the same are not supplied by the respective switchgear manufacturers, together with other necessary materials for jointing and termination shall also be included in Bidder's scope.
- 3.5 Cable laying methodology within plant boundary to be decided during detailed engineering based on the soil condition and other associated factors.

The cables specifications / design shall be suitably selected as per laying final philosophy/ methodology decided during detail engineering by the Bidder considering the site



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environmental conditions etc. Bidder shall submit the final specification with methodology for Owner's Approval

- 3.6 All cables shall be provided with extra cable length at joints & termination end irrespective of route cable length. Adequate loop length shall be provided at every straight joint and at each end of the cable. Cables to each circuit shall be laid in one continuous length. Cable jointing and splicing shall be avoided as far as possible.
- 3.7 UV rated self- locking nylon cable-ties shall be used to hold and guide the solar cables / wires from modules to junction boxes or inverters etc.
- 3.8 The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker. The Bidder shall submit route marker drawing for Owner's Approval.
- 3.9 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 10 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, panels room, transformer yard etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick SS-304/Aluminium with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280.
- 3.10 Bidder shall take special care in designing cable routing for entry of cables in Rooms / station / block etc. to avoid bunching / overcrowding and derating of cables.

4.0 Solar Cable, DC, Control and Power cable laying philosophy

- 4.1 All solar cables should be aesthetically tied to module mounting structure and no loose loops shall be kept. All solar cables shall be laid in UV rated double wall corrugated HDPE conduits with 50% fill factor for inter row connection and to SCB. HDPE conduits shall be laid on cable trestle or above ground cable racks up to the string combiner box. Solar cables shall be terminated at input terminals of SCBs through cable glands of appropriate sizes. Inner sheath / insulation of the cable shall not be exposed to the sun.
- 4.2 All cable to be laid above ground / underground keeping in view of the site-specific issues related to water submergence, soil condition etc., which shall be reviewed during the detail design engineering. Bidder may suggest alternate cable laying methodology which will be finalized during detail engineering. Bidder to ensure that the cables are laid properly in line with the design consideration adopted in sizing calculations and have to guarantee the cable performance and tolerance to the site conditions.
- 4.3 Bidder shall take special care in designing cable routing for entry of cables in Rooms / station / block etc. to avoid bunching / overcrowding and derating of cables.



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- 4.4 Interplant cabling for main routes shall be carried out through as per final cable laying methodology. In case of Duct banks, pull-pits shall be filled with sand and provided with PCC covering.
- 4.5 All cable route sections shall have identification, designations as per cable routing layout drawings and painted / stenciled at each end of cable route and where there is a branch connection to another cable route. For long lengths of trays, the identification shall be painted at every 10 meters.
- 4.6 For good sealing arrangement at entry points, suitable pipe sleeves, adequate in number and of adequate sizes shall be provided in building walls / slabs for passage of cables into a building from cable trays / racks / cable trenches located outside the buildings. Details of sleeves and exact locations of such entry points shall be available on relevant project drawings.
- 4.7 For Inverter station and sub-pooling station area Power and control cables, laying shall be done in Ladder type GI cable tray and for instrumentation Ladder/perforated type cable tray , with top cover and all fittings and accessories like coupler plates, bolts, nuts, washers, brackets, elbows, bends, reducers, tees, crosses, strap, hook etc. shall be provided. Proper GI support system shall be provided for cable tray.
- 4.8 Cables inside the Inverter station and sub-pooling station and in the transformer, yard shall be laid in Galvanized Cable Trays mounted on GI steel supports, in constructed trenches with RCC raft and brick sidewalls and provided with removable RCC covers for outdoor trenches and chequered plate for indoor trenches.
- 4.9 Power and control cables shall be laid on separate tiers in line with approved guidelines/ drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables.
- 4.10 Cable tray shall be fabricated out of mild steel sheets with min thickness of 2 mm and for coupler plates it shall be 3 mm thick. Material of Cable tray and all its fittings and accessories shall be Hot dip Galvanized as per IS standard.
- 4.11 Suitable size clamps with all fixing GI accessories shall be provided for clamping of multicore cables at every 5 meters interval. Die cast Aluminum or Fibre glass or Nylon Trefoil clamps with all fixing GI accessories shall be provided for single core cables. Trefoil clamps shall be provided at distance of every 3 meters for horizontal laying / every 1 meter for vertical laying, and on either side of bends. Control cables shall be bunched, clamped and tied with self-locking type nylon cable ties with de interlocking facility to keep them in position.
- 4.12 Cable drums shall be unloaded, handled, stored and laid as per OEM guideline or as per IS standard. Suitable jacks or on cable wheels shall be used to unreeling the cables. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Ground rollers shall be used at every 2-meter interval for cable laying to avoid cable touching ground.



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- 4.13 Suitable clearances shall be maintained between HT power-LT Power-Control cable laying in line with IS standard. Required length of cable for LT straight through joints shall be kept at each end location for future use.
- 4.14 The cable passing through openings in the cable trenches/ road /wall /floor/cable tunnel/ cable culvert shall be laid in the GI pipe /HDPE// Hume Pipe of approved make. All opening/ entry of cables shall be provided with fire stop sealing.
- 4.15 All cable/wires shall be provided with Punched SS-304/Aluminium/Nylon tags only on both sides of a wall or floor crossing, on each duct/conduit entry / exit, and at every 10 meters in cable tray/trench runs. The marking on tags shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily. Suitable cable tray marking shall be provided. Cross ferruling shall be provided for each control cable cores.

5.0 Fireproof Sealing for Cable Carrier Systems

- 5.1 The fire proofing system for cable carrier system shall broadly consist of the following:
- a) Cable penetration fire stops / seals
 - b) Cable fire breaks.
- 5.2 Fire stops shall be provided for cable penetration openings listed below:
- a) The passage of cables / cable trays from one walled-in fire-zone / area to another, from cable galleries to adjacent rooms / areas, between cable galleries of two units, switchgear rooms to adjacent rooms and from indoor to outdoor locations shall be sealed suitably by fire stops after the installation of all the cables.
 - b) Vertical raceways which carry cables between successive floors, through openings provided in RCC floor slab, shall be sealed by fire stops at each floor level.
- 5.3 For cable sealing arrangement consisting of frames, modular blocks and accessories shall be installed where the underground and over ground cables enter or leave concrete or modular bay kiosks, or any Building.
- 5.4 The system shall be sized, supplied and installed at site by the Bidder. The modular system should have only few components for facilitating simple, easy and quick assembly. The multi diameter-based cables transits shall be repeatedly re-openable and re-usable without need of special tools and discarding the modules in normal operation.
- 5.5 Supplier shall size the modular cable transit / sealing system considering approx. 20% spare for each cable size / outer diameter. so that these spare blocks in future can be used for wide range of cables also, solid blocks / add layer blocks should not be used at all in the installation.
- 5.6 The modular cable transit / sealing system should have been tested for water tightness – 4 bar pressure catastrophic & 0.3 bar pressure constant, gas tightness-2.5 bar pressure, blast load-3 Psi minimum as per OISD 163, 3hrs fire insulation tests as per UL 1479, fire Insulation and Integrity as per EI120 as stated in BS476 & ASTM E814 (also as per Indian National Building

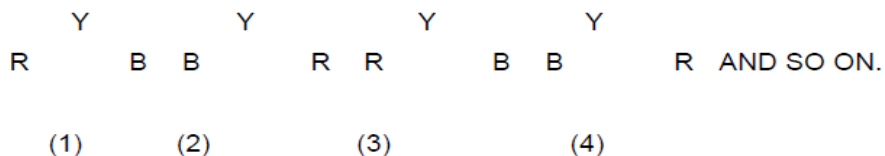


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Code 2016 & CEA guidelines), IP69 as per IEC60529, shock & vibration test as per NES 510 and anti-rats/rodents test certificate. The above-mentioned tests are mandatory.

6.0 Cables in Trays / on Racks / on Trestle

- 1.1 Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. HV power cables shall be laid in top trays and cables of subsequent voltage grade in lower tier of trays. Power and control cables shall never be laid in the same tray.
- 1.2 Power and control / instrumentation cables in trenches, tunnels and racks shall be run in ladder and perforated type cable trays respectively (maximum tray width 600 mm for ladder type & 450mm for perforated type), supported on trench / tunnel / rack carrier arms. The cables shall be tied/clamped to trays by means of ties / strips/clamp at every 3M interval in horizontal run. Interval of clamping shall be 1M for cable trays in vertical disposition.
- 1.3 Power cables of 3.3 kV and above shall be laid in trays / on racks as follows:
- In single layer only, without exception.
 - 3 core cables shall be laid in touching formation, provided proper derating factors are considered while sizing of cables.
 - Single core cables used for AC cabling purpose shall be laid in trefoil groups with spacing equal to diameter of the cable between edges of the trefoils. Cables in trefoil groups of the same circuit shall be laid as indicated below so as to ensure balanced current distribution:



- 1.4 Control and instrumentation cables can be laid up to a maximum of three layers in each tray / rack.
- 1.5 Single core power cables for 3 phase AC circuits laid in trays / racks / trenches in trefoil groups shall be held in trefoil clamps placed at an interval not exceeding 3 meters. The trefoil groups of cables shall be additionally tied by means of 3 mm dia. Nylon cord as follows:
- At an interval not exceeding 1 meter when laid in cable trays / racks.
 - At an interval not exceeding 750 mm when laid in trenches without cable trays.
 - Cables in vertical raceways shall be clamped by saddle type cleats to the horizontal slotted angles.

7.0 Bending Radii for Cables

The bending radii for various types of cables shall be as per cable manufacturer recommendations.



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8.0 Terminations, Clamping & Miscellaneous details

- 8.1 Cable entry to electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.
- 8.2 Identification tags made from SS-304/Aluminium/Nylon sheet shall be attached to each end of each cable by means of nylon / PVC binding wire. Tags shall be additionally put at an interval of 10 metres on long runs of cables and at each bend.
- 8.3 All cable terminations shall be solderless crimping type. Whenever lugs are required to be supplied, adequate size double compression type heavy duty long barrel lugs of approved make shall be used. The crimping tools shall be adequate for the lug sizes.
- 8.4 Saddle type clamps to suit number of cables to be clamped at a particular location shall be used for clamping cables running along walls, ceilings, structures etc.
- 8.5 Adequate support system suitable for site condition shall be provided for supporting vertical runs of one or more single core cables per phase, such as near transformer cable boxes, shall be painted with two coats of fire retarding paint of approved quality.
- 8.6 The Cable glands shall be weather proof Double compression type made of heavy duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 micron. Cable glands shall conform to BS:6121.
- 8.7 All Cable lugs for power cables shall be double compression type Heavy duty Long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve to be terminated to stud type TB only.

8.8 Joints & Termination

- 8.8.1 Termination and jointing kits shall be of proven design and approved make only and fully type tested. Kits shall be complete with all accessories and consumables required for complete termination or jointing. Double compression type Heavy duty long barrel tinned Copper cable lugs & jointing ferrules for straight through joints shall form part of the kit.
- 8.8.2 Termination and jointing kits shall be suitable for the following types of cables as per IS.
- a) 19/33 kV earthed grade cable
 - b) 1.9/3.3 kV cable
 - c) 1.1 kV grade power cables
- 8.8.3 Termination kits shall be 'heat shrinkable type' for LV & HT Cables.
- 8.8.4 Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length. Jointing kits shall be 'heat shrinkable type'. No joints are allowed in control cables.
- 8.8.5 Straight through joint and termination shall be capable of withstanding the fault level of 31.5 kA for 33 kV cables.
- 8.8.6 Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.



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8.8.7 Cable jointer shall be qualified, experience and approved by OEM to carryout satisfactory cable jointing/termination. Bidder shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

8.8.8 Both side end termination including supply of end termination kits with all required accessories and cable support structures for transmission line shall be in the scope of bidder.

8.9 Cable Glands

8.9.1 Cables shall be terminated using cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass machine finished and tinned. Cable glands shall be supplied with neoprene seal and earth lugs suitable for the fault capacity of the armour of the installed cables. The Cable glands shall be weatherproof Double compression type made of heavy duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 micron. Cable glands shall conform to BS:6121. For flame proof equipment cable glands shall be of flame proof type. Removable type gland plates shall be provided as per the requirement. This is applicable to all equipment.

8.9.2 Power Cable Glands shall be supplied with good quality tin plated brass earth tag and serrated washer of adequate thickness. Earth tag shall be connected to nearest earth point with adequate size of wire with ring type lug on both sides.

8.10 Cable Lugs

8.10.1 All Cable lugs for power cables shall be double compression type Heavy duty Long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solder less crimping type.

8.10.2 Cable lugs for conductors of power cables shall be "heavy duty" long barrel type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.

8.10.3 Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be ring type. However, other types such as pin type/flat type /U Type are only permitted if it is technically not feasible.

8.10.4 Type of cable lugs shall be as follows:

- a) Power cables with aluminium conductor : Tinned copper or Bi metallic/Aluminium
- b) Power cables with copper conductor : Copper crimping type.
- c) Control Cables : Copper ring type
- d) Special cables : pin type / maxi-termi type

8.11 Tags

- a) Cables shall be provided with cable number tags for identification.
- b) Cable tags shall be 2.00mm thick of SS-304/Aluminium/Nylon
- c) Cable numbers shall be engraved type.
- d) Tags shall be of durable quality of size 60 mm x 12 mm with a tie hole at each end.
- e) Samples of tags shall be approved by the Owner before delivery.
- f) Tags shall be provided with non-corrosive wire (Nylon tie) of sufficient strength for tagging.


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8.12 Trefoil Cable Clamps

Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.

8.13 Galvanizing

Galvanizing of steel components and accessories shall conform to IS:2629, IS4759 & IS:2633. Additionally, galvanizing shall be uniform, clean smooth, continuous and free from acid spots.

The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified. Galvanization thickness shall be as specified in the Project information section.

9.0 Testing and Commissioning of Cables

9.1 Cables shall be tested for insulation resistance before and after jointing. The voltage rating of the megger for cables of different voltage grades shall be as per the Standard:

9.2 High voltage testing

- a) All cables of 1.1kV grade 400 mm² and above and all HV cables shall be subjected to DC or AC high voltage test after jointing and terminating but before commissioning as per the relevant standards. Testing with DC voltages should be preferred as test equipment required is compact, easily portable and requires low power. The DC test voltages applicable in India shall be as per table no.6 in IS: 1255. The cable cores must be discharged on completion of DC high voltage test and cable shall be kept earthed until it is put into service.
- b) DC test voltage for old cables shall be 1.5 times the rated voltage or less depending upon the age of cables, repair work or nature of jointing work carried out.
- c) In each test, the metallic sheath / screen / armour shall be connected to earth.
- d) Continuity of all cores, correctness of all connections as per wiring diagrams, correctness of polarity and phasing of power cables and proper earth connection of cable glands, cable boxes, armour and metallic sheath shall be checked.

10.0 Earthing

10.1 Metallic sheaths, screens and armour of all multicore cables shall be earthed at both equipment and switchgear end.

10.2 Sheath and armour of single core power cables shall be earthed at switchgear end only.

10.3 Earthing of CT and PT neutral lead shall be done at one end only, as per respective control wiring drawings.


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10.4 GI Earthing flat of suitable design shall be laid along the cable trays. GI Earthing flat shall be connected to earth grid at regular interval and at both end as per IS/IEC standard.

11.0 Cable Tray mountings - General Notes

- 11.1 Assembly of cable tray mounting structure shall be fabricated, supplied, erected and painted. Plate inserts for cable tray mounting structure will be provided in floor slabs at 1000 mm spacing.
- 11.2 Cable tray mounting structure shall be welded to the plate inserts or to steel structural beams / members. Wherever embedded plates or steel structural beams / members are not available for welding the cable tray mounting structure, M.S. plate of the required size shall be supplied and fixed to floor slab by four anchor fasteners of minimum 16 mm dia.
- 11.3 Spacing between cable tray mounting structures shall be 1000 mm for horizontal straight run of cable trays unless otherwise noted.
- 11.4 Loading on a horizontal support arm shall not exceed 100kg / meter run of cable / tray (for say maximum width of tray 600W). Width of the horizontal arms of the mounting structures shall be same as the tray widths required in the cable layout drawings plus length required for welding to the vertical supports (maximum tray width shall be limited to 600 mm).
- 11.5 The length of vertical supporting members for horizontal cable tray runs shall be to suit number of cable tray tiers.
- 11.6 Spacing between horizontal support arms of vertical cable tray runs shall be 600 mm unless otherwise noted.
- 11.7 Minimum clearance between topmost tray tier and structural member / ceiling shall be 300 mm.
- 11.8 Minimum vertical clearance below the bottom of the lowest cable tray tier & any structural member shall be 200 mm and 300 mm in case of steam or process pipelines.
- 11.9 The vertical clearance between two cable tray tiers shall be adopted as 300mm.
- 11.10 All structural steel supplied and exposed surfaces of embedded steel for cable tray mountings shall be galvanized as specified in the project information section.

C2 – EARTHING AND LIGHTNING PROTECTION
1.0 Earthing and Lightning Protection System

- 1.1 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of Practice safety codes and Regulations existing in the locality where the system is installed.

2.0 Codes & Standards

Codes	Description
IS: 3043	Code of practice for Earthing



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Codes	Description
IEC 62305	Protection against lightning
IEEE: 80	Guide for safety in AC substation grounding
BS: 7430	Code of practice for the protective earthing of Electrical installations
IEC 65561 -7	Earth Enhancing Compound
---	Indian Electricity Rules 1956
	CEA regulation for electrical safety / Indian electricity Rules/ Indian electricity Act
IS 2309	Code of practice for the protection of building and allied structures against lightning

- 2.1 The Bidder shall ensure that measuring instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National / International Standards.

3.0 Earthing System

- 3.1 Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

4.0 Design Criteria

4.1 Earthing System Design calculation

The earthing conductor shall be designed considering the maximum DC system fault current for the solar PV yard and AC system fault current for the remaining AC systems. The net earth resistivity shall also be calculated, and the value of net resistivity shall be as per IS 3043. The soil resistivity data will be furnished by Owner during detailed engineering. The Bidder Shall carry out separate ERT measurement without cost implication to the Owner. Earthing pit shall be 1 Nos. per 1.50 MWp. Nos. of earth pit indicated is valid if all the earth pits are interconnected in single mesh of earth pits


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4.2 Conductor Material

The earthing system conductors and accessories proposed are as follows:

- i) Conductors above ground level and in trenches : Galvanized Steel
- ii) Conductors buried in ground or embedded in concrete : Galvanized Steel
- iii) Electrodes : Maintenance free earth pit
- iv) Lightning protection air termination and down conductors for buildings : GI Flat

4.3 The earthing conductor shall be sized for a life of 25 years under the corrosive conditions of site. Conductor shall comply to galvanization requirement mentioned in project information section.

