Bharat Heavy Electricals Limited
(A Government of India Undertaking)
Electronics Division
Mysore Road, Bangalore - 560 026

Scope of Work Cum Technical Specification FOR

Erection and commissioning works (BOS)

For

22MW (AC) Floating Solar Photovoltaic Grid-connected Power plant for NTPC

at

Rajiv Gandhi Combined Cycle Power Project

Kayamkulam

in

Kerala

SPECIFICATION No.: PS-439-1334 REV. 00

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Seal and sign of Bidder

Technical specification
for
Supply of Balance of System items, Installation & Commissioning
for
22MW (AC) Floating Solar Photovoltaic Grid-connected Power plant for NTPC - Rajiv Gandhi Combined Cycle Power Project at Kayamkulam- Kerala .

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	5.17	Installation of electrical panels at platforms constructed for PCUs, Inverter transformers and HT Panels, RTUs and other indoor panels in EEPEBR-Electrical Equipment pre-fabricated Room at each PCU location. Includes installation of UPS for Scada panel. Suitable arrangement to be made by bidder to install electrical equipment's on platforms in water. Refer Tentative layout of Inverter-Transformer-HT switchgear Yard for details.
	5.18	Design, Supply, Laying and installation of Control / data / instrumentation cables
	5.19	Specification of Earthing system
	5.20	Specification of Firefighting and alarm system
	5.21	Specification of cable installation methodology
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1.0 Introduction

1.1 Overall project outline of 22MW (AC) Floating solar photovoltaic power plant:

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up a 22MW (AC) Floating solar photovoltaic (SPV) power plant for NTPC at Rajiv Gandhi combined Cycle Power Project at Kayamkulam, Kerala.

The supply of all floatation devices including hardware for forming floating islands shall be in scope of BHEL. However, assembly of floatation devices as per OEM manual shall be in bidder's scope. All necessary on site hands on training for assembly of floatation devices will be given to the bidder's labours by OEM of floatation devices and BHEL. Design, Anchoring and mooring of the floating island is in the scope of BHEL.

After forming floating island, the installation of BHEL supplied solar PV modules on the floating island using BHEL supplied hardware shall be in the scope of bidder. The floating solar array shall be formed as per the BHEL drawings. Solar PV modules employed at the plant, generates DC electricity that in turn shall be inverted to AC in the range 630V. The output voltage from inverter/PCU stepped up to 33KV level. The combined output at 33KV level shall be terminated in the Kayamkulam indoor panel which is approximately 2500 meters away.

Laying of three runs of 33KV(E), 1CX240 sq.mm Phase cables from 15M WAC, 7MWAC Local Pooling station to Indoor metering cubicle and then to final termination at NTPC Control Room close to the metering cubicle. Necessary tree felling if required during routing and laying of HT cables as above also has to be done. Vendor shall coordinate with Contractor of NTPC for 70MW Floating project regarding laying of HT Cable along common route from 15MWAC to NTPC Control Room. Due to space constraints on the route , vendor shall closely work with 70MW project team for cable laying in common trench if possible.

1.2 Scope of this tender specification

Bidder scope includes supply, installation, testing and commissioning of identified activities of the floating solar photovoltaic power plant.

This scope includes activities but not limited to obtaining approval from BHEL / NTPC for the datasheets / drawings / MQP, manufacture / testing / inspection at manufacturer's works, packing, supply, transportation, transit insurance, delivery to site, unloading, storage, installation and commissioning of AC and DC side activities of power plant identified under this specification.

Note: The above is only a broad outline of bidder scope for the sake of introduction. The detailed bidder scope is elaborated under various other sections of this specification.

1.3 Enclosures to this tender specification (Tender purpose only)

1	AC single line diagram of overall Solar PV power plant
2	Tentative array layout with SCB locations
3	SPV module drawing
4	Tentative layout of EEPEBRs
5	Cable installation methodology
6	Weather monitoring system specification

7	UPS-Battery specification
8	Fire Fighting & Alarm System specification
9	33KV indoor metering cubicle Specification
10	Earthing system specification
11	ESE Lightning Arrester specification
12	Illumination system specification
13	NTPC approved vendor list
14	Auxiliary Transformer specification
15	LT switchgear specification
16	Floater installation manual
17	Tentative layout of inverter-Transformer-HT switchgear Yard
18	Specification for General Civil works
19	PEB room Specification
20	Safety manual

1.4 Location/ address of power plant:

22MW (AC) Floating Solar Photovoltaic Power Plant,
NTPC Rajiv Gandhi combined Cycle Power Project
Kayamkulam ,Kerala

2.0 Scope of Work

2.1 Bidder scope of supply, Installation and Commissioning:

The table below briefly indicates the scope of work for the bidder, as briefly outlined.

#	Bidder scope of work (as briefly outlined)	Qty
	List of Supply items	
1	Supply of cable ties, couplers, joints, bends etc. for 6 sq.mm solar cable routing from string end to SCB.(For DC cable of 2x73.5 Kms)	1 set (as required basis)
2	Supply of M/s. Multi contact make MC4 connectors for string connection	1800 pairs
3	Supply of M/s. Multi contact make Y Connectors	1700 pairs
4	Supply of HDPE DWC pipe for routing of 6sqmm cables through pathways where SCBs are mounted.	5 Kms
5	Supply of 2.5sqmm lug and M4 size self-tapping screw of SS-304 grade for earth cable connection on PV module frames.	190920 sets
6	Supply of 25*3 MM GS/CCS earthing strip for internal earth grid formation	8.8 Kms
7	Supply of 25*6 MM GS/CCS earthing strip for peripheral earth grid formation	4.4 Kms
8	Supply of SCB earthing cable (25 sq.mm CU) with necessary lugs and hardware	500 M
9	Supply of SCB support structure (Aluminium) and SS304 hardware suitable for	80 Nos

	mounting SCBs on HDPE floating pontoons	
10	Supply of 2.5 sq.mm earthing copper cable (Yellow Green PVC sheathed) for inter connecting 30 modules in a row	53 Kms
11	Supply of FRP/Aluminium ladder type cable tray with cover and supporting arrangement consisting of mounting bar and clamp with SS 304 hardware for clamping with HDPE floaters – 300mm wide	15 Km
12	Supply of FRP/Aluminium ladder type cable tray with cover and supporting arrangement consisting of mounting bar and clamp with SS 304 hardware for clamping with HDPE floaters – 600mm wide	1 Km
13	Supply of double compression weatherproof metallic cable gland, bi-metallic strip or washer, SS304 hardware for 400 sq.mm cable- PCU DC side	170 set
14	Supply of double compression weatherproof metallic cable gland, aluminium cable lug, bi-metallic strip washer, SS304 hardware for 400 sq.mm cable- PCU AC side and TRF LV side	140 set
15	Supply of PEB rooms for placing all the Electrical Equipment's (Internal clearance 4x4) Height=Min 3 mts and Staad calaculation for stability to be provided.	4 sets
16	Supply of UPS systems (3 KVA),with 30 mins backup, UPSDB and Ni-Cd type battery bank (Comprising of 2 x100% redundancy for Battery and Charger)	5 sets
17	Supply Auxiliary transformers along with all necessary connections and materials like cables, cable lugs and cable glands 30 KVA Dry Type Auxiliary Transformers for EEPEBRs	4 sets
18	Supply of ACDB inside EEPEBRs for electrical equipment	4 Sets
19	Supply of double compression weatherproof metallic cable gland for 33KV(E), 1CX240 sq.mm cable	70 Nos
20	Supply of indoor cable termination kit for 33KV(E),1CX240 sq.mm	70 Nos
21	Supply of straight through joint kits for 33KV(E), 1CX240 sq.mm cable	15 Nos
22	Supply of straight through joint kits for 3.3KV(E), 1CX400 sq.mm cable	6 Nos
23	Supply of earthing electrodes for under water application for Solar Array and ESE LA for solar array.	50 sets
24	Supply of earthing electrodes with chemical compound for all electrical equipment i.e. termination hardware, cover with inspection lids for inverter platforms, EEPEBRs,	90 sets
25	Supply of control and instrumentation cable for connecting PCU, HT panel, UPS, fire alarm system, inverter transformer, WMS etc. to RTU panel (all OFC cable supplies shall be in BHEL scope)	4 sets
26	Supply of items for LED based outdoor lighting system covering Inverter platforms and transformer yards.	8 Nos
27	Supply of weather monitoring system (WMS)	1 set
28	Supply of safety related items including fire alarm systems for PEB, fire extinguishers, sand buckets, safety gadgets etc	4 set
29	Supply of ESE type lightning arrester including 5 meter pole, counter, base plate and hardware etc.	18 sets
30	Supply of 70 Sqmm bare aluminum conductor for ESE LA earthing with Lugs and clamps	500m
31	Supply of 1Cx70 sqmm PVC sheathed copper cable for earthing interconnections	1 Km

32	Supply of Indoor Metering cubicle with Metering CT,PT, Surge Arrestor, ABT Meters as per specification.	2 Nos
33	Supply of life jackets as per IS 6685.(IROS/ SOLAS approved makes)	40 Nos
34	Supply of small passenger boat for 5 persons. Boat shall be with FRP body construction and 6-8 HP outboard diesel/petrol engine motor (reputed make like Suzuki/Yamaha). Boat shall be certified for water worthiness by concerned agency like IROS (Indian register of shipping/MMD/Govt. Department as applicable). Boat shall come equipped with Nylon ropes for towing, anchoring, mooring and Air tubes (3 Nos.) for functioning in rescue work.	1 No
35	Supply of miscellaneous items such as cable tags, cable ties, cable ferrules, cable route markers, hoarding board, sign boards, danger boards, display boards, plant Layout boards, electrical insulation mat, tool kits, measuring instruments, office furniture, items for remote connectivity of SCADA, etc.	1 set (as required)
36	Supply of spare items	1 set
	List of Works (I&C activities)	
1	**I&C**: Excavation of isolated earthen/ sand dunes, vegetation, coconut tree stumps etc in the kayal (backwater). The location of earthen/sand dunes/vegetation, coconut tree stumps are marked in the layout and the final level required is also indicated. After excavation this earth/vegetation etc is to be disposed at the desired location. (Disposal location shall not exceed 500m). Vendor has to mobilize his team for excavation during the Anchoring and Mooring work done by BHEL. Mobilization of excavation team to be done within 10 days of BHEL intimation for the same. Arrangements for entry of dredger/excavator, power boat for moving excavator machine, barge for soil disposal into the kayal shall part of scope.	1000CUM
2	**I&C**: Installation of floating pontoons and modules as per the instructions and on-site hands-on training by the OEM of pontoons. Supply of pontoons, modules and hardware for installation is in BHEL scope. Anchoring and mooring of the floating island is also in BHEL scope. As per OEM, approximate labour required shall be 3 modules/hour/person. Total number of modules to be installed is 95460 Nos. All tools, tackles and Infrastructure like boats required for Installation of Floaters shall be in the scope of bidder. Bidder has to prepare required no of launch pads (sloped wooden platforms with support on bund) to install the floating platform in the required time duration. (1 AU= 22MWAC Block consisting of approx. 95460 SPV modules)	1AU
3	**I&C:** Connection of anchoring ropes/chains/Buoys to each floating island as per drawing (1 AU= 22MWAC Block consisting of approx. 95460 SPV modules)	1 AU
4	**I&C**: Interconnection of SPV modules, installation of 80 Nos of SCBs, laying/ termination/ ferruling of solar array 1Cx6sqmm cable including related conduit works. 1 AU= 22MWAC Block consisting of approx. 95460 SPV modules)	1 AU
5	**I&C**: Laying and termination of 1Cx400sqmm DC power cable from SCB to PCU through covered cable trays. 1 AU= 22MWAC Block consisting of approx. 95460 SPV modules)	1 AU
6	**I&C**: Laying and termination of 1Cx400sqmm DC power cable on floaters from PCU to inverter transformer LV side 1 AU= 22MWAC Block consisting of approx. 95460 SPV modules)	1 AU

7	**I&C**: Earthing of 95460 nos. modules and 80 nos. of SCBs using combination of earthing cables of adequate size and earthing strips. Total number of underwater earth electrodes for array earthing shall be at least 32 Nos. SCB-SPD earthing cables shall be connected to array earthing grid. (1 AU= 1 earth pit)	32 AU
8	**I&C**: Installation of 18 Nos of ESE type LA on separate floating platform and. LAs on pond shall be placed as per tentative layout. LA shall be earthed to the bottom of the Kayal. Supply of necessary metallic base frame for fitting LA pole to the floats along with stay wires is in scope of bidder. (1 AU=installation of one ESE LA)	18 AU
9	**I&C:** Erection of PCUs, HT panels etc. on the inverter platform including grouting of panels, laying/fixing of cable trays, routing/terminations of cables at the electrical panels and up to LV side of transformers on the inverter platform. (1 AU= 22 MWAC Block)	1 AU
10	**I&C:** Erection of 33kV transformer yard - Erection of 5.3MVA – 4 nos and 2.7MVA – 1 no inverter transformers, cable trays, drain pipes and stone jelly spreading, including stone jelly for drain pit . (1 AU= 22MWAC Block)	1AU
11	**I&C:** Erection of 33kV HT power cables from transformer to HT panels to Local pooling stations to metering cubicle to final evacuation point (using trefoil clamps). Also laying of SCADA communication (OFC) cable from Each RTU inside EEPEBRs to metering cubicle to scada room Trefoils of HT cables laid from the PV plant shall be terminated on the indoor metering cubicle room and further laid through available trenches and terminated at Panels in nearby panel room of customer. Conducting of detailed route survey is in Vendor scope. Based on the route study, Cables shall be suitably laid underground in trenches .Some of the reference photos are attached for vendor reference. (1AU = laying of one trefoil for 1 KM)	4 AU
12	**I&C:** Erection of metering cubicle with CTs , PTs, Surge Arrestor ,ABT Measuring Meters as per KSEB approval	2 sets
13	I&C : Erection of PEB rooms for placing all the Electrical Equipment	4 sets
14	**I&C:** Erection of Auxiliary transformers, ACDB, UPS/ battery bank, RTU panels etc. in PEB EER (Electrical Equipment Pre-Fabricated Building Rooms) near to the inverter platform, including grouting of panels, Supply and fixing of cable trays, routing/terminations of cables. This includes erection of one 3KVA (2 x100% redundancy) UPS in SCADA room of NTPC Control Room. 1 AU= 22MWAC Block	1 AU
15	**I&C**: Installation and commissioning of SCADA and telemetry system by integrating the data cables from all the electrical and weather monitoring system equipment , (WMS) , metering point of the power plant at the data logger/ PLC panel / HMI computer control desk at SCADA (1 AU= for 22MWAC Block).	1 AU
16	**I&C:** Earthing system for Inverter platforms (including EEPEBRs) and 33kV transformer yards including laying of underground earth mat grids, providing	1 AU

	electrodes with earth chambers and lids, laying/termination of earthing strips from all electrical equipment to earth mat grid etc. (1 AU= for 22MWAC Block)	
17	**I&C:** Plant lighting system including outdoor cable laying, cable terminations at poles / lights as well as DB boards of inverter platforms. (1 AU= for 1 LED fixture)	8 AU
18	**I&C:** Miscellaneous and safety items such as cable tags, cable markers, hoarding board, sign boards, danger boards, display boards, electrical insulation mat, checkered plates, air conditioners, office furniture, fire extinguishers, fire alarm system, weather monitoring system, items for remote connectivity of SCADA, identification markings using painting etc (1 AU= for 22MWAC Block)	1 AU
20	**I&C:** Pre-commissioning inspections/ checks/tests, MRT tests, coordination/liaison with state /central departments/CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning (1 AU= for 22MWAC Block)	1 AU
21	Deputation of Safety supervisor for duration of I&C (1 AU = 1 Month)	5 AU
22	Provision of emergency vehicle/Ambulance on standby for duration of I&C (1 AU = 1 Month)	5 AU

3.0 BHEL's scope of supplies (only I & C of components in bidder scope)

For clarity to the bidder, other items and activities within BHEL scope of solar PV plant end of the project are listed below:

1	Supply of solar PV modules	95460 Nos
2	Supply of floating pontoons for modules, SCBs and LAs	As per requirement
3	Supply of 1C x 6 sqmm Solar Cable	~150 Kms
4	Supply of DC cable,3.3 KV,1C x 400sq mm, Al, XLPE, Un armoured as per IS: 7098 (from SCB to PCU and PCU to Transformer)	~55 Kms
5	Supply of 33kV(E) HT cable, 1C x 240 sq.mm, Al, XLPE, armoured as per IS: 7098	~40 Kms
6	Supply of power conditioning units (PCUs) of 2500 kW	9 Sets
7	Supply of String Combining Box (SCB)	81 Nos
8	Supply of inverter transformer 5.3 MVA, 33kV/630-630 V, ONAN	4 Nos
9	Supply of inverter transformer 2.7 MVA, 33kV/630V, ONAN	1 Nos
10	Supply of 33kV HT panels	10 panels
11	Supply of SCADA system including PLC panels, computers, software systems and related peripherals & accessories.	As per requirement

4.0 List of documents to be submitted along with the technical bid:

1. All supporting documents to meet Pre-Qualification Criteria (PQC) as mentioned in the RFQ.
2. Bidder has to enclose the deviation sheet clause wise separately, in case any deviations are

sought by the bidder. Absence of any deviation sheet shall be taken as compliance of BHEL technical specification in total without any deviation.

5.0 Technical specification for supply, installation and commissioning

#	BHEL purchase specification
5.0	**Electrical power / water for construction** a) Power for construction shall be arranged through DG set or by other means by bidder viz. obtaining temporary utility supply on chargeable basis. b) For construction activities if any vendor has to arrange his own water.
5.1	Excavation of isolated earthen/ sand dunes, vegetation, coconut tree stumps etc in the kayal (backwater). The location of earthen/sand dunes/vegetation , coconut tree stumps are marked in the layout and the final level required is also indicated. After excavation this earth/vegetation etc is to be disposed at the desired location. (Disposal location shall not exceed 500m).Vendor has to mobilize his team for excavation during the Anchoring and Mooring work done by BHEL. Mobilization of excavation team to be done within 10 days of BHEL intimation for the same
5.2	**Construction of temporary yards for safe storage of bidder supplied items** a) Bidder shall, at a suitable location at the site, as decided based on discussions with BHEL site engineer, construct temporary yards for safe storage of bidder supplied items. b) Area of all storage yards/sheds shall be selected based on sizes of items. Bidder shall, at the time of starting their activities at site, submit drawings/ sketches/ dimensions etc to obtain approval from BHEL. c) Safety and security of all the items shall be within bidder scope. Accordingly, bidder shall ensure adequate security watch and ward for these items round the clock.
5.3	**Movement of items received at site**: a) Arrangements shall be made by bidder for movement of the stored items from interim storage yards to the exact construction locations within the project site. b) Bidder shall maintain proper documentation / compilation of all the records related to shipping (invoices, LRs, delivery challans, material receipt certificates etc.) and shall take approval from BHEL site engineer for every consignment. The documents shall be suitably preserved for further handing over to BHEL. c) Registers shall be maintained for the yard to keep track of day to day incoming/outgoing items. d) Safety of items at the work spot/s shall be in bidder scope. Accordingly, suitable watch and ward shall be deployed on round-the-clock basis. e) As the most of the proposed plant area is covered with water in three sides , necessary precautions to be taken while transporting.

5.4	**Installation of floating pontoons with module mounting mechanism:** **HDPE floaters and HDPE hardware, Total quantity = 95460+ Nos (BHEL scope of supply)** Bidder shall be imparted necessary training to carry out the work of assembly of floatation platform and surrounding pathway using the HDPE floaters and HDPE hardware and for Mounting of the PV modules on the floaters. The bidder has to arrange work men who shall be trained by the OEM of floater platform to carry out the work and to further ensure and Supervise the proper assembly and quality of the platform and module mounting. The vendor shall arrange the following essential tools/accessories and Safety personnel to enable safety to equipment and work men during the course of work: a) Provide Life jackets for all workers working on water body b) Provide Inflatable / other small boats for work over water and for towing floaters. Boats employed shall have water service fitness certificate issued by IROS/SOLAS/Govt agency c) Provide and lay carpet of Rubber/HDPE/Canvas sheets on land next to water body for enabling assembly of floaters without damage from friction/scratches on concrete/ground and during launching by sliding into water d) Provide temporary nylon ropes for tying floaters to shore before assembly and for towing upto work point and for cordoning safe areas of working e) Provide sheets for holding hardware and cabling accessories for assembly without accidental dropping into water f) One Rescue and Safety motor boat having driver and expert swimmer and provided with additional 3 life jackets and Air tubes and Nylon ropes shall be stationed during working hours for emergency support. g) One qualified Safety supervisor shall be stationed at site throughout the duration of works and activities associated with movement in water. He shall be equipped with binoculars for observation of activities in water and near shore. **For more details, please refer attached installation manual of floater manufacturers (OEM).**
5.5	**Launching platform base Details (sequence work details for floaters assembly)** a) For Assembly of floaters along with PV modules and formation of strings prior to launching in water, sloping platforms with ramp gradient shall be constructed at one or more locations over the bund slope as per location indicated. b) These platforms are normally constructed with wooden planks/particle boards covered with plastic sheet/ tarpaulin sheets to provide smooth gliding surface for movement into water and to avoid damage to floaters. c) Care shall be taken not to damage the bund or its surface, while constructing and securing the platform/s. d) Location for the platform shall be informed to the bider by BHEL in consultation with customer as regards approach and movement

5.6	**Series interconnection of SPV modules to form strings** Type of module and rating: (Min 330 Wp). Total quantity = 95460 Nos. (BHEL scope of supply) Bidder shall interconnect the SPV modules as follows: a) Each module is fitted integrally with a junction box having positive and negative polarity cables (4 sq-mm). b) Positive cable of one module shall be connected to the negative cable of next module. The cables have MC4 type of connectors. One polarity cable has male type connector, while the other has female type connector. c) In this manner 30 modules shall be connected in series. Each set of connections is called as a series string.
5.7	**Interconnection of SPV module strings to 1Cx6sq.mm. cable:** a) Vendor shall connect two series strings of 60(30+30) SPV modules to 1Cx6sqmm cable using **Y-connector.** b) Required tools and tackles for crimping of cable etc. shall be arranged by bidder. This shall include crimping tool MC4, open end spanner set MC4, stripping plier MC4, socket wrench insert to tighten, socket wrench insert to secure, inserts for both 1Cx4 and 1Cx6 (of both pliers). **c)** Extra quantity of Y Connector shall be procured for any damages / pilferage during the installation by vendor at site. Such additional quantities will not be paid for. Vendor shall ensure that there shall not be any shortage during execution time. The cable shall be neatly dressed and tied with UV resistant ties so as not to dangle and be in contact with water.
5.8	**Ferruling for 1Cx6sq.mm cable:** a) For 1Cx6 sq.mm DC solar array cable, bidder shall provide UV resistant ferrules printed with **source / destination** identification of cable. Printing details shall be submitted for **BHEL /NTPC** approval during detailed engineering. b) Printing shall be of appropriate size to ensure readability. Supply of ferrule shall be in bidder scope. c) Ferrules shall be provided on both the termination ends: module end and SCB end.
5.9	**Installation of SCBs on floating pontoons**: Supply of string monitoring boxes (SCB), 80 sets, is in BHEL scope. These are 22-in / 1-out type. a) Bidder shall install the SCBs using suitable fixing mechanism of SCB support structure (Aluminium) and SS304 hardware, which shall be suitably mounted on HDPE floating pontoons. Vendor to assemble proto type of the SCB support structure and demonstrate for approval and clearance for bulk supply.

	b) Supply of SCB support structure is under bidder scope. Provision will be provided in the pontoon to mount the SCB structure. However, necessary hardware like nuts, bolts, washers etc. shall be in the bidder scope of supply. **c)** All necessary labour, tools, machinery etc. for erection work shall be in bidder scope.
5.10	**Routing of 1Cx 6sq.mm cable up to SCB:** a) Cable from the farther end of the string shall be routed below the module till other end. From that point both positive and negative cables shall be neatly routed through HDPE pipe using necessary water tight joints **till SCB input side**. **The HDPE pipes for routing cables are only required in pathways where SCBs are mounted.** Row-wise HDPE pipes are not envisaged. After completing the cabling and terminations at both sides, bidder shall seal the HDPE pipes with non-inflammable foam filling or any other reliable method using reputed makes for water sealing.minimum 5 cm water sealant needs to be present at every ends ot HDPE pipe.The HDPE pipes shall be tied neatly to the pontoon lips at regular intervals. b) HDPE DWC pipe together with necessary HDPE couplers/ joints (T-joints, elbows, bends etc.), UV resistant Cable ties, shall be within scope of bidder supply. **Specification:** As per relevant IS; ID (Internal Diameter) shall be selected to accommodate the number of 1Cx6sq.mm cables to be guided. ID shall be minimum 63mm. However, exact ID shall be selected to ensure that only a maximum of 60% of the ID space is occupied by the cables. Make, part number, sizes/ dimensions shall be submitted for **BHEL/NTPC** approval during detailed engineering. c) Cable ties shall be in bidder scope of supply. Width of the cable ties shall be min 4.5 mm. d) Cable ties, nylon polyamide 6.6 UV stabilized black, UL94 flammability rating V2, operating temperature up to 85 deg C, shall be used to arrest any possibility of movement or sagging. **Cable ties shall be of make: 3M**, **Phoenix contact, Weidmuller, Hellermanntyton, Panduit or other reputed equivalent, subject to BHEL/NTPC approval.** Width and Length shall be so appropriate as to ensure that the bunched cables are held firmly to the mounting structure. During detailed engineering, **BHEL/NTPC approval shall be obtained for the selected brand and sizes of cable tie.** e) Spacing between two adjacent cable ties shall be so appropriate as to ensure that there is no loose hanging of cables and no contact with water.
5.11	**Termination of 1Cx6sq.mm. Copper cables on input side of SCBs:** a) 1Cx6sq.mm cables of positive and negative polarities originating from SPV module strings shall be terminated at the input side of SCBs using MC4 connectors. b) Bidder scope includes removal of sleeve of cable, crimping at the cable end and fixed with MC4 connector to SCB. c) MC4 connector for 6sqmm cable termination to SCB shall be in BHEL scope of supply d) Any other hardware, if necessary for fulfilling the connection, such as bolts, nuts, screws, washers etc. shall be in bidder scope of supply. **All hardware shall be of SS304.** e) All necessary tools such as pliers, strippers, MC4 crimping tools etc. shall be within bidder scope.

	f) After cable termination, all the cable entry points shall be sealed from outside using non inflammable foam or any other reputed proven weather resistant water sealing mechanisms to avoid water ingress.
5.12	**Termination of 2 run 1Cx400 DC power cables at SCBs** a) Cables of 2run, 1Cx400 (Al conductor, XLPE insulation, Un-armored) shall be terminated at the output side of SCBs (positive, negative terminals). b) Bidder scope includes removal of sleeve at the cable end, crimping with suitable cable lug of appropriate type/size and connecting the lugged end to the tinned copper bus bar within the SCB. Cables shall enter the SCB through the cable glands that are also supplied by BHEL along with SCBs. c) All necessary tools such as pliers, strippers, crimping tool etc shall be within bidder scope.
5.13	**Laying of 2 runs of 1Cx400sq.mm Al cable upto inverter platform and terminations at PCU** a) 2 Runs per SCB of 1.1kV, 1CX400 sq.mm cable through ladder type cable tray with cover, shall be connected from SCB to PCU through walkway cable floaters. The cable termination at SCB side by using BHEL supplied hardware and cable termination at PCU side with bidder supplied, gland, lugs and hardware is in bidder scope. b) The laying of cable shall be done without overlapping each other and routing neatly through cable trays using cable ties, supporting arrangement consisting of mounting bar and clamp with SS 304 hardware for clamping the tray(300/ 600mm wide) with HDPE floaters .Cable ties and clamps shall be in bidder scope of supply, shall be of 4.5mm minimum thickness, UV resistant and with adequate length of tying. c) All the cables from SCB needs to raised properly with suitable tray to the elevated inverter platform. All the weight of Cables needs to be transferred to trays so that no cable load should act on PCU terminals. d) Bidder shall carry out drilling of holes in cable gland plates of the PCUs for the positive and negative DC inputs of 1Cx400 cable for 9 nos of PCUs. Gas cutting method is strictly not allowed. Bidder shall organize hole-saw cutters of appropriate size for this purpose. All necessary drilling machines / tools etc. shall be made available at site. e) Prior to termination, each cable shall be checked for continuity and meggered. In case any cable found defective, bidder shall implement suitable corrective action such as cable jointing, replacement/re-laying of cable etc. as applicable. f) Bidder shall carry out glanding of the cables following which the glands shall be fitted to the respective holes of gland plates. Bidder shall carry out the cable terminations for positive and negative inputs that include tasks such as unsleeving, crimping, connecting to the tinned copper bus bars, tightening using torque wrench etc. Proper labelling/tagging is to be planned and fixed on cables.idder shall carry out glanding of the cables following which the glands shall be fitted to the respective holes of gland plates. g) Bidder shall carry out the cable terminations for positive and negative inputs that include tasks such as unsleeving, crimping, connecting to the tinned copper bus bars, tightening using torque wrench etc. Proper labelling/tagging is to be planned and fixed on cables.