4.4 Size of Conductors
a) Main Earthing Conductors

The earthing conductor sizes shall be calculated based on IS: 3043 and the earthing system shall comply with Indian Electricity Rules and IEEE-80.

The calculated size shall be suitably increased (depending on the resistivity of soil) as per table below to account for the loss of material (steel) due to corrosion in soil.

RESISTIVITY OF SOIL IN OHM-M	Reduction in thickness / diameter in mm
<10	8.0
>10 to <25	7.0
>25 to <50	5.5
>50 to <75	4.5
>75 to <100	3.0
>100	1.5

b) Rod Electrodes


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Maintenance free earth pits shall be considered for the complete plant with copper rod electrodes of suitable diameter and length shall be provided as per the recommendation of BS: 7430. Electrodes installed in the test pits shall have disconnecting facilities.

c) Equipment Earthing Leads

The size and nos. of the earthing leads shall be decided based on the type of equipment and structure to be earthed and the earth fault current carried by each equipment shall be provided generally as per IS-3043 and also with a view to minimize the number of sizes. Calculations shall be submitted for Owner's approval.

4.5 General Requirements

- 4.5.1 Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used in line with IS /IEC standard. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.
- 4.5.2 Equipment earthing of all the equipment in the 33kV sub-pooling switchgear, inverter station. PEB's and Control building.
- 4.5.3 Installation depth of Earthing conductors in outdoor areas shall be as per design calculation and site requirements.
- 4.5.4 Inside dimension of the earth pit shall not be less than 600x600 mm. it shall be brick work / precast of M35 Grade RCC with base of 75mm thick PCC below wall.
- 4.5.5 Top cover of Earth Pit shall be of heavy duty cast iron with frame (600x600mm) with suitable hinged type lifting arrangement of reputed make (HDPE/Pre cast covers are not permitted).
- 4.5.6 All bolt joints must be protected from corrosion by applying suitable paste / grease / petroleum jelly etc. at the time of installation. Same shall be included in the notes of all relevant drawings. All metallic hardware such as nuts, bolts, screws, washers etc. shall be of SS304 grade only.
- 4.5.7 SS 304 bolts, nuts with plain and spring washer (on both sides) shall be provided for petty clamp of earth electrode.



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- 4.5.8 Each earth pit shall have permanent identification with engraved plate fixed on OR near to Earth pit. The engraving shall have sufficient depth and letter size shall be not less than 25 mm. Material of engraving plate may be aluminum / aluminum alloy / SS 304.
- 4.5.9 Date of testing, value of earth resistance measured and next date of testing shall be provided on each earth pit either by painting or by weather proof vinyl sticker. Letter size shall be not less than 25 mm.
- 4.5.10 Pre galvanised GI Strip with GI coating not less than 85micron shall be used
- 4.5.11 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.
- 4.5.12 Electronic earth pit shall be provided as recommended by the system supplier. The system supplier shall provide the requirements in writing for the electronic earth pit.
- 4.5.13 Dedicated electronics earth pit shall be provided to wherever it will be applicable suggested by equipment vendor.
- 4.5.14 All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.
- 4.5.15 Required Nos. of risers (2 Nos. for each equipment) shall be provided in, Inverter stations, Transformer yards, outdoor switchgear areas, etc. for connection to various electrical equipment. The exact numbers and location shall be decided during detailed engineering based on layout requirement. Inverter functional earthing (negative earthing, anti PID earthing) shall be carried out as per guideline of OEM . Bidder shall request complete detail of such earthing from OEM and implement the earthing accordingly.
- 4.5.16 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location
- 4.5.17 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals of 750mm. Wherever it passes through walls, floors etc., galvanized iron sleeves shall be provided for the passage of the conductor



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and both ends of the sleeve shall be sealed with silicon or, PU Foam material to prevent the passage of water through the sleeves

4.5.18 For entry of earth wire / earth strip / earth cable to earth chamber, 75 mm PVC/HDPE pipe shall be provided at least on two sides or as required Patty clamp shall be designed for connection of minimum 4 nos. of earth wire/flat/ rod Petty clamp and earth conductor shall be designed so as to facilitate easy disconnection of for testing of earth resistance of earth electrode. Top of earth rod / patty clamp shall be 75 mm below the top cover Earth pits shall be treated with earth enhancement compound if resistivity is more than 20 ohm meter

4.5.19 Bidder shall obtain all necessary statutory approvals for the earthing system before charging of the plant and electrical equipment

4.6 Earthing Conductors Inside Building

4.6.1 Buried grids shall be provided around periphery of the building. These grids shall be interconnected by providing main grid conductors. The grids shall form a closed loop at any point.

4.6.2 Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

4.6.3 Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment / system.

4.6.4 Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.

4.6.5 Measurement of Ground Resistance

After completion of grounding system installation, the measurement of ground resistance shall be performed by the Vendor. Before measurement, the overhead ground wires shall be disconnected from the Substation. The method of measurement shall be as per relevant standards / codes.

4.7 Earthing System Installation

4.7.1 The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.



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- 4.7.2 Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 750 mm.
- 4.7.3 The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.
- 4.7.4 The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.
- 4.7.5 Street lightning poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.
- 4.7.6 Flexible earth conductors shall be provided at expansion joints for earthing gates, operating handles, etc.
- 4.7.7 Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound.
- 4.7.8 Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.
- 4.7.9 The cable sheaths, screens and armour shall be earthed at both ends for multi-core cables. For single core cables, the same shall be done at one end (switchgear end) only.
- 4.7.10 All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.
- 4.8 **Solar Array Earthing**
- 4.8.1 Each Module mounting structure (MMS), PV Module frames, mounting arrangement for String Combiner Boxes, Metallic Junction Boxes, Metal frames / Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system for solar array shall consist of earth mat / earth grid to be laid at a depth of 600 MM below ground. Earth mat shall be a mesh of interconnected Galvanizing Steel (GS) flat laid in the solar farm for the purpose of earthing / grounding. Equipment and structure in the solar farm shall be earthed in compliance with relevant codes and standards indicated above.



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4.8.2 Size of earth mat conductor shall not be less than 25X6 GS flat. Minimum size of riser to connect the structures and JB etc. to the earth-mat in the solar farm shall be 25X3 GS Flat. Location of earth pits and laying of earth conductor shall be decided during detail engineering.

4.8.3 System Requirement:

- a) Life Expectancy : 25 Years (Minimum)
- b) System fault level : As per system requirement
- c) Soil resistivity : Actual as per site conditions
- d) Min. Steel corrosion : 0.12 mm / year as per IS/IEC
Earth Conductor joints, by electric arc welding, with resistance of joint not more than that of the conductor

4.8.4 Connection of riser to the structures shall be bolted or welded type. Portion of galvanized structure which undergoes welding at site shall be coated with two coats of cold galvanizing and anti-corrosion paint after the welding is completed.

4.8.5 Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection, welds should be treated with red lead compound and thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.

4.8.6 Earth conductor shall be laid in ground in manner that distance of any metallic part of the object to be earthed from the earth conductor is not more than 15 Meter. A continuous earth path is to be maintained throughout the PV array.

4.8.7 Each PV Module frame shall be earthed in accordance with module manufacturer and tracker manufacturer guidelines. In case module frame earthing is to be separately provided, it shall be earthed with minimum 2.5 sqmm flexible copper cable with lug at suitable location of module frame. Both ends of the loop of copper cable for earthing shall be connected with nearest earthed structure or earth conductor.

4.8.8 Bidder shall seek owner's approval for connecting solar array earth mat with any other earth mat / earth grid of the solar PV plant.



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4.8.9 Maintenance free earth pits shall be provided with copper rod electrodes of suitable diameter and length as per the recommendation of BS: 7430. Electrodes installed in the test pits shall have disconnecting facilities.

4.8.10 Irrespective of Earthing calculations, minimum four (4) Nos. of maintenance free electrodes shall be considered for each DC block of four (4) inverters.

4.8.11 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by Bidder.

4.9 Testing of Earthing System

4.9.1 Earth continuity tests, earth resistance measurements and other tests shall be carried out to prove that the system is in accordance with the design, specifications, code of practice and regulations.

5.0 Lightning Protection System

5.1 Lightning protection system shall be provided for control buildings, switchgear room etc., depending on the need for protection as per IEC 62305.
If any building is not protected by ESE lightning arresters provided for the solar plant, separate lightning protection shall be considered for the same as illustrated in this section.

5.2 Lightning protection system shall comprise the following:

- a) Vertical air termination rods whenever needed.
- b) Horizontal roof conductor and down conductor.
- c) Testing links.
- d) Earth electrodes.
- e) Fasteners

5.3 Lighting protection system installation

5.3.1 All roof conductors and down conductors shall be cleated to steel structures at 1000 mm interval or cleated to wall at 750 mm interval. Whenever welded, the weld locations shall be treated to provide rust protection.

5.3.2 All connectors, cleats, clamps, anchors, etc. shall be made of galvanized steel.



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- 5.3.3 Joints shall be avoided in down conductors. If necessary joints shall be welded type.
- 5.3.4 Each down conductor shall be terminated on an earth electrode which in turn will be connected to the main earthing grid.
- 5.3.5 All down conductor shall be provided with a testing link at a height of 1500 mm above grade level. Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

6.0 TESTS

Materials offered shall be of type tested and proven type. Type test reports shall be submitted for approval. All routine and acceptance tests in accordance with the latest versions of applicable standards shall be conducted.

7.0 Data to be furnished by vendor after award of contract

Drawings / Documents for Approval and or information:

- a) Earthing and Lightning protection calculations
- b) Technical Data sheet earthing & lightning protection materials
- c) Earthing and Lightning protection layouts
- d) Earthing and Lightning protection installation details
- e) Calculations showing need for Lightning protection

C3 - FIRE PROTECTION, DETECTION & ALARM SYSTEM

1.0 Fire Protection, Detection & Alarm System

The scope of Bidder shall cover design, engineering, manufacture, inspection and testing at manufacturer's works, third party inspection if any, packing and forwarding, supply at site, storage and handling at site, erection with associated civil, I&C and electrical works, inspection, testing and commissioning, performance testing and preparation, the remedy of all defects during the Defect Notification Period of the Complete Fire Protection, Detection & Alarm system.

The Fire protection, detection & alarm system shall be designed, engineered and manufactured to achieve high availability and reliability. The design and engineering shall make use of most recent international standards and best design practices.

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2.0 Codes & Standards

Codes	Description
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 11	Standard for Low, Medium and High - Expansion Foam
NFPA 70	National Electrical Codes
NFPA 72	National Fire Alarm and Signalling Code
NFPA 850	Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
TAC	Tariff Advisory Committee
-	Under writer's laboratory (UL) - USA
-	Fire Officers Committee (FOC) – UK

3.0 Design Criteria

- a) A comprehensive fire detection, alarm as well as fire protection system shall be installed in conformity with relevant IS. In addition, all buildings shall conform to National Building Code.
- b) All building and switchyard shall be provided with fire detection and alarm system based on smoke detector and/or heat detectors. The fire alarm system shall conform to relevant IS or IEC standards.
 - a) Fire Detection and alarm System
 - b) Portable Fire Extinguishers
 - c) Wheel/ Trolley mounted Fire Extinguishers
 - d) Sand buckets (min. 9Ltrs capacity) with stand
 - e) Any other requirement (If Required as per CEA Regulations and other regulatory regulations)
- c) All the systems shall be designed in such a way so as to make the system complete and acceptable to TAC/nominated agency of insurance companies.
- d) Class A wiring of fire detector with fire alarm panel shall be provided

3.1 Fire Detection and Alarm System

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3.1.1 Fire Detection and Alarm System shall consist of:

a) Fire Alarm Panel (FAP):

FAP shall be installed at the Solar PV plant SCADA and monitoring room.

FAP shall also be installed in the Sub-pooling switchboard room, Individual Inverter Station area and adjoining areas. Local fire panel shall be provided in Inverter station room. No of panel shall depend on the distance between Inverter station and number of devices connected to it as per technical standards. These local panel shall be able to send data to Main fire panel, repeaters if required may also be provided. FAP shall receive signals from the detectors, call points installed all over the plant in case of occurrence of fire to provide alarm to the operator in the control room, to identify the location from where the alarm has originated and initiate hooters to draw attention of the personnel and evacuate if necessary.

b) Analogue addressable type of fire detectors: Fire detectors shall be installed in control room, switchgear rooms, Inverter stations (if applicable), battery rooms, etc. to detect the fire at the incipient stage and send signal to FAP.

c) Push type manual call points: Manual call points shall be installed at strategic locations to draw attention of firefighting personnel.

d) Hooter: Hooter of appropriate rating shall be installed in the Inverter stations (if applicable), to draw attention of the personnel in case of fire accident in the plant.

3.1.2 Scheme and layout for Fire Detection & Alarm system shall be prepared covering all areas and the complete plant for effective operation of FDA system.

3.1.3 Proposed detection system for the areas under consideration:

SL. No.	Area	Type of Detectors
1.	ICR Area	
a)	Solar PV plant SCADA and monitoring room	Addressable Multi sensor fire detectors (if located in container), Manual call points
b)	Sub-pooling Switchboard room	Addressable Multi sensor fire detectors (if located in container), Manual call points
c)	Inverter stations	Addressable Multi sensor fire detectors (if located in container), Manual call points

3.1.4 **Fire Alarm Panel (FAP):**



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- a) Microprocessor based fire alarm panel shall comprise of the redundant processor, various functional modules, loop modules for detector loops, display devices, output modules for alarm control & interlocks, communication modules for interfacing etc. The control system shall be analogue type.
- b) Fire alarm panel shall be provided with integral HMI.
- c) The microprocessor-based fire alarm panel shall be incorporated with the following features:
 - i. Continuous supervision of the detector connecting lines, individual detector performance / operation and disconnection / removal of detectors. The system shall automatically reset on clearance of a fault.
 - ii. Discrimination between a real fire and false fire conditions by incorporating signal verification and other features.
 - iii. Individual detector addressing capability.
 - iv. Detection of over / under sensitive detectors and automatic calibration by increasing or decreasing their sensitivity levels based on environmental conditions like air movement, fumes, humidity, etc.
 - v. Pre-alarm in case of any detector / detectors requiring maintenance.
 - vi. Facility shall be provided such that the relevant codes are to be entered for alteration or access to the stored program. The system should be protected against interference by unauthorized personnel.
 - vii. Compatibility with all detector / devices connected to the fire alarm panel.
 - viii. Logging of alarm, time and action text on printers.
 - ix. Programmed activation of various interlocks with fire protection system and other associated system such as ventilation and air conditioning, etc.
 - x. Fire alarm panel shall have adequate potential free contacts for hooking up with HVAC feeders for interlocks in case of fire is detected.
 - xi. Activation of fire alarm sounders or evacuation alert signal.
 - xii. RS485 port shall be provided in Fire alarm panel to interface with SCADA system.
 - xiii. Any fire alarm generated at Inverter station, main fire panel hooter and local panel hooter shall ring the audible alarm and also alarm shall be annunciating in SCADA and log of alarm shall be recorded in alarm/event log.
 - xiv. Bidder shall consider 10% spare provisions in each loop.
 - xv. Bidder shall consider 30 % design and aging margin for selection of nos. of sensors in each loop and length of each loop. Bidder shall submit the certificate from OEM indicating maximum nos. of sensors in single loop and maximum length of single loop allowed with offered panel and type of cable to be used. Each Fire Alarm Control panel shall have provision for minimum 10 (Ten) % rounded to next higher integer but not less than 2 (two) nos. spare loops for future use of owner.



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- d) Fire alarm panel shall derive power supply from 240V, 1ph, 50Hz UPS. Panels shall be provided with SMF Lead acid battery to provide backup time of minimum 48 hours for full load from the instant of charger / AC supply failure after which sufficient capacity would still be available for 30 minutes during alarm condition.

3.1.5 Fire Detectors:

a) **Multi sensor detectors:**

It detects smoldering smoke generated due to short circuit conditions in electric cables and burning of furniture, clothes, PVC flooring. The optical smoke detecting component uses a photoelectric sensor using light scattering method while the heat detecting component uses thermistor based sensor. The advantage of Multi sensor detector is that it can detect both smoke and heat simultaneously.

b) **Heat detectors:**

These detectors are used in areas where heat increases rapidly with very little smoke during a fire. Also, areas where general fumes are present, smoke detection might not be the right detection method since it may give rise to false alarm. Fixed temperature feature of this detector has greater resistance to adverse environmental conditions (such as dust, fumes, etc.) as compared to other type of detectors.

c) **Linear Heat Sensor cables:**

Linear Heat Sensor cables (LHS cables) shall be provided for detecting the abnormal temperature rise along the cable pans, i.e., in areas where normal spot type heat detectors cannot be provided due to inaccessibility of location viz., cable trenches, service areas, areas where cable tiers are installed etc.

d) **Manual Call Points:**

The manual call points (MCP) of push type shall be provided at switchgear rooms, battery rooms, at two ends of corridor of the control building and at strategic locations in ICR areas. MCPs shall be addressable and wall mounted type. Sequence of alarm and actuation scheme for MCPs shall be same as that for fire detectors.

e) **Hooters:**

Indoor type hooters having a distinct sound from other alarms and annunciations with flashing strobe shall be installed at two ends of the corridor in the MCR building. This shall be automatically actuated in case of actuation of any of the detectors / manual call points



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

in Solar PV plant SCADA and monitoring room and inverter station. The minimum sound level shall be 85 dB (A) which shall be adjustable. Provisions shall be made to activate the hooter from the control room.

Hooters shall be either addressable type or conventional type with control module for interfacing with fire alarm panel.

Hooters shall be designed for two tones viz., Fire and All clear.

f) Cabling:

All detectors and manual call points shall be wired for class A wiring.

Cables required for complete fire alarm system for interconnecting fire alarm panel, detectors and manual call points shall be 1100V grade, multicore, annealed, high conductivity stranded copper conductor, extruded PVC / XLPE insulated, laid up inner sheathed, galvanized steel strip / wire armoured, outer FRLS extruded PVC sheathed cable.

Cables shall be cleated on ceiling for detector looping and laid in trenches up to the panel, buried in ground with other control / communication cables in the indoor area.