	h) Bidder shall arrange torque wrench of appropriate range. Torque setting shall be as per the bolt size and property class. For the setting, approval shall be obtained from BHEL site engineer. i) Bidder shall submit details of cable glands/lugs/ties/hardware (Make, part number, size, quantity etc.) Glands shall be of COMET or 3D make. Other than these makes shall not be accepted. j) Cable lugs shall be of Dowell or COMET or 3D make. Other than these makes shall not be accepted. k) All tools/accessories such as crimping tools etc. required to carry out the termination shall be within scope of bidder.
5.14	**Laying and Termination of 1Cx400sq.mm LT AC power cables at PCU and Inverter Transformer** a) LT Cables 6 runs of 1C x 400 sqmm per phase shall be laid between AC side of the PCU and the LT side of the Inverter transformer as per "Cable installation methodology" defined in this specification. b) Bidder scope includes removal of sleeve at the cable end, crimping with suitable cable lug of appropriate type/size and connecting the lugged end to the tinned copper bus bar within the PCU and Transformer. Cables shall enter the PCU and Transformer through the metallic cable glands. c) Cable lug make shall be Dowell, COMET or 3D. Other than these makes shall not be accepted. d) Cable gland metallic type shall be of COMET or 3D make. Other than these makes shall not be accepted. e) Quantity of lug and hardware shall also include contingency requirements arising out of shortage due to various reasons (damage, theft etc.) during installation. f) All necessary tools such as pliers, strippers, crimping tool etc. shall be within bidder scope.
5.15	**Laying and termination of 33KV(E), 1CX240 sq.mm XLPE Al cable from Inverter transformer to HT panel and to local pooling station** a) There will be one no 15MWac, one no 7MWac local pooling station . b) Laying and termination of 3 runs 33KV(E),1CX240 sq.mm XLPE Al armoured cable from HV side of the inverter transformer to HT panels mounted on platforms at each inverter station shall be in vendor scope. c) Laying and termination of 3 runs 33KV (E),1CX240 sq.mm XLPE Al armoured cables from each inverter platform to their corresponding local pooling stations shall be in vendor scope. d) Cable glands, cable lugs, 33kV HT cable termination kits (indoor/ outdoor types as applicable), bolts, nuts, washers etc. shall be in bidder scope of supply. Cable glands make shall be COMET or 3D. Cable lugs make shall be Dowell or COMET or 3D. Other than these makes shall not be accepted. e) HT termination kits (indoor as applicable) shall be Raychem or 3M make/ NTPC approved make. HT termination shall be carried out by certified jointers. Credentials / certification of

	experience from Raychem or 3M for the proposed jointers shall be submitted for BHEL/NTPC approval during detailed engineering.
5.16	**Laying and termination of 33KV(E), 6 (2 nos. of 3 phase lines) runs of 1CX240 sq.mm XLPE Al cable from local pooling station near reservoir to Indoor metering cubicle to evacuation point at existing panels at NTPC Switchgear room** a) Laying and termination of 3run (1 nos. of 3 phase lines) of 33KV(E),1CX240 sq.mm XLPE Al armored cable from 7 MW AC local pooling station to 7MW indoor metering cubicle to final evacuation panel nearly 1.1 Km away through underground cable trench and necessary trays as per standards, shall be in vendor scope. (through proper cable trefoil clamps at regular intervals as per relevant standards) Laying and termination of 3 runs (1 nos. of 3 phase lines) of 33KV(E),1CX240 sq.mm XLPE Al armored cable from 15 MW AC local pooling station to 15MW indoor metering cubicle to final evacuation panel nearly 2.5 Km away through underground cable trench trench and necessary trays above ground if required as per standards, shall be in vendor scope. (through proper cable trefoil clamps at regular intervals as per relevant standards) Conducting of detailed Route survey is in bidder scope. b) Cable glands, 33kV HT cable termination kits (indoor types as applicable), Cable jointing kits, bolts, nuts, washers etc. shall be in bidder scope of supply. Cable glands make shall be COMET or 3D. Cable lugs make shall be Dowell or COMET or 3D. Other than these makes shall not be accepted. c) HT termination kits (indoor as applicable) shall be Raychem or 3M make. HT termination shall be carried out by certified jointers. Credentials / certification of experience from Raychem or 3M for the proposed jointers shall be submitted for BHEL/NTPC approval during detailed engineering. d) All necessary equipment required for termination at evacuation points are in scope of vendor only. i.e. Cable glands, Cable lugs and termination kits, e) Proper HT cable route marker shall be used in regular intervals as approved by BHEL/NTPC. f) Some reference photos are attached for vendor reference.
5.16	**Identification marking of cables using cable tags** a) Cable tags shall be provided on all power cables at both ends just before entering the equipment enclosure. b) Cable tags shall be of rectangular shape. c) Cable tag shall be of 2mm thick aluminum with number punched (embossed) on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. d) Bidder shall submit the technical details of cable tags, ID numbering scheme for BHEL/ NTPC approval during detailed engineering.
5.17	**Installation of electrical panels at platforms constructed for PCUs, Inverter transformer, HT panel and CMCS, other indoor panels at EEPEBRs (Electrical Equipment Pre-fabricated building Rooms) of electrical equipment.** Bidder shall organize necessary resources such as labour, cranes, hydra, forklifts, transportation trucks / trolleys and other accessories for movements and positioning of the panels as below

	(a) PCU: 9 Nos (b) 33kV HT panel: 10 set . (c) SCADA and RTU panel: 1 No scada panel at existing NTPC switchgear indoor room and RTU sub panels in EEPEBRs (PEB buidings- vendor scope) near Inverter platform (d) HMI SCADA control desk with PCs and accessories: 1 set (e) UPS with battery bank (Comprising 2 x100% redundancy) – 5 Sets. (f) ACDB in EEPEBRs– 4 Nos. a) Panels shall be moved to the respective positions and placed over the cable trenches on the inverter platform, in the exact sequence and locations as per drawings approved by BHEL/NTPC. b) PCUs, VCB panels shall be placed on cable trench of Inverter platform, with cable entry openings to match cable trench on bottom side. c) Panels shall be suitably grouted using welding / bolting methods as per relevant standards. BHEL approval shall be obtained for the grouting arrangement. All necessary hardware for the same shall be within bidder scope of supply. Each panel shall be double earthed to the earth mat grid of the room.
5.18	**Design, Supply, Laying and installation of Control / data / instrumentation cables** a) All the cable installation accessories such as cable trays, cable conduits, cable glands, cable lugs, ferrules, cable ties, bolts, nuts, washers etc. shall be in bidder scope of supply. Cable laying and cable terminations shall be in bidder scope. All necessary resources such as labour, tools and accessories required to carry out laying and termination works etc. shall be in bidder scope. b) All the other cables such as (i) control cables from inverter transformer marshalling boxes to relay circuits in VCB panels (transformer trip signals), (ii) control cables from inverter transformer marshalling boxes to SCADA (transformer alarm signals), (iii) control cables from SCADA panels to relay circuits in VCB panels (VCB on/off status, VCB close/open command signals), (iv) instrumentation cables from inverter transformer marshalling boxes to SCADA panels (4-20mA signals, WTI/OTI values) shall be in bidder scope of supply. c) Cable laying and cable terminations shall be in bidder scope. Make shall be as per NTPC approved list of cable vendors. Design calculations for cable selection together with GTP/datasheet particulars shall be submitted for BHEL/ NTPC approval. Number of cores, length requirements shall be appropriately assessed by the bidder. d) Bidder shall lay and terminate the OFC/RS485 cables to SCADA from (a) Local pooling station, (b) Weather monitoring station e) Bidder shall lay and terminate the Ethernet cables to SCADA from (a) PCUs, (b) numerical relays of VCB panels. f) Bidder shall lay and terminate OFC cables from each RTU to SCADA termination point of NTPC at Kayamkulam kulam RGCCPP g) All necessary resources such as labour, tools and accessories required to carry out laying and termination works etc shall be within scope of bidder.

	h) All applicable/ relevant clauses under "**Cable installation methodology**" sections of this specification shall be adopted for all aspects of these cables such as technical specifications (ratings, sizes, calculations etc), cable selection, tests on cables, cable installation, cable accessories etc.
5.19	**Specification of Earthing system: As per attached Annexure**
5.20	**Specification of Firefighting and alarm system : As per attached Annexure**
5.21	**Specification of cable installation methodology: As per attached Annexure**
5.22	**Specification of UPS with battery bank: As per attached Annexure**
5.23	**Specification of Auxiliary Transformer: As per attached Annexure**
5.24	**Specification of ESE type LAs :As per attached Annexure**
5.25	**Specification of 33KV indoor metering cubicle: As per attached Annexure**
5.26	**Specification of illumination system: As per attached Annexure**
5.27	**Specification of PEB rooms: Detailed Specifications are as per attached Annexure. However, specifications of standard bought out PEB rooms of 4Mx4Mx3.0M(H) dimension may also be accepted after design review.**
5.28	**Auxiliary AC/DC power supply system DB of Nearest PCU** distributes the AC power to various utility applications in main control room. (Viz. SCADA, UPS required for SCADA, other utilities required in Main control room such as main control room lights, ceiling fans, exhaust fans, plant lighting, other electric appliances). a. **30 KVA** type Auxiliary Transformer **(Dry type)** for tapping power from LV side of PCU (other four platforms) and for connecting to ACDB (providing LT supply of 3 phase, 415 V). Auxiliary transformer of approved make to be supplied and erected by the bidder at each b. ACDB of each PCU shall be connected all required power consumptions available in the local inverter platforms (Viz. HT panels, UPS required for HT panels, other utilities required in the local Inverter platform). c. Connections of the same with all necessary protection system shall be vendor scope. Vendor shall submit detailed SLD diagram of Aux AC/DC system with ELR/CBCT, MCCB, MCB types (TPN, DP, SP)/ Amp/kA ratings for incoming/ outgoing feeders for various electrical loads/ utilities for BHEL/NTPC approval during detailed engineering. Following DB boards for application in main control room and EERs (RCC buildings) shall be in bidder scope of supply, installation and commissioning: 1. UPS DB for 230V AC UPS supply to SCADA, weather monitoring system, fire alarm system, emergency loads, CR DB (room utilities) - 1 Set 2. Above DB boards shall also provide for any other feeders, if necessary, to meet functional requirements. In addition, at least two spare feeders shall be provided in each of the above DB boards. Further, any extra DB boards to meet functional requirements of Aux AC/DC system shall be provided by the bidder. 3. Above DBs shall be of reputed make such as Legrand, Siemens, Schneider or any other

	reputed make as approved by BHEL/NTPC. 4. DB boards shall be provided with incoming/ outgoing MCB as applicable (based on rating requirements) with spare feeders as shall be approved by BHEL/NTPC. 5. Installation of all the above items including all necessary cables, cable terminations/ installation shall be in bidder scope. 6. Constructional features of the connections shall be as per specification **"LT switchgear**". 7. LT switchgear component of reputed make such as L&T, Siemens, ABB, Schneider or any other NTPC approved makes are only accepted. 8. MFM meter with RS485 communication feature to facilitate SCADA connection shall be provided in LT SWITCHGEAR.
5.29	**I&C of electrical connections to EEPEBRs** Bidder shall provide all necessary electrical connections and laying of LT power cable in EEPEBRs,.
5.30	**Supply and installation of Weather monitoring system** **As per attached Annexure "Weather monitoring system"**
5.31	**Installation and commissioning of SCADA integration systems** (1) SCADA system, supply of which shall be in BHEL scope, comprises of data station panels and PC based control desks with software to collect, store, process and report the data parameters of power plant and also to control the operations of the power plant by integrating the various equipment at the segments as follows: (a) SCADA panels placed on the inverter platforms. (b) Power conditioning units (10 Nos): DC input / AC output parameters of inverters, grid data, fault status and events logged, etc. (c) Inverter transformers (5 Nos): Alarm/Trip signals, WTI/OTI temperature values. (d) 33kV VCB breaker panels (as per SLD): status of VCB breakers, status of protection relays of transformers, oil / winding temperatures, AC parameters. (e) Fire alarm system at main control room: status signals (f) Weather monitoring equipment **(2) BHEL scope of SCADA:** (a) Data station panels with necessary data loggers / PLCs and other accessories such as power supply etc to integrate the data signals. (b) Desktop PCs (HMI control desks) provided with necessary software packages and remote monitoring features. (c) Supply of SCADA related communication/ data / LAN cables as brought out in other clauses of this specification. **(3) Bidder scope of supply and installation of SCADA system:** (a) Bidder shall install the BHEL supplied SCADA system in the SCADA room in NTPC's existing switchgear room. Cable laying/ terminations of all SCADA cables at respective panels / equipments shall be in bidder scope of supply. OFC cables need to be laid from each Inverter platform to respective local pooling station then to metering point and to final evacuation point.

5.32	**Earthing of solar PV modules and SCBs** The solar PV modules and SCBs installed by the bidder shall be provided with appropriate earthing for protection against faults as guided by IEC 60364. Bidder shall use min 2.5 sq.mm earthing copper cable (Yellow Green PVC sheathed) for connecting 30 modules in a row. Similar 3182 Nos of rows shall be directly connected to earthing strip from both sides of row. Same earth strip shall be used for SCB earthing also. Suitable size of cable (2 loops) shall be used for SCB earthing connection to strip. The size of earth strip shall be minimum 25 x 3 mm GS flat. **Bidder shall submit for approval detailed earthing plan with earthing cable sizing and break proof methodology for linking solar PV modules and SCBs earthing**. Supply and laying of earth strip is under bidder scope. **Installation of earthing electrodes on resevoir bed and interconnection to earthing grid** Bidder shall make arrangements to carry out under water drilling on the reservoir bottom to insert the required number of electrodes into ground. Drilling mechanism mounted in boat or by under water equipment shall be used to place earth electrodes at locations marked by BHEL and to connect the earthing conductors from any floating platform to the electrode terminal securely. Required SS 304 hardware, Cable clamp/lug for fastening the conductor with terminal shall be supplied by bidder after finalizing method for permanent connection. The approx. reservoir depth is 2-5 mts.
5.34	**Identification marking of electrical items using painting** Following items shall be identified by way of artistic painting in black letters with yellow background. For danger symbol/text, white letters in red background. Identification number/ text to be painted shall be submitted for BHEL/NTPC approval during detailed engineering for the following. (1) String Combiner boxes: 80 Nos (2) Size/ source/ destination of DC cable 1Cx400 with arrow mark (power flow direction) to be painted on SCBs and PCUs (3) PCUs front side: PCU ID number (1 to 9) with rating 2500kW, AC chamber/ DC chamber, Danger text/symbol (4) PCUs DC chamber back side: SCB ID numbers, cable size (1Cx400 +,-) with upward arrow mark, danger text/symbol (5) PCUs AC chamber back side: Inv Trnfmr ID, cable size (6Rx1Cx400 / ph) with downward arrow mark, danger text/symbol (6) Same way as above, the corresponding panel ID with rating, cable destination with arrow mark in power flow direction, danger text/symbol shall be painted for all VCB panels, Inverter transformers (HV and LV sides). (7) For UPS/ SCADA/ ABT metering Cubicle, all DB boards/ fire alarm panels, ID number shall be painted. Cable size/ destination/ arrow marks not required to be painted as cable tags shall be adequate. (8) For earth chambers of main control room ID number shall be painted. (9) All switchboards shall be painted with ID number.

5.35 Cable markers and cables tags

(1) Cable markers and joint markers for underground cables shall be provided along the route of the cables as per section "**Cable installation methodology**" of this specification.

(2) Cable tags shall be provided at either of the cable (at the entry point to the panel / equipment to which it is connected / terminated) shall be provided as per section "**Cable installation methodology**" of this specification.

(3) Bidder shall submit the respective schemes of marking and tagging for BHEL/NTPC approval during detailed engineering.

5.36 Display boards and sign boards

Sl. No	Description	Qty for Control room
1	Board displaying instruction chart for restoration from Electric Shock	5 No
2	Board displaying instruction chart for artificial respiration	5 No
3	Board displaying dos and don'ts.	5 No
4	Board displaying fire extinguishers details and operations	5 No
5	"No smoking" board	5 Nos
6	Danger boards: 33000V with danger symbol in Hindi, Telugu and English	As required
7	Identification boards, of suitable sizes, within and outside Electrical Equipment room, Transformer yard, HT Switchgear Platform point etc. BHEL will provide list during detailed engineering.	As required

Note: In addition to the above, requirement of hoarding board as well as direction board for the overall power plant shall be fabricated in consultation with BHEL/NTPC and installed at a suitable location near the main entrance gate of the plant.

5.37 Electrical insulation mat

(1) Bidder shall supply electrical insulating mats as follows:

(a) Reputed make as shall be approved by BHEL/ NTPC

(b) As per IS: 15652:2006

(c) Class B

(d) Thickness 2.5 mm minimum

(e) Size = 2m x 1m minimum, exact size shall be as approved by BHEL/NTPC during detailed engineering.

(f) Colour: to be approved by BHEL/NTPC

(g) Max use voltage = 33 kV

(h) Marking of IS standard on the mat

(2) Test certificate shall be provided by bidder

(3) Bidder shall lay the mats in front of all the indoor electrical panels viz. PCUs, VCB panels, SCADA panels, UPS panels etc.

5.38	**Supply and Installation Miscellaneous Items for NTPC Control Room** Furniture for SCADA room as below: • Control desk for OWS and EWS – 1 No • Chair, industry standard, revolving type, with wheels, arm rest, provisions for adjustment of height (hydraulic/ gas lift): 4 Nos • Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. • One Printer Table made of Laminated Wood or Heavy Duty MDF shall be provided for printer. • All the furniture shall be of reputed make (Godrej or Equivalent).
5.39	**Tool kits and instruments:** The bidder shall keep ready stock of tools, tackles and essential spares that will be needed for the day-to-day maintenance of the solar PV system. This shall include but not be limited to the following: • Screw driver and / or Allen key suitable for the connectors, power distribution blocks, Circuit breaker terminals and surge arrestor terminals. • Spanners / box spanners suitable for the removal of solar PV modules from the solar PV module support structure. • Digital multimeter- 2 Nos • AC/DC clamp meter – 2 Nos • Meggering kit (5 KV) – 1 No. • Cable crimping tool – 1 no. 2.5/4/6/10 sq.mm and 1 no. 240-400 sq.mm (hydraulic type) • Crimping tool for MC4 connectors-2 no.s • MC4 joint disconnection tool – 10 no.s • Rechargeable LED type water proof Flash lights – 5 nos. • Discharge rods for 33KV – 1 no. • 33 KV safety gloves – 5 no.s • Vacuum cleaner cum blower – 1 no. Note: Make / model number etc shall be approved by BHEL/NTPC prior to procurement.
5.40	**PRE-COMMISSIONING AND COMMISSIONING FACILITIES** a) The Vendor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. b) During commissioning the Vendor shall carry out system checking and reliability trials on various parts of the facilities. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and

	included in the Vendor's quality assurance plan as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the vendor. c) The pre-commissioning and commissioning activities of the equipment/systems furnished and installed by the vendor shall be the responsibility of the Vendor. The Vendor shall provide, in addition, temporary instrumentation and other measuring devices, test instruments, calibrating devices etc. and labor required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Vendor's workmen required for the above test shall always be present at site during such operations. **All erection & commissioning checks shall be as per manufacturer's manual on mutually agreed terms** a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Vendor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Vendor's quality assurance plan as well as those included elsewhere in the Technical Specifications. b) The Vendor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with subsystems and supporting equipment as a complete plant. c) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period. d) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over for commissioning (start-up), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SCL (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] to be furnished by the manufacturer/supplier. e) The Vendor shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.
5.41	**Spares required to be supplied along with main consignment:** **Spares on DC side** • Indicating lamp set of all types: 1% of total population of respective items • Surge protection devices/ MOV: 1% of total population of respective items • Lighting LED lamps: 5% each type. • Indicating lamp set of all types: 1% of total population of respective items • Straight-through jointing kit for 3.3 kV 1Cx400 cable (Al, XLPE, un-armoured, PVC): 4 kits for DC side.

5.42	**Spares required to be supplied along with main consignment:** **Spares on AC side** 1) 33 KV indoor Current transformer (if applicable) 2) 33 KV indoor voltage transformer (if applicable)33 KV indoor surge arrestor (if applicable) Auxiliary Transformer (Highest size) 3) 33kV(E) termination kit for 1Cx240 cable: 3 Nos 4) 33kV(E) straight through jointing kit for 1Cx240 cable: 3 Nos 5) Fuses of all types: 10% of total population of respective items 6) MCCB, MCB of all types: 10% of total population of respective items 7) Indicating lamp set of all types: 10% of total population of respective items 8) Surge protection devices/ MOV: 10% of total population of respective items 9) Plant lighting LED lamps: 5% each type. Notes: (a) In case quantity arrived based on percentage is a decimal figure, it shall be rounded off to next higher integer. (b) Bidders shall supply the above mentioned item as applicable in their scope.

6.0 General conditions applicable during supply, installation and commissioning phase

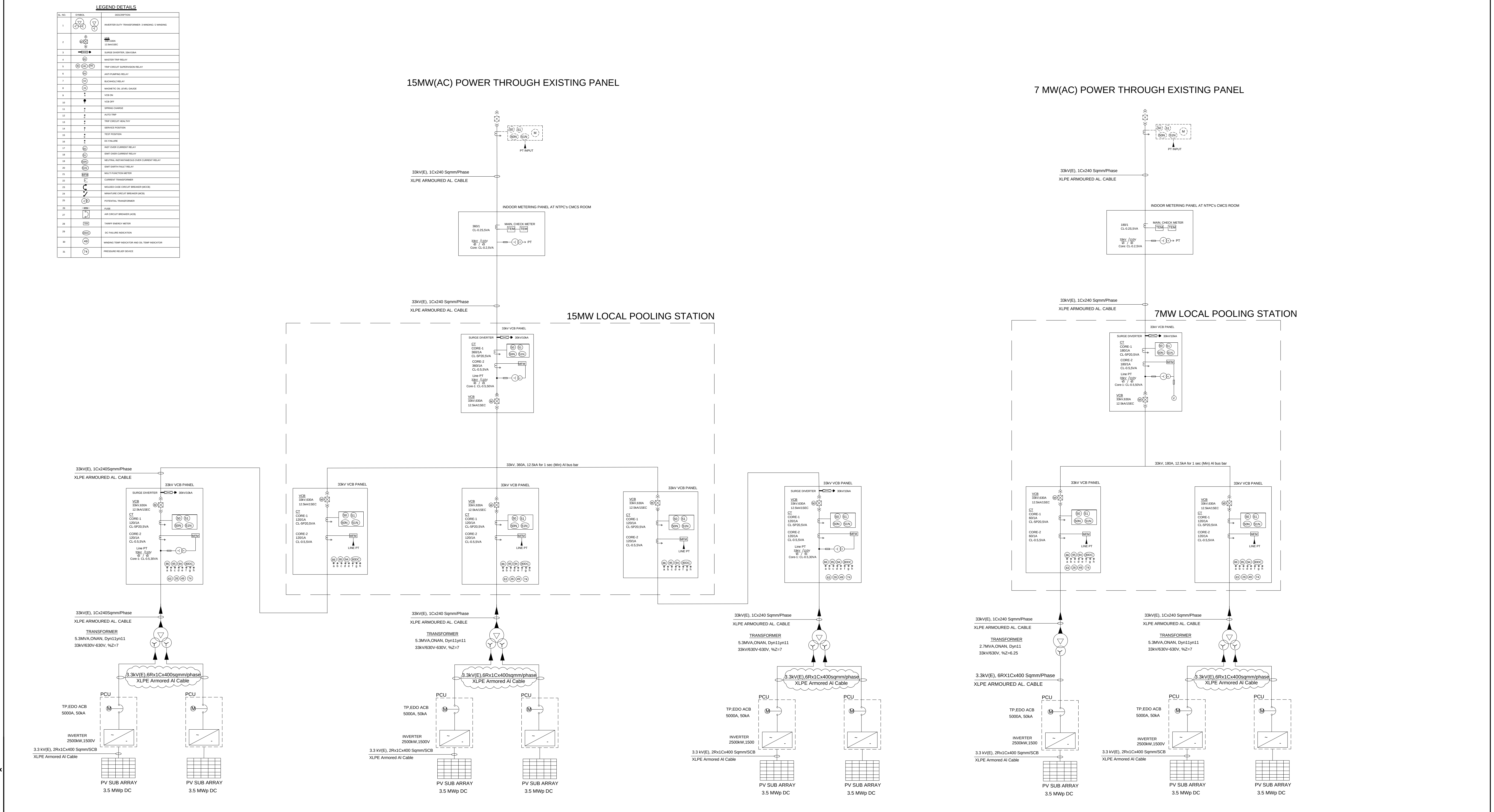
6.1	Bidder shall arrange sufficient water safety equipments for floater installation like, safety vests, nylone ropes, buoys, inflatable rafts etc. Temporary power supply for I&C work shall be taken through LT Panel boards having ELCBs, fuses and duly earthed.
6.2	Bidder to source items as per NTPC approved vendor list as applicable.
6.3	All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement and installation of materials / panels / equipment etc shall be organized by the bidder.
6.4	All necessary tools and tackles such as crimping tool (**including heavy duty tools for crimping copper/ aluminium cables up to 400 sq-mm**), screw driver set, power screw drivers, cutting pliers, nose pliers, spanner sets, adjustable spanners, hole-saw cutter set, bending tools, torque wrenches, hack saw blades, pipe wrenches, flat / round files, HV termination tools, drilling machines, welding machines, concrete mixers, steel bar bending tools / templates/ shuttering materials for RCC works, spade, shovel, hammer etc shall be organized by the bidder.
6.5	All necessary measuring instruments such as digital multimeters, measuring tapes, vernier calipers, electrical testers, digital meggers (1kV, 2.5kV, 5kV), earth resistance meters, clamp meters, transformer oil BDV kit, relay testing kit (secondary injection), primary injection kit, infrared thermal imaging handheld temperature meter etc. All these instruments shall possess valid calibration certificate issued from approved NABL laboratory.
6.6	Bidder shall make their own arrangements for necessary food, drinking water and accommodation for their labour and employees posted at the site. Similarly, food and drinking water required at the site, during the construction operations, shall also be in scope of bidder.
6.7	Bidder shall organize all necessary steps to meet statutory requirements such as labour license, PF, ESI etc and also ensure compliance with relevant acts such as minimum wages act, income tax act, employee insurance act etc for their labour deployed at site.

6.8	Bidder shall maintain updated labour register, with name, age, qualification, salary, attendance details etc. at the site.
6.9	Bidder shall use danger boards, wherever required, to ensure safety of the persons during the work at site.
6.10	Bidder shall adhere to all necessary safety norms such as use of helmet, goggles, hand gloves, gumboots, aprons etc. It is the ultimate responsibility of the bidder in all respect to prevent accidents at the site and safeguard their labour from accidents.
6.11	Bidder shall, at the completion of every work, clear off the debris, which resulted out of the work. In case of excavation work such as cable trench etc, bidder shall finish the land neatly with necessary leveling, rolling etc.
6.12	Bidder shall carry out the work without causing inconvenience to other contract groups at the site. In case of conflicts with other groups, bidder shall ensure that the matter is resolved at once amicably so that the progress of work is not affected.
6.13	Any damages on the building, structures etc. attributable to the acts of labour / employees of bidder shall be rectified and made good by the bidder at their own cost.
6.14	No child labour shall be employed for execution of the present contract.
6.15	Any miscellaneous materials, which are found essential for technical completion of the contract but not mentioned explicitly in this specification, shall be deemed to be included in the specification. Accordingly, such materials shall be included by the bidder as part of the offer.
6.16	Special instruction for earthing: In compliance with Rule 33 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode. Accordingly, all cases such as cable support structures, cable ladders, cable trays (control room) etc. shall be earthed.
6.17	BHEL/NTPC shall witness routine/ acceptance/ type tests performed at manufacturer works for the items supplied by bidder. Bidder shall accordingly provide inspection call to BHEL with submission of quality assurance plan in advance. For the items bought out from dealers, test certificates, as per relevant IS / IEC standards, as issued by manufacturer shall be submitted to BHEL. However, prior approval shall be obtained from BHEL/NTPC for procurement of the item from dealers.
6.18	Field Quality Plan / Quality control system (if applicable) Bidder shall set up a field quality control laboratory with full set up to facilitate testing of all construction materials in accordance with FQP (Field quality control plan) as approved by BHEL/NTPC. Bidder shall deploy a well experienced quality control engineer to monitor all QC activities at site as per approved FQP. Specifically, with reference to civil works, bidder shall submit all concrete mix designs and bituminous mix designs for BHEL/NTPC approval before starting of the work. All the third party testing should be conducted in NABL approved laboratories only. Bidder shall submit the FQP for the civil construction works before starting of the works for approval of BHEL/NTPC.
6.19	Any deviations shall be discussed with BHEL/NTPC site engineers and implementation shall be taken up only after approval from BHEL /NTPC.
6.20	Bidder shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.
6.21	Bidder shall, as and when required by BHEL/NTPC, participate in the review meetings conducted by BHEL/NTPC at project site, BHEL-EDN (Bangalore), BHEL-Corporate office (New Delhi), NTPC office (Kolkata) etc.
6.22	**General Guidelines** a) Any civil or electrical work which is not mentioned or included in this tender document but necessary for functional requirements of the plant shall be carried out by bidder.

	b) Bidder shall prepare all designs / drawings based on the specifications given in the tender and in light of relevant BIS/IS/ equivalent standard. c) Bidder shall provide type test reports and datasheet/ GTP for all equipments covered under bidder scope of supply. d) BHEL reserves right to modify the design at any stage to meet local site conditions / project requirements. e) All work shall be carried out in accordance with the latest edition of the Indian Electricity Act and rules formed thereunder and as amended from time to time.

6.0 Documents to be submitted for BHEL/NTPC approval during detailed engineering

6.1	BHEL / NTPC approval shall be obtained for the following technical documents, which shall be submitted to BHEL in phased manner based on priority sequence of activities during detailed engineering (after receipt of purchase order from BHEL).
6.2	Name of bidder/ make, model number/ part number, specification/ sizes/ dimensions/ drawings/ datasheets shall be submitted for approval to BHEL / NTPC for the items which cases bidders name is not mentioned.
6.3	Design calculations/ general arrangement drawings/ single line diagrams/ GTP particulars/ datasheets/ schemes/ layouts/ bill of materials etc., as applicable, shall be submitted for the following: (1) GI/Aluminium cable trays for internal cable trench, cable ties, HDPE DWC conduits, 33kV termination kits, 33kV straight through jointing kits, cable glands, cable lugs, (2) Earth chambers of solar array / main control rooms: GA, cross section, BoM with GTP/ datasheets etc. (3) Lighting system: lux calculations, lighting layouts, GA drawings of these, SLD, BoM with GTP/ datasheets etc. (4) Fire extinguisher datasheets (5) Weather Monitoring system BoM with GTP/ datasheets etc. (6) LT straight through jointing kits, 33kV termination kits, 33kV straight through jointing kits. (7) LT Switchgear, UPS with battery bank etc. (8) Fire detection/ alarm system: Layouts in main control room, overall layout with zones/ sensor/ hooter/ control panel locations, BoM with GTP/ datasheets etc. (9) Any other designs/ schemes/ layouts etc as applicable as per BHEL / NTPC requirements that will be discussed during detailed engineering.
6.4	Manufacturing Quality Plans for all the bidder supplied items
6.5	Field quality plan for the field work: civil works, electrical works
6.6	Detailed activity-time chart for project implementation
6.7	Detailed manpower deployment schedule
6.8	Operation and maintenance manuals of bidder supplied items.