3.2 Fire Protection System

3.2.1 Portable & Mobile Fire Extinguishers

a) The fire extinguishers shall be selected to suit the hazardous area and normally be located near the exit. Each type and capacity of extinguishers as follows:

- i. Portable (DCP) dry chemical type fire extinguishers (9 Kg)
- ii. Mobile (DCP) dry chemical type fire extinguishers (min. 20 Kg), if applicable
- iii. Portable CO₂ type fire extinguishers (9 Kg)
- iv. Mobile CO₂ type fire extinguishers (20 Kg), if applicable
- v. Mobile Foam type extinguishers (min.20 Kg), if applicable
- vi. Sand buckets with stand & canopy

b) Portable fire extinguishers shall be installed as per the requirements of NFPA 10. Location of extinguishers shall be decided based on following considerations:

- i. Maximum travel distance
- ii. Uniform distribution
- iii. Easy accessibility
- iv. Nearness to doors, windows and emergency doors / exits
- v. Access and escape route
- vi. Safe distance from application area

SCOPE OF WORK & TECHNICAL SPECIFICATIONS
4.0 Technical Parameters

Sl. No.	Description	Unit	Technical Requirements
A.	Fire alarm control panel		
1.	Type	-	Microprocessor Based,
2.	Type of Display	-	LCD, Alphanumeric, display of addresses of at-leaset 320 characters
3.	Response Time	Sec.	3 Sec. (Max.) for full loaded panel
4.	Addressable / Intelligence Capability	-	Yes
5.	Fault Isolation Capability	-	Yes
6.	Alarm Verification Capability	-	Yes
7.	Sensor self test capability	-	Yes
8.	Memory	-	Non volatile
9.	Fault Tolerant wiring capability	-	Required
10.	No. of loops per panel	-	To be decided by the Bidder
11.	Min. acceptable loop length	Km	2.5 km for fully loaded panel
12.	Power Supply	-	230V 10%, 50Hz, mains supply
13.	Type of batteries	-	Lead acid batteries
14.	Weather Protection Class	-	IP 65
15.	Loop Isolator	-	Built-in
16.	Networkable to other panel	-	Yes


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Sl. No.	Description	Unit	Technical Requirements
17.	Temperature Range	°C	0 to 50 °C
18.	Humidity range	°C	0 to 100%
19.	Auto detection of periphery	°C	Yes
20.	No. of wires SLC loop cabling type	°C	2 wire for detectors Style 6, Class A
21.	Other Standard Approvals.	°C	UL Listed, ULC listed, FM approved,
22.	Seismic Acceleration		0.36g
B.	Multi – sensor detector		
1.	Type	-	Analogue addressable type Photo thermal Multi criteria detector comprising of photoelectric type & Fixed temperature type detection
2.	Memory	-	Non volatile
3.	Temperature setting of the rate of rise sensor	°C/min	8° C/min
4.	Sensor Coverage / Nominal Sensitivity for Optical smoke sensor	-	Wide, 0.5% obs / ft to 4% obs / ft
5.	Facility to adjust the sensitivity and Facility to reset the detector sensitivity to factory setting level	-	Required
6.	Base	-	Suitable to mount the Multicriteria detector in a simply click/turn arrangement. Shall have inbuilt fault isolator in the base. Suitable for two wire loop-in loop-out termination
7.	Fault isolator module	-	To be present in the detector base



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Sl. No.	Description	Unit	Technical Requirements
8.	Operating voltage & power requirements	-	24V DC, loop powered
9.	LED indication	-	Multi status – Multi colour LED with 360°angle view, to be visible from 6 m distance
10.	Type of addressability	-	Electronic addressability with device mapping
11.	Moisture	-	0-100 % RH
12.	Operating temperature	°C	0-60°C
13.	Type of signaling circuit suitable for	-	Class A , Style 6
14.	Wire to which the base shall be suitable for	-	2C x 1.5 Sq mm
15.	Remote and Local Test Capability		Required
16.	Marking of the detector	-	Type, Power supply requirement, Upper limit & Lower limit, date of manufacture
17.	Facility for cleaning the detector during maintenance	-	Required
18.	Pre-alert alarm capability	-	Required
19.	Audible base	-	Not required
C.	Manual call point		
1.	Type	-	Analogue addressable type microprocessor based pull down type manual call point
2.	Power supply requirement	-	Loop powered, 24 V DC


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Sl. No.	Description	Unit	Technical Requirements
3.	Colour	-	Fire red shade as per IS-5
4.	Operating temperature	°C	0-60°C
5.	Moisture	-	100% RH, Non-condensing
6.	Operating instructions	-	Clear And Visible Operating Instructions on the Body
7.	Marking and data	-	To be marked the type, manufacturer name, maximum operating voltage, current and frequency The word FIRE indication on the front of the MCP in raised letters, 1.75 inches (44 mm) or larger
8.	Dimensions for knock-outs for conduit	-	25 mm diameter, Top entry
9.	Type of addressability	-	Electronic addressability with device mapping
10.	LED indication	-	Not required
11.	Cable to be used	-	2C x 1.5 Sq. mm.
12.	Ingress protection	-	IP-54 for indoor use and IP-67 for Outdoor use
13.	Memory	-	Non-Volatile
14.	Remote and Local Test Capability	-	Required
15.	Fault isolator module	-	Required to be Integrated
D.	Siren / Hooter		
1.	Type	-	Electronic hooters, Addressable, 4 wire, suitable in industrial environment


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Sl. No.	Description	Unit	Technical Requirements
2.	Sound level	dB	Range of 75 dB - 120dB (A) with field settable feature.
3.	Mounting	-	Type – A Hooter: Suitable for Recessed mounting. Type – B Hooter: Suitable for Surface / wall mounting
4.	Fault isolator module	-	To be inbuilt in control module
5.	Operating voltage & power requirements	-	24V DC, separately powered
6.	LED indication	-	Multi status – Multi colour LED with 360°angle view, to be visible from 6 m distance.
7.	Moisture	-	0-100 % RH
8.	Operating temperature	°C	0-60°C
9.	Type of signaling circuit suitable for	-	Class A, Style 6
10.	Remote and Local Test Capability	-	Required
11.	Marking of the detector	-	Type, Power supply requirement, date of manufacture, sound level
12.	Enclosure	-	Weatherproof protection, IP 55
13.	Facility for cleaning the detector during maintenance	-	Required
E.	Dry Chemical Powder (DCP) type fire extinguisher		
1.	Extinguishing agent Type	-	Dry Chemical Powder type as per NFPA 10
2.	Extinguisher handling mode	-	Portable - handheld


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Sl. No.	Description	Unit	Technical Requirements
3.	Class of fire	-	A, B, C
4.	Capacity	kg	9 kg
5.	Mounting type		Wall/column mounted
6.	Mounting arrangement along with all necessary hardware/ plates for fixing extinguishers	-	To be provided
7.	Material of construction		
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non conductor of electricity
	c) Approval	-	UL Listed / FM Approved
F.	Trolley mounted fire extinguisher (DCP type)		
1.	Extinguishing agent Type	-	Dry Chemical Powder type as per NFPA 10
2.	Extinguisher handling mode	-	Mobile – Trolley/ Wheeled mounted
3.	Class of fire	-	A, B, C
4.	Capacity	kg	20 kg (minimum)
5.	Mounting type	-	Wheel type trolley
6.	Trolley	-	Carbon steel with corrosion resistant coating
7.	Wheel type	-	Toughened Rubber
8.	Material of construction		


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Sl. No.	Description	Unit	Technical Requirements
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non conductor of electricity
	c) Approval	-	UL Listed / FM Approved
G.	CO2 type fire extinguisher		
1.	Extinguishing agent Type	-	CO2 type as per NFPA 10
2.	Extinguisher handling mode	-	Portable - handheld
3.	Class of fire	-	A, B, C
4.	Capacity	kg	9 kg
5.	Mounting type	-	Wall / Column mounted
6.	Mounting arrangement along with all necessary hardware/ plates for fixing extinguishers	-	To be provided.
7.	Material of construction	-	
	a) Body		Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved
H.	Trolley mounted CO2 type fire extinguisher (if applicable)		
1.	Extinguishing agent Type	-	CO2 type as per NFPA 10
2.	Extinguisher handling mode	-	Mobile – Trolley/ Wheeled mounted
3.	Class Of fire	-	B, C



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Sl. No.	Description	Unit	Technical Requirements
4.	Capacity	kg	20 kg (minimum)
5.	Mounting type	-	Wheel type trolley
6.	Trolley	-	Carbon steel with corrosion resistant coating
7.	Wheel type	-	Toughened Rubber
8.	Material of construction		
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved
I.	Trolley mounted Foam type fire extinguisher (if applicable)		
1.	Extinguishing agent Type	-	FOAM type as per NFPA 10
2.	Extinguisher handling mode	-	Mobile – Trolley/ Wheeled mounted
3.	Class Of fire	-	A, B
4.	Capacity	kg	20 kg (minimum)
5.	Mounting type	-	Wheel type trolley
6.	Trolley	-	Carbon steel with corrosion resistant coating
7.	Wheel type	-	Toughened Rubber
8.	Mounting arrangement along with all necessary hardware/ plates for fixing extinguishers	-	To be provided


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Sl. No.	Description	Unit	Technical Requirements
9.	Material of construction		
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved

5.0 Inspection and Testing

The scope of inspection shall comprise of but shall not be limited to the following:

- a) The requirements of NFPA for the various systems shall form the basis of the inspection test protocols. The Bidder shall submit an acceptance test procedure for approval.
- b) After completion of work, site tests shall be carried out to demonstrate satisfactory performance of the entire system.
- c) Representatives of the Bidder, Owner, Owner's insurance carrier and local firefighting authority may witness the testing if required.
- d) After successful placement in operation of the complete fire protection system, the Bidder shall submit a fire protection system report.
- e) The Bidder shall complete and submit the Inspection and Test forms required as per NFPA as follows:
 - (i) Inspection and Testing Form based on NFPA.
 - (ii) Supplier's Material and Test Certificate as per NFPA.

5.1 Inspection:

- a) Prior to testing, the complete system shall be visually inspected for completeness.
- b) Inspection of fire protection equipment, piping, valves and fittings shall comply with this specification unless otherwise specified in the equipment requirements.
- c) Prior to system energization, a complete check of all wiring and connections shall be performed. Each electrical component shall be checked and confirmed as operational.



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5.2 Tests at Site

5.2.1 Acceptance Tests:

All required acceptance tests shall be performed and complete the "Material and Test Certificate" as specified in NFPA standard. Visual and performance aspects of the acceptance tests shall be to the satisfaction of the Owner and shall be done in the presence of the Inspector.

5.2.2 Performance Tests:

Each fire protection equipment shall be performance tested to demonstrate satisfactory operation and to provide base data for the assessment of performance throughout the operating life of the equipment.

Unless otherwise specified in the equipment requirements, the program of performance test shall include at least the following:

- a) Determination of maximum continuous rating (worst case scenario)
- b) Determination of normal operation and performance
- c) Leak test

6.0 Data to be furnished by Vendor after award of contract:

- a) Detailed design / drawing submission schedule including erection, testing & commissioning schedules.
- b) Quality assurance plan.
- c) Material test certificates.
- d) Operation and maintenance manual for all equipment.
- e) Technical data sheets for all equipment covered.
- f) Detailed write-up, Layout drawings and equipment drawings etc.
- g) Installation drawings and manuals for all equipment / systems.
- h) Detailed write-up for shop tests and site performance tests.
- i) Test certificates for type / routine and standard acceptance tests.
- j) As-built drawings for all equipment / systems supplied under this contract and all buildings / structures / works executed under this contract incorporating all changes / modifications up to the time of commissioning / handing over to the Owner.
- k) Materials test certificates and performance test certificates for all equipment tested at works.
- l) Drawings / data required to be submitted to statutory authorities.


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- m) Any other document / details as required as per approved QAP.
- n) Current UL / FM certificates.

C4 - CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM
1.0 Introduction: Closed Circuit Television System (CCTV)

1.1 The CCTV System shall be meant for gathering video information from the various areas of the plant with display and recording facilities with night vision and motion sensors as per requirement per requirement.

1.2 The location of the Fixed or PTZ (Pan Tilt Zoom) or combination shall be as follows

- a) Inverter Stations
- b) SCADA, Monitoring and store room buildings
- c) Switchgear Sheds
- d) All Entry/Exit Gates
- e) Security/Guard room
- f) All gates for entry

CCTV Surveillance of periphery of project is recommended. Number of cameras shall be selected based on it.

1.3 The CCTV system shall be designed as a standalone IP based network architecture.

1.4 System shall use video signals from different cameras at different locations, process the video signals for viewing on monitors at Control building and simultaneously record all the video streams using H.264 or better compression technique.

1.5 A complete integrated CCTV system with all hardware and software as required shall be supplied to enable on-line monitoring and to generate a record to facilitate post event analysis. All components of the system shall be designed for continuous operation. The area under surveillance shall be monitored and controlled from the Control Room through workstation and mouse/keyboards. Bidder's offered CCTV system shall include but not limited to the details specified in subsequent paragraphs.

1.6 The CCTV system shall be high quality, high performance, network based, and digital video security systems and shall be designed to allow persons to be clearly seen at any position



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within the area of coverage. The camera locations shall be such that full coverage of the station shall be provided.

- 1.7 IP based Camera system shall be provided for CCTV monitoring. All cameras and CCTV system shall be connected to Industrial Ethernet switches through Fibre Optic cable for transferring camera video signals. Ethernet switches will then be connected to a network controller to a separate high-speed LAN that shall handle high-capacity video files.
- 1.8 Video imaging and associated equipment including cameras, lenses, camera housings / protection, integral dome cameras, etc. Transmission equipment including optical fibre cable, co-axial cables, control and power cables, conduits, tee-offs, splitters, ground isolation transformers, amplifiers, media converters for wireless/Fibre Optic transmission etc.
- 1.9 The CCTV System along with all its system components i.e. network switches, storage devices, servers, LAN switches, media converters etc. shall be powered from UPS system. Bidder shall also provide local power distribution boxes as required for sub distribution of UPS supply.
- 1.10 Camera server shall be provided with sufficient storage space to store recordings of all cameras at 25/30 FPS at 1920X1080 (For HD cameras) using necessary compression techniques. All recordings shall have camera ID, Location, Date and time of recording.
- 1.11 Application Software for Video Monitoring, Recording & Management shall be used to display, store, control & manage the entire surveillance system. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitors for live video. The system shall support video analytics Video motion detection, Object tracking, Object classification Tracking
- 1.12 LED screen quantity shall be decided based on the number of cameras and in such a way that all cameras shall be monitored simultaneously, without any interruptions
- 1.13 Bidder shall furnish the absolute (maximum) limit for the no. of system components i.e. Cameras, etc., that can be connected/handled by the offered system and any limitations/constraints in expanding the offered system.
- 1.14 The system supplied shall be complete in all respects for reliable performance. The Bidder shall submit the detailed block schematic, video, signal & power wiring diagram, describing



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the connections between the network switch/camera server Systems and various cameras, monitors, keyboard, and joystick.

- 1.15 Bare copper 1x50mm² for grounding under the trenches. The system will be connected to the Plant general grounding. Each CCTV pole (if any) shall be connected to the station grounding system. For termination with the buried part of grounding grid a multiple under-ground connection is allowed, that shall be provided following the procedure for grounding conductor extensions.
- 1.16 Fixed position cameras with variable focal length lenses facilities shall be employed as required to give the necessary coverage.
- 1.17 Galvanized steel poles of 4m height shall be provided.
- 1.18 CCTV system must be feed from the critical loads supply (UPS).
- 1.19 Security Logger located in the Control Building.
- a) CCTV recording for at least 30 days shall be stored in the hard disk. The CCTV server shall have features to transfer CCTV recording storage to external hard disk through USB port. The CCTV recording stored on external hard disk can be retrieved and played back in CCTV server or any other computer on windows media player, without requirement of any additional software or hardware.
 - b) CCTV system shall be programmed to see live CCTV screen/recording on any popular web browser, without need of any additional software or hardware. For authentication of user, user id and password shall be required. User id and password can be changed from CCTC server only in administration mode.

2.0 Codes and Standards

IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60728	(a) Cable distribution system primarily intended for sound and telev operating between 30 MHz and 1 GHz.
EIA	Electronic industry association standards.
IEC 60870-5-104	Standard for TCP/IP protocol



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IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related system
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Standards not indicated in the specification are acceptable subject to approval by the Purchaser/Purchaser's Consultant if they are established to be equal or superior to the standards indicated in the specification. In case of conflicts between the standards and this specification, this specification shall govern.

3.0 Design Criteria

3.1 IP Based Fixed Camera

- a) The IP Based Fixed cameras shall comprise minimum of an auto focus colour camera. The protection class shall be IP65 or better for outdoor & IP-55 for indoor. It shall feature back light compensation and line-lock synchronisation. It shall be possible to define presents and patterns/tours for the camera.
- b) Camera lenses shall have a shall be at least 1/3 inch or better with Full HD resolution. The cameras shall be with Wide Dynamic Range (WDR).
- c) For each camera, the operator shall be able to configure the parameters such as camera streamer type, resolution, video frame rate, choice of live levels of video compression, equally distributed from minimum to maximum compression, streamer IP address, streamer camera number, choice of frame rate or bandwidth limited streaming, unicast or multicast transmission of video, PAL camera format.

3.2 Video Recording

Network video recorders should be provided to record continuous videos from all cameras and continuous snapshots from critical cameras. High-capacity discs should be installed and the time between each snapshot should be chosen so that overwriting will not occur in less than 24 hours or as specified by the OWNER. The emergency / contingency plan for the Solar plant should provide for the removal of discs after an event to prevent further overwriting and to allow for later analysis.

3.3 Network Array Storage

The storage capacity of each NVR/NAS shall be not less than 30 days with 15 FPS per camera. An alarm shall be initiated when storage capacity of any NVR/NAS reaches 80%. On failure of a storage element, transfer to the redundant storage element shall be


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automatic. The storage system shall have facilities to superimpose camera number and date/time data on the images.

3.4 Power Supply

- a) The system (cameras, monitors and recorder(s)) shall be connected to a power supply which will continue to operate in the case of a mains power failure. This supply can be the plant emergency generating set, instrument-vital, battery-based power supply, or a dedicated-vital power supply. The vital power supply should allow operation of the whole CCTV system for at least 4 hours.
- b) The system with cameras shall be provided with UPS 230 V AC power supply. Provision of UPS is included in the scope of bidder.
- c) Bidder shall derive internally all required voltages to operate the devices and all the necessary cabling including patch connectors, patch leads, accessories, adapters, etc. will be in the scope of the Bidder.