NOTE:

1. Outdoor PCU, INV Transformer, outdoor HT panel, EEPEB room shall be located on raised platforms along the periphery of the reservoir at 4 pre-determined locations.
2. Aux power requirement for each platform is taken from aux transformer placed inside EEPEB room.
3. CMCS building is not a part of this contract. NTPC shall provide space for metering panel with CT&PT in switchgear room and space for placing SCADA panel and UPS at SCADA room. Aux power for UPS will be taken from NTPC's CMCS room.

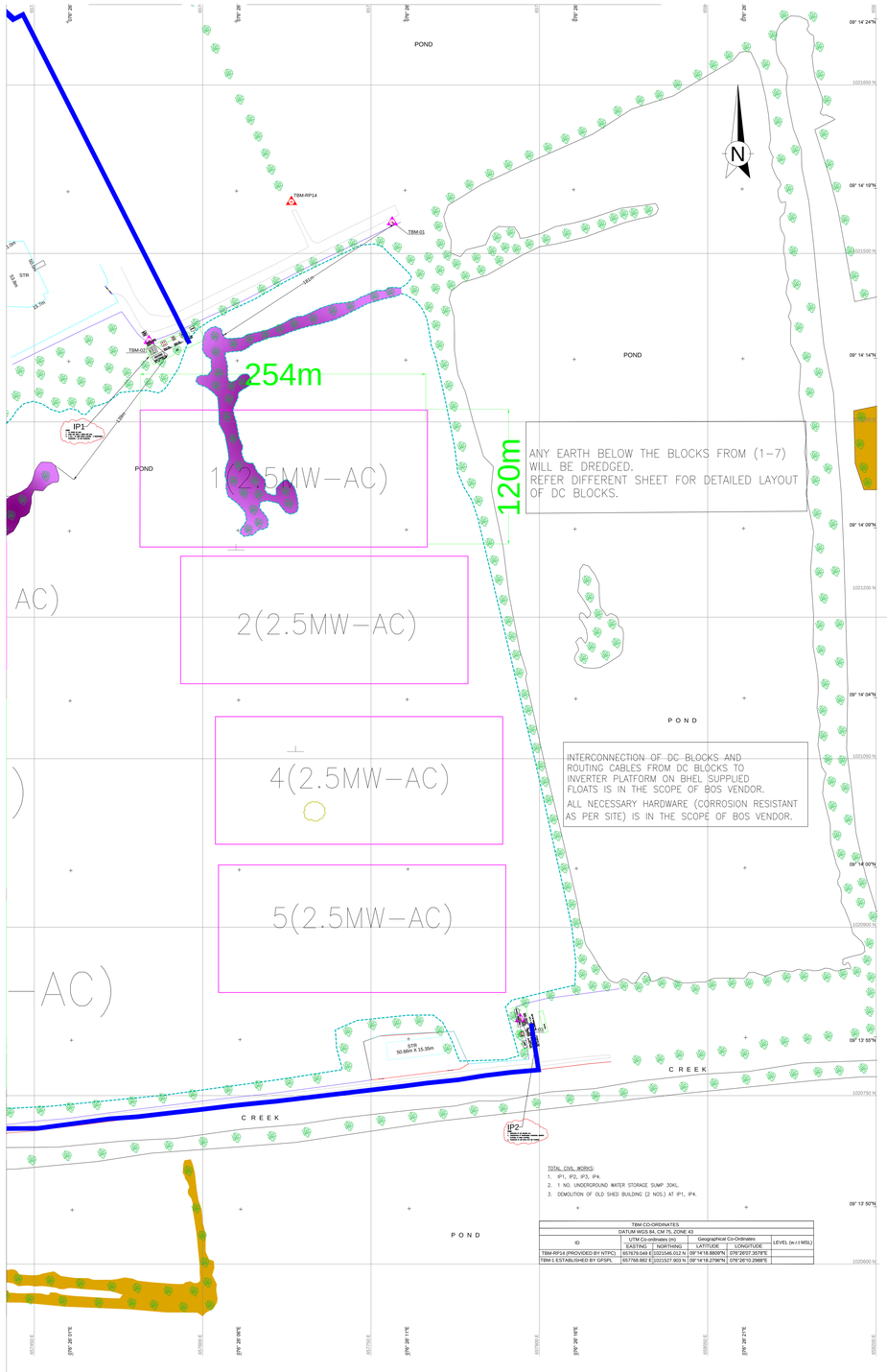
PROJECT : 22MW (AC) FLOATING SOLAR POWER PLANT
CUSTOMER : NTPC-KAYAMKULAM

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

SINGLE LINE DIAGRAM-AC

1) HT panel detailes modified.

DRAWING NO. 5742-004-PVE-P-101



TOTAL CIVIL WORKS:
1. IP1, IP2, IP3, IP4.
2. 1 NO. UNDERGROUND WATER STORAGE SUMP 30KL.
3. DEMOLITION OF OLD SHED BUILDING (2 NOS.) AT IP1, IP4.

TBM CO-ORDINATES					
DATUM WGS 84, CM 75, ZONE 43					
ID	UTM Co-ordinates (m)		Geographical Co-Ordinates		LEVEL (w.r.t MSL)
	EASTING	NORTHING	LATITUDE	LONGITUDE	
TBM-RP14 (PROVIDED BY NTPC)	657679.048 E	1021545.012 N	09°14'16.8609"N	076°26'07.3578"E	
TBM-1 ESTABLISHED BY GFSPL	657768.882 E	1021527.903 N	09°14'16.2796"N	076°26'10.2988"E	

GENERAL :-
- UTM GRID INTERSECTION (WGS84 DATUM)
- GEOGRAPHICAL GRID INTERSECTION (WGS84 DATUM)
- BANK LINE
- FENCING
- LAND AREA
- LAND FORM INSIDE THE WATER BODY
- TBM-RP14 PROVIDED BY NTPC
- TBM ESTABLISHED BY GFSPL
- STR — PERMANENT STRUCTURE
- TREES AND BUSHES
- 1.5 — MINIMUM WATER DEPTH
- 5.0 — MAXIMUM WATER DEPTH

BATHYMETRY :-
- 3.4 — WATER DEPTH IN METRES & DECIMETRES
- BATHYMETRY CONTOURS SHOWING AS PER WATER DEPTHS
- 2.25 — TOPOGRAPHIC SURVEY W.R.T ABOVE MEAN SEA LEVEL (MSL)

NOTES:

1) BATHYMETRY SURVEY WAS CARRIED OUT FROM BOAT MFB-SWAMI AYYAPPA BETWEEN 27th to 29th JANUARY 2020.
2) TOPOGRAPHIC SURVEY WAS CARRIED OUT FROM SOUTH NTS3429N6 TOTAL STATION BETWEEN 26th TO 28th JANUARY 2020.
3) POSITION FIXING WAS CONTROLLED FROM HEMISPHERE DGPS POSITIONING SYSTEM.
4) ODOM HYDROTRAC SINGLE BEAM ECHOSOUNDER WAS DEPLOYED FOR RECORDING WATER DEPTH.
5) THE VALUE OF TEMPORARY BENCH MARK AT NTPC KAYAMKULAM POWER PLANT IS 5.259 (RP-1)ABOVE MEAN SEA LEVEL.
6) SURVEY AREA CO-ORDINATES WERE PROVIDED BY THE CLIENT.

GEODETIC PARAMETERS

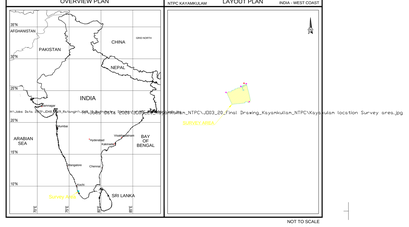
HORIZONTAL CO-ORDINATE SYSTEM	: WGS84
GEODETIC DATUM	: WGS84
ELLIPSOID	: WGS84
Semi major axis	: 6378137.000 m
Semi minor axis	: 6356752.314 m
Inverse flattening	: 298.257223K
PROJECTION	: Universal Transverse Mercator
Central Meridian (CM)	: 75° E (Zone 43)
Latitude of Origin	: 0°
False Easting	: 500000 m
False Northing	: 0 m
Scale factor at CM	: 0.99960

REFERENCE DRAWINGS

Rev. No.	Date:	Drawing No.	Description:

LOCATION MAP

OVERVIEW PLAN | LAYOUT PLAN — NTPC KAYAMKULAM — INDIA - WEST COAST



NOT TO SCALE

CLIENT

M/s. Bharat Heavy Electricals Limited,
Electronics Division,
Mysore Road,
Bangalore - 560026.

SURVEY CONTRACTOR

GEO FOUNDATIONS & STRUCTURES PVT LTD
NO.89, 1ST MAIN ROAD, GANDHI NAGAR, ADYAR
CHENNAI, TAMIL NADU-600020
Ph: 044-24451972, 24430399, 044-24540930

PROJECT

BATHYMETRIC SURVEY FOR THE PROPOSED PROJECT SITE OF FLOATING SOLAR POWER PLANT OF 22 MW AT RGCCPP, NTPC KAYAMKULAM, KERALA.

BATHYMETRY & TOPOGRAPHIC SURVEY CHART
BATHYMETRY GRID (20m X 20m)

SCALE

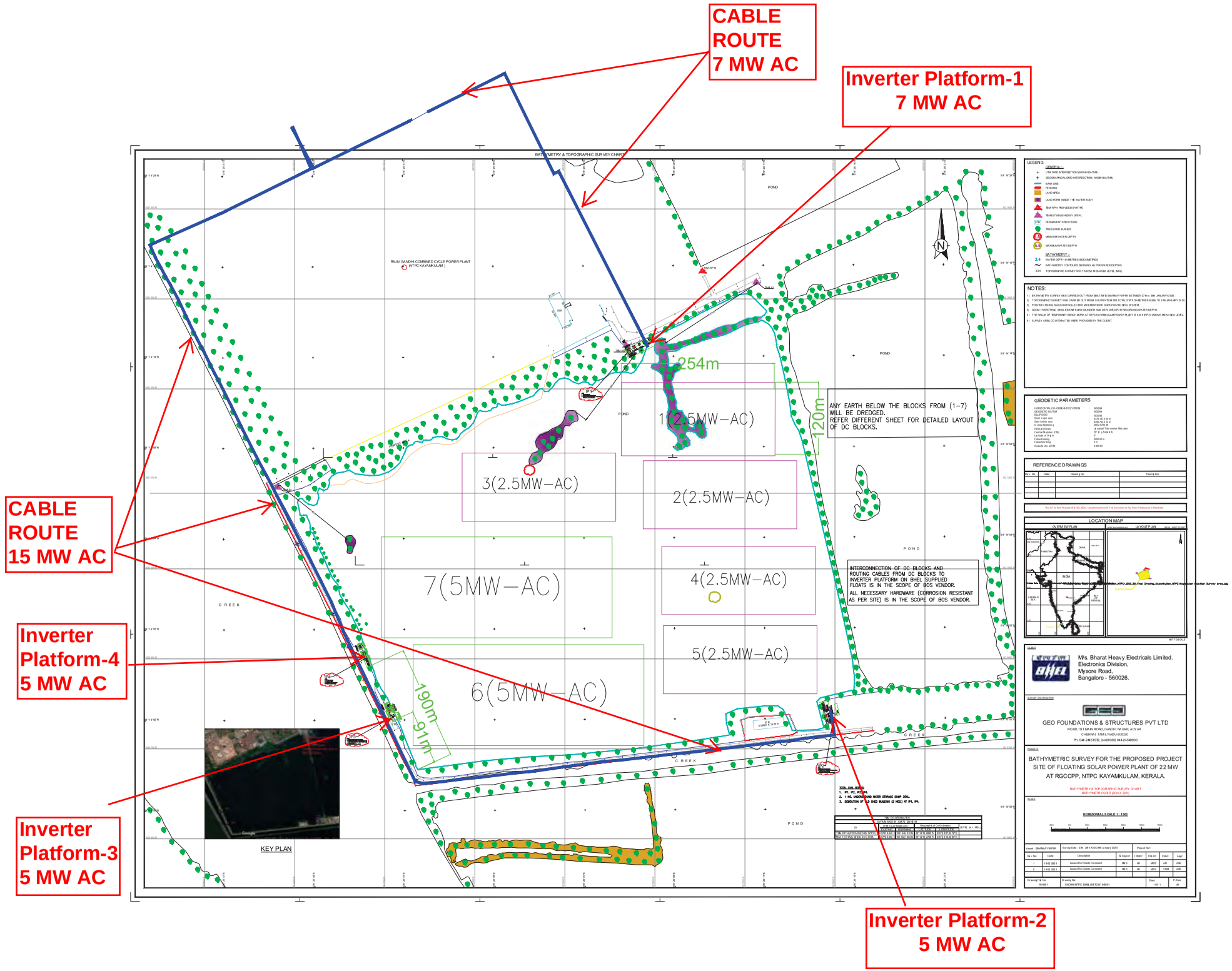
HORIZONTAL SCALE 1 : 1500

30m 0m 30m 60m 90m 120m 150m

Vessel : SWAMI AYYAPPA | Survey Date : 27th, 28th AND 29th January 2020 | Project Ref :

Rev. No:	Date:	Description:	Surveyed:	Interpr.	Drawn:	Chkd:	Appr:
1	19-02-2020	Issued For Clients Comment	SMS	AS	MSS	AR	ASK
0	14-02-2020	Issued For Clients Comment	SMS	AS	MSS	VNM	ASK

Drawing File No:	Drawing No:	Chart:	P.Size:
154901	SI/CHN/NTPC-BHEL/B&T/20/154/01	1 OF 1	A0

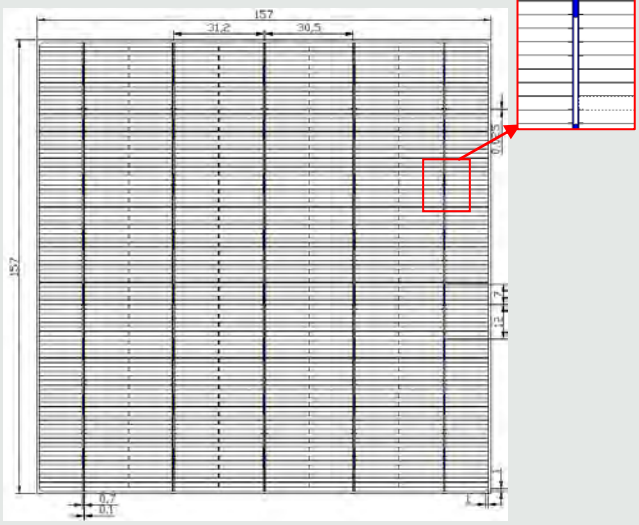

CABLE ROUTE 7 MW AC
Inverter Platform-1 7 MW AC
CABLE ROUTE 15 MW AC
Inverter Platform-4 5 MW AC
Inverter Platform-3 5 MW AC
Inverter Platform-2 5 MW AC
BATHYMETRY & TOPOGRAPHIC SURVEY CHART
RAJIV GANDHI COMBINED CYCLE POWER PLANT (NTPC KAYAMKULAM)
POND
CREEK
254m
120m
190m
91m
1(2.5MW–AC)
2(2.5MW–AC)
3(2.5MW–AC)
4(2.5MW–AC)
5(2.5MW–AC)
6(5MW–AC)
7(5MW–AC)
ANY EARTH BELOW THE BLOCKS FROM (1–7) WILL BE DREDGED. REFER DIFFERENT SHEET FOR DETAILED LAYOUT OF DC BLOCKS.
INTERCONNECTION OF DC BLOCKS AND ROUTING CABLES FROM DC BLOCKS TO INVERTER PLATFORM ON BHEL SUPPLIED FLOATS IS IN THE SCOPE OF BOS VENDOR. ALL NECESSARY HARDWARE (CORROSION RESISTANT AS PER SITE) IS IN THE SCOPE OF BOS VENDOR.
KEY PLAN
LEGEND
NOTES:
GEODETIC PARAMETERS
REFERENCE DRAWINGS
LOCATION MAP
M/s. Bharat Heavy Electricals Limited, Electronics Division, Mysore Road, Bangalore - 560026.
GEO FOUNDATIONS & STRUCTURES PVT LTD
BATHYMETRIC SURVEY FOR THE PROPOSED PROJECT SITE OF FLOATING SOLAR POWER PLANT OF 2.2 MW AT RGCCPP, NTPC KAYAMKULAM, KERALA.
HORIZONTAL SCALE 1 : 1500

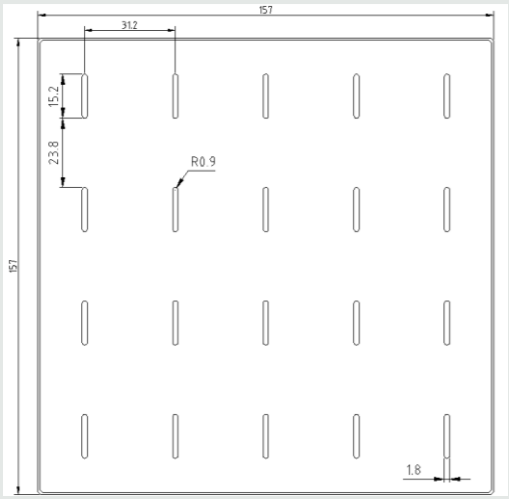
Poly-crystalline cells ——EN157P220.5-5BB

Physical Characteristics

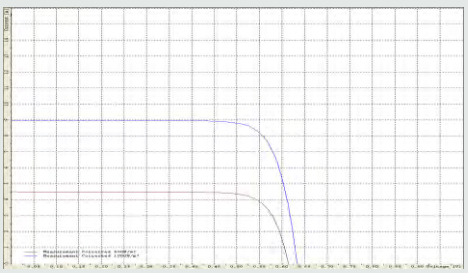
Dimensions	157mm×157mm±0.25mm
Diagonal	220.5mm±1mm
Thickness(Si)	180μm±20μm; 200μm±20μm
Front surface	Blue silicon nitride antireflective coatings
	5*0.7mm-width silver contact on silicon nitride
Back surface	Full-surface aluminium back-surface field
	1.8mm silver discontinuous soldering pads

Basic Dimensions





I-V Characteristic Curve



Features and Quality Control

- Each of Econess's solar cells features silicon nitride antireflection coatings which are deposited using plasma-enhanced chemical vapor deposition process
- Cells have state-of-the-art silver front contacts, silver back contact strips, and full-coverage aluminium back contacts with back surface field
- Metal pastes are screen printed in a fully automated process
- 100% checked for visual appearance, unqualified degraded after measuring electrical performance
- Classified the grades by cell efficiency, Series/parallel resistor and reverse current
- Frequent reliability monitoring

Our Commitment to Quality

- Econess is ISO 9001 and ISO 14000 certified
- Color uniformity among cells and within cells
- Excellent resistance to PID attenuation performance
- Long-term stability & reliability
- Small light-induced degradation

Electrical Characteristics

（Test conditions: AM1.5, 1000±50W/m², 25±2℃ Area：243.34cm²）

No.	Efficiency range	Nominal efficiency	Nominal power
1	>19.30%	19.30%	4.696W
2	19.20%-19.30%	19.20%	4.672W
3	19.10%-19.20%	19.10%	4.648W
4	19.00%-19.10%	19.00%	4.623W
5	18.90%-19.00%	18.90%	4.599W
6	18.80%-18.90%	18.80%	4.575W
7	18.70%-18.80%	18.70%	4.551W
8	18.60%-18.70%	18.60%	4.526W
9	18.50%-18.60%	18.50%	4.502W
10	18.40%-18.50%	18.40%	4.478W
11	18.30%-18.40%	18.30%	4.453W
12	18.20%-18.30%	18.20%	4.429W

江苏东鋆光伏科技有限公司
Jiangsu Econess-energy Co., LTD

TECHNICAL DATA SHEET FOR PHOTOVOLTAIC MODULES

Project	22 MW NTPC, Kayamkulam Floating Solar Power Project
Product	Solar PV Module – 330 Wp
PV Module Manufacturer	Econess Energy Co., Ltd, China
Quantity	Total Quantity : 31.515 MW 330 Wp – 31.515 MW
Customer	NTPC, India
BHEL Purchase Order No.	

BHEL Approval with Seal and Sign

ಮುಹಮ್ಮದ್ ಶಕೀರ್ ಎಂ.ಕೆ., ಹಿರಿಯ ಎಂಜಿನಿಯರ್/ಎಸ್.ಸಿ.ಸಿ ಪಿ.ವಿ.-ಎಂ.ಎಂ.
मुहम्मद शकीर एम.के., वरि.इंजीनियर/एससी एवं पीवी-एम.एम.
MUHAMMED SHAKIR M.K., SR.ENGINEER SCSS PVM
BHEL-EDN, MYSORE ROAD, BANGALORE-560 026.

REVISION NUMBER: 00	**DATE** 01.05.2020
PREPARED 2020.5.7	**APPROVED WITH SEAL** 2020.5.7

1. PHYSICAL CHARACTERISTICS:

PV MODULE TYPE NO.	EN156P-72-330
CONFIGURATION	Single glass laminated type with 72 nos. of 157 mm multi-crystalline silicon solar cells (12*6) in series configuration
OVERALL MODULE SIZE	1960* 992 * 35 mm
WEIGHT	21.5 Kg. (Typ.)
SOLAR CELLS	'A' grade solar cells
BILL OF MATERIAL (BOM)	As per IEC 61215 certified materials
FRAME MATERIAL	Anodized Aluminium
JUNCTION BOX (JB)	IP68 Grade
CABLES CONNECTED TO JB	1.2 Metre length, 4 Sq. mm size
CONNECTORS	MC4 Compatible connectors
BYPASS DIODES	3 nos. per junction box
RATING STICKER	Each PV module will be provided with a rating sticker on backside.
PID FREE MODULE	PV Module is PID free.
PV MODULE SYSTEM VOLTAGE	1500 V
PV MODULE REGISTERED WITH BIS	The offered PV module is BIS registered. (BIS No. R-41115355, Date: 08.02.2019, Valid upto: 13.01.2021)
RFID Tag	RFID Tag fixed outside the laminate on the backsheet and shall contain the following information. a. Name of module manufacturer with country of origin b. Month & year of manufacture of modules c. Name of cell manufacturer with country of origin d. Month & year of manufacture of cells e. I-V curve at standard test condition f. Pmax, V_{mp}, I_{mp}, V_{oc}, I_{sc},Temperature coefficient of Power, Fill factor g. Module model number h. Unique Module serial number i. Date of obtaining IEC qualification certificates j. Name of test lab issuing IEC certificates
Packing Box identification	Each carton box will have one wattage PV module and shall be identified with wattage (eg. 330 Wp) on the carton.

2. TYPICAL ELECTRICAL CHARACTERISTICS OF PV MODULES :

TYPICAL ELECTRICAL CHARACTERISTICS	330 Watts
OPEN CIRCUIT VOLTAGE (Voc)	45.9 V
SHORT CIRCUIT CURRENT (Isc)	9.29 A
VOLTAGE AT PEAK POWER POINT (Vmp)	37.73 V
CURRENT AT PEAK POWER POINT (Imp)	8.75 A
MODULE POWER RATING (Pmax)	330 Wp
MODULE EFFICIENCY (%)	16.97%
FILL FACTOR	≥ 0.75

Note : No negative tolerance on module power rating (P_{max}).

3. OPERATING CONDITIONS:

TEMPERATURE RANGE	: - 40 deg C to +85 deg C
RELATIVE HUMIDITY	: 85 %
WIND SPEED (GUST)	: 150 km/hr

4. TEMPERATURE CO-EFFICIENTS (% / deg C):

CURRENT	: +0.0499
VOLTAGE	: - 0.3062
POWER	: - 0.4146

5. WARRANTY:

5.1. Product Warranty:The modules are warranted for 10 years for failures due to material defects and workmanship.

5.2. Performance Warranty: 90% of the peak power capacity at the end of 10 years and 80 % at the end of 25 years. Degradation of PV module for first year shall be limited to 2.5% and shall not be more than 1 % in any subsequent year.

6. PACKING

The modules shall be packed in carton boxes. Module power rating (330 Wp) shall be displayed with a sticker on both the longer sides of the carton box.

7. IEC Certifications

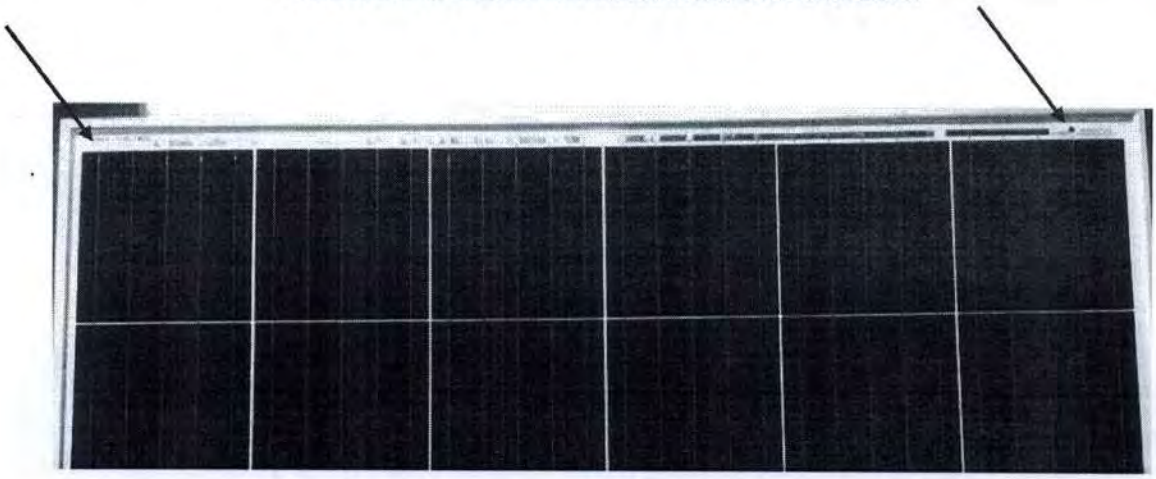
PV Module Model No. : EN156P-72-330

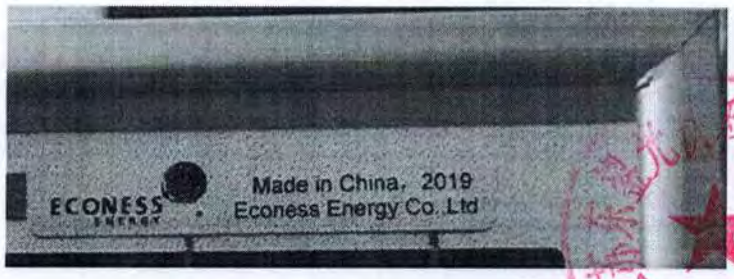
Sl. No.	IEC Certificate	Certificate Issued by	Validity of Certifciate upto date
1.	IEC 61215-1:2016 (Design Qualification and Type Approval-Part 1) IEC 61215-1-1:2016 (Design Qualification and Type Approval-Part 1-1) IEC 61215-2:2016 (Design Qualification and Type Approval-Part 2)	TUV NORD	2023-11-06
2.	IEC 61730-1:2016 (Safety Qualification – Part 1) IEC 61730-2:2016 (Safety Qualification – Part 2)	TUV NORD	2023-11-06
3.	IEC 61701:2011 (Salt Mist Corrosion testing)	SGS	2024-04-22
4.	IEC 62716:2013 (Ammonia Corrosion testing)	TUV NORD	2024-12-12
5.	IEC 62804-1:2015- (Test methods for the detection of PID - Part 1)	SGS	2024-04-22

8. Bill of Materials (as per IEC Type tested CDF)

Sl. No.	Item Description	Brief Spec.	Source or Make
1.	Solar Cells	Type : Multi-crystalline solar cells Size of Cells :157 mm*157 mm Cell Wattage : ⩾4.644W Cell efficiency :≥18.9 No. of busbars : 5 **Solar cell product catalogue enclosed**	Econess Energy Co.,Ltd.
2.	Glass	Size :1954*986*3.2mm Light Transmission : ≥93.5%	Xinyi PV Products (Anhui) Holdings Ltd.
3.	EVA	Type : Fast Cure Thickness :0.45mm Gel content : 75%-95% UV Resistant : Yes	Hangzhou First Applied Material Co.,Ltd.
4.	Back Sheet	No. of layers:3 Thickness : 0.313mm Water vapour transmission rate : <2.0 $g.m^2$ /day	Cybrid Technologies inc.
5.	Al. Frame	Corrosion resistant, anodized Aluminum. Anodizing thickness : AA15	Jiangyin East-China Aluminum Technology Co.,Ltd
6.	Junction box	Grade : IP67 grade No. of bypass diodes : 3 nos. UV resistant & weather-proof : Yes	Zhejiang Renhe Photovoltaics Technology o.,Ld.
7.	Cables	Two nos. of 4 sq mm UV resistant cables Cable length : 1.2 Metre	Zhejiang Renhe Photovoltaics Technology o.,Ld.
8.	Connectors	MC4 compatible Plug in connectors (Male and Female)	Zhejiang Renhe Photovoltaics Technology o.,Ld.
9.	Adhesive for framing and junction-box fixing	Colour : white	Tonson Adhesive Inc.
10.	Adhesive for Junction-box potting	Colour : white	Tonson Adhesive Inc.
11.	Solder Busbars	Size :6*0.35mm Coating : Sn60pb40	Suzhou Yourbest New Materials o.,Ltd.
12.	Solder Tabs	Size :0.27*0.9mm Coating : Sn60pb40	Suzhou Yourbest New Materials o.,Ltd.
13.	Liquid Flux	Model no. : PV105A	Vital New Material Co.,Ltd

Module Sl. No. Sticker laminated inside the PV module.



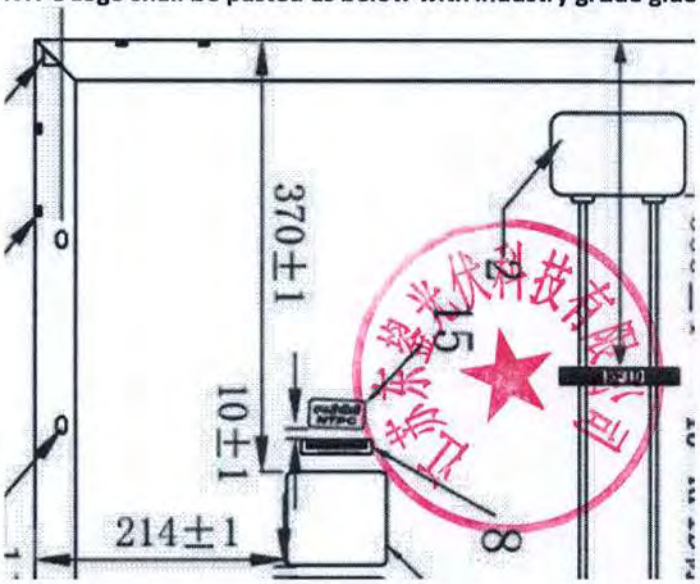


Note: No negative tolerance on module power rating, will be offered against the project

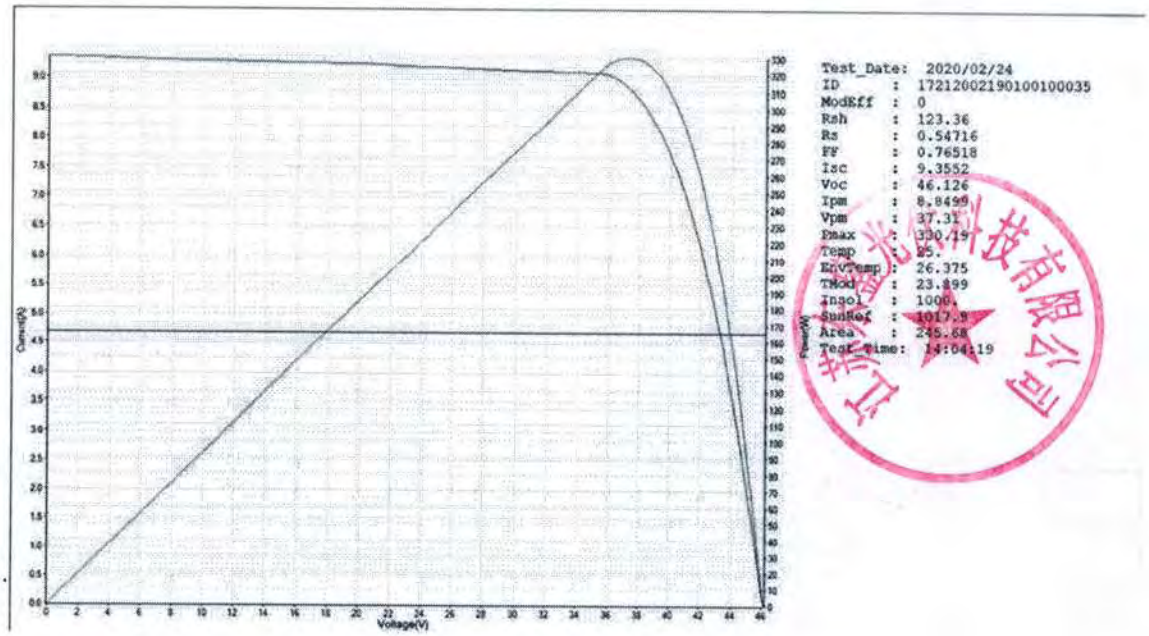
RFID Tag fixed on the back sheet. Indicative picture below

Typical Picture of Rating Sticker or Name Palte for 330 Wp PV Module

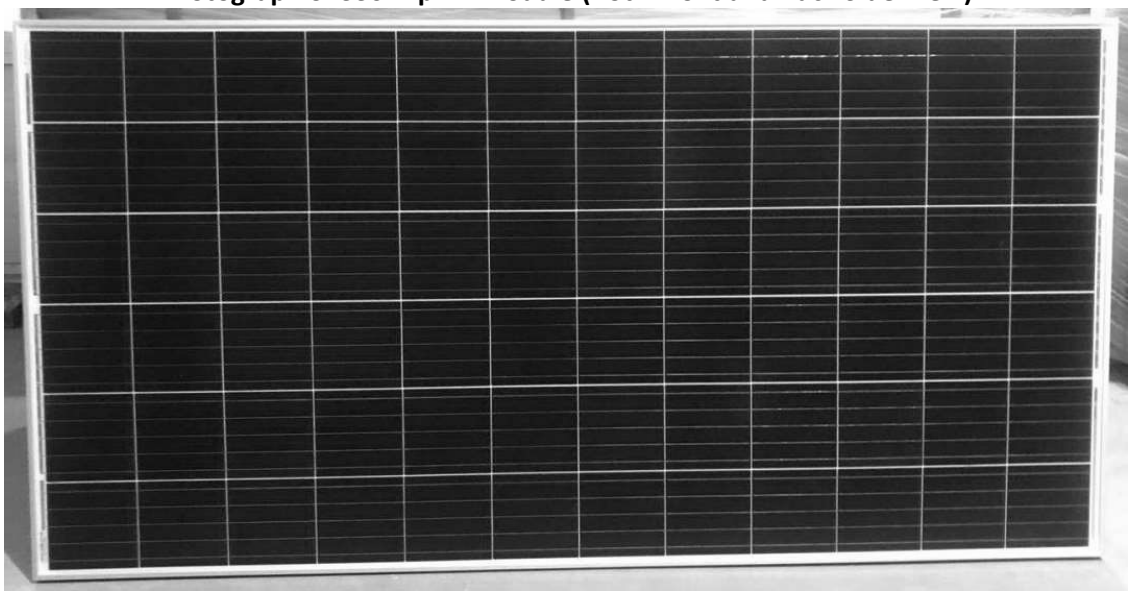
NTPC Logo shall be pasted as below with industry grade glue



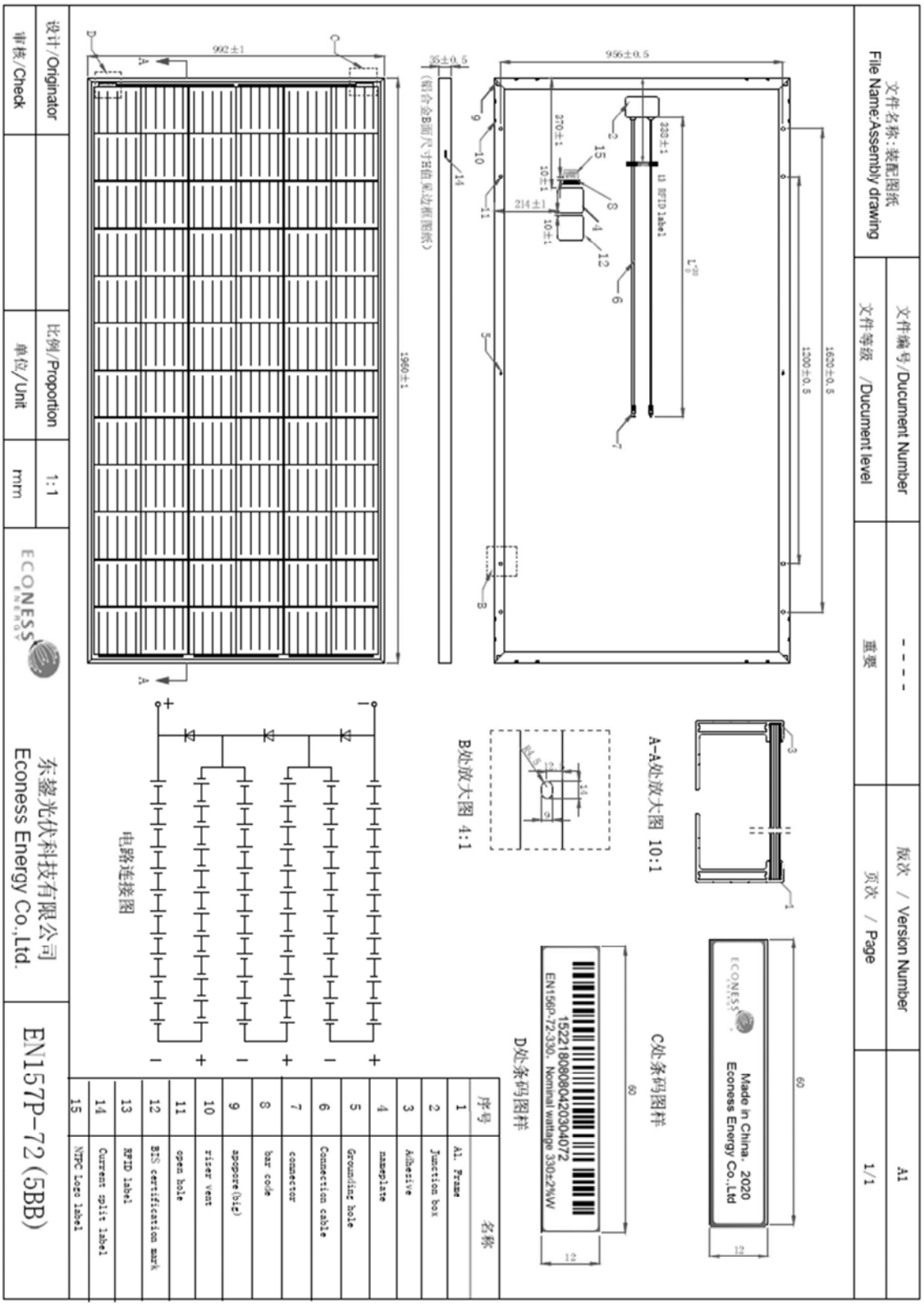
Typical I-V Curve for 330 Wp PV Module



Photograph of 330 Wp PV Module (Both Front and Back Side View)

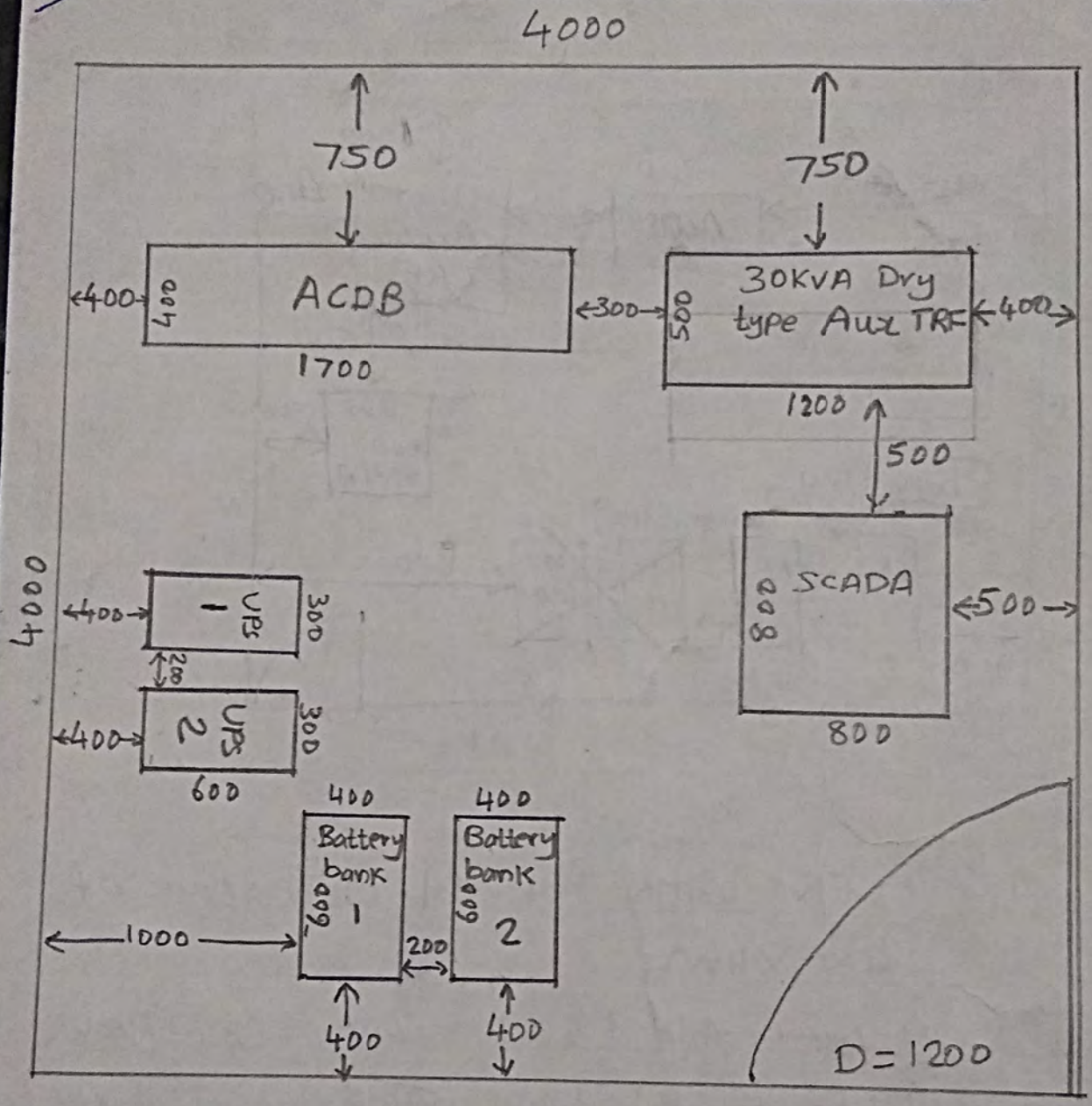


PV Module Overall assembly Drawing



07-04-20

Electrical Equipment Room



Notes: 1). Dimesions of equipments are typical. May vary slightly during detailed engineering of equipment.

2). No cable trenches are envisaged. Cables will be routed through trays whereever required.

3). EER internal clear area, 4000X4000mm.

C-6 CABLE INSTALLATION METHODOLOGY

1.0 CODES AND STANDARDS

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

IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubulars and other wrought steel fIttings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:2309	Code of Practice for the protection of building and allied structures against lightning.
IS:2629	Recommended practice for hot dip galvanising of iron & steel
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3043	Code of practice for Earthing

IS:3063	Fasteners single coil rectangular section spring washers.
IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal - arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 6.6kv upto and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial & commercial power systems
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

2.0 DESIGN AND CONSTRUCTIONAL FEATURE

Inter Plant Cabling

Interplant cabling for main routes shall be laid in Cable trenches/cable trays/buried/duct banks. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. All buried cables shall be armoured

Cable Sizing Conditions

All cables shall be suitably derated as per the laying conditions for carrying the required load current and fault current. For derating, the ambient temperature for directly buried cables shall be taken as 40° C and 50° C for cables laid in air.
All XLPE cables shall be rated at 90° C conductor temperature for AC Voltage drop calculation and 80° C for DC Voltage calculation .

Trenches

PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

General

The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.

Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.

Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:

- Meet all safety requirements
- Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc

3.0 EQUIPMENT DESCRIPTION

Cable trays, Fittings & Accessories

Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.

Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm

Support System for Cable Trays

Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".

Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fitings and accessories shall be prefabricated factory galvanised.

c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvansied surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied

d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drill ing and other machining operation.

e. Support system shall be able to withstand

- weight of the cable trays
- weight of the cables (75 Kg/Metre run of each cable tray)
- Concentrated load of 75 Kg between every support span.
- Factor of safety of minimum 1.5 shall be considered.

PIPES, FITTINGS & ACCESSORIES

Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

GI Pipes shall be of medium duty as per IS:1239

Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

Hume pipes shall be NP3 type as per IS 458

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Junction Boxes

Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

Terminal blocks shall be 1100V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded copper conductors of size upto 2.5 sq mm each. All internal wiring shall be of minimum 1.5 sq. mm cu. Conductor PVC wire.

Terminations & Straight Through Joints

Termination and jointing kits for 33kV, 11kV, 6.6 kV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 33kV, 11kV and 6.6 kV grade joints and terminations shall be type tested as per IS:13573. 3.3kV grade joints and terminations shall be type tested as per VDE0278. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solderless crimping type cable lugs & ferrule as per DIN standard.

Straight through joint and termination shall be capable of withstanding the fault level for the system.

1.1 KV grade Straight Through Joint shall be of proven design.

Cable glands

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS:6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.

Cable lugs/ferrules

Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to relevant standard

Trefoil 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.

Cable Clamps & Straps

The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment

Receptacles

Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped gavanised or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break,AC23 category,

suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable mA sensitivity.

Galvanising

Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising 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

Welding

The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595

4.0 INSTALLATION

Cable tray and Support System Installation

Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.

Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable

trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with relevant standard.

The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.

The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval.

All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.

In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

Conduits/Pipes/Ducts Installation

The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/ roof/ wall/ cable tunnel/ cable trenches made for conduit installation shall be sealed and made water proof by the Contractor **either with any proven fire sealing system rated for one hour or** Modular multi-diameter cable sealing system consisting of frames, blocks, Compression wedge and its accessories. **The Cable sealing system should have been tested for fire insulation for min. 1 hr as per BS 476 and shall also provide water sealing. System shall be anti- rodent and anti- termite.**

GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material

Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	**Spacing**
Upto 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm and above	3.0 M

For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.

Junction Boxes Installation

Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

Cable Installation

Cable installation shall be carried out as per IS:1255 and other applicable standards.

For Cable unloading, pulling etc following guidelines shall be followed in general :

- Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

- While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.

Cables shall be laid on cable trays strictly in line with cable schedule

Power and control cables shall be laid on separate tiers in line with approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two meter. All multi core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with self-locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multi core power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multi core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.

No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.

In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

Wherever few cables are branching out from main trunk route troughs shall be used.

Wind loading shall be considered for designing support as well Cable trays wherever required.

Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.

The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

Separation

At least 300mm clearance shall be provided between :

- HT power & LT power cables,

- LT power & LT control/instrumentation cables,

Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

No. of cores in cable	No. of spare cores
2C,3C	NIL
5C	1
7C-10C	2
14C and above	3

Directly Buried Cables

- Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255.

- RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags

While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.

Cable Terminations & Connections

The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.

The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self-locking type nylon cable ties with de interlocking facility to keep them in position.

All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.

All cable terminations shall be appropriately tightened to ensure secure and reliable connections

E-1 WEATHER MONITORING STATION

As a part of weather monitoring station, Bidder shall provide following measuring instruments with all necessary software & hardware required to integrate with SCADA so as to enable availability of data from meteorological instrument in SCADA. Each instrument shall be supplied with necessary cables, transmitters and accessories (Trackers, Mounting and base stand etc.) provided by OEM of the sensors only.

Aux. power required by instruments and data logger (If supplied) shall be from UPS only. Data logger shall have provision to receive redundant power supply.

All the instruments to be supplied shall have valid calibration certificate.

1.0 SOLAR RADIATION SENSORS

Contractor shall provide Solar Radiation Sensors as per specification given in following section. Contractor has the option to provide these sensors on separate base or on a single base (radiation monitoring station) with tracker, shadow ring and transmitter etc provided by the OEM. Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with solar radiation sensors. Bidder shall provide Instrument manual in hard and soft form.

1.1 Pyranometer

Bidder shall provide minimum **02 (Two) numbers** of Secondary Standard Pyranometers as per ISO 9060 **for measuring incident solar radiation as for following**

- **Global Horizontal Irradiance (GHI)- 1 Nos.**
- **Global Inclined Irradiance (GII)-1 Nos**

Sl.No	Details	Values
1.	Principle	Thermopile
2.	Spectral Response.	310 to 2800 nm
3.	Sensitivity	Min 7 micro-volt/w/m^2
4.	Time response (95%):	Max 15 s
5.	Non linearity:	±0.5%
6.	Temperature Response:	±2%
7.	Tilt error:	< ±0.5%.
8.	Zero offset thermal radiation:	±7 w/m^2

9.	Zero offset temperature change	±2 w/m^2
10.	Operating temperature range:	0 deg to +80 deg.
11.	Uncertainty (95% confidence Level):	Hourly- Max-3%, Daily-Max-2%
12.	Non stability:	Max ±0.8%
13.	Response Time(95% of final value)	<5 sec

Bidder shall provide 1 nos (one) Battery powered portable logger for pyranometer supplied by the OEM of the offered Pyranometer.

Both the pyranometers have to be mounted on floating unit at shade free location. The GII pyranometer has to be mounted at similar angular tilt either through module projection or standalone installation.

2.0 TEMPERATURE SENSORS

2.1 Ambient Air Temperature Sensor (Qty -1 no.)

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

2.2 Indoor Air Temperature Sensor (Qty – 1 no. at each Inverter room)

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

2.3 Module Temperature Sensor (Qty – 1 no. per 5 MW)

Sl.No	Details	Values
1.	Principle	RTD (Platinum) Resistance proportional to temperature
2.	Range	0-100 ° C

3.	Accuracy	± 0.2 ° C
4.	Operating Temperature	0 to 100 ° C

Module temperature sensor shall be fixed on the back of module surface with adhesive or tape without using any mechanical fastener.

3.0 CALIBRATION

All the instruments to be supplied shall have valid and traceable calibration certificate. Each Pyranometer shall be recalibrated at an interval not more than two years and all other instruments shall be recalibrated at an interval not more than four years.

4.0 DATA LOGGER

Weather Monitoring system shall be provided with standalone Data logger suitable for outdoor application with IP65 Protection and industrial grade hardware suitable for operating temperature up to 55 Deg. C. Data logger shall be calibrated and proven in field for at least one year in outdoor environment. Data logger shall have following minimum features:

Processor	32 bits
Time synchronization	With Built in GPS Clock or with Solar SCADA GPC Clock
Wireless communication	GSM/GPRS Modem
Data storage	SD card, Min 2GB for storage of raw and processed data locally at resolution of 1 Second for retrieval whenever required. Data to be stored shall be in unencrypted CSV or equivalent format.
Display	LCD display for easy maintenance and debugging for site engineer
Scan resolution	1 Sec
Analog to Digital Converter (ADC)	16 Bit, Sampling -10 Hz (Min)
I/P Channel	As required with 20 % spare of each type of channel

It shall have facility for arithmetic processing (Time Integration, Simple Average, and Moving Average etc.) of incoming raw data. Data logger shall be interfaced with Solar SCADA on modbus preferably on TCP-IP. Vendor shall submit Factory Acceptance Test (FAT) report and procedure before dispatch of material to site.

Data logger shall be provided with key-locked door access and all the cables (Power and Signal) to the data logger shall be protected with heavy duty HDPE pipes.

Project file (software, settings and sample reports) shall be handed over to site on permanent storage media (CD/DVD) in two copies after data integrity is verified by site and weather monitoring is commissioned.

1.0 Introduction

This technical specification provides BHEL requirements for supply of UPS with Ni-Cd battery bank for the solar photovoltaic project.

2.0 Scope of supply

Sl. No	Item Description	Qty
1	UPS System - 3KVA, along with Ni-Cd Battery bank	5 set

Note: NTPC approved vendors only are acceptable.

3.0 Technical specifications

The UPS system shall meet the following minimum specifications.

1.0	**Type**	1. UPS System - 3KVA along with Ni-Cd Battery bank shall be required for other four PCUs (placed on inverter platforms).Total auxiliary requirement of PCUs, HT panels and others are included.
2.0	**Configuration**	UPS system shall have **2x100% configuration**, at a time one incomer shall be in service. On failure of any UPS, its load shall automatically get transferred to the other healthy UPS. Suitable auto changeover logic shall be provided. The minimum capacity of the UPS at load factor of 0.8 lagging inclusive of 10% design margin at 50 deg C. The UPS shall have an overload capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 seconds. The overall efficiency of UPS shall be at least 80% on full load. The UPS system shall be capable of operating without D.C. battery in circuit under all conditions of load and the performance of various components of UPS like inverter, charger, static switch etc. shall be guaranteed without the battery in circuit.
3.0	**Charger**	The chargers shall be self-regulating, solid state silicon controlled, full wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates, effective current limiting features and filters to minimise harmonics. The charger should be capable to fully charge the required batteries as well as supply the full rated load. Furthermore, the charger should be able to re-charge the fully discharged battery within 8 hours. The charger shall be current limited for charger circuit protection and protection of battery from overcharge shall also be provided. The current limit shall be continuously adjustable. The chargers shall have a slow walk-in circuit. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. The charger shall be design for input supply voltage variation of ± 10% and frequency variation of ± 5%. Battery Chargers shall have a selector switch for selecting the battery charging mode i.e. whether Trickle or Boost charging. All Battery Chargers shall be provided with facility for both automatic and

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

		Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 1% irrespective of the DC load, even when they are not connected to a battery. The DC System shall be ungrounded and float with respect to the ground potential when healthy. An earth fault relay shall be provided by the bidder in the DC distribution board for remote annunciation. Digital Outputs shall be configured for connection to the SCADA for realtime charger status updation. Outputs like charger output current, output voltage, float/boost mode, etc may be configured to provide the update to SCADA. The Battery Chargers as well as their automatic regulators shall be of static type. The Chargers shall be designed to operate, as mentioned above, at an ambient air temperature of 50°C. Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC Nickel-Cadmium Batteries while supplying the D.C. loads. The Batteries shall be Trickle charged at 1.4 to 1.42 Volts per cell. All chargers shall be capable of Boost Charging the associated D.C. Battery at 1.54 to 1.7 Volts per cell at the desired rate. All Battery Chargers shall have an AC contactor on the input side. It shall be of air break type and suitable for continuous duty. A thermal overload relay incorporating a distinct single phasing protection (using differential movement of bimetal strips) shall also be provided for the AC input. The relay shall trip the above contactor. The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger. Digital or analog indicating instruments shall indicate DC current, DC voltage & AC voltage. The Chargers shall be indoor, floor mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Charger shall be fabricated using cold rolled sheet steel shall not be less than 1.6 mm and shall have folded type of construction. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. Removable undrilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be supplied by the Contractor. The Charger shall be tropicalized and vermin proof. Ventilation louvers shall be backed with fine brass wire mesh. All doors and covers shall be fitted with synthetic rubber gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed. Treatment as per IS: 6005. Two coats of lead oxide primer followed by powder painting with final shade of RAL9002 for complete panel except end

		covers & RAL 5012 for end covers. All acceptance and routine tests as per the manufacture recommendations and relevant standards shall be carried out. The cabinets shall be IP-42 protection class for indoor application and IP65 for outdoor application. The Contractor shall also carry out the site tests on battery charger systems required to be conducted as a standard practice of the UPS manufacture or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer. For UPS capacity 5 kVA or more, in addition to indications/display on UPS panel, important alarms along with important analog signal shall also be provided for use in SCADA. For UPS capacity less than 5 kVA bidder shall provide status, common alarm and trip DI (soft or hard) signal to SCADA
4.0	**Battery**	**BATTERY: NICKEL-CADMIUM BATTERY** Ni-Cd vented type, pocket plate high discharge battery of adequate capacity to meet the requirement of UPS, generally conforming to IS-10918. **BATTERY PARAMETERS** a) Battery Voltage : To be decide during Detail Engineering b) No. of Cells : To be decide during Detail Engineering c) Battery type : Nickel-Cadmium d) Nominal discharge voltage per Cell: 1.2 V e) Float voltage : 1.42V/Cell Batteries should be suitable for continuous operation for the maximum ambient temperature as defined in technical parameters. **CODES AND STANDARDS** All standards, specifications and codes of practice referred to herein, shall be the latest editions including all applicable official amendments and revisions as on date of opening of techno-commercial bid. In case of conflict between this specification and those (IS codes, Standards etc.) referred to herein, the former shall prevail. All works shall be carried out as per the following standards and codes: IEC 60623/ IS 10918 : Specification for vented type Nickel Cadmium Batteries. IS 106 : Quality tolerances for water for storage batteries IEC 60993 : Electrolyte for vented Nickel-Cadmium cells Indian electricity rules Indian electricity acts Equipment complying with other internationally accepted standards such as IEC., BS, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of techno-commercial bid and shall clearly bring out the salient

		features for comparison. DC Batteries shall be stationary Nickel Cadmium Pocket plate type conforming to IS:10918. The batteries shall be high/medium discharge performance type suitable for the backup time as specified. For the purpose of design an ambient temperature of 50 deg.C and relative humidity of 85% shall be considered. DC batteries shall be suitable for standby duty. The batteries shall normally be permanently connected to the load in parallel with a charge and shall supply the load during emergency conditions when AC supplies are lost. Batteries shall be suitable for a long life under continuous float operations and occasional discharges. The batteries shall be boost charged at about 1.54 to 1.7 volts per cell maximum and float charged at about 1.42 V/cell. **Sizing** a) Environmental temperature 0 to 50 degC. b) Power factor of load - 0.8 c) Adequate I2 t capability to clear fault in the maximum rated branch circuit. d) UPS shall be capable to operate without DC battery in circuit and under all conditions of load. e) In case of failure of a charger / input power, other charger whose input supply is healthy shall be capable to charge the battery and as well supply input power to inverter. No discharge of battery is allowed. f) Inrush current **Construction Features**: **a) Containers** Containers shall be made of polypropylene plastic material. Containers shall be robust, heat resistance, leak proof, non-absorbent, alkali resistant, non-bulging type and free from flaws, such as wrinkles, cracks, blisters, pin holes etc. Electrolyte level lines shall be marked on container in case of translucent containers. **b) Vent Plugs** Vent plugs shall be provided in each cells. They shall be anti-splash type, having more than one exit hole shall allow the gases to escape freely but shall prevent alkali from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition, the ventilator shall be easily removed for topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into the vent to take electrolyte samples. **c) Plates** The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The construction of plates shall conform to latest revisions of IS:10918. The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion. The positive and negative terminal posts shall be clearly marked.

		d) Sediment Space Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells. **e) Electrolyte** The electrolyte shall be prepared from battery grade potassium hydroxide conforming to IEC 60993. The cells can be shipped either in charged condition or in dry condition. Necessary electrolyte for make-up shall be supplied separately. **f) Connectors and Fasteners** Nickel plated copper connectors shall be used for connecting adjacent cells and PVC insulated flexible copper cables shall be used for inter-row / inter-tier / inter-bank connections. Bolts, nuts and washers shall be Stainless Steel / Nickel coated steel to prevent corrosion. The thickness of Nickel coating of connectors should be not less than 0.02 mm. All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds. **g) Battery racks** Mild steel racks for all the batteries shall be provided. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators/High impact plastic insulators. Batteries shall preferably be located in the single tier arrangement. However, batteries having a complete cell weight of lower than 50 Kg could be located in the double tier arrangement. The batteries racks and supports for cable termination shall be coated with three (3) coats of anti-alkali paint of approved shade. Name plates, resistant to alkali, for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor. **h) Test** The Contractor shall submit for Owner's approval the reports of all the type tests carried out as per latest IS-1146(for all applicable tests for containers) / IS-10918 (for NI-CD batteries). The complete type test reports shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier. Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of battery.
5.0	**Inverter**	The UPS inverter shall be of continuous duty, solid state type using proven Pulse Width Modulation (PWM)/Quasi square wave/step wave technique. Ferro-resonant types Inverters are not acceptable. The nominal voltage output shall be 230 Volts single phase ,50 Hz. The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, etc. The total harmonic content shall be 5% maximum and content of any single harmonic shall be 3% maximum. The bidder shall provide status, common alarm and trip DI (soft or hard) signal to SCADA.
6.0	**Efficiency**	a) 100% Full load- 80%
7.0	**Synchronization limit**	Between inverter & standby AC source shall be within 47 Hz to 53 Hz field adjustable. Inverter shall remain synchronized with the AC mains.
8.0	**Inverter protection**	Overload, short circuit and 100% loss of load.
9.0	**Load sharing**	At a time one incomer from UPS shall be in service. On failure of any UPS, its load shall automatically get transferred to the other healthy UPS

		without any degradation of the UPS power quality. Suitable auto changeover logic shall be provided. Power shall be transferred to the standby AC power without a break in synchronization if within limit in case of failure of both inverters. Asynchronous transfer to standby AC source in case inverters are being out of synchronism limit with AC mains.
10.0	**Static switch**	To transfer UPS loads automatically without any break from faulty inverter to standby AC source. Manual bypass switch shall be employed for isolating the UPS during maintenance.
11.0	**Enclosure**	Individual enclosure shall be ventilated switchboard type fabricated from not less than 1.6-mm thick sheet steel. Enclosures shall be furnished with concealed hinges. Front and rear doors shall be designed to permit easy access to all components for maintenance or replacement. The enclosures shall be reinforced with formed steel members as required to form a rigid self-supporting structure. Doors shall have three point latches. Adequate ventilating louvers and enclosure top panels shall be included. All vent openings shall be covered with corrosion resistant fine screen coverings. The cabinets shall be IP-42 protection class for indoor application and IP65 for outdoor application. The temperature rise inside all the cabinets/enclosures shall not exceed 10 deg.C above ambient temperature.
12.0	**Spare feeders**	25%
13.0	**Accessories**	Power distribution board, Voltage & current meters, power factor meter, KVA, frequency, panel alarms, switches etc. One set of tool shall be provided for maintenance and testing purposes.