3.5 Mounting of Camera

- a) Wherever possible, existing non-vibrating structures shall be used for mounting the camera, otherwise special structures shall be provided. The Bidder can also use the Lighting poles (If feasible) across the plant to mount the cameras, otherwise separate pole to be considered to mount the cameras. The location of the camera shall be selected so that the camera and its supporting structure will present the least obstruction and the risk of accidental damage will be minimized. Where it is necessary, protective rails or fences shall be provided. The cameras shall be easily accessible for maintenance with fixed or mobile access platforms. Swing-type poles are not recommended.
- b) The apparent vibration of any object on the screen due to the vibration of the structure on which the camera is mounted shall be less than 2 mm with a frequency of less than 2 Hz.

3.6 Cabling

The instrumentation and control cables and Fibre optic cables shall be as per the Bidder offered system requirements & IEC standards. Any special cable required for the system shall be in the responsibility of the bidder. Conduits are to be provided for cables.

3.7 CCTV Monitor

- a) 24" monitor at for Central Control room with mouse, keyboard/joystick etc. shall comprise a high-resolution LCD/LED display with electronics housed in a rugged case. It shall provide a clear and well-defined picture display on the screen. All controls for



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brightness, contrast, etc. shall be provided on the front panel. The monitor shall feature loop through connections for coupling the video to other monitors.

- b) Multiplexing shall be provided. Resolution shall be Full HD. Number of characters per line shall be minimum 80 and number of lines per display page shall be minimum 48. Total number of characters shall be minimum 256 graphic characters + ASCII. Minimum Sixteen (16) colours shall be provided. Anti-reflection feature shall be provided. All VDUs shall have dedicated keyboard.
- c) Control Keyboard shall be a full-feature keyboard capable of performing programming functions, camera and monitor call-up, operation of sequences and patterns and alarm configuration/acknowledgement and the functions mentioned in for the front panel controls/indications above the unit shall be capable of multi-speed control of variable speed receivers/drivers. The keyboard shall be capable of connecting to the LAN.

3.8 CCTV Accessories

- a) Remote-controllable 'window' cleaning facility
 b) Rain/Sun shield
 c) Protective cover for the 'window'
 d) Thermostatically controlled internal and/or 'window' heaters to avoid internal condensation or condensation on the window.

4.0 TECHNICAL PARAMETERS

IP BASED FIXED CAMERA		
Sl. No.	Description	Technical Data
1.	Camera Locations	<ul style="list-style-type: none"> • PV Plant SCADA, monitoring and Spare Building. • Inverter Stations • 33kV Switchgear Stations • All Entry/Exit Gates • Security/Guard room • All gates for entry into different plots
2.	Enclosure Type	Boxed/Dome (As per requirement)
3.	Sensor Type	1/4" CCD or 1/3" CMOS, Day / Night Camera
4.	IR cut filter or IR corrected lens	Required


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5.	Lens Type - Zoom (Optical + Digital)	36x Optical Zoom and 12x Digital Zoom
6.	Resolution	1920x1080p
7.	Focal Length of Lens	*
8.	Light Sensitivity (AGC On)	0.01 Lux minimum
9.	Signal-to-Noise Ratio	> 50 dB
10.	White Balance	Auto/Manual
11.	Backlight Compensation	Auto/Manual
12.	AGC, Auto IRIS	Auto/Manual
13.	Privacy Masking	Required
14.	Compression/Digital Encoding	H.264 or better
15.	Max. Resolution PAL / NTSC	Full HD
16.	Horizontal Resolution	Full HD
17.	Max. Frame Rate/Video Capturing Rate	25/30 fps
18.	Video Output	1.0 V p-p / 75 ohm
19.	Light loss	*
20.	Presets	NA
21.	Patterns	NA
22.	Angle of View	*
23.	Range	* m
24.	Synchronisation modes	*
25.	F-STOP Range	F/1.4 to F/16
26.	Automatic gain control (AGC)	Min. 20 dB
27.	Network Interface/Speed	*
28.	Network support/Protocols	*
29.	Operating Temperature	40°C*
30.	Operating Relative Humidity	20 - 90% non-condensing
31.	Electronic shutter	* sec
32.	Surge Protection	Required for video, power input/output, communication, etc.
33.	Protection Class	Min. IP-55 for Indoor, Min. IP-65 for Outdoor,
34.	Standards UL, CE	Required



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35.	Type: photocell with integrated IR LED array (refer notes)	Built in camera or Separate source *
36.	Wavelength	*
37.	Beam angle	*
	Other Requirements	
38.	User definable sectors / zones (minimum 8)	Required
39.	Advanced Troubleshooting and diagnostics via diagnostic LEDs and on-screen displays	Required
	Accessories	
40.	Name Plate / Metal Tag	SS Name Plate
41.	All Installation Hardware	As per project requirement
42.	Sunshade & Wiping System	As applicable
	Tests	
43.	Type Test	As per QAP & ITP
44.	Routine Test	As per QAP & ITP
	• NA Not Applicable	
	• *Supplier to indicate	
	Note: These are the minimum requirements. Supplier/Vendor must furnish other important data as applicable.	
CAMERA SERVER/NETWORK VIDEO RECORDER		
Sl. No.	Description	Technical Data
1.	Video Resolution	Full HD -1080P,
2.	Video Frame	25/30 fps (PAL)
3.	Recording Mode	Time and events, alarm, manual trigger, continuous video.


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4.	Processor	Hexa core or Octa-core /3.5 GHZ/16 MB cache/128bit /10000rpm. *
5.	OS	Latest, standard 64 bit/*
6.	RAM	16 GB (min)
7.	Network	*
8.	IOPS	*
9.	Signal System	PAL
10.	Video Inputs	IP mode access
11.	Video Outputs	*/1 no. composite video and 1 SVGA.
12.	Video Compression	H.264 or better
13.	Alarm Inputs	*/Minimum 4 nos.
14.	Alarm Output	*/Minimum 4 nos.
15.	Pan / Tilt / Zoom Control	To be provided over serial link to the receivers; control keys on front panel / discrete keyboard to be provided.
16.	Image Rate Settings/Update Rate	Selectable from 1 to 50 images per second per camera in duplex mode.
17.	Hard Drive Storage Space	*/Minimum 4TB. (Internal Hard disk), SATA 3.5" 1000RPM.16 MB cache
18.	Connectors	To be provided for composite video inputs and outputs (BNC), alarm inputs and outputs, com ports, USB ports (4 Nos.), port for SVGA monitor, port for connecting to Ethernet TCP/IP LAN, parallel port for printer and port for power connections.

NETWORK ARRAY STORAGE (NAS)

Sl. No.	Description	Technical Data
1.	Capacity:	Min. 30 days data storage
2.	Configuration	*
3.	RAID Support	RAID 0, 1, 10, 5, and ,10,30,60 protection on a per-Storage Pool basis
4.	Expandability:	*
5.	High Performance	*
6.	Sophisticated networking	*


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7.	Mounting	Desktop
8.	Redundancy	Required
	• NA Not Applicable	
	• *Supplier to indicate	
	Note: These are the minimum requirements. Supplier/Vendor must furnish other important data as applicable.	

5.0 Vendor QUALIFICATION REQUIREMENT

Bidder shall present its relevant utility and CCTV experience (with references and contact information) and its financial capability to support the warrantee offered.

The Bidder shall confirm evidence, concerning the following:

- a) The vendor as a qualified manufacturer, who regularly manufactures the CCTV of the type and capacity specified and has adequate technical knowledge and practical experience.
- b) Financial stability and status adequate to meet the financial obligations pursuant to the scope of the works.
- c) Engineering and design capability, plant and manufacturing capacity and testing facilities available to perform the Works properly and expeditiously within the period specified. The evidence shall consist of written details of the installed manufacturing capacities and the present commitments of the Bidder.
- d) Field service organization shall provide the necessary field erection and management services required to successfully erect, test and commission the System as required by the Specifications and Tender Documents.
- e) The Bidder has established systems to provide quality assurance and organization designed to achieve high levels of Plant reliability, both during his manufacturing and field installation supervision activities.
- f) Provide reference for successful operation of CCTV for any PV plant at least 5 years.
- g) Further, The Bidder is required to submit with his Tender the information listed below for determination of financial, technical and production capabilities and qualifications to perform the Contract:



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- i. Company name of the Bidder, business address and place of incorporation.
- ii. Type of Company. Individually owned, partnership, corporation or joint venture including the names of its owners or partners.
- iii. Annual report and audited financial statements together with complete reports forming part of it giving general description of the Company, sort of business carried out, balance sheet and profit and loss statement for last three financial years, turnover and business done by the firm, duly authenticated.
- iv. The time since the Bidder has been in the CCTV business including the time since he has been engaged in similar works.

6.0 Test and Inspection

CCTV System shall be subjected to test as per approved quality plans/ test procedures to fully demonstrate to the purchaser's satisfaction, each equipment/ subsystem/ system as well as software modules (as applicable) furnished, fully meet the functional parameter and other requirements of the specification and purchaser's approved drawings/documents. The Bidder shall bring out in his proposal all such tests. Bidder shall be responsible in obtaining test certificates related to calibration of all the hardware and Instruments and submit for Purchaser approval.

The tests are intended to demonstrate that the individual hardware units and items of software are operational and comply with their individual specification, that they are compatible under these conditions and that when assembled into a complete system they will operate safely and effectively over an extended period with acceptably low outage time under the environmental conditions specified. The Bidder shall make the calibration records in the respective test reports. Test / Calibration Certificates shall be furnished for all the hardware and instruments for Purchaser review.

7.0 Drawings / Documents for Approval

- 7.1 Technical documentation consisting of engineering, manufacturing, erection, commissioning, operation, and maintenance package.
- 7.2 Electrical and Mechanical datasheets


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- 7.3 General Electrical and Mechanical Arrangement drawing
- 7.4 All relevant technical literatures and catalogues
- 7.5 CCTV Configuration diagram
- 7.6 CCTV Control philosophy
- 7.7 Interface details with other required System
- 7.8 Camera location drawing (Indoor & outdoor)
- 7.9 Bill of quantities for shipment and erection
- 7.10 Preliminary CCTV supports or foundations drawings with loads
- 7.11 Supports or foundations required design criteria
- 7.12 Equipment lists
- 7.13 Power Consumption & Heat Dissipation Data (UPS Sizing details)
- 7.14 Quality documentation including certificates according to the relevant codes and standards.

C5 - LIGHTING SYSTEM
1.0 Lighting System

- 1.1 This specification covers design engineering, supply, erection, testing and commissioning of lighting system with LED luminaires for the complete plant and not limited to the areas listed below (Indoor and Outdoor):
 - a) Inverter stations including IDT area
 - b) Sub-pooling switchgear stations, inverter station and including IDT Area
 - c) PV Plant SCADA, monitoring and spare room buildings
 - d) Entry and exit gates including security cabins.
 - e) Duty guard cabins

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2.0 Codes & Standards

Codes	Description
SP 72	National Lighting Code
IS 3646	Recommended Illumination Level
IS 1944-1	Outdoor Illumination level
IS 6665	Code of Practice for Industrial lighting
EN 61347-2	Particular requirements for D.C. or A.C. Supplied electronic control gear for LED modules
EN 62384	D.C. or A.C. supplied electronic control gear for LED modules.
EN 61000-3-2	Luminaire EMC specification. Electromagnetic compatibility (EMC)
IS 16101:2012	General lighting LED and LED modules, term and definition
IS 9537	conduit for electrical installation

3.0 General Technical Requirements

- 3.1 The lighting system for indoor areas of Solar Power Plant shall be designed in such a way that uniform illumination is achieved.
- 3.2 All LED luminaires shall be supplied with proper diffuser to avoid direct visibility of LED.
- 3.3 LED luminaires of renowned brands indicated in Schedule-IV shall be supplied.
- 3.4 The LED luminaire housing, heat sink, pole mounting bracket, individual LED reflectors and front heat resistant tempered glass should be provided.
- 3.5 The LED luminaire housing should be made of non-corrosive high pressure die cast aluminum and the housing should be power coated grey, so as to ensure good weatherability.
- 3.6 All lighting fixture suitable for indoor and outdoor shall be of LED Type without control gear. outdoor LED fixture shall have IP65 or better rating.



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- 3.7 The illumination level shall take into account appropriate light output ratio of luminaires, coefficient of utilization maintenance factor (of 0.7 or less) to take into account deterioration with time and dust deposition.
- 3.8 Tubular swaged type poles with junction boxes, cables, conduit, control gear and wiring etc. fitted with area lighting LED luminaires to be provided for transformer yards, outdoor switchgear area, inverter stations and other critical areas. The height of the poles to be decided by the illumination calculation to obtain the minimum illumination level indicated in the table below.
- 3.9 Each individual LED source should be provided with an asymmetrical distribution high reflectance aluminized reflector, which should ensure that the light distribution of the luminaire is suitable for the area to be illuminated..
- 3.10 The distribution of lighting fixtures / receptacles shall be such that the loading on each phase of the LDB is approximately equal. Loading per circuit shall preferably be limited to 2000W.
- 3.11 All the lamps indoor and outdoor lighting fixture shall be energy efficient LED luminaire with luminous Efficacy of 110 lumen/W or better
- 3.12 Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires, the following colour wires shall be used.
- a) R – Phase - Red
 - b) Y – Phase - Yellow
 - c) B - Phase - Blue
 - d) Neutral - Black
- 3.13 Adjacent light fixtures in inverter station/PEB shall be provided with alternate phase supply.
- 3.14 Colour designation of LED shall be cool day light minimum (5700 K) type for indoor LED luminaires. further for outdoor type luminaires, the colour designation shall be 5000k . the Led luminaires shall have minimum life of 25000 burning hours with 80% of lumen at the end of life
- 3.15 Photometry calculation and Design data shall be provided during detailed engineering stage The lighting panels shall be rated for 415V, 3 phase, 4 wire, AC with neutral bus and earth bus and suitable for wall / column mounting / Floor mounting.
- 3.16 Wall mounted switches shall be provided at the entrance to equipment / office rooms. Occupancy sensors & lighting panels with auto / manual mode shall be provided for all indoor areas. Occupancy sensor with separate panels for separate lighting zones shall be provided at each entry-exit.
- 3.17 Each Outdoor lighting circuit shall be controlled locally from push button stations provided at strategic locations. Outdoor lighting circuit can be operated from any of the push button station independently (Stop push button shall be of NO type with required interposing relay in feeder / control cubicle). Outdoor lighting shall have auto / manual mode of operation.



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- 3.18 Adequate numbers of power sockets 5/15 A shall be provided in all indoor areas. Details shall be finalized as per purchaser's requirement. Receptacles with decorative cover plates shall be used in office / control rooms
- 3.19 Each outgoing circuit shall have RCBO (RCCB+MCB) of required rating and sensitivity. Outgoing RCBO (RCCB+MCB) shall have thermal elements for overload protection and instantaneous magnetic trip to protect against severe faults.
- 3.20 20A, 240V, single phase industrial receptacles shall be provided in Transformer area to provide 240V supply outlets for small power services such as drilling, grinding etc.
- 3.21 Suitable nos. Ceiling fans are to be provided in all indoor areas. (Also to be provided where AC's are considered). Ceiling fan shall be of BLDC technology with highest energy efficiency rating (Specifications similar to Atomberg). The Bidder shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and board for mounting switch, suspension rod, canopy and accessories. The electronic regulator for Ceiling fans will be housed in common switchboard for lighting and shall be of similar make and model as that of modular switches. The wall mounted fans shall be of 400 mm sweep. Exhaust fans shall be of 300mm size. Winding of the fans shall have Class-E insulating material. Winding shall be of copper wire.
- 3.22 Building peripheral lighting shall cover all walls of the building and at least 3 meter parallel to building wall.
- 3.23 All fixing / locking screws, washers, nuts, brackets, studs etc. shall be zinc plated and passivated. All supports / fixing / mounting structures, Hardware & accessories shall be GI only.,
- 3.24 Colour rendering index:
- a) For outdoor/ Industrial interior area lighting, CRI \geq 70
 - b) For office room/ control room etc., clean interiors, CRI > 80
- 3.25 Lighting pole shall be tubular type, galvanized steel (minimum 910gm/sq.mm), joint less, supplied with base plate (with minimum 300mm PCD, 12mm thick), foundation bolts (SS-316 or, better), necessary fixing-bracket for fixing the luminaire. Lighting pole shall have integral junction box (minimum IP 55). In each lighting panel, 4 pole TPN Surge Protection Device, type-2 shall be provided. The System shall be capable of withstanding the appropriate wind load etc as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole.
- 3.26 SS 304 grade Integral Junction Box shall be minimum of 100 x 400 mm (H x W) and shall be minimum at 1200mm from base of pole. The foundation bolt & finished top of civil foundation for lighting poles shall be minimum 150mm higher from FFL of road shoulder. Foundation for Lighting Pole shall be of M-35 grade RCC.



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- 3.27 For outdoor lighting, XLPE insulated, armoured, FRLS aluminum / copper conductor cables shall be provided. Cables from lighting pole to pole and any underground lighting cable shall be laid in HDPE pipes (of size minimum of 1.75 times of total cable OD passing through) with smooth inside surface.
- 3.28 Light poles, junction boxes with integral poles, cable and cable boxes / glands shall be connected to the earthing conductor running along with the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points. Earthing installation shall be carried out as per IS 3043.
- 3.29 The light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB
- 3.30 The Cable glands shall be weather proof Double compression type made of heavy duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 micron. Cable glands shall conform to BS:6121.
- 3.31 All Cable lugs for power cables shall be Heavy duty Long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve.
- 3.32 All control terminal shall be of Stud type (screw drive operated) and control wiring shall be terminated with tinned copper ring type lugs with insulated sleeve. 20% spare terminal shall be provided of each type. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS:375. Red Ferrules should be provided on trip circuit wiring.
- 3.33 All metallic hardware such as nuts, bolts, screws, washers etc. shall be of Hot dip galvanized as per IS standard.
- 3.34 All cable entries shall be located at bottom side of the panels / Junction boxes / MKs /DBs etc to prevent any possibility of water ingress into the box. All panels/Junction boxes/MKs /DBs etc shall be min. 450mm above finished floor level for cable connections.
- 3.35 Outdoor panels / JB's / MKs /DBs etc shall be completely weather-proof with a sloping extended SS304 / Aluminium canopy for protection against rain and providing a degree of protection of IP 55.
- 3.36 Painting of all metallic enclosed electrical panels / JB's / MKs /DBs etc shall be of paint shade RAL -7035 and Shall be as per ISO 12944-5, corresponding to minimum C4-M category specifications.
- Unless noted otherwise all steel structures exposed to environment would be painted to meet the requirements of corrosion category or would be galvanized to minimum as specified in Project information section.
- 3.37 Design shall be as per Seismic Zone - V of IS 1893.

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4.0 Illumination Levels

Average LUX level to be maintained in various areas shall be as under:

Sl. No.	Area	Average Lux
1.	SCADA cum Office Room and Meeting Room, etc.	300
2.	Sub-pooling station	250
3.	Inverter Station (Outdoor area)	150
4.	Battery Room	200
5.	Kitchen cum Pantry	150
6.	Spares Room	100
7.	Toilets	50
8.	Transformer Yard	50
9.	Periphery	10

5.0 Emergency Light Points

5.1 Emergency Light points with LED lamps of 15-20 W (at 240 V) shall be provided for following areas:

- a) Inverter Stations
- b) Security and Guard rooms
- c) Sub-Pooling Stations
- d) PV SCADA, Monitoring and Spare room buildings

5.2 These lights shall operate on AC/DC changeover supply from the UPS distribution Board. Emergency AC lighting system shall be fed from normal supply and from emergency supply from UPS only during normal supply failure. Automatic change over scheme with sensing devices shall be incorporated in each lighting distribution board. Manual change over with interlock shall also be provided. Separate wiring and distribution board shall be provided from these lights. Separate modular switchboards for Emergency lighting shall be provided. Colour of the switchboard shall be different from normal switchboards.

5.3 The location of emergency lights shall be strategically decided to enable proper evacuation of personnel with help of Exit lamps. Emergency Light shall also cover the Fire Alarm and manual call point area.

5.4 Quantity of light fixtures shall be decided based on design calculations during detailed engineering.



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6.0 Receptacle units

- 6.1 240V, 50 Hz, 3 pin Power Receptacles 6A and 16A shall be provided in all buildings. Inside a building, receptacles shall be provided for hand tools, water coolers etc. Minimum 2 Nos. of 6A and 1 No. 16A receptacles shall be provided in each room. 16A receptacles shall be provided for exhaust fans wherever required. Receptacle units shall consist of socket outlet with associated switch, neon indicating lamp and plug. The socket outlet and MCB shall be flush mounted within a galvanized 1.2 mm thick CRCA sheet steel enclosure.
- 6.2 20A metal clad type sockets shall be provided for AC & ventilation and shall be controlled through MCCBs.
- 6.3 All receptacles shall be of heavy duty type, suitable for fixing on wall/column and complete with individual switch. The outdoor Receptacles shall have IP 55 (minimum) protection. Receptacles shall be housed in a box made out of 1.5 mm thick Stainless Steel of Grade 304 with hinged doors with suitable locking arrangements. Door shall be lined with good quality gasketing.
- 6.4 The enclosure shall be with extended rain canopy and removable gland plate entry from bottom. Composite receptacle with switch modules housed in a box shall be with degree of protection IP 66.
- 6.5 The receptacle units shall be suitable for 240 V, 1 phase, 50Hz/ supply.
- 6.6 Single phase receptacles shall be associated with a switch / MCB of same current rating and the receptacle shall become live only when the associated switch / MCB is in "ON" position.

7.0 Lighting wires / cables

The wires for wiring in lighting system shall be 1100 V, 1 core, PVC insulated, with stranded copper conductors. The minimum area of conductors shall be 2.5 sq.mm for light fittings / Industrial fans and 4 sq.mm for receptacles. In outdoor areas such as transformer yard and road lighting, cable wiring shall be adopted. The cables for outdoor lighting shall be 1.1 kV grade, with single / multicore stranded copper conductor, insulated with PVC inner sheath, armoured, FRLS PVC outer sheathed, conforming to IS 1554. Cables below 6sq.mm size shall be with copper conductor only. Minimum cable size shall be 4 sq mm and 6 sq.mm, for wiring of lighting equipment and receptacles respectively where cable wiring is specified.

8.0 Conduits

- 8.1 Non metallic conduits and their associated fittings shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm diameter for concealed installation.
- 8.2 Steel conduits shall be seamed by welding and hot dip galvanised unless otherwise specified. They shall be supplied in standard lengths of 5 m.
- 8.3 Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting installation work.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- 8.4 Separate conduits shall be provided for normal and emergency lighting.
- 8.5 Each conduit shall be limited to one lighting circuit.
- 8.6 All conduits shall be FRPVC and surface mounted in general. In office rooms and control rooms, conduit shall be concealed/wall mounted type. Conduit fill criteria shall not be more than 50%. Conduits should have the minimum number of bends in their run with pull boxes at suitable locations. Conduits shall be sloped to avoid water accumulation and draining into the equipment at its end.
- 9.0 Lighting distribution board and lighting panels**
- 9.1 Outdoor LDBs for area lighting shall have ON/OFF operation through real time-based timer in addition to manual control. In this case, incomer to LDB shall have suitably rated contactor in addition to MCCB and same shall be controlled by timer.
- 9.2 When some of the outgoing feeders of indoor LDBs are used for street lighting / area lighting, these feeders shall have timer contactors in addition to MCCB.
- 9.3 Boards and panels shall be CRCA sheet of 2mm thick with paint shade of RAL 7035 painting as per project information. enclosed and shall be fully dust and vermin proof. Outdoor panels shall in addition be completely weather-proof with a sloping extended canopy for protection against rain and providing a degree of protection of IP 55 and IP 42 for indoor applications. Panel shall have adequate space at least 20% free space shall be provided for mounting of components including cable entry, DIN channel etc. Design and dimensions of the panel / DB shall be finalized during detailed engineering.
- 9.4 All boards and panels shall be provided with double door type hinged doors and suitable locking arrangement for access to equipment. Doors shall be gasketed all round with neoprene gaskets. The floor mounted lighting distribution boards shall be provided with MCCB for incomer and outgoing feeders with MCBs arranged in tier formation. For wall mounting lighting panels when provided with ELCBs and MCBs a hinged, latched front door shall be provided with a slotted bakelite sheet inside. Only the ELCBs/MCCBs operating knobs shall project out of the bakelite sheet slots for safe operation and neat appearance.
- 9.5 All accessible live connection / metals shall be shrouded and it shall be possible to change individual MCBs and ELCBs from the front of the boards/panels without danger of contact with live parts.
- 9.6 For floor mounting type lighting distribution boards, adequately sized mounting channels shall be supplied and for wall/column/structure mounting type panels suitable mounting straps shall be provided.
- 9.7 Adequate interior cabling space and suitable removable cable entry plates shall be provided for bottom entry of cables through glands and or conduits. Necessary number of glands to suit the specified cable sizes shall be provided.
- 9.8 The Cable glands shall be weather proof Double compression type made of heavy duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 micron. Cable glands shall conform to BS:6121.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- 9.9 All Cable lugs for power cables shall be Heavy duty Long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve.
- 9.10 Two earthing terminals shall be provided for all Boards/Panels.
- 9.11 All control terminal shall be of Stud type (screw drive operated) and control wiring shall be terminated with tinned copper ring type lugs with insulated sleeve. 20% spare terminal shall be provided of each type. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS:375.
- 9.12 All wiring shall be carried out with wires of 1.1 KV grade, stranded copper conductors. The insulation shall be flame retardant. Power circuits shall be wired with stranded copper conductors of adequate sizes to suit the rated current, the minimum size shall be 2.5 sq. mm. Unless otherwise specified, control alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 sq. mm.
- 9.13 All metallic hardware such as nuts, bolts, screws, washers etc. shall be of Hot dip galvanized as per IS standard.
- 9.14 All cable entries shall be located at bottom side of the panels / Junction boxes / MKs /DBs etc to prevent any possibility of water ingress into the box. All panels/Junction boxes/MKs /DBs etc shall be min. 450mm above finished floor level for cable connections.

10.0 Earthing

Light fittings shall be earthed by 12 SWG GI wires, run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit.

10.1 Earthing for Light Poles

GI flat of adequate size shall be laid / buried in ground at a depth of 600 mm along with lighting cables and from this strip, two (2) Nos. GS flat riser shall be tapped off for earthing of light poles and junction boxes on the poles. The earth conductor shall be connected to the nearby main earthing grid at the first and last poles of each feeder circuit and at some intermediate poles. In case the main earth grid is far away from the pole, local earth pit shall be provided for pole earthing.

Local rod earthing shall be provided for each of the light poles and the same shall be connected with two (2) Nos. GS flat from the pole.

11.0 Testing and Commissioning

Before a completed installation is put into service, installation tests stipulated in applicable standards and codes of practices shall be carried out by the Bidder in the presence of the Owner's representative.

12.0 Data to be furnished after award of Contract

12.1 Drawings / Documents for approval:


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- a) Lighting design calculations for all the areas covered under the scope.
- b) Lighting layout drawings.
- c) Circuit distribution scheme.
- d) Single line diagrams
- e) Descriptive and illustrative literature on the lighting fixtures.
- f) Performance data of each fixture giving utilization factor, light distribution curves and technical data of fixtures & accessories.
- g) General arrangement drawings of lighting distribution boards, lighting panel, and fixtures showing outline dimensions, fixing details, size and locations of cable entries and earthing terminal.
- h) Diagrams showing wiring inter connection between all the accessories of the fixtures.
- i) Quality Plan

12.2 Drawings / Documents for information:

- a) Type and routine test certificates of all luminaries and standard accessories e.g. ballast, capacitors, lamps etc.
- b) Engineering data and O&M manuals.
- c) The manual shall furnish catalogue numbers of all components liable to be replaced during the life of the fixtures.
- d) Any special instructions regarding assembling and handling of the fixtures.

C6 – INSTALLATION WORKS
1.0 SCOPE OF WORK:

Scope of work shall include following items / equipment / service to be supplied, stored, fabricated, installed, connected-up / wired, tested and commissioned by the Bidder in the plant area specified hereafter:

- a) PV Modules (Free issued by Owner)
- b) MMS / Tracker system
- c) Module cleaning system works
- d) String Combiner Box
- e) Inverters
- f) Inverter Duty Transformers, Auxiliary Transformers
- g) 33/11 kV switchgears
- h) LV Switchgears, ACCBs, ACDBs, etc.
- i) UPS System
- j) 110V Battery and Battery Charger, DCDB
- k) Earthing and Lighting system



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- l) Cable laying system
- m) Erection, Testing and commissioning of Critical equipment shall be done in supervision of OEM.
- n) Miscellaneous works

2.0 PV Modules

- 2.1 PV modules free issued by the Owner shall be unloaded, stored and transported within solar PV plant with utmost care and shall be installed as per manufacturer's recommendations and instruction manuals.

3.0 String Combiner Box

- 3.1 Bidder shall ensure that combiner box post must be plumb and properly aligned to level in accordance with site specific construction plan. Combiner boxes shall be mounted as per specified height and ground clearance not less than 600mm. Bidder shall use specified mounting hardware or hardware that has been approved by Owner's engineer.

- 3.2 Sufficient cable loops shall be left beneath the combiner box to allow proper termination of DC cables within combiner box. Termination of all input cables shall be done with pin type cu lugs and properly inserted within spring cage type terminal block of DC fuse holder and terminal block.

- 3.3 Termination of all DC output cables shall be properly torqued and torque marking shall be provided. Ensure that all connections show torque marks.

- 3.4 Combiner Box shall be grounded per drawing details. SPD shall be earthed through the minimum 16sq.mm Cu cable and terminated to nearest DC earth grid riser. Termination distance for SPD earth shall not be more than 2m.

- 3.5 All combiner boxes shall be labelled as per project drawing requirements.

3.6 Testing:

- a) All combiner boxes shall be fully tested on site prior to putting into service to ensure that all items are in required working condition, correctly installed and free from damage. An experienced and qualified testing Engineer shall be engaged by the Bidder to perform the site testing and commissioning.
- b) Following minimum tests shall be carried out on all the combiner boxes.
 - i. Each individual string shall be visually inspected for its orientation and proper interconnections with other modules.
 - ii. String Voc open-circuit and string Isc short-circuit current tests shall be conducted for 100% of the strings, unless otherwise approved by Owner.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- iii. Open-circuit Voc voltage and short-circuit Isc current tests shall be conducted for 100% of the combiner boxes.
- iv. Polarity test shall be carried out on each string. The value of open circuit voltage Voc shown by meter should be positive for required polarity. If a reversed polarity connection is detected in any one part of the system, DC polarity re-testing shall be done after reconnection. After testing the polarity of each cable, the polarity label and the circuit label shall be checked.
- v. The DC system test shall be recorded in an electronic log file.

4.0 Inverters

4.1 Central Inverters

- 4.1.1 The inverters shall be mounted / fixed on channels through mounting holes provided at the base of the inverter. If the inverter is provided with clamping plates, it shall be placed on the foundation before the fixing holes are drilled. Bidder shall ensure that Inverters are plumb and properly aligned to level in accordance with site specific construction plan.
- 4.1.2 Visual inspections shall be performed to confirm that all Inverters are appropriately installed, mounted, aligned and connected and are free of damage, corrosion, heavy soiling and construction debris and to identify any visually observable defects, other faults that require correction prior to proceeding with further testing. All Inverters shall be labelled as per project drawing requirements. A visual inspection log shall be completed for each of the inverter.
- 4.1.3 Clearance to be maintained with respect to other panels shall as per approved drawings and relevant standards. Bidder shall obtain a specific approval on Inverter room general arrangement drawing from the Inverter manufacturer in order to ensure no default on manufacturer warranty terms.
- 4.1.4 Inverters shall be mounted as per specified front, side and rear clearances. Bidder shall use specified mounting hardware or hardware that has been approved by Owner's engineer.
- 4.1.5 Sufficient cable loops shall be left prior to entering DC cables within Inverter station to allow proper termination of DC cables. Termination of all the cable inputs shall be done with bimetallic tubular lugs.
- 4.1.6 All DC input terminations shall be adequately torqued with appropriate torque marks as evidence.
- 4.1.7 Bidder shall ensure visibility of cable tags / labels within the specified distance of termination for both positive and negative conductors.


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

4.1.8 Inverter shall be grounded as per inverter manufacturer's recommendations. Inverter negative pole shall be suitably grounded with a minimum of 75x6mm GI strip or 150mm² copper cable only.

4.1.9 Termination of all AC and DC cables shall be done with suitable double compression glands, bimetallic lugs, washers, nuts and bolts. All terminations shall be fastened with proper torque values.

4.1.10 **Testing:**

a) All Inverters shall be fully tested on site prior to putting into service to ensure proper working condition, correctness of installation and free from damages. Testing and commissioning of inverters shall be conducted only under the supervision of manufacturer's representative or authorised and trained engineer of manufacturer.

b) Following minimum tests shall be carried out on all the Inverters prior to commissioning:

- i. Open-circuit VOC voltage shall be conducted for 100% of the combiner boxes inputs to Inverters.
- ii. Polarity test shall be conducted out on each PV module string. The value of open circuit voltage VOC shown by meter should be positive for proper polarity. In case VOC is negative, then DC terminations should be reversed.
- iii. Depending upon the inverter type and the instruction manual, the routine tests and acceptance criteria may differ. Unless otherwise specified by the inverter manufacturer, the following minimum tests shall be performed for inverter commissioning:
 - (a) Functional test on exhaust fans.
 - (b) Clockwise phase sequence availability for auxiliary power.
 - (c) Checking that cable connections for firmness.
 - (d) Checking inverter cabling for conformity to schematic diagrams.
 - (e) Checking of suitability of termination of incoming and outgoing cables / bus duct as per project drawings.
 - (f) Checking AC grid voltage. AC voltage measurements between the external conductors should be approximately the same as the nominal voltage of the inverter.
 - (g) Checking the internal AC power supply.
 - (h) Inserting fuses or links (if applicable).
 - (i) Checking of status indicators by switching on the voltage supply by turning on the grid monitoring circuit breaker (if applicable) and the external voltage supply circuit breaker. Status indicators should not show any fault.
 - (j) Checking of power export to the grid (if the irradiation level is above the inverter threshold) and for any abnormal noise.

4.2 **String Inverters**



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- 4.2.1 The inverters shall be mounted / fixed on MMS structures (if approved by tracker manufacturer or on a separate structure through mounting holes provided at the rear side of the inverter. Bidder shall ensure that Inverters are plumb and properly aligned to level in accordance with site specific construction plan.
- 4.2.2 Visual inspections shall be performed to confirm that all Inverters are appropriately installed, mounted, aligned and connected and are free of damage, corrosion, heavy soiling and construction debris and to identify any visually observable defects, other faults that require correction prior to proceeding with further testing. All Inverters shall be labelled as per project drawing requirements. A visual inspection log shall be completed for each of the inverter.
- 4.2.3 Bidder shall use specified mounting hardware or hardware that has been approved by Owner's engineer.
- 4.2.4 Sufficient cable loops shall be left prior to entering DC cables within Inverter station to allow proper termination of DC cables. Termination of all the cable inputs shall be done with bimetallic tubular lugs.
- 4.2.5 All DC input terminations shall be adequately torqued with appropriate torque marks as evidence.
- 4.2.6 Bidder shall ensure visibility of cable tags / labels within the specified distance of termination for both positive and negative conductors.
- 4.2.7 Inverter shall be grounded as per inverter manufacturer's recommendations.
- 4.2.8 Termination of all AC and DC cables shall be done with suitable double compression glands, bimetallic lugs, washers, nuts and bolts. All terminations shall be fastened with proper torque values.
- 4.2.9 **Testing:**
- a) All Inverters shall be fully tested on site prior to putting into service to ensure proper working condition, correctness of installation and free from damages. Testing and commissioning of inverters shall be conducted only under the supervision of manufacturer's representative or authorised and trained engineer of manufacturer.
 - b) Following minimum tests shall be carried out on all the Inverters prior to commissioning:
 - i. Open-circuit VOC voltage shall be conducted for 100% inputs to Inverters.
 - ii. Polarity test shall be conducted out on each PV module string. The value of open circuit voltage VOC shown by meter should be positive for proper polarity. In case VOC is negative, then DC terminations should be reversed.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

- iii. Depending upon the inverter type and the instruction manual, the routine tests and acceptance criteria may differ. Unless otherwise specified by the inverter manufacturer, the following minimum tests shall be performed for inverter commissioning:
- (a) Clockwise phase sequence availability for auxiliary power.
 - (b) Checking that cable connections for firmness.
 - (c) Checking inverter cabling for conformity to schematic diagrams.
 - (d) Checking the internal AC power supply.
 - (e) Inserting fuses or links (if applicable).
 - (f) Checking of status indicators by switching on the voltage supply and the external voltage supply circuit breaker. Status indicators should not show any fault.