4.0 APPROVAL

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

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

Drawings and scheme shall be submitted by the bidder for approval of BHEL/NTPC.

E-2 FIRE FIGHTING AND ALARM SYSTEM

The SPV plant shall be equipped with suitable fire protection & fire fighting systems for protection of entire equipment switchyard & control room as per CEIG requirements.

1.0 Bidder shall comply with recommendation of Tariff Advisory Committee to incurring minimal premium for insurance. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.

2.0 The fire fighting system for the proposed power plant for fire protection shall be consisting of:

a) Sand buckets
b) Portable fire extinguishers
c) Microprocessor based fire alarm panel.

2.1 Portable Fire Extinguishers and Sand Buckets

Bidder to provide following numbers of type tested portable fire extinguishers as per relevant code in the rooms mentioned below.

Rooms	DCP Type (ABC type) (10 Kg. Capacity)	CO_2 Type 9 kg capacity	Foam Type Hand 9 kg	Hand Portable pressurized water $C0_2$ 9 Litre	Sand Buckets
Control Room	2	2	1	1	1
Each Inverter Room	1	1			
ACDB Room(If applicable)	1	1			
Each Transformer Yard	1	1	1		1

2.2 Microprocessor based fire alarm panel

Bidder to provide intelligent microprocessor based main fire alarm panel of modular construction complete with central processing unit, input and output modules, power supply module, supervision control and isolator modules with 10% spare provisions in each loop. Fire detection alarm system shall include) but not limited to the following items

a. Fire Alarm control Panel
b. Multi Sensor smoke detector
c. Heat Detectors
d. Hooter cum strobe
e. Manual call Point
f. Hooter
g. Fault isolation modules
h. Control Modules
i. Cables from Sensors to Fire panels.
j. Digital output from the fire detection system shall be integrated with SCADA
k. Network Control Module
l. Interfacing of Fire Alarm System with SCADA for display and storage of status and alarm in SCADA

Multi sensor type smoke detectors and heat detectors shall be provided for below false ceiling areas of control room and ACDB and/or inverter rooms. One (01) sensor shall be provided for each 20 sq. Meter of area. All the cable trench inside the control room and inverter room shall be provided with Multi Sensor smoke detector.

Fault Isolation module shall be provided in every room and for every 15 sensors at location proposed by Bidder to be approved by employer during detail engineering.

2.3 Fire Alarm Control Panel Indication

i. Alarm conditions shall be immediately displayed on the control panel and in SCADA. Alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged the LED shall remain lit. A subsequent alarm received from another zone after acknowledgement shall illuminate the alarm LED and the panel display shall show the new alarm information.
ii. During an alarm condition, an alarm tone shall sound within the control panel until the alarm is acknowledged.
iii. If the audible alarm signals are silenced for any reason, they shall automatically resound if another zone is activated.
iv. All alarm signals shall be automatically “locked in” at the control panel until the operated device is returned to its normal condition and the control panel is manually reset

There shall be weather proof Hooter cum strobe outside and strobe inside each Inverter room and control room for indication fire alarm for respective zone/area at suitable location that is visible from all direction. All the

hardware, relay and accessories required for completeness of fire alarm system is in Bidder scope. Fire alarm system shall have its own battery and charger and it shall be provided power from UPS DB. Each Inverter room and control room shall be also be provided with manual call point, Alarm acknowledge and reset facility for alarm for respective zone only.

Bidder shall submit document to employer for approval that will include fire alarm system configuration, layout, BoM, Datasheet and necessary test report.

Bidder shall consider 30 % design and aging margin for selection of nos. of sensors in each loop and length of each loop. Bidder shall submit the certificate from OEM indicating maximum nos. of sensors in single loop and maximum length of single loop allowed with offered panel and type of cable to be used. Each Fire Alarm Control panel shall have provision for minimum 10 (Ten) % rounded to next higher integer but not less than 2 (two) nos. spare loops for future use of employer.

Bidder shall submit Site Acceptance Test (SAT) for approval by employer. Complete fire alarm system shall be checked at site for verification of faithful performance and completeness of the system. Bidder shall carry out necessary modification and supply hardware/accessories if required.

TECHNICAL SPECIFICATION FOR 33KV INDOOR METERING CUBICLE

There will be 15MW, 7MW indoor metering panel each one number.

The 15MW Indoor metering panel shall have

1. Measuring CT with CL-0.2S, 5VA , 360/1A as per SLD.
2. Measuring PT with CL-0.2, 5VA , 33/√3 kV / 110/ √3 kV as per SLD.
3. ABT meters as per SLD and as per state electricity board approved make.

The 7MW Indoor metering panel shall have

1. Measuring CT with CL-0.2S,5VA , 180/1A as per SLD.
2. Measuring PT with CL-0.2,5VA , 33/√3 kV / 110/ √3 kV as per SLD.
3. ABT meters as per SLD and as per state electricity board approved make.

Note: Maximum foot print of both the panels shall not exceed 1100mm X 1100mm.

All standards, specification and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of Techno commercial bid. In case of conflict between this specification and those (IS Codes, Standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.

Sl No	IS Code	Name Of Equipment
a)	IS: 722	AC electricity meters.
b)	IS: 996	Single phase small AC and universal electrical motors.
c)	IS: 1248	Direct Acting indicating analogue electrical measuring instruments and Accessories.
d)	IS/IEC: 60947	Degree of protection provided by enclosures for low voltage and control gear.
e)	IS: 2544	Porcelain post insulators for systems with nominal voltages greater than 1000 Volts.
f)	IS: 2705	Current transformers.
g)	IS: 3156	Voltage Transformers
h)	IS: 6005	Code of practice for phosphating of iron and steel.
i)	IS: 5082	Specification for wrought aluminium and aluminium alloy bars, rods, tubes and selections for electrical purposes.
j)	IEC: 61850	Communication Standard for Numerical relays
k)	IEC: 61131-3	Automation Standard for Numerical relays
l)	IS: 9046	AC contactors for voltages above 1000 volts and upto and including 11000 Volts.
m)	IS: 13703	Low voltage fuses
n)	IS: 9385	HV fuses
o)	IS: 9431	Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 volts upto and including 300 kV
p)	IS: 9921	A.C. disconnectors (isolators) and Earthing switches for voltages above 1000 V

q)	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
r)	IS: 13118	Specification for high voltage AC circuit breakers.
s)	IEC: 60099-4	Metal oxide surge arrestor without gap for AC systems
t)	IS/IEC: 62271100	High voltage alternating current circuit breakers.
u)	IS/IEC: 62271200	High voltage metal enclosed and control gear.
v)	IEC: 60947-7-1	Terminal blocks for copper conductors
w)	IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips

TECHNICAL PARAMETERS		
A. SYSTEM PARAMETERS		
a)	Nominal System voltage	33kV
b)	Highest System voltage	36kV
c)	Rated Frequency	50Hz
d)	Number of phases/ poles	Three
e)	System neutral earthing	Solidly Earthed
f)	One minute power frequency withstand voltage	
	- for Type tests	70kV
	- for Routine tests	70kV
g)	1.2/50 microsecond Impulse withstand voltage	170kV (peak)
h)	Minimum system fault level	As per SLD
i)	Short time rating for bus bars, circuit breakers, current transformers and assembly.	As per SLD for one (1) sec.
c	Dynamic withstand rating	2.5 times of system fault current
k)	- Space heaters	240 V AC single phase with neutral solidly earthed
l)	Maximum ambient air temperature	50 deg. C
m)	Internal Arc testing	As Specified in chapter-A2
B. BUS BARS		
a)	Continuous current rating at 500C ambient:	As Per Requirement
b)	Temper Rise allowed above ambient	^{0} ^{0} 40 C for plain joints 55 C for Silver plated joints
c)	Rated Frequency	50Hz
d)	Number of phases/ poles	Three

C. METERING. PANEL CONSTRUCTIONAL REQUIREMENTS		
a)	Colour finish	
	Exterior	RAL9002 (Main body) RAL 5012 (Extreme end covers)
b)	Cable entry	
	Power Cables	Bottom
	Control Cables	Bottom
c)	Earthing conductor	Galvanized steel strip
d)	Service Continuity of metering (LSC2B-PM)	as per IS/IEC 62271200

E. CURRENT TRANSFORMER		
	Accuracy	Two, Tariff CTs shall be with 0.2s accuracy class./ as per tender SLD

F. VOLTAGE TRANSFORMERS		
a)	Accuracy	For tariff metering VT - 0.2

BUSBARS AND INSULATORS

All Busbar and jumper connections shall be of high conductivity aluminium alloy. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit currents.

Busbar cross-section shall be uniform throughout the length. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage.

Contact surfaces at all joints shall be silver plated or properly cleaned and non-oxide grease applied to ensure an efficient and trouble free connection. All bolted joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance.

Bimetallic connectors or any other technically proven method shall be used for aluminum to copper connections.

Busbar insulators shall be of arc and track resistant, high strength, nonhygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100pico coulomb at rated voltage x 1.1 / 3. Use of insulators and barriers of in-flammable material such as Hylam shall not be accepted.

Successful Bidder shall furnish calculation establishing adequacy of busbar sizes for the specified continuous and short time current ratings.

All busbars shall be color coded.

The temperature of the busbar and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of relevant Indian Standards, duly considering the specified ambient temperature (50 deg. C). The temperature rise of the horizontal and vertical busbars when carrying the rated current shall in no case exceed 55 deg. C for silver plated joints and 40 deg. C for all other type of joints. The temperature rise at the

terminals intended for external cable termination shall not exceed 40 deg. C. Further the parts handled by the operator shall not exceed a rise of 5 deg. C .The temperature rise of the accessible parts / external enclosure expected to be touched in normal operation shall not exceed 20 deg.C.

EARTHING AND EARTHING DEVICES

A copper / galvanized steel earthing bus shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.

Suitable arrangement shall be provided at each end of the earth bus for bolting to Employer's earthing conductors. All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.

All non-current carrying metal work of the panel shall be effectively bonded to the earth bus. Electrical continuity of the whole enclosure frame work and the truck shall be maintained even after painting.

The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. SERVICE and ISOLATED as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.

All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. Looping of earth connections which would result in loss of earth connection to other devices, when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.

VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

Separate earthing trucks shall be provided by the Contractor for maintenance work. These trucks shall be suitable for earthing the busbars as well as outgoing / incoming cables or busducts. The trucks shall have a interlock to prevent earthing of any live connection.

As an alternative to separate earthing trucks the Bidder may also offer built-in earthing facilities for the busbars and outgoing / incoming connections, in case such facilities are available in their standard proven design. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the panel. These switches shall have facility for padlocking in the earthed condition.

PAINTING

All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

SURGE ARRESTOR

The surge arrestors shall be provided as per tender SLD/ as per system requirement and shall be of metal oxide, gapless type generally in accordance with IEC 60099-4 and suitable for indoor duty. These shall be mounted within the switchgear panel between line and earth, preferably in the cable compartment. Surge arrestor selected shall be suitable for un-earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear.

INSTRUMENT TRANSFORMERS

All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.

All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly. The current transformer shall further have the dynamic and short time ratings at least equal to those specified for the associated switchgear and shall safely withstand the thermal and mechanical stress produced by maximum fault currents specified when mounted inside the switchgear for circuit breaker modules.

The parameters of instrument transformers specified in this specification are tentative and shall be finalized by the Employer in due course duly

Current transformers may be multi or single core and shall be located in the cable termination compartment. All voltage transformers shall be single phase type. The bus VTs shall be housed in a separate panel on a truck so as to be fully withdrawable.

All voltage transformers shall have suitable current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted on the withdrawable portion. Replacement of the primary fuses shall be possible with VT truck in isolated position. The secondary fuses shall be mounted on the fixed portion and the fuse replacement shall be possible without drawing out the VT truck from service position.

All voltage transformers shall be designed and manufactured for 0.8 Tesla operating point on B-H curve. VT shall be fully insulated type (i.e. double pole construction and neutral side fully insulated to rated BIL). VT shall be manufactured without any joint in secondary winding.

SPACE HEATER

Each panel shall be equipped with thermostatically controlled space heater(s), suitably located in breaker and cable compartments to prevent condensation within the enclosure. The space heater shall be connected to 240V single phase AC auxiliary supply available in the switchgear, through switches and fuses provided separately for each panel.

A 240V single phase 50 Hz AC plug point shall be provided in the interior of each panel with ON-OFF switch for connection of hand lamp.

POWER CABLE TERMINATION

Cable termination compartment shall receive the stranded Aluminium conductor, XLPE insulated, shielded, armored / unarmored, PVC jacketed, single core / three core, unearthed / earthed grade power cable(s).

A minimum clearance of about 600 mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnection of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTs, gland plates etc. and

the electrical clearances available shall be submitted for Employer's approval during detail engineering.

Cable termination compartment shall have provision for termination of power cables of sizes as indicated during detailed engineering with removable undrilled gland plates. For all single core cables gland plates shall be of nonmagnetic material. Cable entry shall be from bottom. Any change will be intimated later .

Metering panel with padlock arrangement needs to be as per KSEB approval.

The panel GA and Technical GTP needs to be approved by BHEL/NTPC before manufacturing.

C-13 METERING SYSTEM

1.0 Energy meter (0.2s accuracy class suitable for ABT requirement with metering panel as required conforming to STU/PGCIL requirement shall be as per Cl. 2.0 of Chapter-A2.

2.0 For measurement of Auxiliary power consumption, MFM in ACDB incomer shall be provided by the bidder.

3.0 Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment. Bidder shall synchronize the meter using GPS time synchronization equipment. All the hardware required for synchronization shall be in scope of bidder.

4.0 The ABT meters supplied under this contract shall also meet the requirement of respective RLDC/State power Utilities.

5.0 This metering system shall have following features:

i. Meters shall be microprocessor-based MWH meters having an accuracy class of 0.2S or better. MVARH meters shall have accuracy class of 0.5 or better.

ii. These meters shall have provision for downloading of data through an optical port and /or through RS 232/485 port.

iii. Even under absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.

6.0 **Technical Requirements of Energy Meters for ABT Requirement**

Contractor shall supply energy meters along with metering station, 4 Nos. machine Clients, 20 nos web client license. MRI or lap top (as applicable) as per the technical specification given below:

a) Shall be microprocessor-based conforming to IEC 62052-11, IEC 62053-22, IS 14697

b) Shall carry out measurement of active energy (both import and export) and reactive energy (both import and export) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.

c) Shall have an accuracy of energy measurement of at least Class 0.2S for active energy and at least Class 0.5 for reactive energy.

d) The active and reactive energy shall be directly computed in CT & VT primary ratings.

e) The reactive energy shall be recorded for each metering interval in four different registers as MVARh (lag) when active export, MVARh (Lag) when active import, MVARh (lead) when active export, MVARh (Lead) when active import.

f) Two separate registers shall be provided to record MVARH when system voltage is >103% and when system voltage is < 97%.

g) Shall compute the net MWh and MVARh during each successive 15-minute block metering interval along with a plus/minus sign, instantaneous MWh, instantaneous MVARh, average frequency of each 15 minutes, net active energy at midnight, , net reactive energy for voltage low and high conditions at each midnight.

h) Each energy meter shall have a display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MWh demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.

i) All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.

j) At least the following data shall be stored before being over-written for the following parameters.

	Parameters	Details	Min No of days
1.	Net MWH	15 min block	40days in meter
2.	Aver Freq	15 min block	40days in meter
3.	Net MVARH for V > 103%	15min block	40days in meter
4.	Net MVARH for V < 97%	15min block	40days in meter
5.	Cumulative Net MWH at every midnight		10 days in meter/ 40 days in PC
6.	Cumulative Net MVARH for V> 103% at every midnight		10 days in Meter/ 40 days in PC

7.	Cumulative Net MVARH for V < 97% At every midnight		10 days in Meter/ 40 days in PC
8.	Date and time blocks of VT failure on any phase.		

k) Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.

l) Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment being supplied by the contractor.

m) The voltage monitoring of shall be inbuilt feature provided to signal failures to the Substation Automation System, The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be less than 2 VA.

n) The power supply to the meter shall be healthy even with a single-phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years. Even under absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meter. Incase data downloading is not possible in absence of VT supply, meter with provision of 220V DC auxiliary power shall be provided. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory.

o) Shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software . The contractor shall supply the MRI and/or notebook complete with all optical interface unit required.

p) The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.

q) Each meter shall have a unique identification code provided by the Owner and shall be permanently marked on the front of the meter and stored in the non-volatile memory of the meter.

7.0 **Type Test requirement for Energy Meter**

All Type Test Reports shall be provided as per IEC 62052-11, IEC 62053-22, IS 14697.

ANNEXURE -A

KAYAL WATER TEST READINGS (North of South Bund- 22MW floating Solar plan)											
	pH	Conductivity	Turbidity	CaH	Total hardness	Total Alkali	Chlorides(Cl^-)	Sulphates(So_4^{2-})	Silica(Sio_2)	Fe	Organic Matter
SAMPLE 1	7.66	7.94	2.94	130	790	22	2573.75	38.602	0.8723	0.2016	1.2
SAMPLE 2	7.67	7.85	3.79	140	770	26	2556	34.045	0.8659	0.1837	1
SAMPLE 3	7.64	7.49	4.48	120	750	28	2564.87	36.488	1.3119	0.1318	1.1

sample 1 - From east side
sample 2- From south side
Sample 3- From west side

PURCHASE SPECIFICATION FOR

SUPPLY OF

ESE LIGHTNING ARRESTOR SYSTEM

01	21-05-2020	VIPINDAS CP	SREENATH M
Revision	**Date**	**Prepared**	**Checked & Approved**

1.0 Introduction

This technical specification provides BHEL requirements for supply of ESE Lightning protection system for the Floating type solar photovoltaic project.

2.0 Scope of supply

Sl. No	Item Description	Qty
A	**Supply of Lightning arrestor protection system** (comprising of following components) • Supply of ESE lightning arrestor terminal as per clause A 1.0 • Supply of 5m LA mounting pole & accessories for array as per clause A 2.0 • Supply of Down Conductor as per clause A 3.0 • Supply of Lightning Event Counter as per clause A 4.0 • Supply of earthing set for LA as per clause A 5.0 • Installation of ESE lightning arrestor as per clause A 6.0	18 sets

3.0 Documents to be submitted along with offer

- BHEL specification duly signed and sealed by vendor on each page
- Product catalogue of ESE-LA
- Type test certificates for ESE-LA terminal with test reports complying to NF C 17 102(2011)
- General arrangement and detailed drawings with bill of materials of the overall LA arrangement
- Lightning arrestor protection coverage area calculations
- Installation manual for ESE-LA

A) Supply and Installation of Lightning arrestor protection system

The vendor shall supply lightning protection system to protect the **floating** solar array, floating inverter platform and control room using ESE-type Lightning arrestors complying to NF C 17 102 (2011) standard. Vendor shall provide the lightning radius coverage with supporting calculations.

The complete lightning protection system will comprise the following key components:

1. ESE type Lightning Air Terminal
2. Mounting support and mounting accessories
3. Down conductor
4. Lightning Event Counter
5. Dedicated earthing system

1.0 ESE type Lightning Air Terminal

1. The lightning air terminal shall be an Early Streamer Emission type terminal which will respond dynamically upon downward leader activity in the near area.
2. The external shape of the advanced lightning rod shall be such that it will limit the development of sharp point corona discharge under static thunderstorm conditions and enhance leader initiation.
3. The lightning air terminal shall have no moving parts and will have no dependence on an external power supply or batteries.
4. All components of the advanced lightning terminal shall be non-corroding.

5. The lightning air terminal should have been tested and certified in accordance with NF C 17-102:2011.
6. The radius of coverage of LA shall be as per protection Level 4 (minimum 107m protection radius).
7. Triggering gap shall be selected so that streamers are not launched until the electric field conditions are at an optimum magnitude for conversion to a stable, propagating upward leader.

2.0 LA mounting pole for Lightning Air Terminal

1. The mounting pole shall be used to support the lightning air terminal. It shall be steel material.
2. Lightning protection system shall protect the solar array modules which are floating on the water body. The lightning pole height shall be minimum 5 m from floater surface level for PV array and inverter platform, and minimum 5 m for control room.
3. The mounting pole shall be supported with minimum 3 set of Guy wires with suitable guy ring, clamps and hardware. The guy wire kit shall be supplied by vendor.
4. Mounting pole shall have appropriate base plate for mounting on floating platform/RCC control room.
5. Suitable provision for running the down conductors through the centre of the pole shall be provided.

3.0 Down Conductor

1. Each lightning air terminal shall be connected to earth (under water) using down conductor.
2. The down conductors shall have a minimum size of 50 mm^2 each and shall be insulated round stranded copper conductor cable of reputed make. The down conductors shall be fixed securely every one meter along the length of mast wherever exposed.
3. Below water down conductor can be bare conductor also.
4. The down conductors shall allow for direct connection to the lightning rod and to the earth electrode through the use of compression lug. The ESE lightning terminal shall have provision for the lug connection. Suitable lugs and hardware shall be supplied along with the down conductor.

4.0 Lightning Event Counter

1. Each ESE type lightning arrester shall be provided with individual lightning event counter to record lightning events arrested by particular ESE LA.
2. Lightning counters shall have IP65 or better rating enclosure and shall have provision for fixing of lightning mast pole using clamp, bolts and nuts.
3. Lightning counter shall have suitable lightning current withstand capacity according to the ESE LA rating. Test links shall be supplied along with each Lightning event counter to enable testing of LA and counter.

5.0 Earthing set for ESE LA

The earthing system shall incorporate minimum two dedicated chemical earth electrode for each ESE LA. The electrode shall be deep driven solid copper, copper bonded steel rod. Earth resistance enhancing compound shall be used in order to reduce the resistivity levels of the earthing system. All components of the earthing system shall be electrically connected to the central injection rod which is securely connected to the lower end of the high voltage shielded cable. The earthing system shall be installed so that the enhanced earth resistance reading does not exceed 5 Ohms.

6.0 Installation of ESE LA

Vendor shall fabricate suitable base plate for fixing the LA on HDPE floating platform or construct the suitable RCC foundations for installing on ground on case to case basis and install the LA mast along with guy wires, down conductor, lightning event counters and test link. The earth pit installation and interconnection with associated LA is also in vendor scope.

B) Documents to be submitted within 7 days after receipt of purchase order

1. General arrangement and detailed drawings with bill of materials of the overall lightning arrestor arrangement
2. Lightning arrestor protection coverage area calculations
3. Mounting details of base plate arrangement.
4. Installation manual for LA-ESE and earthing

C) Documents to be submitted along with consignment

1. ESE LA installation manual with GA drawings
2. Manufacturer test report for each LA

C-10 PLANT ILLUMINATION SYSTEM

This chapter covers supply and installation of suitable illumination system along the peripheral roads and along the approach roads to inverter room and main control room, control room, inverter room(s), switchyard and other facilities inside the plant.

1.0 DESIGN PHILOSOPHY

A comprehensive illumination system shall be provided in the entire project. Each building shall be provided with adequate light fittings,6A/16A socket, fans, etc. Exhaust fans shall also be provided in toilets, battery room, etc

All outdoor lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.

2.0 LIGHTING SYSTEM DESCRIPTION for CMCS and inverter room

Normal AC Lighting System: AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels Control Board (LPs) which in turn will be fed from the lighting distribution boards (LDBs) of AC Switch board MCC.
Emergency AC Lightning System: The emergency lighting system consisting of 20% of the lights shall be fed from UPS DB or DCDB as per scheme adopted by the EPC bidder. Load of the same has to be considered for UPS/ Battery and charger sizing. Bidder shall provide indoor and outdoor emergency lighting at each inverter room, CMCS, security room and main gate.

3.0 Lighting Fixture, Lamps & Accessories

a. All lighting fixtures and accessories shall be designed for continuous operation for its life under atmospheric conditions existing at site.
b. AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of +/-10%, frequency variation of +/- 5% and combined voltage and frequency variation (absolute sum) of 10% DC lighting fixtures and accessories shall be suitable for operation on 220 V, with variation between 190 V & 240 V.
c. All lighting fixtures shall be complete with lamp(s), lamp holder(s), LED chip assembly, terminal blocks, clamps, locking arrangements, fixing brackets etc. Driver circuit/Control gears shall be provided as applicable / specified. The fixtures shall be fully wired upto terminal block. The internal wiring of the fixtures shall be done with suitable low smoke halogen free thermo-plastic or silicon rubber insulated or fire

retardant PTFE copper conductor wires of suitable size and type. Further fuse protection of suitable rating in input side shall also be provided specifically for LED luminaires. However, the normal cross section of conductor shall be not less than 0.5 Sq. mm and minimum thickness of insulation shall be 0.6 mm. The wiring shall be capable of withstanding the maximum temperature to which it will be subjected under specified service conditions without deterioration and affecting the safety of the luminaire when installed and connected to the supply. All fixing /locking screws, washers, nuts, brackets, studs etc, shall be zinc plated and passivated.

d. All lighting fixtures shall be provided with an external, brass/GI earthing terminal suitable for connecting 14 SWG, GI earthing wire. All metal or metal enclosed parts of the housing and accessories shall be bonded and connected to the earthing terminal as so to ensure satisfactory earthing continuity through out the fixture
e. The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection
f. The reflectors shall be manufactured from CRCA sheet steel or aluminium as specified. The aluminium reflectors shall be made of high purity aluminium sheet, polished electrochemically brightened and anodized or proven alternate arrangement of anodizing
g. Starters shall have bi-metal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without use of any tool. Starter shall have brass contacts and radio interference suppressing capacitor.
h. LED luminaires body shall such designed that heat sink/heat dissipating housing shall be mounted outside the overall luminaires fixture housing, and shall be suitably clearing the driver circuit. Further for outdoor type LED luminaires, the exposed heat sink shall be suitably designed to avoid dust/foreign particles accumulation on the same.
i. LED luminaires housing/body shall be pressure die cast aluminium or extruded Aluminium or CRCA as specified alongwith finished powder coating. Care shall be taken in the design that there is no water stagnation anywhere.

4.0 LED LUMINAIRES:

4.1 CODES AND STANDARDS

All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of techno-commercial bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the

former shall prevail. All work shall be carried out as per the following standards & codes.

16101:2012	General Lighting. LEDs and LED modules Terms and definitions
16102(Part 1):2012	Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.
16102(Part 2):2012	Self Ballasted LED Lamps for General lighting Services. Part-2 Performance Requirements.
16103(Part I):2012	LED modules for General lighting Safety Requirements.
15885(Part 2/Sec. 13) :2012	Lamp control gear Part 2 particular Requirements Section 13 d.c. or a.c. Supplied Electronic control gear for LED modules
16104:2012	d.c. or a.c. Supplied Electronic control gear for LED modules - Performance Requirements.
16105:2012	Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources.
16106:2012	Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products
16107:2012	Luminarie Performance
16108:2012	Photobiological safety of Lamps and Lamp Systems
IS 513	Cold rolled low carbon steel sheets and strips
IS 12063	Classification of degree of protection provided by enclosures.

IS 14700 (Part 3/Sec. 2)	Electro magnetic compatibility (EMC) – Limits for Harmonic emission – THD < 15% (equipment, input current < 16 Amps. per phase.
IS 9000 (Part 6)	Environment testing: Test Z – AD: composite temperature/humidity cyclic test.
IS 15885 (Part 2/Sec. 13) IS 16004 – 1 and 2)	Lamp control gear: particular requirements for DC or AC supplied electronic control gear for LED modules.
IS 4905	Method for random sampling
IEC 60598	Ingress protection, luminaire performance and safety
IEC 61000-3-2	Total Harmonic Distortion
IEC 61000-4-5	Surge Protection
IES-LM 80 along with TM 21/ IS 16105	Lumen Depreciation and Rated life of LED chip
IES-LM 79 / IS 16106	Luminaire optics and color parameter and electrical parameter

4.2 LED LIGHTING SYSTEM

LED Luminaires shall be used for the lighting of all the indoor & outdoor areas. However for DC lighting & hazardous areas conventional type luminaires shall be used. In false ceiling area LED luminaires shall be recessed mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type.

The individual lamp wattage for LED shall be upto 3 watt for outdoor type luminaires. However for indoor type luminaires fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall not be less than 80 Lm/W. Heat sink/heat dissipation arrangement shall be provided in the luminaires. The LED used in the luminaires shall have colour rendering index (CRI) of Min 70 and 80 for outdoor and indoor luminaires respectively.

Colour designation of LED shall be “cool day light” (min 5700K) type for indoor type LED luminaires. Further for outdoor type luminaires, the colour designation shall be 5000K, except for well glass type LED luminaires, where the colour designation shall be 4000K. The LED luminaires shall

have minimum life of 25,000 burning hours with 80% of lumen maintenance at the end of the life.
The beam angle for LED chip for indoor type luminaires shall be 120 degrees. However for highbay & flood light type outdoor luminaires the LED chip with suitable beam angle shall be used to deliver better lumen-output. The maximum junction temperature of bare LED without heat sink shall be limited to 85 deg C, further the lumen maintenance at this temperature shall be min 90%. The THD of tube light based LED Luminaires shall be less than 20%. For other type of luminaries, it shall be minimum 10%.

Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink/ heat dissipation arrangement, with proper thermal management shall be designed for the luminaires.

Driver Circuit: LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED manufacturer.
LED Drivers may have following control & protections:-

- Suitable precision current control of LED.
- Open Circuit Protection
- Short Circuit Protection
- Over Temperature Protection
- Overload Protection
- Surge Protection

Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have IP55 degree of protection.
Wires of different phase shall normally run in separate conduit.
Power supply shall be fed from 415 / 240 V normal AC supply through suitable number of conveniently located lighting distribution boards (LDB) and at least one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc.
Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for welding purposes at one location.
Incandescent lamps may be used only with DC Lighting.
Electrification of all building shall be carried out as per IS 732-1989, IS 4648-1968 and other relevant standards.

Indoor Lighting fixtures shall generally be controlled from switch boxes of each area not directly from lighting panel. Each switch shall control a maximum of three fixtures.

All luminaries and their accessories and components shall be of type readily replaceable by available Indian makes.

Following test reports to be submitted for LED chip/LED luminaires:

a) LED parameters like Lumen per watt, CRI, Beam angle from manufacturer.

b) LM 80/IS: 16105 report.

c) LM 79/IS: 16106 report

5.0 JUNCTION BOXES, CONDUITS, FITTING & ACCESSORIES

Junction box for indoor lighting shall be made of fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type.
Junction boxes for street lighting poles and lighting mast if applicable , shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55.
All switches and receptacles upto 16A shall be modular type. These shall be provided with pre-galvanized/galvanized modular switchbox & plate.
Conduits, Pipes and Accessories:
Heavy duty PVC conduits conforming to IS: 9537 Part-III along with various accessories shall be used for indoor wiring in the buildings. These conduits shall be concealed in the wall/floor/roof. However, in PEB's, conduits can be fixed on surface.
Pull out boxes shall be provided at suitable interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, etc. Pull-out boxes shall have cover with screw. Pull out boxes used outdoor shall be weather proof type suitable for IP: 55 degree of protection and those used indoor shall be suitable for IP: 52 degree of protection.

6.0 LIGHTING WIRES

Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R,Y,B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper

7.0 LIGHTING POLES

The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. Height of the poles should be chosen so as not to affect working of Solar panels. The poles shall be hot-dip galvanized as per relevant IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS 875

considering prevailing soil/ site condition considering all accessories mounting on pole.
The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB. The required illumination level shall be as per Cl. 9.0 taking consideration of existing lighting infrasture.

Hot dipped Galvanized with 80 mm thickness hexagonal/Octagonal lighting pole with inbuilt JB shall also be acceptable
Bidder to provide 20A industrial socket at each 100 meter distance interval at the street light pole.

8.0 EARTHING

Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the ends.
Alternately Vendor may offer technically superior and proven product subject to approval of employer.

9.0 AVERAGE ILLUMINATION LEVEL

Location	Average Illumination Level (Lux)	Type of Fixture
Control Room	300	LED Luminaries
Store Room	200	LED Luminaries
Switchgear Room, HT Room	150	LED Luminaries
Inverter Room	150	LED Luminaries
Street lighting-Roads	10	LED Luminaries
Yard/ Substation	20(general) 50(on strategic equipment)	LED Luminaries

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Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
1.	SPV module	I	Q-001	BHEL	Bangalore	A	
				Warree	Surat	A	
				Emmvee	Bangalore	A	
				Vikram Solar	Parganas	A	
				Lanco Solar	Chattisgarh	A	
				Tata Power Solar	Bangalore	A	
				Alpex	Solan	A	
				Synergy	Durgapur	A	
				Photonix	Satara	A	
				HHV Solar	Bangalore	A	
2.	Power Conditioning Unit (PCU)	I	Q-002	Schneider	Bangalore	A	Conditions apply
				ABB	Bangalore	A	Conditions apply
				Bongfiglioli	Germany	A	Conditions apply
				Fecon	Germany	A	Conditions apply
				AEG	Bangalore	A	Conditions apply
				Hitachi-Hirel	Gandhinagar	A	Conditions apply
				Hitachi-Hirel	Sananad	A	Conditions apply
				Vacon	Bangalore	A	Conditions apply
3.	String Monitoring Box (SMB)	II	Q-003	Trinity Touch	Palwal	A	Conditions apply
				Hensel	Sriperumbudur	A	Conditions apply
				AEG	Bangalore	A	Conditions apply

एनटीपीसी NTPC	PROJECT : DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP KAYAMKULAM KERALA PACKAGE : SOLAR CONT. NO. :				INDICATIVE VENDOR LIST		DOC NO. : REVISION NO. 00 PAGE : 2
Sl. No.	**ITEM**	**QP / INS CAT.**	**QP No. -**	**ACCEPTABLE SUPPLIER AS PER DATABASE**	**PLACE**	**SC APPL STATUS**	**REMARKS**
				Statcon	Pilkhuwa	A	Conditions apply
				Weidmuller	Spain	A	Conditions apply
4.	Weather station panel (comprising of Pyranometer, anemometer & thermometer etc.)	III		Any make-model with VDE/ CE/UL/ CSA marking or BIS approved with CML no. (Refer Note-6)			
5.	DC Cable Connector	III		Any make-model which is Type Tested as per EN 50521 or having marking of VDE/ CE/UL/ CSA/ "BIS with CML no." (Refer Note-1)			
6.	Floor mounted Draw out type indoor LT Switchgear Panel (MCC etc.) Refer Note-5	I	Q-004	L&T	Mumbai / Coimbatore/Ahmednagar	A	BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
				GE	Bangalore	A	
				C&S Electric	Noida / Hardwar	A	
				Schneider	Nasik	A	ACB from Schneider, France
				Unilec	Gurgaon	A	
				Siemens	Kalwa	A	Conditions apply
				Tricolite	Sahibabad/ Manesar	A	Conditions apply
				Nitya Electrocontrols	Noida	A	
7.	LV Air Circuit	*		C&S Electric	Noida	A	*(part of Swgr MQP)

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
	Breaker						
				L&T	Mumbai	A	
				GE	Bangalore	A	
				Siemens	Germany	A	
				Schneider	France	A	
8.	Floor mounted Fixed type indoor LT Switchgear Panel (ACDB / DCDB / MLDB etc.) Refer Note-5	I	Q-005	Switching Circuits	Kolkata	A	BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
				Hindustan Control & equipment Ltd	kolkata	A	With fabrication & painting at unit II & MP Electrical Narendrapur
				Maktel	Vadodara	A	Prior Type Testing
				Jakson	Greater Noida	A	
				Vidyut Control	Gaziabad	A	
				Adlec Power	Rohad (Jhajjar)	A	
				Pyrotech	Udaipur	A	
				Conquerent Control System	Manesar	A	Condition apply ,upto 1250A
				Control & Schematics	Hyderabad	A	
				Positronics	Vadodara	A	
				Anand Power Ltd.	Noida	A	
				Additionally all vendors identified for Floor mounted Draw out type indoor LT			

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Switchgear Panel			
9.	Wall mounted fixed type indoor / outdoor LT Switchgear non compartmentalized Panel (Lighting panels / AC / DC Fuse boards etc.) Refer Note-5	I	Q-006	Control Devices	Kolkata	A	BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
				Jasper	Noida	A	
				Havells	Faridabad	A	
				Novateur Electrical & distribution systems	Murthal	A	
				Avaid Technovator	Manesar	A	
				Additionally all vendors identified for Floor mounted Draw out type indoor LT Switchgear Panel			
				Additionally all vendors identified for Floor mounted fixed type indoor LT Switchgear Panel			
10.	Lighting & Welding Transformer	II	Q-007	Southern Electric	Chennai	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Indcoil	Thane	A	
				Pragati	Thane	A	
				Prayog	Pune	A	
				Precise	Mumbai	A	
				Logicstat	Delhi	A	
				Gujarat Plug in	Vadodara	A	
				AE	Thane	A	
				Power Pack Enterprises	Mumbai	A	
				Amex Impex,	Ahmedabad	A	
11.	LT CT/PT/CBCT/ Control Transformer	III		Kappa	Bangalore	A	
				Southern Electric	Chennai	A	
				Precise	Mumbai	A	
				G&M	Baroda	A	CBCT Only
				Silkaans	Mumbai	A	
				Ind Coil	Mumbai	A	
				Pragati	Thane	A	
				Prayog	Pune	A	
				AE	Mumbai	A	
				Logicstat	Delhi	A	For control transformer only
				C&S Electric	Noida	A	For CT only
				Newtek	Aurangabad	A	For CT/PT/Control transformer
12.	1.1Kv LT Power Cable	Refer	Q-008	Universal Cable Ltd.	Satna	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
	(From SMB to PCU)	Note-2					
				NICCO	Shamnagar , Kolkata	A	
				Torrent Cable Ltd	Nadiad	A	
				Incab	Pune	A	
				Hindustan Vidyut Products Ltd	Faridabad	A	
				KEI Industries	Bhiwadi	A	
				Delton Cable Ltd	Faridabad	A	A) Unarmoured cable all sizes. B) Armoured cable up to 3.5 x 240 sq. Mm with GI strip armour and 1CX70 sq mm with Al strip armour
				Paramount Cable	Khushkhera	A	
				Polycab Wires Pvt. Ltd	Daman	A	
				Gemscabs Industries	Bhiwadi	A	
				Cords Cables	Bhiwadi	A	
				Havells India Ltd.	Alwar	A	
				Sri ram Cables	Bhiwadi	A	
				Ravin Cables	Pune	A	
				Thermocables	Hyderabad	A	
				Sbee Cables	Bangalore	A	
				Suyog Cables	Vadodara	A	
				Gupta Power Cables	Khurda	A	
				Finolex	Pune	A	
				Scot Innovation wires and cables	Baddi	A	
				Anhui Hualing	China	A	

				LS Cable	Korea	A	
				Radiant Cables	Hyderabad	A	
				Tirupati Plastomatics	Jaipur	A	
				Apar Industries	Umbergaon	A	
				Special Cables	Rudrapur	A	
				ABB Kabel	Germany	A	
				Advance cable	Bengaluru	A	
				Step Industries	Shahjahanpur	A	
				Taihan Electric Wire	Korea	A	
				Tbea Shandong	China	A	
				CMI	Baddi	A	
				Dynamic Cables	Jaipur	A	Conditional Approval
13.	1.1 KV Control Cable	Refer Note-2	Q-009	Universal Cable Ltd.	Satna	A	
				NICCO	Shamnagar, Kolkata	A	
				Torrent Cable Ltd	Nadiad	A	
				Incab	Pune	A	
				Polycab WiresPvt. Ltd	Daman	A	
				Hindustan Vidyut Products Ltd	Faridabad	A	
				KEI Industries	Bhiwadi	A	
				Delton Cable Ltd	Faridabad	A	
				Paramount Cable	Khushkher	A	

एनटीपीसी NTPC	PROJECT : DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP KAYAMKULAM KERALA PACKAGE : SOLAR CONT. NO. :				INDICATIVE VENDOR LIST		DOC NO. : REVISION NO. 00 PAGE : 8
Sl. No.	**ITEM**	**QP / INS CAT.**	**QP No. -**	**ACCEPTABLE SUPPLIER AS PER DATABASE**	**PLACE**	**SC APPL STATUS**	**REMARKS**
					a		
				Gemscabs Industries	Bhiwadi	A	
				Cords Cables	Bhiwadi	A	
				SPM Cables	Hyderabad	A	
				Elkay Telelink	Faridabad	A	
				Havells India Ltd.	Alwar	A	
				R.R. Kabel	Silvasa	A	
				Ravin Cables	Pune	A	
				Gupta Power cable	Khurda	A	
				Thermocables	Hyderabad	A	
				Finolex	Pune	A	
				Sbee Cables	Bangalore	A	
				Suyog Cables	Vadodara	A	
				Scot Innovation wires and Cables	Baddi	A	
				Anhui Hauling	China	A	
				LS Cable	Korea	A	
				Radiant Cables	Hyderabad	A	
				Tirupati Plastomatics	Jaipur	A	
				Apar Industries	Umbergaon	A	
				Special Cables	Rudrapur	A	
				Advance cable	Bengaluru	A	
				Step Industries	Shahjahanpur	A	
				Taihan Electric Wire	Korea	A	
				Tbea Shandong	China	A	
				CMI	Baddi	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Goyoline Fibres(I) Ltd	Daman	A	
14.	HT Cable Upto 11KV	Refer Note 2	Q-010	Universal Cable Ltd.	Satna	A	
				NICCO	Shamnagar , Kolkata	A	
				Torrent Cable Ltd	Nadaid	A	
				Incab	Pune	A	
				Polycab Wires Pvt. Ltd	Daman	A	
				KEI Industries	Bhiwadi	A	
				Havells India Ltd.	Alwar	A	
				Sri ram Cables	Bhiwadi	A	
				Krishna Electrical Industries Ltd	Gwalior	A	
				Apar Industries	Valsad	A	
				Finolex	Pune	A	
				KEC International	Vadodara	A	
				Tirupati Plastomatics	Jaipur	A	
				Gupta Power	Kashipur	A	
				Paramount	Khuskhera	A	
				Gemscab	Bhiwadi	A	
				Sterlite	Haridwar	A	
15.	HT Cable upto 33KV	Refer Note 2	Q-011	Universal Cable Ltd.	Satna	A	
				Torrent Cable Ltd	Nadiad	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Polycab Wires Pvt. Ltd	Daman	A	
				KEI Industries	Bhiwadi	A	
				Havells India Ltd.	Alwar	A	
				Apar Industries	Valsad	A	
				Finolex	Pune	A	
				KEC International	Vadodara	A	
				Gupta Power	Kashipur	A	
				Paramount	Khuskhera	A	
				Gemscab	Bhiwadi	A	
				Sterlite	Haridwar	A	
				Gupta Power	Kashipur	A	
16.	DC Cable (Interconnecting SPV Modules, SPV Module to SMB) As per NTPC specification	I	Q-012	Siechem	Pondicherry	A	Upto 35 sq.mm.
				Apar	Khatalwada	A	Conditions apply
17.	Battery (Ni-Cd)	II	Q-013	M/S HBL-Power System	Hyderabad	A	Up to 990 Ah with conditions
				M/S Amcosaft	Bangalore	A	8Ah to 990Ah- KPH type 10Ah to 1365 Ah- KPM type 11Ah to 1550Ah – KPL type
18.	Battery Plante /Tubular	II	Q-014	M/s Exide	Kolkata	A	
				Hoppeke	Brilon,Ger	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
					many		
19.	Battery charger	II	Q-015	M/s Amararaja	Tirupati	A	
				M/s HBL- Power System	Hyderabad	A	
				M/s Chhabi electrical	Jalgaon	A	
				M/s. Chloride Power	Kolkatta	A	
				M/s Statcon	Hapur	A	Up to 220, V 850 A
				M/s Dubas	Bangalore	A	Up to 220 V, 250 A
				M/s Saft Nife Power Systems	Singapore	A	
				M/s Masstek	Jalgaon	A	
20.	Earthing & Lightning Protection Material like GI Strip/GI Wire etc	III		Main contractor Approved Sources box subject to galvanization at NTPC approved sources as per Note-4			
21.	HT Cable Termination Kits & Straight Through Jointing Kit (Heat shrinkable type)	III		M/s 3M Electro & Communication	Pune	A	Upto 33KV
				Raychem	Halol	A	Upto 33KV
				Hari Consolidated	Delhi	A	Upto 11KV(conditions apply)
22.	Lighting fixtures with accessories including lamp (Filament type)	II	Q-016	M/s Crompton	Mumbai	A	
				M/s Bajaj Electricals	Mumbai	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				M/s Philips	Noida	A	
				M/s Wipro	Mumbai	A	
				M/s Surya Roshni	Noida	**A**	Conditions apply
23.	Lighting fixtures with accessories including lamp (LED type)	II	Q-017	M/ s Wipro	Pune	A	Conditions apply
				M/s Surya Roshni	Noida	A	Conditions apply
				M/s Bajaj	Mumbai	A	Conditions apply
				M/s Goldwyn	Noida	A	Conditions apply
24.	MCB Boxes/Junction boxes / Link Boxes/ Test Link Box/ Adopter box, Switch Boxes, Pull Boxes (Hot Dip Galvanized)	III		Main Contractor approved sources with galvanization from NTPC approved sources			BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no, Refer Note-6
25.	Industrial /welding receptacles & boxes	III		Schneider	Nasik	A	
				M/s BCH	Faridabad	A	
				M/s Ajmera	Mumbai	A	
				M/s. Sakthi & Crown	Chennai	A	
				Any other make having CE / UL / CSA mark or BIS approval with valid CML number.			
26.	PVC conduit/hume pipe/lighting wire/GI	III		BIS licensee with valid CML number / ISI marked with valid CML number			

	pipes/HDPE pipe/Structural Steel/ GI steel rigid conduit/ epoxy conduit						
27.	MV Switchgear Panel (Refer Note-5)	I	Q-018	BHEL	Bhopal	A	Upto 33KV
				Megawin	Salem	A	Upto 33KV
				L&T	Ahmednagar	A	Upto 33KV
				Siemens	Mumbai	A	Upto 33KV
				Jyoti	Vadodara	A	Upto 33KV
				ABB	Nasik	A	Upto 33KV
				Schneider	Kolkata	A	Upto 11KV -Salt lake works -VG series Interrupter made at Salt Lake Works
28.	MV Vacuum Type Circuit Breaker	(part of Swgr MQP)		Siemens	Mumbai	A	Upto 33kv
				BHEL	Bhopal	A	Upto 33kv
				L&T	Ahmednagar	A	Upto 33kv
				ABB	Nasik	A	Upto 33kv
				ABB	Italy	A	Upto 33Kv
				Megawin	Salem	A	Upto 33kv
				Jyoti	Vadodara	A	Upto 33kv

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Schneider	Kolkata	A	Upto 11kv
29.	IEC 61850 compliant Numerical Protection Relays	(Part of Swgr MQP)		SEL	Pullman, USA	A	
				ALSTOM T&D	Stafford, UK	A	P14X, P34X, P44X, P64X, P74X models only.
				ALSTOM T&D	Chennai	A	P14X, P24X, P34X, P44X, P64X, P74X models only.
				ABB	Finland	A	
				ABB	Baroda	A	For 6XX Series
				GE Multilin	Zamudio, Vizcaya, Spain/ Markham, Ontario, Canada	A	F-650 only
				Schneider	Stone, UK	A	PX30, PX40, VAMP 5X and VAMP 2XX models only.
				Siemens	Germany	A	7SX Series only
				Siemens	Goa	A	7SR2X , 7SJ66X series only
30.	Single Rod Air Terminal Type Solar Array Lightning	III		Main Contractor approved sources: subject to manufacturer / supplier having valid Type Test Report as per IS 2309 or equivalent Standard			

एनटीपीसी NTPC	PROJECT : DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP KAYAMKULAM KERALA PACKAGE : SOLAR CONT. NO. :				INDICATIVE VENDOR LIST		DOC NO. : REVISION NO. 00 PAGE : 15
Sl. No.	**ITEM**	**QP / INS CAT.**	**QP No. -**	**ACCEPTABLE SUPPLIER AS PER DATABASE**	**PLACE**	**SC APPL STATUS**	**REMARKS**
	Arrestor						
31.	ESE Type Solar Array Lightning Arrestor	III		Main Contractor approved sources: subject to manufacturer / supplier having valid Type Test Report as per latest version of NF C 17-102 & country of origin documents			
32.	Lighting Poles	III		BIS Licensee as per IS 2713			
33.	Cable Lug	III		M/s Dowell	Mumbai	A	
				M/s Billets Elektro Werke Ltd. (3 D)	Umbergaon	A	
				M/s Chetna	Nasik	A	
				Additional Vendors with Make-Model having mark of VDE/ UL /CSA / BIS with CML no. Refer Note-1			
34.	Cable Gland	III		Any Make-Model having mark of VDE/ UL /CSA / BIS with CML no. Refer Note-1			
35.	GI Cable Tray, fitting, accessories including bends	Refer Note-3	Q-019	Inar Profiles Ltd	Enkapalli (Vishakhapatnam)	A	
				Vatco	Mumbai	A	Galvanization at Sigma Mumbai
				Indiana cable trays	Mumbai	A	Galvanization at Karamtara galvanizer- Mumbai
				Industrial Perforation	Kolkata	A	Galvanized and offered for inspection at M/s Industrial Perforation Pvt Ltd, Ganganagar , Kolkata, WB
				Ratan Projects	Howrah	A	Galvanization at DMP Projects- Howrah

एनटीपीसी NTPC	**PROJECT : DEVELOPMENT OF 22 MW FLOATING SOLAR PV** **PROJECT AT RGCCPP KAYAMKULAM KERALA** **PACKAGE :** SOLAR **CONT. NO. :**				**INDICATIVE VENDOR LIST**		**DOC NO. :** **REVISION NO.** 00 **PAGE :** 16
Sl. No.	**ITEM**	**QP / INS CAT.**	**QP No. -**	**ACCEPTABLE SUPPLIER AS PER DATABASE**	**PLACE**	**SC APPL STATUS**	**REMARKS**
				India Electric Syndicate	Kolkata	A	Galvanization at BMW Industries/B.P Projects- Howrah
				Steelite engg.	Mumbai	A	
				Premier Power Products	Howrah	A	Galvanising at Neha Galvaniser- Howrah
				Indiana Gratings	Pune	A	
				M.J. Engineering	Okhla/ Bhiwadi	A	
				T.R.G	Chennai	A	Galvanization at TM Radhakrishna Chetty & Co-Chennai
				Amtech	Pune	A	Galvanization at B.G. Shirke - Pune
				Kannade Anand Udyog	Mumbai	A	Fabrication at their units: Plot No. 42, Morivali, MIDC Thane & Plot No.: D-35 Anand Nagar MIDC, Addl. Ambernath , Dist.Thane Galvanization and offer the galvanized cable trays for inspection at D-34 Anand Nagar MIDC, Addl. Ambernath, Dist.Thane.
				Rukmani	Raipur	A	Ladder type cable trays only
				Passive Infra	Hasangarh (Rohtak)	A	
				Unitech Fabricators & Engineers	Howrah/ Hoogly (Kolkata)	A	
				Patny System	Hyderabad	A	
				Rabi Engg	Kolkata	A	Galvanizing from NTPC approved sources
				MKSD Industries	Taloja	A	Galvanising at Encorp Power trans PVT Ltd, Palghar
				Reliable Sponge	Kalunga	A	
				Rukmani	Hoogly	A	Galvanization at Rukmani Fab & Gal- Howrah
				Eros Metal Works	Nagpur	A	Conditions apply

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Indmark Formtech	Pune	A	Conditions Apply
36.	Cable Tray Flexible Tray Support System	Refer Note-3	Q-020	Vatco	Mumbai	A	Galvanising at Sigma Mumbai
				Inar profiles	Enkapalli	A	
				Industrial perforations	Kolkata	A	
				Premier power products	Howrah	A	Galvanising at Neha Galvaniser- Howrah
				Steelite engg.	Mumbai	A	
				Indiana gratings	Pune	A	Galvanising at Poona Galvaniser- Pune
				Amtech	Pune	A	Galvanising at B.G. Shirke- Pune
				Ratan Projects	Howrah	A	Galvanization at NTPC approved sources
				MKSD Industries	Taloja	A	Galvanising at Encorp Power trans PVT Ltd, Palghar
				Indmark Formtech	Pune	A	Conditions apply
37.	Piping – ERW (IS 1239)	III		Main Contractor approved sources; with valid BIS license			
38.	INSTRUMENTATION CABLE	REFER NOTE-2	Q-021	DELTON CABLES LTD	FARIDABAD	A	PVC, FRLS TYPE
				PARAMOUNT COMMUNICATION LTD	KHUSHKHERA	A	PVC, FRLS TYPE
				CORDS CABLE INDUSTRIES LTD	BHIWADI/ KAHARANI	A	PVC, FRLS TYPE
				KEI INDUSTRIES LTD	BHIWADI	A	PVC, FRLS TYPE
				POLYCAB WIRES PVT. LTD	DAMAN	A	PVC, FRLS TYPE
				THERMOCABLES	HYDERABAD	A	PVC, FRLS TYPE

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				ELKAY TELELINKS	FARIDABAD	A	PVC, FRLS TYPE
				GUPTA POWER	KHURDHA	A	PVC, FRLS TYPE
				CMI	Faridabad	A	PVC, FRLS TYPE
				Universal Cables	Satna	A	PVC, FRLS TYPE
39.	FIRE ALARM PANEL (-MICROPROCESSOR BASED) & MANNUAL CALL POINTS	II	Q-022	NOTIFIER	USA	A	
				TYCO	USA	A	SIMPLEX BRAND
				AUTRONICA	NORWAY	A	
				SCHRACK	AUSTRIA	A	
				EDWARDS	USA	A	
				Shield Fire Safety	UK	A	
40.	ADDRESSABLE DETECTORS (MULTI SENSOR), INTERFACE UNITS ,HOOTER CUM STROBE & HOOTER	II	Q-023	NOTIFIER	USA/GURGAON	A	
				TYCO	USA	A	SIMPLEX BRAND
				AUTRONICA	NORWAY	A	
				SCHRACK	AUSTRIA	A	
				EDWARDS	USA	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Shield Fire Safety	UK	A	
41.	FIBRE OPTIC CABLES	III		BIRLA ERICSSON OPTICAL	REWA	A	
				AKSH FIBER	BHIWADI	A	
				FINOLEX	PUNE/GOA	A	
				R&M	SWITZERLAND	A	
				HFCL	GOA	A	
				Molex	UK	A	
				Corning	USA	A	
42.	PLC BASED SCADA SYSTEM	I	Q-024	SIEMENS	NASIK	A	
				SCHNEIDER ELECTRIC	BANGALORE	A	
				ROCKWELL AUTOMATION	SAHIBABAD	A	
				ABB	BANGALORE	A	
				GE INTELLIGENT PLATFORM	BANGALORE	A	
43.	ENCLOSURE FOR PANELS	*		PYROTECH	UDAIPUR	A	*Part of PLC Based SCADA System
				PENTAIR (HOFFMAN)	BANGALORE	A	*Part of PLC Based SCADA System
				RITTAL	BANGALORE	A	*Part of PLC Based SCADA System
				MPP	Bangalore	A	*Part of PLC Based SCADA System
44.	UPS SYSTEM with	I	Q-025	FUJI ELECTRIC	JAPAN	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
	ACDB						
				Vertiv Energy (Emerson)	AMBERNATH	A	APPROVED UP TO 160 KVA, 1Φ
				HITACHI HIREL	GANDHINAGAR	A	APPROVED UP TO 160 KVA, 1Φ
				Vertiv Energy (DB Power)	PUNE	A	APPROVED UP TO 125 KVA, 1Φ
				KELTRON	TRIVENDRUM	A	APPROVED UP TO 150 KVA, 1Φ
				GUTOR	SWITZERLAND	A	
				AEG(Saft)	Germany	A	
45.	CCTV COMPONENTS IP Based (Refer Note-7)	II	Q-026	BOSCH	BANGALORE	A	1.All active main CCTV components like Camera, Server / Storage, Joystick, Video management software will be of Bosch make and to be procured from ***M/s. Bosch Ltd., Bangalore*** [Work address: ***Hosur Road, Adugodi, Bangalore – 560 030***]. 2.Other items like workstation, keyboard, monitors, network switches, media converters, interconnecting cables will be supplied as per LOA agreed source.
				Axis	Sweden	A	1-CCTV components will be of Axis communication AB,Sweden make & Video Management Software will be of Milestone Brand. 2.To make the system complete, other indigenous items like server/OWS/PC, Network Switch, Cables etc are to be procured from NTPC approved sources which will be tied up during the finalization MQP 3. Toshniwal Industries Pvt lts (works address: industrial Estate, Makhupura, Ajmer-305002, Rajasthan, India) will do the complete integration of CCTV System and installation at site which is noted by NTPC.
				Honeywell	Gurgoan	A	CCTV active component including explosion proof camera along with VMS will be honeywell china make