5.0 Inverter Duty Transformers

- 5.1 All components despatched separately shall be cleaned inside and outside before being fitted. Utmost care shall be taken to prevent any foreign material from being dropped into transformer.
- 5.2 The transformer shall be moved into position through railings (if applicable) or placed in position as per project drawings and the base should be levelled. Erection, Testing and commissioning shall be carried out in supervision of OEM representative.
- 5.3 Plinth height should be maintained at minimum 750mm from the Natural ground level.
- 5.4 All connections should be examined for proper contacts, sealing and tightness. The sizes of cables, bus bars, earthing conductors should be cross verified.
- 5.5 Installation of firefighting arrangement shall be carried out if applicable in supervision of OEM. Clearances should be maintained as per applicable Electricity norms and standards. All transformers shall be provided with stone pebble filled soak pits.
- 5.6 Calibration of the WTI and OTI should be checked with hot oil. Working of the WTI / RTD repeaters shall be checked at the control room. Testing of buchholz relay shall be done.
- 5.7 Cable ends should be sealed to prevent from absorbing moisture. All cable boxes, metallic sheathing and armouring shall be efficiently earthed. as per vendors/ system requirements.

The Cable glands shall be weatherproof Double compression type made of heavy duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 microns. Cable glands shall conform to BS:6121.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

All Cable lugs for power cables shall be Heavy duty Long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve.

- 5.8 Sampling valve or drain valve should be conveniently arranged for drawing oil samples.
- 5.9 The phase to phase clearance after completion of CCA shall not be less than 18mm in any case.
- 5.10 Transformer to be stored and preserved (short and long durations) at site as per OEM recommendations.
- 5.11 **Testing:**
- a) The transformers shall be fully tested on site prior to putting into service to ensure that all items are in proper working condition, correctly installed and free from damage. An authorised testing professional Engineer shall be engaged by the Bidder to perform the site testing and commissioning.
 - b) Tests shall be performed at site as mentioned in relevant section of this tender:
- 5.12 Transformer tap-changing, temperature relays & controls and all other auxiliary relays shall be operated to prove that they are functioning satisfactorily before the transformer is put into service.
- 6.0 Auxiliary Transformers**
- 6.1 Transformer foundation drawings shall be verified with manufacturer drawings for its orientation and withdrawal positions before installation.
- 6.2 The transformer foundation should be prepared such that the transformer shall have adequate air circulation necessary to cool the transformer. In case of outdoor installation, plinth height should be maintained to minimum 1m from ground.
- 6.3 Clearances should be maintained as per local Electricity norms and as per applicable standards. If necessary, transformer neutral earthing shall be carried out according to relevant IEC standard.
- 6.4 Cable ends should be sealed to prevent from absorbing moisture. All cable boxes, metallic sheathing and armouring shall be efficiently earthed. as per vendors/ system requirements.
- The Cable glands shall be weather proof Double compression type made of heavy duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 micron. Cable glands shall conform to BS:6121.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

All Cable lugs for power cables shall be Heavy duty Long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve.

7.0 33/11 kV Switchgears

7.1 Bidder shall follow the best construction requirements of respective manufacturers.

7.2 In addition, Bidder shall comply with following specific installation requirements:

- a) All fasteners of panel body, busbar and doors shall be checked for tightness before installation.
- b) The Panel shall be free standing mounted on mounting channels. The HT Panel shall be fixed to the foundation with clamping plates or through mounting holes at the base of the panels. If the panels are installed with clamping plates, the panels must be placed on the foundation before the fixing holes are drilled. If the panels are installed with mounting holes, the fixing holes must be prepared before the panels are placed on the foundation.
- c) Bidder shall ensure that Panel shall be properly aligned to level in accordance with site specific construction plan.
- d) Sufficient cable loops shall be left in trenches to allow proper termination of cables at termination points using termination kits.
- e) All cable termination shall be done with bimetallic tubular lugs, properly torqued and torque marking shall be provided.
- f) Clearances as per OEM / statutory requirement for O&M shall be maintained during installation. Space for future panel installation shall be provided for each 33kV sub pooling station.
- g) Relay setting shall be done as per system study and equipment protection requirement.
- h) Proper earthing shall be ensured
- i) Proper installation of Gas duct.
- j) Proper installation of insulating mats at front and rear side of the panels

7.3 **Testing:** Tests shall be performed at site as mentioned in relevant sections of this tender.

8.0 LV Switchgears, ACCBs, ACDBs, etc.

8.1 Switchgear panels / JB, MB, DB shall be installed on finished surfaces or concrete or steel sills. Supporting structural beams shall be provided in the cut-outs and cable trenches wherever required to suit the panel erection. Proper aligning, joining of various vertical shipping sections, busbar connections, inter panel wiring etc. shall be the responsibility of Bidder.

8.2 Fabrication and erection of cross beams in cut-outs and cable trenches shall be done before placing of panels.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

8.3 The Bidder shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be installed only after erection of switch gear / relay panels is completed.

9.0 UPS System

9.1 Bidder shall follow the installation requirements of respective manufacturers.

9.2 UPS system shall be installed on finished surfaces or concrete or steel sills.

10.0 110V Battery and Battery Charger

10.1 Battery and associated equipment like battery charger, DCDB, etc installation shall be done as per OEM guideline in line with statutory requirement. Battery Erection, Testing and Commissioning shall be done in supervision of OEM representative. Contact surfaces of battery terminals and inter cell connectors shall be cleaned and coated with protective grease and assembled.

10.2 Battery chargers shall be installed on finished surfaces
Battery initial charging and discharging cycle to be carried out as per recommendation and in presence of OEM representative.

11.0 Miscellaneous works

12.1 The Bidder shall also supply the structural steel, fabricate and install steel supports, to form:
a) Mounting arrangement for String combiner boxes and other local devices.
b) Supporting arrangement for transformer cable boxes as per relevant drawings.

12.0 General Note

- a) The Cable glands shall be weather proof Double compression type made of heavy-duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 micron. Cable glands shall conform to BS:6121.
- b) All installation shall be as per Seismic Zone - V of IS 1893



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

C7 – HVAC SYSTEM

1.0 HVAC System

The design, manufacture, supply, transportation, receipt, handling, storage at site, erection, testing and commissioning of air conditioning and ventilation system shall comply with all latest versions of standards, statutes, regulations and safety codes in the locality where the equipment is proposed to be installed.

1.1. Areas to be air conditioned

PV Plant SCADA and Monitoring Room and / or any other area/room as per GIPCL requirement 100% redundancy.

Hi Wall Split Air Conditioners

The Hi Wall Split Unit shall be provided and would be located inside the area to be air conditioned.

The Hi wall Split Unit would essentially comprise the following:

- i. Indoor unit complete with fans, filters, cooling coils, expansion valves etc.
- ii. Outdoor unit complete with outdoor fans, condenser coils etc.
- iii. Refrigerant piping shall be copper and connected between the indoor and outdoor units, insulation for suction line.
- iv. Necessary drain piping up to the nearest floor drain for each hi wall split unit with thermal insulation
- v. Complete Electrical Supply system like MCC, cabling, control Wiring, etc. to be provided by bidder.

1.2. Areas to be ventilated

Buildings (Wherever AC is not installed):

In buildings, Ventilation system shall consist of multiple axial flow supply air fan units. The air being supplied is free from dust particles and shall be supplied with pre filters and fine filters.



SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Ventilation of buildings shall be designed in such a way that the temperature rise of the rooms does not exceed the maximum designed temperature of equipment and other auxiliaries. Accordingly, adequate quantity of supply air fan and exhaust fan shall be suitably chosen to remove the heat from the buildings. The air quality supplied by the ventilation system shall be as per the recommendations of equipment manufacturers. All exhaust and fresh air fans shall be provided with thermostat control.

2.0 Codes & Standards:

The HVAC system shall conform to the latest applicable Indian/International standards. Some of the applicable standards are listed below:

Codes	Description
ISHRAE	Indian society of heating, refrigeration & air conditioning engineers
ASHRAE	American Society of heating, refrigeration & air conditioning engineers
ARI 430	Central station Air Handling Units
ARI 410	Forced Circulation Air-Cooling and Air Heating coils
IS 277	Galvanised Steel Sheets
IS 325	Three phase induction motors
IS 655	Metal Air ducts
IS 7613	Method of testing panel type air filters for air conditioning and Ventilation process.
IS 2312	Propeller type AC ventilation fans
IS 3588	Electric axial fans
IS 4894	Centrifugal fans
UL 555	Fire dampers

SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Codes	Description
IS 7098 Part-1	Power cables
IS 1554 Part-1	Control cables

3.0 Design Criteria

- i) The following are the various input data to be considered in the design of air conditioning and ventilation system

a) **Outside design conditions:**

Site Specific

b) **Inside design conditions to be maintained inside air-conditioned areas:**

a)	Dry bulb temperature:	24 °C ± 1 °C
b)	Relative Humidity:	Not exceeding 60%

- ii) The mechanical ventilation system shall be designed based on maintaining inside temperature not exceeding design temperature of individual electrical equipment or 3 deg. C above outside dry bulb temperature whichever is higher.

4.0 Technical Parameters

Sl. No.	Description	Technical Requirements
1.0	Material of Construction	
1.1	Non ductable split air conditioners:	As per manufacturers standard (5 Star rating, Inverter Type)
1.2	Air Distribution system:	
	a) Duct construction method	As per IS 655
	b) Ducting sheet material	GSS as per IS 277
	c) Back draft dampers	
	i. Casing sheet thickness	18G GSS

SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Sl. No.	Description	Technical Requirements
	ii. Blade thickness	24G GSS
	d) Supply air louvers	
	i. Minimum percentage of free area	35-37%
	ii. Casing sheet thickness	18G GSS
	iii. Blade thickness	24G GSS
	iv. Face velocity	2.5 m/s
	e) Bird screen	
	i. Size	10 sq mm
	ii. Wire mesh	16 G wire mesh
1.3	Axial or Propeller Fan:	
	a) Casing	Mild steel plate to IS 2062
	b) Impeller	The impeller shall have blades of an aerofoil design
	c) Shaft	EN 8
	d) Inlet Cone / Outlet cone	Mild steel
	e) Noise	Shall not exceed 85 dB(A) measured at a distance of 1.5 meters from the source in any direction
1.4	Pre-filter:	
	a) Designation	Filters for ambient ventilation system
	b) Type	Cassette type / Flanged type


SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Sl. No.	Description	Technical Requirements
	c) Whether cleanable	Yes
	d) Efficiency	90% down to 10 microns
	e) Maximum filter face velocity	2.5 m/s
	f) Maximum allowable pressure drop for design flow rate in	
	i. Clean condition	6 mm WC
	ii. Clogged condition	12 mm WC
	g) Filter Media	High Density Poly ethylene (HDPE) media.
	h) Frame	18 G GSS

5.0 Data to be furnished by vendor after award of contract
Drawings / Documents for Approval and or information:

- a) Technical Data sheet
- b) General Arrangement drawing showing overall dimensions, location of various devices, etc.
- c) Heat rejection/ transfer calculation.
- d) Equipment Warranty certificates
- e) Instruction manuals

C8 - QUALITY HEALTH, SAFETY AND ENVIRONMENT (QHSE)
1.0 SCOPE:

This specification establishes the Environment, Health and Safety (EHS) management requirement to be complied by the Bidders during construction. Requirements stipulated in this specification shall supplement the requirements of EHS Management given in relevant Act (s) / legislations. General Conditions of Contract (GCC), Special Conditions of Contract (SCC) and Job Specifications. Where different documents stipulate different requirements, the most stringent shall be adopted.


SCOPE OF WORK & TECHNICAL SPECIFICATIONS
2.0 REFERENCES

This document should be read in conjunction with following:

- i) General Conditions of Contract (GCC)
- ii) Special Conditions of Contract (SCC)
- iii) Job Specifications

3.0 REQUIREMENTS OF ENVIRONMENT, HEALTH & SAFETY (EHS) MANAGEMENT SYSTEM TO BE COMPLIED BY BIDDERS
3.1 Policy

The Bidder should have a documented QHSE policy to cover commitment of their organization in line with GIPCL QHSE and other relevant policies to ensure Quality, health, safety and environment aspects in their line of operations.

Bidder shall develop, implement and monitor QHSE management system as per ISO 9001; ISO 14001, ISO 45000 and IFC Principle standards, Labour and Working Condition, Security, Grievance redressal, Environmental and Social Impact assessment and management plan, and other applicable policies.

3.2 Risk Assessment and Environmental Aspect Impact

The Bidder shall establish, implement and maintain procedure(s) for the hazard identification, risk assessment and determination of necessary controls related to human health and safety, Environmental aspect and Impact related to the site activities.

3.3 Legal Aspects

Bidder shall identify all applicable legal requirements and maintain a legal register. All applicable licenses, NOC's and permission shall be obtained from regulatory agencies/Gram Panchayat etc. Bidder shall also comply strictly with the state/ local regulations such as child labour prohibition, payment and wages, workmen welfare and other applicable legislations.

3.4 Objectives and Management Plans



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QHSE Plan in accordance with the policy shall be developed separately for construction, operation, maintenance and decommissioning phase, same shall be implemented, monitored and reported.

Bidder shall develop QHSE objective and target in line with owner's QHSE objective and targets. (Copy of owner's QHSE objective and target shared).

3.5 Roles, Responsibilities and Authorities

Bidder shall display Organization structure along with roles, responsibility and authority on QHSE and Social activities. Bidder shall be fully responsible for planning and implementing QHSE and social requirements. Bidder as a minimum requirement shall designate / deploy the following to co-ordinate the above:

QHSE person over Nos. of workers and work area deployment

- a) A suitably qualified Quality person (manager) for relevant scope of work e.g. Electrical / Civil etc. with not less than 8 years of experience shall be deployed to implement, monitor, manage and report quality aspect of project activities along with his team per shift of eight hours.
- b) A suitably qualified HSE person (Manager) with not less than 8 years of experience shall be deployed to implement, monitor, manage and report HSE and Social aspect of project activities along with his team per shift of eight hours.
- c) In addition of above following are minimum QHSE manpower requirement:
 - i. Up to 100 - Designate one qualified and minimum 4 years experienced HSE (Health Safety & Environment) supervisor in each shift of eight hours
 - ii. Above 100 & up to 200 - Deploy one additional qualified and minimum 6 years experienced HSE Engineer/ officer in each shift of 8 hours.
 - iii. Above 200 - One additional HSE (for every 50 or less) engineer/officer as above in each shift of 8 hours.
 - iv. One qualified and minimum 4 years experienced HSE officer and Quality officer for each work-front and each scope of work spread in 200 acres of per shift of 8 hours.

Bidder shall indemnify & hold harmless GIPCL & either representative free from all liabilities arising out of non – fulfilments of QHSE requirements.



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3.6 Communication, Training and Awareness

- 3.6.1 The Bidder shall promote and develop consciousness for Quality Health Safety and Environment among all personnel working for him. Regular awareness and training programs, tool box talks, site meetings etc. shall be arranged on QHSE activities to cover hazards involved in various operations during construction and associated records shall be retained for audits of GIPCL.
- 3.6.2 All mandatory and regulatory signs shall be displayed at appropriate and prescribed locations at site, in compliance with legal requirement. QHSE promotion signage shall be displayed in addition to above at appropriate location.
- 3.6.3 Bidder shall promote QHSE through various mean and medium at site and among workmen. QHSE awards, Celebration of Safety week and Environment day, QHSE training, emergency response training to workmen are minimum requirement and each shall be conducted once in a year. Report of the same with photographs shall be submitted to Owner.

3.7 Documentation

- 3.7.1 The Bidder shall prepare the documents related to QHSE management for implementation and monitoring of QHSE requirements. This shall be submitted to GIPCL for approval. The documents shall be updated with new system introduction and changes in the process/ procedure. These documents shall be safeguarded and produced during the time of audit.
- 3.7.2 Bidder shall permit/ provide appropriate and required space for display of Owner's policy, certificates and other such information at project site/office if the infrastructure is shared or owned by Bidder.
- 3.7.3 Copy of valid IMS (Integrated Management System) or relevant QHSE certificates, details of award if any, shall be submitted to owner.

3.8 Emergency Preparedness and Response

- 3.8.1 All potential emergency situations including the circumstances having impact over community shall be identified, and an emergency preparedness plan shall be developed. Required infrastructure, equipment and training shall be provided. Mock drill shall be conducted as per Emergency Response Plan (ERP). Owner representative shall be informed while conducting mock drill and shall be allowed to participate in such drills.
- 3.8.2 Emergency response team (ERT) shall be identified / trained and deployed in a way that at any point of time (24 x 7) member of ERT are present at site.



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- 3.8.3 Bidder shall identify potential for fire incidents and shall develop a management plan. Adequate and required firefighting arrangements shall be made available at site.
- 3.8.4 Contract shall arrange suitable first aid measures such as First Aid Box, certified first aiders, Stand by Ambulance and regular training of first aiders.
- 3.8.5 The Bidder shall install fire protection measures such as: adequate number of steel buckets with sand and adequate fire extinguishers as per the local fire department norms and to the satisfaction of GIPCL. Suitable weather and fall protection shall be done for all fire extinguishers, if installed in open.
- 3.8.6 Emergency escape route, emergency assembly area shall be marked at site, restricted entry and keep away from EMF (Electric magnetic field) area e.g. Substation, Transformers etc.as applicable shall be marked at appropriate location. Use of mobile phone / communication device shall be restricted in high EMF zone, e.g. Sub-station, high voltage electric panels etc.
- 3.8.7 Suitable signages shall be fixed for identification of emergency equipment. Monthly Inspection shall be carried out for Emergency equipment. Defective and unfit equipment shall be replaced with fit equipment. Bidder shall keep 10% extra (buffer) stock of fit to use emergency equipment as compared with required /planned emergency equipment.

3.9 Monitoring and Measurement

The monitoring for implementation shall be done by regular inspections and compliance to the observations thereof. The Bidder shall get similar QHSE and Social requirements implemented at his sub-Bidder(s) work site/office. However, compliance of QHSE and Social requirements shall be the sole responsibility of the Bidder. Any review / approval by GIPCL shall not absolve Bidder of his responsibility / liability in relation to all QHSE and Social requirements.

3.10 Incident Reporting

Bidder shall notify all reportable and serious incident to owner within 4 hours over phone/ text message / email and a formal report shall be shared which should include, What, When, Where, to Whom and How, about the incident within 8 (eight) hours.



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All near miss, first aid, emergency occurrence, good practices, training, mock drill, environmental incident, community complaint etc. shall be shared as monthly report in prescribed format.

Government/ Regulatory notice shall be shared with owner and shall be treated as reportable incident.

3.10 Investigation and Non-conformance

Bidder shall allow/ permit and co-operate with GIPCL's representative or it's designated representative to

- i. Conduct QHSE audit as per ISO 9001; ISO 14001, ISO45001, IFC Principle standards / guidelines.
- ii. Conduct Incident /accident investigation for reportable incident or near miss having potential to cause reportable incident.

Gap/s if any identified in the audit will be shared with Bidder. Suitable management plan/ corrective and preventive action plans shall be developed, agreed and implemented/ closed within agreed time. Evidence and report for the same shall be submitted with GIPCL.

- i. Qualified QHSE Person shall be available and represent Bidder along with its site Head or designated representative of similar capacity during QHSE Audit/ Inspection/ Investigation.
- ii. Bidder shall share all QHSE, Legal permission and other related documents during QHSE audit, Inspection and other related activity. These documents will be treated as confidential documents and will be used only for audit/ inspection / Investigation purpose.
- iii. With regular audits/ inspections, Bidder shall determine the QHSE deficiencies and factors that are contributing to these occurrences/ incidences.
- iv. Bidder should agree to share its internal QHSE Audit reports as and when required for review and action plan status for the same.
- v. Bidder should proactively share stakeholder, community complaints and Incident reports, Corrective and preventive action plan, mitigation plan, management plan for the same and status of closure shall be submitted accordingly.



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- vi. Non-Conformance on QHSE by Bidder (including his Sub-Bidders) as brought out during review/ audit by GIPCL's representatives shall be resolved forthwith by Bidder. Compliance report shall be provided to GIPCL.
- vii. QHSE Committee/ Workmen grievance committee/ Community Grievance committee shall be formed, and regular meetings shall be held. Owner representative, if any shall be notified in advance and shall be allowed to join such meeting.
- viii. The Bidder shall ensure participation of his Resident Engineer / Site-in- Charge in the Safety Committee / QHSE Committees/ Workmen grievance committee/ Community Grievance committee meetings arranged by GIPCL. A notice for same shall be provided by owner, minimum one week in advance. The compliance of any observations shall be arranged urgently. He/ She shall assist GIPCL to achieve the targets set by them on QHSE during the project implementation.
- ix. GIPCL Reserves right to notify Bidder on violation of QHSE agreement and impose monetary penalty as below.
 - a. On, behavioural violation on QHSE e.g. Unsafe Act, not attending QHSE meeting without valid reason, delaying closure of gaps identified in internal and third-party audit, not submitting required reports, failing to report incidents as in Sl. No. 29 on time etc. -Fine up to INR 5000/- per violation.
 - b. Delay in closure of QHSE audit action points without valid reason- GIPCL can implement required actions for closure of QHSE action items and deduct payment from Bidder on actuals or hold payments. This will be done by providing 3-time notice within 45 days. (Not applicable for legal and regulatory requirements).
 - c. Legal requirements shall be complied 100% and deviation is not acceptable
- x. All fatal accidents and other personnel accidents shall be investigated by a team of Bidder's senior personnel for root cause & recommend corrective and preventive actions. Findings shall be documented, and suitable actions taken to avoid recurrences shall be communicated to GIPCL. GIPCL shall have the liberty to independently investigate such occurrences and Bidder shall extend all necessary help and co-operation in this regard.

4.0 GENERAL ENVIRONMENT, HEALTH AND SAFETY COMPLIANCES



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Bidder shall follow and comply to the welfare and wages and other requirement as per BOCW act during construction and Factories act and rule during operation and maintenance irrespective of its applicability.

- i. Provision for suitable and assessable drinking water, toilets, clean and designated eating place, first aid, first aid equipment and materials, rest area etc. shall be provided at work place for all workmen.
- ii. Workmen camp shall not be constructed within or in radius of 500 meters of project boundary. Picking of wood from nearby areas for cooking shall not be allowed. Bidder shall ensure that workmen camp is established and has required facility for sanitation, safe drinking water, fire prevention and protection, housekeeping, etc.
- iii. Children shall not be allowed in project area. Suitable arrangements shall be made for stay and food of workmen children at workmen camp when they are not accompanied by parents.
- iv. Workmen shall be verified for communicable disease and background (crime history) before they are deployed at work. In case police verification is not meeting the time lines, project site head shall develop inhouse mechanism for such verification.
- v. Appropriate medical check for workmen including vertigo test for workmen working at height shall be done annually.
- vi. Induction and training of workmen and visitors shall be conducted and documented before working/ visiting the site.
- vii. The Bidder shall provide safe means of access to any working place including provisions of suitable and enough scaffolding at various stages during all operations of the work for the safety of his workmen and GIPCL. Bidder shall ensure deployment of appropriate equipment and appliances for adequate safety and health of the workmen and protection of surrounding areas.
- viii. Bidder shall ensure availability and supply of all required best/agreed quality PPE (Personal Protective equipment) at site. Damaged PPE shall be destroyed and replaced immediately. Bidder shall also ensure use of safety belt, protective goggles, gloves etc. by the personnel as per job requirement. All these gadgets shall conform to relevant IS specifications or equivalent.
- ix. Bidder shall ensure that a proper Safety Net System shall be used at appropriate locations. The safety net shall be located not more than 30 feet (9.0 metres) below



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the working surface at site to arrest/reduce the consequences of possible fall of person working at different heights.

- x. Bidder shall ensure that flash back arresters are used at torch and Gas cylinder while using Gas cutters at site. All safety precautions shall be taken while use of gas cutters for example Cylinders shall be mounted on trolleys, hoses shall be checked for leakage with soap water, hot permit shall be used, fire prevention mechanism shall be in place, only industrial gas cylinders shall be used etc.
- xi. Bidder shall assign work to his workmen, tasks commensurate with their qualification, experience and state of health for driving of vehicles, handling and erection of materials and equipment's. All lifting equipment's shall be tested certified for its capacity before use. Adequate and suitable lighting at every work place and approach there to, shall be provided by the Bidder before starting the actual operations at night.
- xii. Hazardous waste management, e-waste management, Batteries management, Municipal waste management, Construction and Demolition waste management shall be done in accordance with applicable law, relevant law shall be complied 100% even in case of ambiguity of its applicability.
- xiii. Hazardous and/or toxic materials such as solvent coating or thinners shall be stored in appropriate containers.
- xiv. All hazardous materials shall be labelled with the name of the materials, the hazards associated with its storage, handling and use and necessary precautions to be taken.
- xv. Bidder shall not dump, release or otherwise discharge or dispose of hazardous materials and substance. An awareness training shall be given to all employees on hazardous materials.
- xvi. Appropriate personal protective equipment's such as gloves, goggles, aprons, chemical resistant clothing and respirator shall be used while handling hazardous material, if any.
- xvii. Chemical spills shall be contained and cleaned up immediately to prevent further contamination.
- xviii. All personnel exposed to physical agents such as ionizing radiation, ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with the type of exposure involved.



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- xix. All the construction vehicles used at site shall have fitness and PUC certificates so that the vehicle exhaust is under acceptable and permissible legal and industrial good practice, for example IFC PS range.
- xx. To avoid dust generation due to vehicular movement, a dust prevention and control management plan shall be developed. These control measures may include Water sprinkling considering water availability in the project area. Gary water shall be used for sprinkling on best effort basis.
- xxi. DGs and other equipment used at site shall confirm to applicable Air and Noise and other relevant legal requirements /standards.
- xxii. Reasonable Canteen facilities / eating area shall be made available at appropriate location depending upon site conditions.
- xxiii. Suitable facilities for toilet, drinking water, proper lighting (minimum 200 lux for workplace and minimum 100 Lux for pathway) shall be provided at site and labour camps, commensurate with applicable Laws / Legislation and IFC PS.
- xxiv. Bidder shall ensure that the wastewater generated during the construction works shall not be disposed of without treatment. Bidder can provide septic tank with soak pits or transport the wastewater to the nearest STP in tankers. The treated waste water confirming permissible limits of State pollution control board for disposal on land can be used to control dust.
- xxv. Bidder shall ensure storage and utilization methodology of materials that are not detrimental to the environment. Where required Bidder shall ensure that only the environment friendly materials are selected.

Workmen includes all person deployed at site for construction/ operation and other project related activities.

5.0 HOUSEKEEPING

Bidder shall ensure that a high degree of housekeeping is maintained and shall ensure inter alia the followings wherever applicable:

- i. All surplus earth and debris are removed/disposed-off from the working areas to identified location(s) in compliance with construction and demolition waste regulation.


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- ii. Unused/ Surplus Cables, Steel items and steel scrap lying scattered at different places within the working areas are collected and stored in designated location(s) and disposed-off with approved recycler.
- iii. All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be collected and stored in designated storage area (waste storage area/ scrap yard). Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips and bricks etc. shall not be allowed to rest on the roads to obstruct free movement of men & machineries.
- iv. Fabricated steel structural, pipes & piping materials shall be stacked properly for erection.
- v. Water logging on roads shall not be allowed.
- vi. No parking of trucks / trolleys, cranes and trailers etc. shall be allowed on roads which may obstruct the traffic movement. A traffic management plan shall be developed and implemented, to eliminate risk of accident in nearby community. Drivers, cleaners, workmen shall not be allowed to rest under parked vehicle or cook food in or around vehicle. A designated resting place (shade) for drivers, cleaners and workmen shall be provided.
- vii. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.
- viii. Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the premises and on road to avoid public nuisance.
- ix. Only properly designed steel scaffolding materials shall be used for working at heights.

6.0 DETAILS OF EHS MANAGEMENT SYSTEM BY BIDDER
6.1 On Award of Contract

The Bidder shall, prior to start of work submit his Quality Health Safety and Environment Manual and/ or procedures and QHSE Plans for approval to GIPCL.

The Bidder shall participate in a meeting with GIPCL to finalize QHSE Plans including the following:



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- i. Job procedure to be followed by Bidder for activities should cover- Handling of equipment, Scaffolding, Electric Installation, describing the risks involved, actions to be taken and methodology for monitoring each activity.
- ii. GIPCL review / audit requirement.
- iii. Organization structure along with roles, responsibility and authority on QHSE activities.

6.2 During Job Execution

Implement approved Quality, Health, Safety and Environment management procedure including but not limited to as brought out under para 3.0. Bidder shall also ensure to:

- i. Arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc., as applicable.
- ii. Arrange all QHSE permits before start of activities (as applicable) like hot work, confined space, work at heights, storage of chemical / explosive materials and its use and implement all precautions mentioned therein.
- iii. Submit timely the completed checklist on QHSE activities, Monthly QHSE report, accident reports and investigation report etc. as per GIPCL requirements. Compliance of instructions on QHSE shall be done by Bidder and informed urgently to GIPCL.
- iv. Ensure that Resident Engineer/ Site-in-Charge of the Bidder shall attend all the Safety Committee/ QHSE meetings/ Workmen grievance committee/ Community grievance committee meeting arranged by GIPCL. Only in case of his absence from site that a second senior most person shall be nominated by him in advance and communicated to GIPCL.
- v. Display at site office and work locations- caution boards, list of hospitals, emergency services available.
- vi. Provide posters, banners for safe working to promote safety consciousness.
- vii. Carryout audits / inspection at sub-Bidder works as per approved QHSE Plan and procedures.
- viii. Document and submit the reports for GIPCL review.


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- ix. Assist in QHSE audits by GIPCL and submit compliance report.
- x. Generate & submit QHSE records/ report as per QHSE Plan.
- xi. Appraise GIPCL on QHSE activity.

C9 – COMMISSIONING TESTS
1.0 General

- 1.1 This section covers the installation and commissioning requirements of all major equipment of the project.
- 1.2 Tests on all equipment shall be conducted as per latest revisions of relevant IS and IEC Standards.
- 1.3 Verification of commissioning Tests shall be according to the latest published testing procedure 'IEC 62446: All parts.
- 1.4 The inspection by Owner and issue of Inspection Certificate there on shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed quality assurance program.
- 1.5 The commissioning activities shall be completed alignment for aligning with first time charging procedures by RLDC and relevant regulation / guidelines of SLDC/GETCO / CEA.

2.0 Pre Commissioning Works

- 2.1 On completion of erection of the equipment, each item of the equipment shall be thoroughly cleaned before charging. The equipment shall then be inspected jointly by the Owner and the Bidder for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site.
- 2.2 The Bidder shall submit detailed test procedures to the Owner for its approval, at least 60 Days prior to the anticipated Commercial Operation Date.
- 2.3 The Owner shall review / approve the Detailed Test Procedures and the approved Test Procedures shall be adhered by Bidder at site.
- 2.4 The Bidder shall be responsible for satisfactorily working of complete integrated system and guaranteed performance.

3.0 Site Tests and Commissioning Checks
3.1 General

- 3.1.1 All the equipment shall be tested at site to make sure and to prove suitability of their condition for required performance.


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- 3.1.2 The test indicated in subsequent pages shall be conducted after installation. All tools, accessories and required instruments shall be arranged by the Bidder. Any tests other than those indicated, that is considered necessary by the manufacturer of the equipment mentioned in the commissioning manual shall also be conducted at site.
- 3.1.3 In addition to tests on individual equipment, some tests / checks are to be conducted / observed from overall system point of view. Such checks are highlighted under miscellaneous tests, but these shall not be limited to as indicated and shall be finalized in consultation with the Owner before charging of the system.
- 3.1.4 The Bidder shall be responsible for satisfactory working of complete integrated system and guaranteed performance.
- 3.1.5 All Tests must comply with the requirements of all applicable standards and codes, including the Grid Code.
- 3.1.6 If any inverter or Plant fails to pass any Test as per Schedule, repeat Tests shall be carried out until all inverters and the whole Plant pass all Tests.
- 3.1.7 All checks and tests shall be conducted in the presence of Owner / Owner's representative and test results shall be submitted to Owner with one copy to Electrical Inspector. Test results shall be filled in proper proforma.
- 3.1.8 After clearances from Electrical Inspector, system / equipment shall be charged in step-by-step method.
- 3.1.9 Based on the test results, clear observations shall be indicated by the Owner / Owner's representative with regard to suitability for charging of the equipment.
- 3.2 **Trial Run Test**
- After the successful test of each equipment as per standard test procedure, the entire control system shall be put on trial run test on actual site conditions and operation of the system.
- 3.3 **Acceptance Test**
- The acceptance test on the system shall be carried out by the Bidder as per mutually agreed test procedures to establish satisfactorily functioning of the system as a whole and each equipment as part of the system.
- The site tests and acceptance tests to be performed by Bidder are detailed below:
- 3.3.1 **General Checks**
- a) Check for physical damage.
 - b) Visual examination.
 - c) Check from name plate that all items are as per order / specification.


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- d) Check tightness of all bolts & nuts, clamps and connecting terminals using torque wrenches.
- e) For oil filled equipment, check for oil leakage, if any. Also check oil level and top up if necessary.
- f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.
- g) Check cleanliness of insulator and bushings.
- h) All checks and tests specified in drawings and manuals furnished by the manufactures, as well as all tests specified in the relevant code of erection.

3.3.2 Commission Checks for Equipment

- a) Inspection of all equipment of DC system.
- b) Inspection of all equipment of AC system.
- c) Inspection of all Cables.
- d) Inspection of safety equipment such as surge arrestors and earthing.
- e) Inspection of ESE Lightning Arrestor.
- f) Testing of the tracking mechanism under real conditions, including backtracking capability civil works (if applicable for tracker configuration).
- g) Inspection of the PV modules support structure.
- h) Inspection of the support structure foundations.
- i) Testing to confirm that all works have been carried out in accordance with applicable Laws and the Grid Code.
- j) Testing to confirm proper connection and labelling of all components.
- k) Inspection of security systems such as fences and alarms.
- l) Inspection of weather monitoring system.
- m) Inspection of CCTV surveillance system and
- n) Inspection of complete as-built documentation for the Plant.

3.4 Commissioning Tests

- a) The commissioning Tests shall be carried out off-grid as well as in connection with the Transmission System.
- b) During commissioning Tests, the Bidder shall demonstrate that the Plant (including each inverter) and all other relevant equipment operates in accordance with:
 - i) Equipment manufacturer specifications.


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ii) Grid Code and other relevant national and international norms and standards.

3.4.1 PV array

The Tests on the PV array shall be conducted according to IEC-62446.

The start-up tests shall be the first step for provisional acceptance of plant. These tests shall essentially include:

a) **Establish power (Wp):** Prior to conducting any tests, the Bidder must establish the total installed power of the plant. power measurement shall be carried out at string level for the entire plant using an industry accepted PV analyser. power obtained during test conditions shall be extrapolated to STC conditions to arrive at the plant installed capacity. Accepted deviation in extrapolated power and module nameplate power should always be in the range of $\pm 5\%$. For negative deviations each module in the string shall be checked and any damaged module shall be replaced.

b) **Open circuit voltage (Voc):**

This test verifies that strings are properly connected (module and string polarity) and that all modules are producing the expected voltage according to the module data sheet. To measure Voc, the following procedure must be used:

- i) Array junction box is opened.
- ii) Array Junction box fuses leading to the sub main junction box are removed.
- iii) The voltage is measured with a calibrated, industry accepted instrument (PV Analyser) from the negative bus bar to the module side of the string diode, for each string.

3.4.2 Inverter

Generally, the inverter shall be commissioned and tested according to the manual provided by the inverter manufacturers. Inverters shall be tested under different operation modes including but not limited to:

- a) Loss of auxiliary power.
- b) Anti-islanding.
- c) Maximum power point tracking.
- d) Total harmonic distortion.
- e) Active / reactive power control.
- f) Fault Ride through condition (LVRT / ZVRT and HVRT).
- g) Negative grounding system.
- h) Night-time reactive power compensation.
- i) Automatic wake up and shut down.


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- j) Closed loop plant controller and
- k) Reverse polarity test
- l) Test of basic network management functions (including frequency and automatic voltage regulation).

3.4.3 MV / LV Equipment

All medium voltage and low voltage equipment shall be tested according to relevant IEC and the manuals provided by the equipment manufacturer including but not limited to:

- a) MV switching equipment for protection of feeders and transformers.
- b) Grounding connection.
- c) Auxiliary LV power supply.
- d) UPS system
- e) IR-camera tests for MV equipment.

3.4.4 I&C Equipment

All instrumentation and control equipment shall be tested according to the manuals provided by the equipment manufacturer, including but not limited to:

- a) SCADA system.
- b) Weather monitoring system and
- c) Plant security and surveillance system.
- d) Robotic Cleaning System
- e) Any other I&C Systems shall be checked as per OEM recommendation

3.4.5 HVAC System

All equipment of HVAC system, viz., Air conditioners, Exhaust fans, etc. shall be tested according to the manuals provided by the equipment manufacturer and demonstrate desired performance of these equipment.

3.4.6 Fire Alarm and Firefighting system

All equipment of Fire Alarm and Firefighting system, viz., Fire alarm panel, Fire / smoke detectors, Firefighting equipment etc. shall be tested according to the manuals provided by the equipment manufacturer and demonstrate desired performance of these equipment.