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
46.	Fire Extinguisher	III		BIS approved sources with valid BIS License.			
47.	Circuit Breaker upto 220 Kv (SF6 & outdoor type)	I	Q-027	Siemens	Aurangabad	A	
				ABB	Vadodara	A	
				CGL	Nasik	A	
				BHEL	Hyderabad	A	
				GE	Kanchipuram	A	
48.	Isolator upto 220 kv (outdoor type)	I	Q-028	GR Power	Hyderabad	A	
				Hivelm	Chennai	A	
				S&S	Pondicherry	A	
				Switchgear & Structurals	Hyderabad	A	
				Siemens Ltd	Hyderabad	A	
49.	PT (Outdoor Type, upto 33Kv)	I	Q-029	Mehru	Bhiwadi	A	
				ABB	Vadodara	A	
				GE	Hosur	A	
				CGL	Nasik	A	
50.	CT (Outdoor Type, upto 220 Kv Oil Filled	I	Q-030	Mehru	Bhiwadi	A	

	type)						
				GE	Hosur	A	
				ABB	Vadodara	A	
				CGL	Nasik	A	
				BHEL	Jhansi/Bhopal	A	
				Vishal Transformer	Meerut	A	UP TO 33 KV CT ONLY
				Heptacare	Meerut	A	UP TO 33 KV CT ONLY
51.	CVT (Outdoor Type, upto 220 Kv	I	Q-031	GE	Hosur	A	
				ABB	Vadodara	A	
				CGL	Nasik	A	
				BHEL	Jhansi/Bhopal	A	
52.	LA (Outdoor Type, upto 220 Kv)	I	Q-032	Oblum	Hyderabad	A	
				Lamco	Hyderabad	A	
				Elektrolite	Jaipur	A	UP TO 33 KV ONLY.
				CGL	Nasik	A	
53.	AB Tariff energy meter	II	Q-033	SEMS	Udaipur/Solan	A	Inspection with representative from Local Electricity Board.
				Elster	Mumbai	A	
				L&T	Mysore	A	With CMS software.
54.	Conductor	III		Smita	Ghaziabad	A	
				Gupta Power Infra	Bhubaneswar	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Saravathy	Bangalore	A	
				Galaxy	Sangli	A	
				Hindustan Vidyut products	Faridabad	A	
				Apar Industries	Vadodara / Silvassa	A	
				Hira Cables	Hirakud	A	
				JSK	Silvasa	A	
				Cabcon	Kolkatta	A	
55.	Disc Insulator/Long Rod Insulator	III		Aditya Birla	Rishra	A	For Disc Insulator only
				Aditya Birla	Halol	A	For Long Rod Insulator only
				IEC	Bhopal	A	For Disc Insulator only
				WSI	Chennai	A	For Disc Insulator only
				BHEL	Bangalore	A	
				Imperial Ceramics	Bikaner	A	For Disc Insulator only, Upto 90KN
				Modern Insulator	Abu Road	A	For Disc Insulator only
				Goldstone	Hyderabad	A	For Long Rod Insulator only
56.	Bus Post Insulator	III		Aditya Birla	Halol	A	
				IEC	Bhopal	A	
				WSI	Chennai	A	
				MODERN Insulator	Abu Road	A	
				SARAVANA Global Energy	Cuddalore	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
57.	Clamps & connectors	III		KLEMMEN ENGG	CHENNAI	A	
				MILIND	MUMBAI	A	
				EMI	MUMBAI	A	
				NOOTAN ENGG	MUMBAI	A	
				TAG CORPORATION	CHENNAI	A	
				ITPL	MUMBAI	A	
				RASHTRAUDYOG	KOLKATA	A	
				PEE VEE ENGG	BANGALORE	A	
				MEGHA Engg	CHENNAI	A	
				EXALT	Mumbai	A	
58.	Insulator hardware, conductor accessories & earthwire accessories	III		RASHTRA UDYOG	KOLKATA	A	
				IAC	KOLKATA	A	
				ITPL	MUMBAI	A	
				EMI	MUMBAI	A	
				EMTT	Kolkatta	A	
59.	Aluminium tube	III		HINDALCO	RENUKUT	A	
				INDALCO	ALUPURAM	A	
				CENTURY EXTRUSIONS	KOLKATA	A	
				JINDAL ALUMINUM TUBE	BANGALORE	A	
				ALOM EXTRUSIONS	KOLKATA	A	
				BALCO	KORBA	A	

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				SUDAL	NASIK	A	
				Banco	Vadodara	A	
60.	Switchyard Control & Relay Panel / SAS	I	Q-034	GE (Alstom)	Chennai	A	
				Siemens	Kalwa/Goa	A	
				ABB	Peenya	A	
				Schneider	Noida	A	
				BHEL	Bhopal	A	Approved for C&R Panel only
61.	Numerical Relays for Switchyard	(part of C&R MQP)		GE	UK/Chennai	A A	
				Siemens	Germany	A	
				ABB	Sweden/ Bangalore	A	
				Schneider	UK	A	
62.	Transformer (Oil filled type) Refer Note-8	I	Q-035	BHEL	Bhopal	A	up to 400 kV Class
				GE (T&D)	Naini	A	up to 400 kV Class
				Toshiba	Hyderabad	A	up to 400 kV Class
				TELK	Agnamaly, Kerala	A	up to 400 kV Class
				ABB	Vadodara	A	up to 765 kV Class

एनटीपीसी NTPC	PROJECT : DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP KAYAMKULAM KERALA PACKAGE : SOLAR CONT. NO. :				INDICATIVE VENDOR LIST		DOC NO. : REVISION NO. 00 PAGE : 26
Sl. No.	**ITEM**	**QP / INS CAT.**	**QP No. -**	**ACCEPTABLE SUPPLIER AS PER DATABASE**	**PLACE**	**SC APPL STATUS**	**REMARKS**
				CG Power & Industrial Solutions Ltd.	Kanjur Marg	A	up to 400 kV Class
				EMCO	Thane	A	up to 400 kV Class
				BHEL	Jhansi	A	up to 220 kV Class
				Schneider	Vadodara	A	up to 50 MVA, 132 kV Class
				T&R	Ahmedabad	A	up to 90 MVA, 132 kV Class
				Kanohar	Merrut	A	up to 16 MVA, 33 kV Class
				EMCO	Jalgaon	A	up to 16 MVA, 33 kV Class
				Kirloskar	Mysore	A	up to 16 MVA, 33 kV Class
				Andrew Yule	Chennai	A	up to 10 MVA, 33 kV Class
				Tesla (unit-2)	Bhopal,(23A, Sector-B, Industrial Area, Govindpura, Bhopal	A	up to 5.0 MVA, 33 kV Class,
				Indotech Transformers	Chennai	A	up to 16 MVA, 11 kV Class
				PETE Hammond	Hyderabad	A	up to 10 MVA, 33 kV Class
				CG Power & Industrial Solutions Ltd.	Malanpur	A	up to 7.5 MVA, 33 kV Class
				ECE	Sonepat	A	up to 4.0 MVA, 11 kV Class
				Voltamp	Savli	A	up to 3.5 MVA, 33 kV Class
				Kirloskar	Pune	A	up to 2.0 MVA, 33 kV Class
				RAYCHEM RPG	Pune	A	Up to 5 MVA, 33 kV Class
				Esennar	Medak	A	Up to 16 MVA, 66 kV Class
				Technical Associate Ltd	Sitarganj	A	up to 16 MVA, 33 kV Class, Conditions Apply
				Prime Meiden Ltd	Nellur	A	up to 63 MVA, 132 kV Class
				KRYFS Power Components Ltd	Silvassa	A	Up to 2.5 MVA, 33 kV Class

Sl. No.	ITEM	QP / INS CAT.	QP No. -	ACCEPTABLE SUPPLIER AS PER DATABASE	PLACE	SC APPL STATUS	REMARKS
				Sudhir Transformers	Bangalore	A	Upto 12.5 MVA, 33KV Class
				Sudhir Power Ltd	Silvassa	A	Upto 12.5 MVA, 33KV Class
63.	Dry Type	I	Q-036	ABB	Savli	A	up to 8 MVA, 24 kV Class
	Transformer			Raychem	Pune	A	Up to 3.5 MVA, 33 kV Class
	(refer note-8)			Toshiba	Hyderabad	A	Up to 2.0 MVA, 33 kV Class
				BHEL	Jhansi	A	Up to 6.3 MVA, 33 kV Class
				Kirloskar	Pune	A	Up to 4.0 MVA, 33 kV Class
				Voltamp	Savli	A	Up to 3.25 MVA, 33 kV Class
				PETE Hammond	Hyderabad	A	Up to 95 KVA, 33 kV Class
				Sudhir Power Ltd	Silvassa	A	Upto 12.5 MVA, 33KV Class
64.	132KV Cables	I	Q-037	Iljin Electric	South Korea	A	
				KEI Industries	Bhiwadi	A	
				Phelps Dodge	Bangkok	A	
				Universal Cable Ltd.	Satna	A	
65.	Battery Health Monitoring System (220V/110V)	II	Q-038	M/s. Chloride Power	Kolkatta	A	
				M/s Dubas	Bangalore	A	
				M/s HBL- Power System	Hyderabad	A	

Under Sub Supplier approval status as per NTPC column:
A: mean that manufacturer proposed main contractor for this items is acceptable to NTPC.
CA: mean that manufacturer proposed by main contractor is acceptable to NTPC with certain conditions

एनटीपीसी NTPC	PROJECT : DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP KAYAMKULAM KERALA PACKAGE : SOLAR CONT. NO. :				INDICATIVE VENDOR LIST		DOC NO. : REVISION NO. 00 PAGE : 28
Sl. No.	**ITEM**	**QP / INS CAT.**	**QP No. -**	**ACCEPTABLE SUPPLIER AS PER DATABASE**	**PLACE**	**SC APPL STATUS**	**REMARKS**

DR-mean that manufacturer proposed by main contractor for the items will be assessed by NTPC. Main contractor is obliged to procure the item from "DR" category manufacturer only after written approval from NTPC

Under QP / INSPN CATEGORY column:

CAT-I : For these items the Quality Plans approved by NTPC & final acceptance will be on physical inspection & witness by NTPC

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on basis of verification of documents as per approved QP

CAT-III : For these items Main supplier approves the Quality Plans. The final acceptance by NTPC shall be on basis of certificate of conformance by the main supplier.

General Notes:

1) Vendors acceptance is subject to sub-QR clearance as applicable. Sub-QR/Proveness criteria as per the scope/technical specification shall also be applicable for consideration as approved manufacturer/vendor

2) Vendor list & inspection category of the mandatory spares shall be as mentioned above.
3) For item not appearing in the above list, Main Contractor to approach NTPC for acceptable vendors & inspection categorization of the same.
4) NTPC Approval conditions to above identified vendors shall be adhered to. Vendor's approval conditions will be informed on specific request of Main Contractor.

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

Note-2-

Category of inspection for Instrumentation cable/LT Cable(Power & controls) :

TOTAL CONTRACT QUANTITY PER SIZE	CATEGORY OF INSPECTION
LESS THAN EQUAL TO 1KM PER SIZE/TYPE	CAT-III AND SUBMISSION OF TC AND CERTIFICATE OF CONFORMANCE BY MAIN CONTRACTOR
TOTAL QUANTITY UPTO 2.5 KM PER SIZE/TYPE	CAT-II
TOTAL QUANTITY MORE THAN 2.5 KM PER SIZE/TYPE	CAT-I

Category of inspection for HT cables

TOTAL CONTRACT QUANTITY PER SIZE/TYPE	CATEGORY OF INSPECTION
LESS THAN EQUAL TO 500 M	CAT-III
GREATER THAN 500 M	CAT-I

Note-3-

FOR CABLE TRAYS THE CATEGORY OF INSPECTION SHALL BE AS FOLLOWS

TOTAL CONTRACT QUANTITY PER SIZE /TYPE	CATEGORY OF INSPECTION
LESS THAN EQUAL TO 1KM	CAT-III AND SUBMISSION OF TC AND CERTIFICATE OF CONFORMANCE BY MAIN CONTRACTOR
GREATER THAN 1 KM AND LESS THAN EQUAL TO 5 KM	CAT-II
GREATER THAN 5 KM	CAT-I

FOR CABLE TRAYS SUPPORT SYSTEM:

THE CATEGORY OF INSPECTION SHALL BE AS FOLLOWS

TOTAL CONTRACT QUANTITY PER TYPE	CATEGORY OF INSPECTION
LESS THAN EQUAL TO 1KM OF SUPPORT CHANNEL	CAT-III AND SUBMISSION OF TC AND CERTIFICATE OF CONFORMANCE BY MAIN CONTRACTOR
GREATER THAN TO 1KM AND LESS THAN 5 KMS OF SUPPORT CHANNEL	CAT-II
GREATER THAN TO 5KM OF SUPPORT CHANNEL	CAT-I

TOTAL CONTRACT QUANTITY PER SIZE / TYPE	CATEGORY OF INSPECTION
LESS THAN EQUAL TO 500 NOS. OF CANTILEVER ARMS	CAT-III AND SUBMISSION OF TC AND CERTIFICATE OF CONFORMANCE BY MAIN CONTRACTOR
GREATER THAN TO 500 NOS. AND LESS THAN 2500 NOS CANTILEVER ARMS	CAT-II
GREATER THAN TO 2500 NOS. CANTILEVER ARMS	CAT-I

Note-4- Indicative List of acceptable galvanizing sources:

1. M/s M J Engg,Delhi 2. M/s Indmark , Pune 3. M/s A.V. Engg, Kolkata 4. M/s Inar Profiles, Vishakapatnam 5. M/s Anand Udyog, Mumbai 6. M/s Techno Engg,Chandigarh 7. M/S Steelite Engg, Mumbai	8. M/s National Galvanizer, Kolkata 9. M/s Unistar Galvanizer, Kolkata 10. M/s B.P. Project. Kolkata 11. M/s Bajaj Pune 12. M/s Electrocare Industries, Mumbai 13. M/s B.G. Shirke, Pune 14. M/s Gurpreet Galvanizer, Hyderabad	15. M/s Sigma, Mumbai 16. M/s Radhakrishnan Shetty, Chennai 17. Karamtara Mumbai 18.Poona Galvanizers Pune 19. Neha Galvanizer- Kolkata 20. Unitech Fabricators & Galvanizers- Hoogly 21. Patny Systems- Mehdak	22. Indian Gratings, Pune 23. Encorp Power trans PVT Ltd, Palghar 24. Reliable Sponge, Kalunga 25- Rukmani Fab & Gal- Howrah

Note-5:

a**.** Raw material & Bought Out components for main equipment will be finalized with vendor identified by Main Contractor.

Note-6: "VDE / CE / UL / CSA MARKING CERTIFICATION PREFERABLY FROM THIRD PARTY AGENCY" OR "BIS APPROVAL LETTER" SHALL BE SUBMITTED FOR NTPC's VERIFICATION /INFORMATION.

Note-7: CCTV Components consists of Camera with motorized zoom lens, Enclosure, Pan Tilt arrangement, Matrix Switcher, Key Board with LCD, Digital Video Recorder, Monitor, Receiver Driver Unit, Code Distribution unit, Amplifier etc. shall be supplied from the principal manufacturer of CCTV and shall be identical make. Other than this item can be supplied from Indigenous local source approved by NTPC or Principal Manufacturer's approved source.

Note-8:

8.1 Raw material & bought out components for main equipment will be finalized with vendor identified by Main Contractor.

8.2 For Auxiliary Transformers (Oil Filled & Dry Type- below 1.0 MVA, 11 KV Class):

a. Main Contractor's approved sub-vendors will also be acceptable subject to sub-vendor shall have minimum two years of supply experience for similar rating & type of transformers.

b. NTPC will review the Routine Test Inspection Report, witnessed by Main Contractor as per IS 2026/IS 1180 for Oil Filled Transformer and as per IS 11171 for Dry type Transformer

	PROJECT: DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP,KAYAMKULAM KERALA	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
	PACKAGE: SOLAR					REV. NO.	0
	MAIN SUPPLIER:	SUB SYSTEM: CIVIL WORKS					
	CONTRACT NO.:						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
1.	**CEMENT**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
2.	**CONSTRUCTION CHEMICALS - ADMIXTURES, PLASTISIZERS, RETARDERS WATER PROOFING COMPOUNDS GROUTS**	**III**	-	SIKA INDIA LTD	-	A	
				CICO TECHONOLOGIES LTD	-	A	
				FOSROC CHEMICALS (I) PVT LTD	-	A	
				BASF	-	A	
3.	**PAINT AND PAINTING SYSTEM**	**III**	-	BERGER	-	A	
				SHALIMAR PAINTS	-	A	
				JENSON AND NICHOLSON	-	A	
				KANSAI NEROLAC	-	A	
				AKZO NOBEL	-	A	
				ASIAN PAINTS	-	A	
4.	**GI PIPES**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-		
5.	**BITUMEN ASPHALT**	**III**	-	ALL GOVERNMENT REFIINARIES	-		
6.	**PLASTIC/ PVC PIPES**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-		
7.	**BITUMEN IMPREGNATED FIBER BOARD JOINT FILLER , BITUMEN SEALING COMPOUND**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-		
8.	**CERAMIC / VITRIFIED TILES**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	

	PROJECT: DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP,KAYAMKULAM KERALA	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
	PACKAGE: SOLAR					REV. NO.	0
	MAIN SUPPLIER:	SUB SYSTEM: CIVIL WORKS					
	CONTRACT NO.:						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
9.	**PARTICLE BOARDS, PLYWOOD, MDF**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
10.	**HIGH SOLID CONTENT LIQUID APPLIED URETHANE BASED ELASTOMERIC MEMBRANE FOR WATER PROOFING**	**III**	-	STP	-	A	
				IWL INDIA LTD	-	A	
				LLOYDS	-	A	
				CICO TECHONOLOGIES LTD	-	A	
				FOSROC CHEMICALS (I) PVT LTD	-	A	
11.	**POLYTHENE WATER STORAGE TANKS**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-		
12.	**MINERAL WOOL FOR THERMAL INSULATION**	**III**		ROCKWOOL INDIA LTD.	HYDERABAD	A	
				PUNJSTAR INSULATION FIBRE COMPANY	BHILAI	A	
				LAPINUS	MALANPUR (MP)	A	
				MINWOOL	RAJANANDGAON	A	
				LLOYD INSULATION	BHILAI	A	
				GOENKA ROCKWOOL (I) PVT LTD	RAIPUR	A	
				SHREERAM EQUITECH PVT LTD	DURG	A	
				U.P. TWIGA	BULENDSHAHAR	A	
13.	**CI PIPES**	**III**	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE			
14.	**FLOATING SYSTEM**	**III**		MAIN CONTRACTOR'S APPROVED SOURCES			

	PROJECT: DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP,KAYAMKULAM KERALA	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
	PACKAGE: SOLAR					REV. NO.	0
	MAIN SUPPLIER:	SUB SYSTEM: CIVIL WORKS					
	CONTRACT NO.:						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
15.	**GALAVANISED STEEL STRUCTURES FOR TRANSMISION LINE**	**I**		L&T	PITAMPUR	A	
				NAMPA STEEL	HOWRAH	A	
				UNITECH POWER TRANSMISSION LTD.	NAGPUR	A	
				L&T	PONDICHERRY	A	
				ASSOCIATED POWER STRUCTURES	VADODARA	A	
				GOOD LUCK STEEL TUBES	SIKANDRABAD	A	
				R.S. INFRAPROJECTS PVT. LTD	SURAJPUR	A	
				ADVANCE STEEL TUBE	SAHIBABAD	A	
				RICHARDSON & CRUDDAS (1972) LTD	NAGPUR	A	
16.	**GALVANISED STEEL STRUCTURE (LATTICE & PIPE)**	**I**		GOOD LUCK STEEL TUBES	SIKANDRABAD	A	
				RICHARDSON & CRUDDAS (1972) LTD	NAGPUR	A	
				L&T	PONDICHERY	A	
				L&T	PITAMPUR	A	
				R.S. INFRAPROJECTS PVT. LTD	SURAJPUR	A	
				VIJAY TRANSMIISION P. LTD	RAIPUR	A	
				UNIQUE STRUCTURES & TOWERS LTD.	RAIPUR	A	
				VATCO ELEC-POWER PVT. LTD.	NAVIMUMBAI	A*	*Galvanising at M/s Sigma Galvaniser, Navi Mumbai
				R.S. INFRAPROJECTS PVT. LTD	GHAZIABAD	A	
				ADVANCE STEEL TUBE ,	SAHIBABAD	A	
				SANGAM STRUCTURES LTD.	ALLAHABAD	A	

	PROJECT: DEVELOPMENT OF 22 MW FLOATING SOLAR PV PROJECT AT RGCCPP,KAYAMKULAM KERALA	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
	PACKAGE: SOLAR					REV. NO.	0
	MAIN SUPPLIER:	SUB SYSTEM: CIVIL WORKS					
	CONTRACT NO.:						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
				NEW MODERN TECHNOMECH	MAYURBHANJ (OR)	A	
				UNITECH POWER TRANSMISSION LTD.	NAGPUR	A	
				ASSOCIATED POWER STRUCTURES	VADODARA	A	
				RELIABLE SPONGE PVT LTD,	KALUNGA, ODISHA	A	
17	**FOUNDATION BOLT**	**III**		MAIN CONTRACTOR'S APPROVED SOURCES			

LEGENDS:
1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)
A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any.
DR – For these items "Details required" for NTPC review. To be identified with letter "DR" in the list.

2. QP/INSPN CATEGORY:
CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.
CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved quality plan.
CAT-III : For these items Main Supplier approves the Quality Plans.
UNITS/ WORKS : Place of manufacturing Place of Main Supplier of multi units/works.

NOTE 1: For the items placed in CAT-III for Civil Works, the review and final acceptance shall be done by NTPC-EIC/ FQA on the basis of MTC / certificate of conformance in line with Indicative FQP / Technical Specifications.
NOTE 2: Clearance from NTPC Engineering required wherever the Proveness / Sub-QR criteria mentioned against that particular BOIs or Sub-Suppliers in the Technical specifications.

Specification of auxiliary transformer 30 KVA 630V/415V, Dyn11

1.0 Technical parameters and specifications:

#	Technical parameter	Specification
1	Transformer type	Dry type
2	IP class	The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23 or higher. The enclosure shall be provided with suitable hardware (as required).
3	Type of cooling	AN
4	Governing Standard	IS:2026, IS:11171 or equivalent to any other international standard, Indian Electricity Act 2003, BEE Guideline & CEA notifications
5	Rating in KVA	30 KVA as mentioned in specification a. power requirement, **30 KVA** type Auxiliary Transformer **(Dry type)** for tapping power from LV side of nearest PCU for connecting to ACDB (providing LT supply of 3 phase, 415 V).
6	No. of phases	3
7	Frequency	50 Hz, +/- 3%
8	HV winding	630kV, 3-Ph, with **Delta** connection
9	LV windings	433V, 3-Ph, with **Star** connection
10	Winding material	Electrolytic grade copper for both HV and LV windings
11	Winding Insulation	Class F or better
12	Neutral on LV side	Neutral terminal shall be brought out separately to facilitate earthing connections.
13	Vector Group	Dyn11
14	Short circuit withstand time (thermal)	2 sec.
15	% Impedance	As per IS: 1180
16	Termination HV/LV/Orientation	Air insulated cable box with disconnecting chamber, for both HV and LV sides. Cable box / Cable box / 180^0.
17	Cable entry on HV side	Bottom entry of cables. **Cable supply in bidder scope.**
18	Cable entry on LV side	Bottom entry of cables. **Cable supply in bidder scope.**
19	Cables and accessories	Cables, Cable glands cable lugs (Dowell/Comet/3D make) and connecting hardware shall be in bidder scope of supply.
20	Tapping on HV winding	Off circuit tap changer (OCTC) switch with five tap positions: +5%, +2.5%, 0, -2.5%, -5%.

	21	Loading Capability	Continuous operation at rated KVA on any tap with voltage variation of +/-10%. Transformer shall be capable of being loaded in accordance with IS: 6600 / IEC 60076-7.
	22	Ambient temperature	Max 50 deg C
	23	Temperature rise	90 deg C. (class F) 115 deg C. (class H)
	24	Flux density	Not to exceed 1.9 Wb/sq.m at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over-fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating b) 125% for at least one minute c) 140% for at least five seconds Bidder shall furnish over-fluxing characteristics up to 150%
	25	Air Clearance	As per CBIP
	26	Load loss principal tap at 75^0C, with IS tolerance	This shall be provided by bidder.
	27	No Load loss at rated voltage on principal tapping and at rated frequency, with IS tolerance	This shall be provided by bidder.
	28	No load current at rated voltage and rated frequency	This shall be provided by bidder. To be indicated as percentage.
	29	Efficiency at 75^0C, UPF	As per IS 1180 and CBIP
	30	Regulation at full load, 75 ^{o}C	< 2 % for UPF For 0.8 PF lagging, to be indicated by bidder.
	31	Harmonics	Shall be designed to suppress harmonics especially 3^{rd}& 5^{th}.
	32	Vibration & noise	Noise level shall be according to NEMA TR-1 standard
	33	Highest system voltage	LV side: 1.1 kV HV side: 3.3 kV
	34	Bushing rating, Insulation class (Winding & bushing)	As per relevant IS/IEC Creepage distance : 35 mm/kV
	35	Overall dimensions in mm Length x Breadth x Height	This shall be provided by bidder.

37	Weight of transformer in Kg	This shall be provided by bidder.
38	Painting	The inside of enclosure and accessories (except M. Box) shall be painted with two coats of fully glossy white colour with total DFT of 25 to 60 microns. The external paint colour of transformer & accessories shall be blue corresponding to **RAL 5012**. The external surface of transformer & accessories shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of polyurethane finish paint with total DFT of 80 to 150 microns. The internal surface of Marshalling Box shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of chemical & thermal resistant epoxy enamel white paint with total DFT of 80 to 150 microns.
39	Constructional features	As per relevant clause of this specification
40	Fittings and accessories	As per relevant clause of this specification

2.0 Tests on auxiliary transformer

2.1

Sl.No.	ROUTINE TESTS
1	All routine test shall be carried out in accordance with IEC 60076.
2	Measurement of Voltage Ratio & phase displacement
3	Measurement of winding resistance on all the taps (as per IEC 60076-1)
4	Vector group and Polarity Check
5	Magnetic Balance and Magnetising Current Test
6	Measurement of no load current with 415 V, 50 Hz AC supply
7	Measurement of no load losses and current at 90%, 100% & 110% of rated voltage
8	Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps
9	IR measurement (As per IEC 60076-1)
10	Separate Source Voltage Withstand Test /Applied voltage test.
11	Induced overvoltage test/Induced voltage withstand (IVW) test .
12	Repeat no load current/loss & IR after completion of all electrical test
13	Oil leakage test on completely assembled transformer along with radiators (as per relevant clause of this sub section)
14	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.
15	IR measurement on wiring of Marshalling Box.

2.2 Type Tests

Sl.No.	TYPE TESTS
1	Temperature Rise test at a tap corresponding to maximum losses as per IS 2026.
2	Tank Vacuum & Pressure Test (as per CBIP norms)

3.0 Constructional features and details of transformer components

3.0	Dry Type Transformer shall be constructed in accordance to IS: 2026, IS: 11171 or equivalent to any other international standard, Indian Electricity Act 2003, BEE Guideline & CEA notifications. Transformer rating and all related technical parameters including tap changer (if applicable) shall be as per system requirement/SLD and relevant standards. Transformer shall be suitable for continuous indoor duty application. Transformer shall be complete & functional in all respect. The other important construction particulars shall be as below. All materials / components used shall be of best quality and class most suitable for working under the conditions specified. These shall withstand the variations of temperature and atmospheric conditions, overload, over-excitation, short-circuits as per specified standards without distortion or deterioration, without development of stresses in any part and also without affecting the strength and suitability of the various parts for the work that they have to perform.

3.1 Core

3.2.1	The core shall be constructed from non-ageing, cold rolled, super grain oriented silicon steel laminations equivalent to M4 grade steels or better.
3.2.2	The insulation structure of the core to clamp plates shall be such that it withstands a voltage of 2kV (rms) for one minute in air.
3.2.3	Adequate lifting lugs will be provided to enable the core & windings to be lifted.

3.2 Windings

3.3.1	Windings shall be of electrolytic grade copper free from scales and burrs.
3.3.2	Windings shall be subjected to a shrinking and seasoning process so that no further shrinkage occurs during service.
3.3.3	Windings shall have uniform insulation.
3.3.4	Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratios.
3.3.5	The completed core and coil assembly shall be dried in vacuum and shall be immediately impregnated with oil after the drying process to ensure elimination of air and moisture within the insulation.
3.3.6	Windings shall be made in dust proof and conditioned atmosphere. Bidder shall indicate those details of facilities (as available at the winding works) that will ensure meeting this requirement.

3.4 Internal earthing

3.4.1	The frame work and clamping arrangements of core and coil shall be securely earthed inside the tank by copper strip connection to the tank.

3.5 Bushings

3.5.1	a) Bushing below 52 kV shall be oil communicating type with porcelain insulator. b) No arcing horns to be provided on the bushings.

3.6 Bushing CTs

1.Shall be of adequate rating for protection as required, WTI (WTI CTM applicable for transformer above 50 KVA) etc.
2. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.

3.7 Cable boxes & disconnecting chamber (Disconnecting chamber applicable 3.3 kV and above)

(a) HV Cable boxes shall be of phase segregated air insulated type & shall be of sufficient size to accommodate Employer's cable & termination. Phase segregation shall be achieved by insulating barriers (for 3.3 kV and above side)

(b) Cable boxes shall have bus bars / suitable terminal connectors of adequate size & bolt holes to receive cable lugs.

(c) A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box

(d) The support from base for the cable box (for 3.3 kV and above side) shall be of galvanized iron.

(e) The contractor shall provide earthing terminals on the cable box, to suit Employer's GI flat.

(f) The minimum length provided for terminating 33 kV, 11KV & 3.3 KV XLPE cable shall be 1000 mm (for 33 kV) 650 mm (for 3.3 kV and 11 kV) from cable gland plate to the cable lug) for the cable boxes, for 433V side suitable length shall be provided (shall be discussed during

detail engineering). The final cable size, number & length of terminating XLPE cable shall be furnished during detailed engineering.

(g) Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).