3.4.7 Inverter Duty Transformer Testing

Following testing shall be done but not limited to:

Pre-commissioning tests for Inverter duty transformer at site



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- a) SFRA
- b) Tan Delta
- c) DGA
- d) Comprehensive oil testing
- e) IR Value
- f) Winding resistance at all taps
- g) Ratio at all taps
- h) Comprehensive scheme testing (Buchholz, OTA, WTI, PRV/PRD, MOG, etc..)
- i) Comprehensive testing of NIFPS (First time charging of Transformer shall be allowed only after successful testing of NIFPS)
- j) Bushing CT Testing if applicable
- k) Any other testing required as recommended by the OEM

3.4.8 HT Switchgear

Following testing shall be done but not limited to:

- a) Relays and meters testing by secondary injection
- b) Verification of Relay settings and configuration and downloading of same
- c) CTs, PTs Testing by Primary injection
- d) IR Testing of power circuit
- e) Comprehensive scheme testing
- f) Hipot test and timing test of breaker
- g) ABT Metering system (Tariff metering, CTs, PTs and ABT Meters) as per requirement of concerned competent authority
- h) Any other testing required as recommended by the OEM

3.4.9 33KV Cable

Following testing shall be done but not limited to:

- a) Hipot testing
- b) IR before and after Hipot testing
- c) Phase sequence, Continuity and resistance measurement
- d) Visual check of cable termination and tightening.
- e) Any other test required as per recommended by OEM.



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3.4.10 SCB to Inverter Cable

- a) Hipot testing
- b) IR before and after Hipot testing
- c) Continuity and resistance measurement
- d) Visual check of cable termination and tightening.
- e) Any other test required as per recommended by OEM.

3.4.11 LT Cables

- a) IR Testing
- b) Phase sequence, Continuity and resistance measurement
- c) Visual check of cable termination and tightening.
- d) Any other test required as per recommended by OEM.

C10 - OPERATION & MAINTENANCE FOR FIVE (05) YEARS

OPERATION AND MAINTENANCE

1. The successful bidder shall carryout Comprehensive Operation and maintenance of complete SPV Plant along with power evacuation system till point of grid interconnection from date of commissioning of full project capacity. Additionally, bidder to refer commercial portion of bidding document for details regarding O&M of part capacity commissioned. The Work shall be executed in conformity with the relevant applicable latest standards, codes, rules/ordinances & regulations. During O&M period, GIPCL personnel shall have unrestricted entry to the solar plant and Control Room any time. GIPCL may suitably depute its personals to associate with O&M activities. Bidder shall assist them in developing expertise through their day-to-day O&M activities. All records of maintenance must be maintained by the Bidder which can be accessed by GIPCL on demand. These records are to be handed over to GIPCL after the O&M period of contract.
2. The bidder shall be responsible for supply of all spare parts, consumables, repairs / replacement of any defective equipment at his own cost as required from time to time during the O&M period.
3. The Bidder shall be responsible for the Operation and Maintenance of the entire Solar PV plant during the O&M period. The brief scope of works is listed below. The details shall be further elaborated by the bidder in the O&M manual to be submitted to GIPCL for approval.
 - a) Ensuring successful operation of SPV Plant for optimum energy generation.
 - b) During the O&M period, the Contactor shall be responsible for any defect in the work due to faulty workmanship or due to use of sub-standard material in the work. Any



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defects in the work during the O&M (irrespective of equipment warrantee) period shall there be rectified/replaced by the Bidder without any extra cost to the Owner within a reasonable time as may be considered from the date of receipt of such intimation from Owner failing which Owner shall take up rectification work at the risk and cost of Bidder.

- c) Ensuring Breakdown maintenance, Preventive maintenance overhauls, arranging visit of O&M experts (when required) to maximize the availability of the solar plant.
- d) Daily work of the operators involves logging the voltage, current, power factor, power, and energy output of the SPV plant, temperature, logging down individual array output data. The operator shall also note down failures, interruption in supply and tripping of different relays, reason for such tripping, duration of such interruption etc.
- e) The operator shall record daily/ monthly energy output of each array and transformer and reports shall be prepared on performance of SPV plant. Furnishing the energy generation data and other performance parameters of the Plant to GIPCL.
- f) Submission of periodical reports to the owner on the energy generation & operating conditions of the SPV plant.
- g) Ensuring Safety and protection of the plant by deputing sufficient security personals (24x7).
- h) Monitoring, controlling, troubleshooting, maintaining of records, registers etc.
- i) Recording/logging of all the operational parameters (e.g., voltage, current, power factor, energy output, temperature etc.) and preparation of daily/weekly/monthly reports etc. including submission of periodical consolidate plant performance reports to the Owner /GIPCL.
- j) Scheduling and forecasting of energy as per RLDC requirement. The cost for appointment of QCA (Qualified coordinating agency) for scheduling and forecasting shall be equally shared by GIPCL and Contractor. Further, the penalty of DSM charges shall be equally shared by GIPCL and Contractor.
- k) Supply of all type of maintenance spares, consumables, and fixing / application of the same is in contractor's scope. In order to meet the emergent requirements, Bidder, with the permission of Owner can utilize the mandatory spares being supplied under the contract. However, the used spares shall be replenished by the Bidder within reasonable time.
- l) Supply and use of all safety PPEs like safety shoes, reflective jackets, safety helmet, hand gloves, gum boots, safety goggles, etc. One set of first aid box should be available in site control room.
- m) Cleaning and Housekeeping of Control Rooms and plant including array yard on regular basis and as and when required.



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- n) Cleaning of drains, cable trenches, box culverts etc.
- o) Module washing as per as per approved schedule and maintain the records for cleaning cycle on daily basis in DGR.
- p) Herbicide spray, cleaning including cutting/removing of bushes/vegetation/grass etc. of the complete plant on a periodic basis and as and when required. Bidder also ensured that removed grass/vegetation shall be immediately transferred to safe location to avoid any fire incident near PV Modules/Inverters/Other electrical equipment
- q) Particular care shall be taken for outdoor equipment to prevent corrosion. Cleaning of the junction boxes, cable joints, insulators etc. shall also be carried out at every month interval.
- r) According to the recommendations stock of special tools and tackles shall be maintained for Inverter's and other major electrical equipment
- s) The Bidder shall at his own expense provide all amenities to his workmen as per applicable laws and rules.
- t) The Bidder shall ensure that all safety measures are taken at the site to avoid accidents to his employees or his Co-Bidder's employees
- u) The Bidder shall immediately report the accidents, if any, to the Engineer In charge & to all the concerned authorities as per prevailing laws of the state.
- v) The Bidder 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.
- w) In order to ensure longevity, safety of the core equipment and optimum performance of the system the Bidder should use only genuine spares of high-quality standards / as recommended by OEMs.
- x) Operation part consists of deputing necessary manpower to operate the Solar Photovoltaic Power Plant at the optimum capacity. Operation procedures such as preparation to start, routine operations with safety precautions, monitoring of Solar Power Plant etc. shall be carried out as per the manufacturer's instructions to have trouble free operation of the complete system.
- y) Bidder is required to maintain adequate O&M spare during the O&M contract period of the Solar PV plant with the view to maximize availability and generation of the plant.



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In case, Bidder uses mandatory spares, the Bidder shall have to return/replenish the spare(s) of the matching quality, quantity, and rating within shortest possible time.

- z) At the time handing over of the plant by the Bidder to GIPCL (Post commissioning Or Post termination or in both conditions), the Bidder shall handover equipment and all the mandatory spares which was given in the list in healthy condition.
- aa) Breakdown / Corrective Maintenance: Whenever a fault has occurred, the Bidder must attend to rectify the fault within shortest possible time. The O&M also includes comprehensive O&M of plant as well as transmission system up to interconnection point.
- bb) A maintenance record is to be maintained by the Bidder to record the regular maintenance work carried out as well as any breakdown maintenance along with the date of maintenance, reasons for the breakdowns and steps have taken to attend the breakdown duration of the breakdown etc. and to be shared with GIPCL on regular basis
- cc) The Schedules will be drawn such that some of the jobs other than breakdown, which may require comparatively long stoppage of the Power Plant, shall be carried out preferably during the non-sun period.
- dd) The Bidder shall ensure that all safety measures are taken at the site to avoid accidents to his employees or his co-contractor's employees as per prevailing safety rules.
- ee) Supply of all spares, consumables, and fixing / installation of the same including proper storage of tool, tackles & spares. Bidder shall keep updating the spares inventory at the site every time there is consumption of spare items towards replacement. Bidder has to share the Inventory report on monthly basis with GIPCL.
- ff) Coordinating with sub-station upon grid failures, line problems etc. and implementing the needful steps to restore the plant to normal operation
- gg) Coordinating, on behalf of GIPCL, and obtaining renewal of statutory licenses, clearances and approvals from state/Central departments such as State Electricity Supply & Transmission Boards/CEIG/CEI/GEDA/SLDC etc.
- hh) Theft incidents: immediate reporting to GIPCL, filing FIRs with police stations on behalf of GIPCL, coordination for site inspection by insurance companies and clearance of insurance claims, logging of events (date, time) and maintaining records. All necessary documents/records submission for successful claim settlement is the responsibility of Bidder.
- ii) Bidder must take Comprehensive Annual Maintenance Contract (AMC) from Original Equipment Manufacturer (OEM) or OEM authorized service provider for a period of 10 years for the following components:



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- a) Inverter System
Replacement of spares like inductors, capacitors, electronic cards, breakers, relays, and any other items required for operation / maintenance as per OEM recommendations
- b) SCADA & PPC
- c) Tracker System
Replacement of spares as per OEM recommendations

Further Manufacturer / Suppliers of above system shall endorse and honor comprehensive AMC obligations with GIPCL as well as any other O&M agency appointed by GIPCL.

Comprehensive AMC shall include all preventive maintenance and breakdown maintenance including replacement of any component to ensure that equipment is working satisfactorily as per design/system requirement. During AMC period, the OEM or its representative are required to visit at least once a year or as per OEM recommendation cycle for periodic maintenance. During AMC period, the OEM is required to respond within one working day through telecom or any electronic mean. In case of breakdown of the system, OEM must send their representative within 72 hours. For the minor faults not hampering the generation e.g., communication, display etc., the OEM must get the fault rectified within 7 working days.

Failure from the OEM to adhere the activity and the time schedule may lead to BG encashment.

- jj) Replacement of equipment/spare parts/ updating of software's being phased out or not being supported by OEM's is also included in bidder's scope.
- kk) O&M contractor shall be responsible to comply all cyber security guidelines of NCIIPC/ State/ Central Agency from time to time. All the costs related to cyber security/ upgradation etc. if any shall be in the scope of the O&M contractor for initial three years.
- ll) Bidder shall be responsible to carry out all test and work as required by statutory regulation in effect as on date of Techno-commercial bid opening during O&M period.
- mm) Transformers Preventive maintenance and testing shall be in scope of O&M Contractor. Testing frequency for all Transformers shall be annual, In case of outage of transformer or abnormality, testing shall be carried out as per instruction of OEM/GIPCL.

Routine Tests:

- a) All routine test shall be carried out in accordance with IEC 60076.
- b) Measurement of Voltage Ratio & phase displacement (as per IEC 60076-1)
- c) Measurement of winding resistance on all the taps (as per IEC 60076-1).
- d) Measurement of no-load current with 415 V, 50 Hz AC supply.
- e) IR measurement (As per IEC 60076-1).



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- f) Measurement of capacitance & tan delta of Transformer As well HV Bushings to determine capacitance between winding & earth.
- g) Yearly Transformer Oil Testing.
- h) Transformer Oil Top Up & Filtration if required.

- nn) O&M Contractor shall carry out the calibration of WMS instruments as per the OEM recommendation. Reports of calibration is to be maintained by contractor and to be submitted to GIPCL.

- oo) O&M Contractor shall maintain the healthiness of all Batteries of UPS and FCB Chargers by routine maintenance as per OEM's guidelines. Battery healthiness to be verified by battery bank capacity test every year. Contractor shall submit the reports of Battery capacity test to GIPCL.

- pp) O&M Contractor shall be responsible to maintain real time communication with RLDC, ALDC, SLDC, REMC, etc. as per statutory requirements and GIPCL SCADA system at Baroda.

- qq) Permit to Work system as approved by GIPCL shall be followed and contractor shall identify the engineers who are competent to issue the permits. Contractor shall inform to GIPCL in writing the details of these competent Engineer.

- rr) Any damage to CIVIL/ ELECTRICAL/ MECHANICAL components of the plant is to be reworked/replaced/supplied without any extra cost and time by the Contractor during O&M period. This means after completion of O & M period every component of the plant should be in good and working condition.

- ss) Sufficient numbers of 4-wheelers and 2-wheelers vehicles are to be kept at site for better mobility of O&M Staff.

- tt) Firefighting equipment available at site shall be maintained in perfect condition with regular checking, replenishment & firefighting trainings/drills.

- uu) For Rainwater logging necessary Pumping arrangement & portable pump sets to be provided by contractor.

4. Insurance

- 4.1. Operator shall provide or obtain and maintain in force throughout the period of O&M the following insurance coverage:
- a) Insurance to cover third party liability of appropriate value along with an undertaking indemnifying GIPCL from any such claim.
 - b) Workmen compensation and /or group personal accidents Insurance policy covering all its employees and works including of the sub-Operator. Pilferage, theft, burglary also to be covered by the operator.
 - c) Fire and allied perils including earthquake, flood, storms, cyclone, tempest, insurance policy shall be taken by the Owner regularly. In case of any loss/ claim under the policy, Operator shall immediately inform the same to the Owner.


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- d) The Operator may or may not take MBD insurance policy but it would be the responsibility of the Operator to operate and maintain the Solar plant and all the associated equipment at his own cost for the quoted O&M period for which the Owner shall pay the agreed O&M charges only. Any replacement / repair / modification of any item / equipment shall be Carried out by the Operator at his own cost for the quoted O&M period, so as to have minimum machine/equipment down time The Owner shall not be responsible for any break down / failure of any equipment to any reason thereof except for Force Majeure / Fire & Allied Perils Events or extraneous reasons.
- e) The risks such as, riot, civil commotion, weather conditions, fire, war etc. would be excluded from the Operator's scope. Contractor shall also effect and maintain any other insurance that may be required under any law or regulation or practice from time to time.
- f) The Contractor shall take all reasonable precautions to prevent fire of any nature in the general area of his operations and he shall be responsible for all damages due to fires directly or indirectly.
- g) As an owner, GIPCL will take Insurance policy as per normal practices. GIPCL is responsible for Insurance of Fire and Allied Perils as well as any Force Majeure condition. Force Majeure condition shall be applicable only in case of Act of God, other extraneous reasons beyond control of O&M contractor. Any claim arises due to poor Operation & Maintenance activities/practises, negligence like short-circuit, overheating, oil spillage etc., O&M contractor shall be responsible.

4.2. Workmen's Compensation Insurance

This insurance shall protect the Bidder against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Bidder against claims for injury, disability disease or death of his or his Sub-Bidder's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following:

Workmen's Compensation - As per Statutory Provisions
Employee's Liability - As per Statutory Provisions

4.3. Comprehensive Automobile Insurance

This insurance shall be in such a form to protect the Bidder against all claims for injuries, disability, disease, and death to members of public including the Owner men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated:

Fatal Injury	:	Rs.100,000 each person
	:	Rs.200,000 each occurrence
Property Damage:		Rs.100,000 each occurrence

4.4. Comprehensive General Liability Insurance

The insurance shall protect the Bidder against all claims arising from injuries, disabilities, disease, or death of members of public or damage to property of others, due to any act or omission on the part of the Bidder, his agents, his employees, his representatives and Sub-Bidders or from riots, strikes and civil commotion. This insurance shall also cover all the



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liabilities of the Bidder arising out of all relevant clauses in Section General Conditions of Contract (GCC).

The hazards to be covered will pertain to all the Works and areas where the Bidder, his Sub-Bidders, his agents, and his employees have to perform work pursuant to the Contract.

5. LD for shortfall in Generation during O&M

5.1. Bidder's liability during O&M period.

Refer relevant clauses of GCC & SCC of this Tender.

5.2. Bidder's liability during AMC period.

Bidder shall carry out regular predictive maintenance during entire AMC period through OEM or OEM authorized service provider.

Bank Guarantee (BG) for O&M, AMC and Warranty contract up to a period of 5 years shall be taken from Bidder by way of enhancement of value of Contract Performance Security of O&M, AMC and Extended warranty contract. The value and modality for submission and validity of this BG shall be mentioned in GCC/SCC of bidding document.

From 6th year to 10th year, the BG amount is revised depending on the offered solution as follows:

The AMC document has to be submitted before commissioning of full capacity. Joint undertaking document (as per Performa attached in Volume -1, Schedule -7, Appendix - 35) is to be furnished by Bidder before completion of O&M contract. After the end of O&M period, BG against comprehensive AMC has to be submitted by Bidder for following value:

- i. BG amount against comprehensive AMC of Inverter & SCADA – 1.0 Lakhs / MW.
- ii. BG Amount against comprehensive AMC of Tracker based MMS (if applicable) - 0.25 Lakhs/MW.

Thus, for 6th to 10th year, BG Value would be revised to 1.25L/MW by the Bidder which would cover comprehensive AMC of Inverter, SCADA and Tracker (if applicable) based MMS.

The requirement of Comprehensive AMC of Critical Equipment is revised as follows:

Equipment/System	Comprehensive AMC*
Inverter	10 Years
SCADA	10 Years
SAS (if applicable)	10 Years
Tracker (if applicable)	10 Years

* Starts from date of commissioning of full capacity


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Further details and conditions regarding this BG shall be as mentioned in SCC.

6. Handing over of the Plant

- a) At the end of the contract period, the Bidder shall hand over the plant and equipment along with requisite tools & Tackles and spares etc. back to the owner in completely safe and healthy condition and without any pending defect.
- b) The Bidder shall demonstrate functional operations of all the major & critical Plant & Equipment.
- c) The items supplied by GIPCL on returnable basis, such as spares parts (from mandatory spares or through procurement), consumables, tools and plants, documents, SCADA and communication system and setup along with all software access with credentials of User id and password etc. shall be return to GIPCL. Else suitable recoveries shall be made from the Bidder's bills.

7. After O&M period, GIPCL may at its discretion decide to extend the existing O&M contract for 5 years at same contract conditions with escalation of 5% on basic O&M price for each year from 6th year.

8. it is the responsibility of the Bidder to liaison with the following authorities:

- a) Liaison with State/Central Government.
- b) Liaison with State Power Utilities.
- c) Liaison with State Renewable Agency.
- d) Any other department / agency as may be required.
- e) GIPCL shall provide required documents.

9. During O & M period, all the statutory charges / annual charges related to SLDC/any other charges shall be in the Scope of GIPCL.