(h) Cable boxes shall have removable top cover (for transformer above100 KVA) & ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.

3.8 Fittings and accessories

Following fittings per transformer shall be provided. Bidder shall indicate compliance (Yes / No) for each line item. In case of non-compliance or deviation, bidder shall indicate and provide comments.

a	Winding temperature indicator (WTI)	Shall be Platinum resistance type temperature detector in each limb. Single Indicating meter may be provided for display of temperature of all limbs. Accuracy class of Indicating meter shall be +/- 1% or better and it shall have least count of 0.1 °C or better. 1 no. 4-20 mA signal shall be provided for remote monitoring of winding Temperature.
b	RTD/Thermistors	1 No. PT-RTD shall be embedded in each limb with alarm and trip contacts for remote annunciation. Additional 1 No. thermistor/RTD shall be embedded in each limb.
c	Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Cooling equipment.	
d	Cover lifting eyes, transformer lifting lugs, towing holes and core and winding lifting lugs, inspection cover, Bilingual R&D Plate, Terminal marking plates, two nos. earthing terminals etc.	
e	Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.	
The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformers are deemed to be included.		

4.0 Inspection and testing of transformers at bidder works

4.0	Bidder shall provide inspection call to BHEL for the type and routine tests. Prior to the call, bidder shall submit the routine test results as per Manufacturing Quality Plan (MQP) for scrutiny of BHEL/NTPC.

5.0 Documents to be submitted after receipt of purchase order

5.1	Following documents shall be submitted for BHEL approval within seven days from date of purchase order. (1) GA drawings including foundation details (2) GTP (3) MQP (4) Valid type test report as above

6.0 Documents to be submitted along with consignment

		6.1	Following documents shall be submitted to BHEL at the time of delivery of the consignment: (1) As built drawings of transformer (2) Routine test reports on transformer (3) Type test reports on transformer (4) Test certificate for transformer oil (5) Operations and maintenance manual of transformer

1.0 Introduction

This technical specification provides BHEL requirements for LT Switchgear system for the solar photovoltaic project.

1.1 Technical specification

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

The Scope shall include supply of 415 V (3 phase, 1 neutral and single phase for lighting etc.) power distribution line for the entire area from the LT switchgear with necessary breaker, switch fuse unit as and when required, Boards as above along with gland plates for all power and control cables, base frames, special tools i.e. operating handles, trolley necessary for removing the circuit breakers for maintenance etc. Isolators should be provided in the line to connect or isolate the connection from both the station auxiliary transformer.

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

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

1.2 STANDARDS

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

Sl. No.	Standards	Description
1	IEC 60947/IS13947	Specification for Low-Voltage Switchgear and Control gear.
2	IS: 10118 (Part 1 to 4)	Code of practice for selection, installation and maintenance of switchgear & control gear.
3	IS 3043	Code of practice for earthing.
4	IS 3072	Code of practice for installation and maintenance of Switchgear
5	IS: 2705	Current Transformers
6	IS: 3156	Voltage Transformers
7	IS: 3231	Electrical Relays for Power System Protection
8	IEC 60255	Electrical Relays
9	IS 3202	Code of practice for climate proofing of electrical equipment.
10	IS: 8828	Circuit breakers for over current protection for household and similar installations
11	IS: 13703 / IEC 60269	HRC Cartridge fuses
12	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.

2.0 TECHNICAL PARAMETERS		
A. POWER SUPPLY (AC SYSTEM)		
(i)	Voltage	415V + 10%, 3 Phase, 4 wire,Neutral Solidly Earthed
(ii)	Frequency	50 Hz +/- 5%
(iii)	Minimum system fault level	As per system fault current (for 1 sec)
(iv)	Short time rating for bus bars,ckt.breakers,current transformers and swgr. Assembly.	As per system fault current (for 1 sec)
(v)	Maximum ambient air Temperature	50 deg. C
BUS BARS		
(vi)	Continuous current rating at 50ºC ambient:	As Per Requirement

(vii)	Temperature Rise allowed above ambient	40^0C for plain joints 55^0C for Silver plated joints
B. MCCB		
(i)	Rated voltage	415V
(ii)	Rated Insulation Level	690V
(iii)	Rated ultimate and service SC breaking capacity(As per system requirement)	As per system fault current (for 1 sec)
(iv)	Rated making capacity	2.1 times of System fault current
(v)	Utilization category	A
C. DIGITAL MFM		
(i)	Accuracy class	0.5
(ii)	MFM shall be provided at LT incomer feeder. MFM shall have suitable communication port for integration with SCADA system.	
D. CURRENT TRANSFORMERS		
(i)	Type	Cast Resin Bar Primary
(ii)	Voltage class and frequency	650V, 50HZ
(iii)	CT Secondary Current	1:00 AM
(iv)	Class of insulation	E or better
(v)	Accuracy class & burden	
	a) For Protection	5P20, 5VA
	b) For Metering	Class 1.0, 5VA (min)
(vi)	Instrument Security Factor for metering CT	5
E. VOLTAGE TRANSFORMERS		
(i)	Type	Cast Resin
(ii)	Voltage Ratio	415 / 110V for line PT
		415/√3 / 110/√3V for Bus PT
(iii)	Neutral Solidly Earthed	Vee Vee
(iv)	Accuracy Class	0.5
(v)	Rated Voltage factor	1.1 continuous, 1.5 for 30 sec.
(vi)	Class of insulation	E or better
(vii)	One minute power frequency withstand voltage	2.5 KV
F. HRC FUSES		
(i)	Voltage Class	650 Volts

(ii)	Rupturing capacity	80kA (RMS) for AC circuits
G. CONTACTORS		
(i)	Type	Air break electro magnetic
(ii)	Utilising Category	AC3 of IS/IEC 60947 for nonreversible AC4 of IS/IEC 60947 for reversible drives
H. SWGR. CUBICLE CONSTRUCTIONAL REQUIREMENTS		
(i)	Colour finish	
	Exterior	RAL9002 (Main body) RAL 5012 (Extreme end covers) ,The paint thickness shall not be less than 50 microns
	Cable entry	
(ii)	Power Cables	Bottom
	Control Cables	Bottom

3.0 DETAILS OF INDOOR DISTRIBUTION BOARDS

Applicable for Auxiliary Power Supply system and String Inverter distribution board of rating upto & including 400A.

3.1 Switchboards shall be of metal enclosed, indoor, floor-mounted, free-standing type.

3.2 All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material.

3.3 All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that they do not permanently bulge/ bend by the weight of maintenance personnel working on it.

3.4 The switchboards shall be of bolted design. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cut outs shall be true in shape and devoid of sharp edges.

3.5 All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS/IEC 60947. All cutouts shall be provided with EPDM / Neoprene gaskets. Feeder Pillar with IP 55 enclosure protection meeting the technical requirement is also acceptable.

3.6 All switchboards shall be of uniform height not exceeding 2450 mm.

3.7 Switchboards shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates.

3.8 All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. Replacement /Maintenance of individual equipment/ component shall be possible without switching off or isolating the other equipments/components.

3.9 Each switchboard shall be provided with undrilled, removable type gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall be provided with gasket to ensure enclosure protection.

3.10 The minimum clearance in air between phases and between phases and earth for the entire busbars shall be 25mm. For all other components, the clearance between "two live parts", "a live part and an earthed part", shall be at least ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for busbars the clearances specified above should be maintained even when the busbars are sleeved or insulated. All connections from the busbars up to switch / fuses/MCCB shall be fully insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits. All busbars and jumper connections shall be of high conductivity aluminium alloy / copper of adequate size.

3.11 All switchboards shall be provided with three phase and neutral busbars. Entire busbar system shall be insulated with PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.

3.12 The cross-section of the busbars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars.

3.13 All busbars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength sheet molded compound or equivalent type polyester fiber glass molded insulator. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The busbar insulators shall be supported on the main structure.

3.14 All busbar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-

silver plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the busbar. All copper to aluminium joints shall be provided with suitable bimetallic washers.

3.15 All busbars shall be colour coded as per IS: 375.

3.16 Wherever the busbars are painted with black Matt paint, the same should be suitable for temperature encountered in the switchboard under normal operating conditions.

3.17 The Bidder shall furnish calculations establishing the adequacy of bus bar sizes for specified current ratings.

3.18 Panel space heaters shall be provided and the supply for this shall be tapped from incomer, before the isolating switch/circuit breaker. Incoming circuit to space-heater shall have an isolating switch, HRC fuse and neutral link of suitable rating. Panel illumination and plug-socket shall also be tapped from the space heater supply.

3.19 A galvanized steel / Copper / Aluminium earth bus shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar. Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus.

3.20 The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth without exceeding the allowable temperature rise.

3.21 All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting.

3.22 All metallic cases of relays, instruments and other panel-mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. All the equipment mounted on the door shall be earthed through flexible wire/braids. Insulation color code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors, soldering is not acceptable. Looping of earth connections, which would result in loss of earth connections to other devices, when a device is removed, is not acceptable. However, looping of earth connections between equipment to provide alternative paths to earth bus is acceptable.

3.23 VT and CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that

earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.

3.24 All hinged doors having potential carrying equipment mounted on it shall be earthed by flexible wire/ braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges/ hinge pins of proven design may also acceptable. The Contractor shall establish earth continuity at site also.

3.25 All switchboards shall be supplied completely wired internally upto the terminals, ready to receive external cables.

3.26 All auxiliary wiring shall be carried out with 650V grade, single core stranded copper conductor, colour coded, PVC insulated wires. Conductor size shall be 1.5 mm2 (min.) for control circuit wiring and 2.5 mm2 (min) for CT and space heater circuits.

3.27 Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped.

3.28 All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.

3.29 All internal wiring terminations shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible. Screw-less (spring loaded) / cage clamp type terminal shall also be provided with lugs.

3.30 Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.

3.31 Cable termination arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminium conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc., shall be provided by the contractor, to suit the final cable sizes.

3.32 All power cable terminals shall be of stud type and the power cable lugs shall be of tinned copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.

3.33 All Switchgears, MCCs, Distribution Boards, Fuse boards, all feeders, local push-button stations etc. shall be provided with prominent, engraved identification plates.

3.34 All name plates shall be of non-rusting metal or 3-ply Lamicoid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Employer's approval.

3.35 Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.

3.36 The gaskets, wherever specified, shall be of good quality EPDM / neoprene with good ageing, compression and oil resistance characteristics suitable for panel applications.

3.37 The bidder shall, ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per indian standards / specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.

3.38 ON/OFF status and protection trip status of incomers and bus coupler (if available) be provided for SCADA system.

3.39 Suitable changeover and interlocking arrangement shall be provided for incomers and bus coupler.

3.40 It shall be the responsibility of the contractor to fully coordinate the overload and short circuit breakers/fuses with the upstream and downstream circuit breakers / fuses, to provide satisfactory discrimination. Further the various equipment supplied shall meet the requirements of type ii class of co-ordination as per IS: 8544.

3.41 All sheet steel work shall be pretreated, in tanks, in accordance with is: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "class-c" as specified in is: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, electrostatic powder coating shall be used. Powder should meet requirements of is 13871 (powder costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the employer. The paint thickness shall not be less than 50 microns.

4.0 MCCB

a. MCCB shall be fixed type module, air break type, having trip free mechanism with quick make and quick break type contacts. MCCB shall have current limiting feature. MCCB of identical ratings shall be physically and electrically interchangeable. MCCB shall be provided with 1 NO and 1NC auxiliary contacts.

b. MCCB shall have inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit also. The protection settings shall have suitable range to achieve the required time & current settings. LED indications shall also be provided for faults, MCCB status (on/off etc).

C. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit rating. Extended cable terminal arrangement for higher size cable may also be offered. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door can not be opened unless the MCCB is in OFF position. Means shall be provided for defeating this interlock at any time. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked. The MCCBs being offered shall have common/interchangeable accessories for all ratings like aux. switch, shunt trip, alarm switch etc. The MCCBs shall have the current discrimination up to full short circuit capacity and shall be selected as per manufacturer's discrimination table.

5.0 FUSES

5.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be rated for 80kA rms (prospective) breaking capacity at 415V AC and for DC circuits, 20kA rms breaking capacity at 240V DC.

5.2 Fuse shall have visible operation indicators. Insulating barriers shall be provided between individual power fuses.

5.3 Fuse shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchboard.

5.4 The Neutral links shall be mounted on fuse carriers which shall be mounted on fuse bases.

6.0 INDOOR LT SWITCHGEAR FOR STRING INVERTER

In addition to the above clauses (relevant), the following shall also be applicable for switchgear ratings more than 400A

6.1 All switchboards shall be divided into distinct vertical sections (panels), each comprising of the following compartments

(a) BUSBAR COMPARTMENT:- A completely enclosed bus bar compartment shall be provided for the horizontal and vertical busbars. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power busbars shall be in separate compartments.

(b) SWITCHGEAR / FEEDER COMPARTMENT:- All equipment associated with an feeder of rating above 400A shall be housed in a

separate compartment of the vertical section. ACB shall be provided for feeders of rating 1000A and above. The design of the vertical section for such an arrangement shall ensure ease of termination of power cables of size & quantity as per system requirement. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. Insulating sheet at rear of the compartment is also acceptable. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure.

CABLE COMPARTMENT/CABLE ALLEY:- A full-height vertical cable alley of minimum 250mm width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations located in cable alley of capacity more than 400 A shall be designed to meet the Form IVb and for less than 400A A shall be designed to meet the Form 3b (as per IEC 61439) for safety purpose. Wherever cable alleys are not provided for distribution boards, segregated cable boxes for individual feeders shall be provided at the rear for direct termination of cables. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley. Cable alley door shall be hinged.

(d) CONTROL COMPARTMENT:- A separate compartment shall be provided for relays and other control devices associated with a circuit breaker.

6.2 All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS/IEC 60947. However, the busbar chambers having a degree of protection of IP: 42 are also acceptable where continuous busbar rating is 1600A and above. Provision shall be made in all compartments for providing IP: 5X degree of protection, when circuit - breaker or module trolley has been removed. All cutouts shall be provided with EPDM / Neoprene gaskets.

6.3 Provision of louvers on switchboards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating is 1600 A and above.

6.4 Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. EPDM / Neoprene gasket shall be provided between the panel sections to avoid ingress of dust into panels.

6.5 The minimum clearance in air between phases and between phases and earth for the entire busbars. and bus-link connections at circuit-breaker shall be 25mm. All busbars and jumper connections shall be of high conductivity aluminum alloy / copper of adequate size.

6.6 After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.

6.7 All switchgear (circuit-breaker) panels shall be of single-front type. The covers shall be provided with "DANGER" labels. All panel doors shall open by 90 deg or more.

6.8 All circuit-breaker modules shall be of fully draw out type having distinct 'Service' and 'Test' positions. Suitable arrangement with cradle / rollers, guides along with tool / lever operated racking in / out mechanism shall be provided for smooth and effortless movement of the chassis.

6.9 All switchboards shall be provided with three phase and neutral busbars. Two separate sets of vertical busbars shall be provided in each panel of double front DBs. Interleaving arrangement for busbars shall be adopted for switchboards with a rating of more than 1600A. Entire busbar system shall be insulated with PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.

6.10 ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door cannot be opened unless the MCCB is in OFF position. Means shall be provided for defeating this interlock at any time. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked.

6.11 The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear switchgear also.

6.12 Temperature raise test of LT switchgear of rating more than 400A:- The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current.

6.13 The carriage and breaker frame shall get earthed while being inserted in the panel and positive earthing of the breaker frame shall be maintained in all positions, i.e. SERVICE & ISOLATED, as well as throughout the intermediate travel.

6.14 Electrically controlled circuit breaker boards shall be provided with DC control supply.

7.0 CIRCUIT BREAKERS

7.1 Circuit breakers shall be three pole, air break, horizontal draw out type, and shall have fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified.parameters of continuous current rating and fault making / breaking capacity only after provision of cooling fans or special device shall not be acceptable.

7.2 Circuit breakers along with its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker.

7.3 There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "Test" position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLLY WITHDRAWN" position. Circuit Breaker rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa shall be possible only in the compartment door closed condition.

7.4 Separate limit switches, each having required numbers of contacts shall be provided in both "SERVICE" and "TEST" position of the breaker. All contacts shall be rated for making, continuously carrying and breaking 10 Amp at 240 V AC and 1 Amp (Inductive) at 240 V DC respectively.

7.5 Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE ", "TEST" AND "SPRING CHARGED" positions.

7.6 Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half a cycle of rated frequency.

7.7 Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably not trip the circuit breaker. In case the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exists between the fixed and drawout contact at the time of breaker trip so that no arcing takes place even with the breaker carrying its full rated current.

7.8 Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position.

7.9 Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.

7.10 Breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

7.11 Circuit breakers shall be provided with coded key / electrical interlocking devices, as per requirements.

7.12 Circuit breaker shall be provided with anti-pumping feature and trip free feature, even if mechanical anti-pumping feature is provided.

7.13 Mechanical tripping shall be possible by means of front mounted Red "trip" push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.

7.14 Complete shrouding / segregation shall be provided between incoming and outgoing bus links of breakers. In case of bus coupler breaker panels the busbar connection to and from the breaker terminals shall be segregated such that each connection can be approached and maintained independently with the other bus section live. Dummy panels if required to achieve the above feature shall be included in the Bidder's scope of supply.

7.15 Circuit breaker open/close shall be possible from SCADA and open/close status and all other important signal status shall be provided for SCADA monitoring.

7.16 Power operated mechanism shall be provided with a Universal motor suitable for operation on DC Control supply. In case of DC supply motor should satisfactorily operate with voltage variation between 85% to 110% nominal control supply voltage. Motor insulation shall be class "E" or better.

7.17 The motor shall be such that it requires not more than 30 Seconds for fully charging the closing spring at minimum available control voltage.

7.18 Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.

7.19 The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

7.20 Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.

7.21 All circuit breakers shall be provided with closing and trip coils. The closing coil shall operate correctly at all values of voltage between 85% to 110% nominal control supply voltage. The trip coil shall operate satisfactorily at all values of voltage between 70% to 110% nominal control supply voltage.

7.22 Provision for mechanical closing of the breaker only in "Test" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds.

7.23 The ACB Panel door shall not be possible to open in breaker closed condition. Further, the racking mechanism shall be accessible only after opening the breaker panel door.

7.24 Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit-breaker module in a cubicle at each location. The trolley shall be such that the top most breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. The telescopic trolley shall be such that all type, size and rating of breaker can be withdrawn /inserted of particular switchgear.

7.25 Electrical Parameter of Circuit Breaker

1)	Type	Air break spring charged stored energy type
2)	Operating duty	O-3 MIN-OC-3 MIN-OC
3)	Symmetrical interrupting	As per system fault current (for one sec)
4)	Short circuit rating	2.1 times of System fault current (peak)
5)	Short Circuit Breaking current	
	a) AC Component	As per system fault current (for one sec)
	b) DC Component	As per IS:13947
6)	Short time withstand	As per system fault current

8.0 AC JUNCTION BOXES (for use with string inverters)

8.1 Separate AC Junction box shall be used for string inverters AC output connection. Protection class for AC junction box shall be IP 54 or better protection. All components of junction box shall be suitable for rated output

voltage (with + 10% variation) of string inverter, grid frequency of 50 Hz +/- 5%, ambient temperature 50 deg. C and system fault current for 1 sec.

8.2 AC junction box shall be of metal enclosed type. All frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. The minimum clearance in air between phases and between phases and earth shall be at least twenty five (25) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers.

8.3 All power cable terminals shall be of stud type and the power cable lugs shall be of tinned copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.

8.4 EPDM / Neoprene gasket shall be used to prevent ingress of dust into panels.

8.5 All non-current carrying metal work of the junction box shall be effectively connected to the system earth bus.

8.6 Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns.

9.0 TEMPERATURE-RISE (For LT Switch-gear having capacity more than 400A)

The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current.

10.0 DERATING OF COMPONENTS

The Bidder shall, ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per Indian Standards / Specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.

The Bidder shall indicate clearly the derating factors if any employed for each component and furnish the basis for arriving at these derating factors duly considering the specified current ratings and amb. Temperature of 50 deg C.

Purshotam Profiles Private Limited

CONFIDENTIAL

Installation Manual

Contents

Site preparatory works

Project implementation begins with site preparation, when the EPC contractor starts building access roads for equipment delivery, clears the site, and removes objects that might impede construction. Usually all the activities related to site clearance, landfill, evacuation, and debris removal is done during this phase. In addition, the EPC contractor establishes site security and a security office and erects fencing and gates

Delivery of materials and storage

Floats can be unpacked and stored at the launching site with a sufficiently large staging area. Electrical equipment like inverters, LV switchboards, and transformers should be stored indoors or under a canopy to protect them from dust or rain until their deployment.

Preparation of launching area

Before construction begins, identify a suitable launching area by the water body with a gentle slope. This important supporting infrastructure is where the floating structure is assembled and launched. In general, working on land is easier than assembling the components directly on water. The launching area always needs some preparation. A launch ramp can be constructed on the bank's natural slope into the water body. This temporary infrastructure could be built with metal or wooden scaffolding and slats at minimal investment. Although not mandatory in all cases, a launch ramp can ease deployment efforts and reduce float damages; hence, it is highly recommended. Workers can gently push the assembled floats into the water, so lifting machinery is not necessary.

Assembly of floating structures

Once the materials are delivered onsite, the assembly work of the floating structure commences. Assembly is usually done as smaller single blocks of floating units. Single units are assembled first by multiple teams of workers. The construction varies depending on the floating structure design.

The following steps are carried out for the construction of a single block of floating units:

- Layup of floating component
- Assembly of floats together and interconnection of floats, where relevant
- Assembly of module support structures
- Installation of modules Once assembled, the single units are linked together
- Connection of wires to the modules and ready for connection with combiner box
- **After a few units are linked, the entire row is pushed**

Subsequent rows are built and launched until the floating island is completed

The next steps of construction could be outlined as:

- Interconnection of single units/block to a larger row
- Electrical interconnection as per the design
- Launching or sliding into water
- Towing to designated position
- Mooring and anchoring Upon completion, the entire FPV island is towed to its final location by motor boat The system is ready for mooring and anchoring.

Safety considerations

▲ Workers should undergo Mandatory Basic Safety Training for land-based construction work

▲ Job specific safety training and regular refresher training should be provided to workers to enhance/maintain their safety awareness of potential hazards associated with work over water/near water, including those during inclement weather.

▲ Specific safety training should be provided to workers on the use and checking procedures of life jackets, and rescue arrangements for persons who fell into water.

▲ Supervisors/workers should be trained on emergency and evacuation procedures, including the conduct of regular drills, in respect of work over water/near water.

Assembly View

Below is a reference picture of a small floating array. The image highlights the various floats that are combined together to form the floating structure. This installation manual guides the user step by step on how to connect the different floating pontoons to form a bigger array.

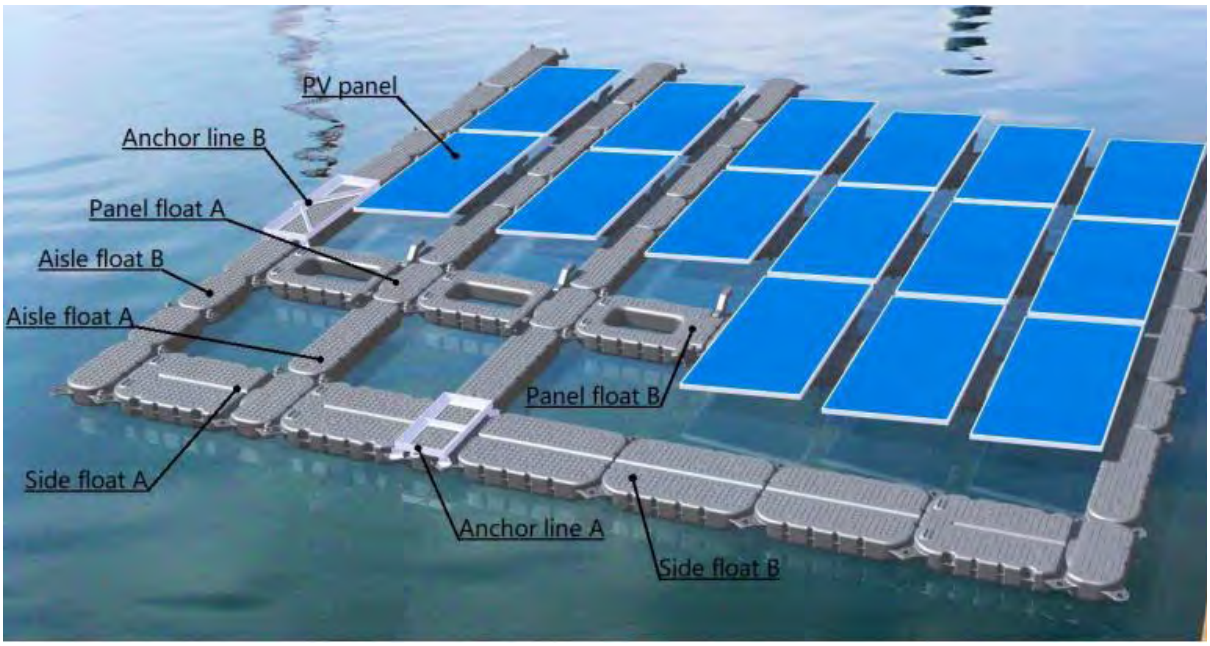


Image 1 : Source: Prabh Dayal Om Parkash Infra Ltd

2) Detailed Specification of Floats

The table below depicts the different type of floats and accessories. These components when joined together form an array (Refer to Image 1). The table highlights the dimensions and material of every item

II. Product information

NO.	PIC	ITEM	Material	Dimension (mm)	unit
1		Aisle Float A	HDPE	1420×520×184	Pcs
2		Aisle Float B	HDPE	1520×520×184	Pcs
3		Side Float A	HDPE	1570×870×200	Pcs
4		Side Float B	HDPE	1270×870×200	Pcs
5		Panel Float A	HDPE	1570×870×200	Pcs
6		panel Float B	HDPE	1270×870×200	Pcs
7		Support Float	HDPE	365×232×70	Pcs
8		Conneting Screw	HDPE	¢75×120	Pcs
9		Nuts	PE	¢78×38	Pcs
10		anchorline A	Q235b+HDG	950×520×150	Set
11		anchorline B	Q235b+HDG	1400×580×150	Set

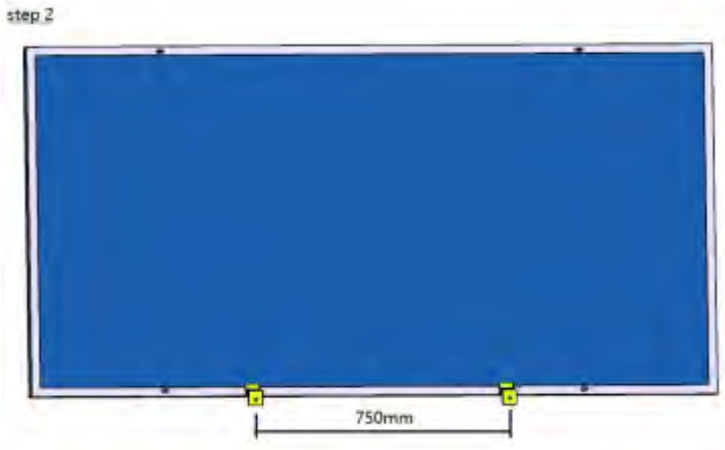
3) Installation Steps

The installation of the floating pontoons requires ample space and a clear area. Please refer to the preparation of launch area and site preparatory work. Before beginning installation, the contractor should ensure they have a spacious area more than 2000m2 for assembly near the site.

Please follow the steps below for installation

Step 1) Place the photovoltaic module on a flat surface

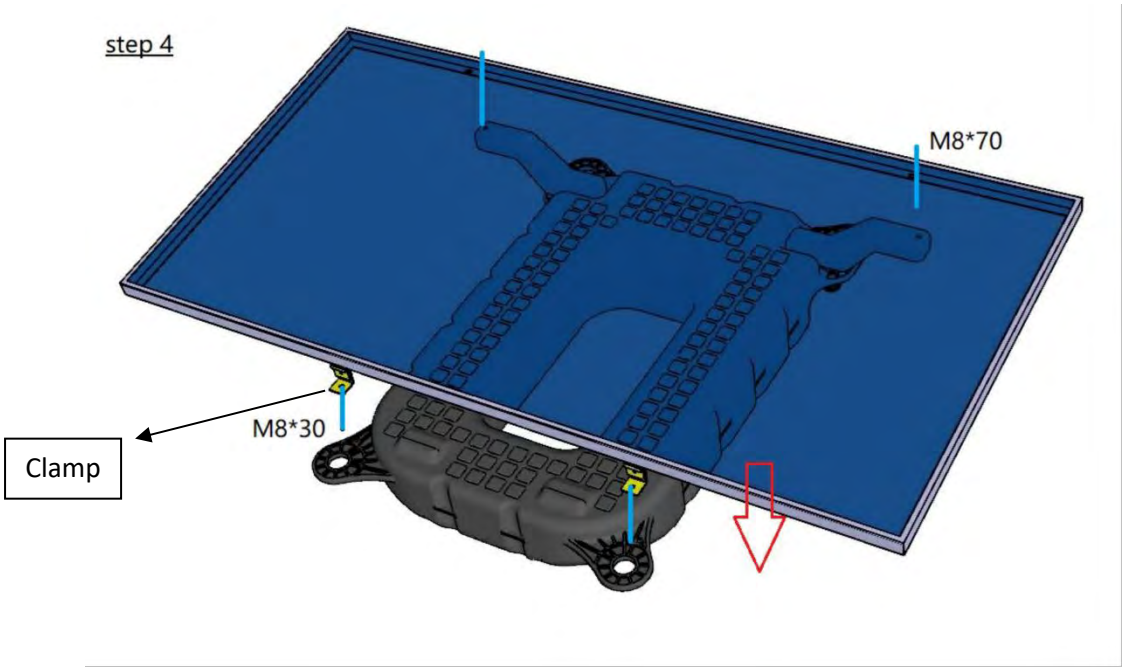
Step 2) Install two clamp（with SS screw) at specific position keeping distance of 750mm on the back face of the panel



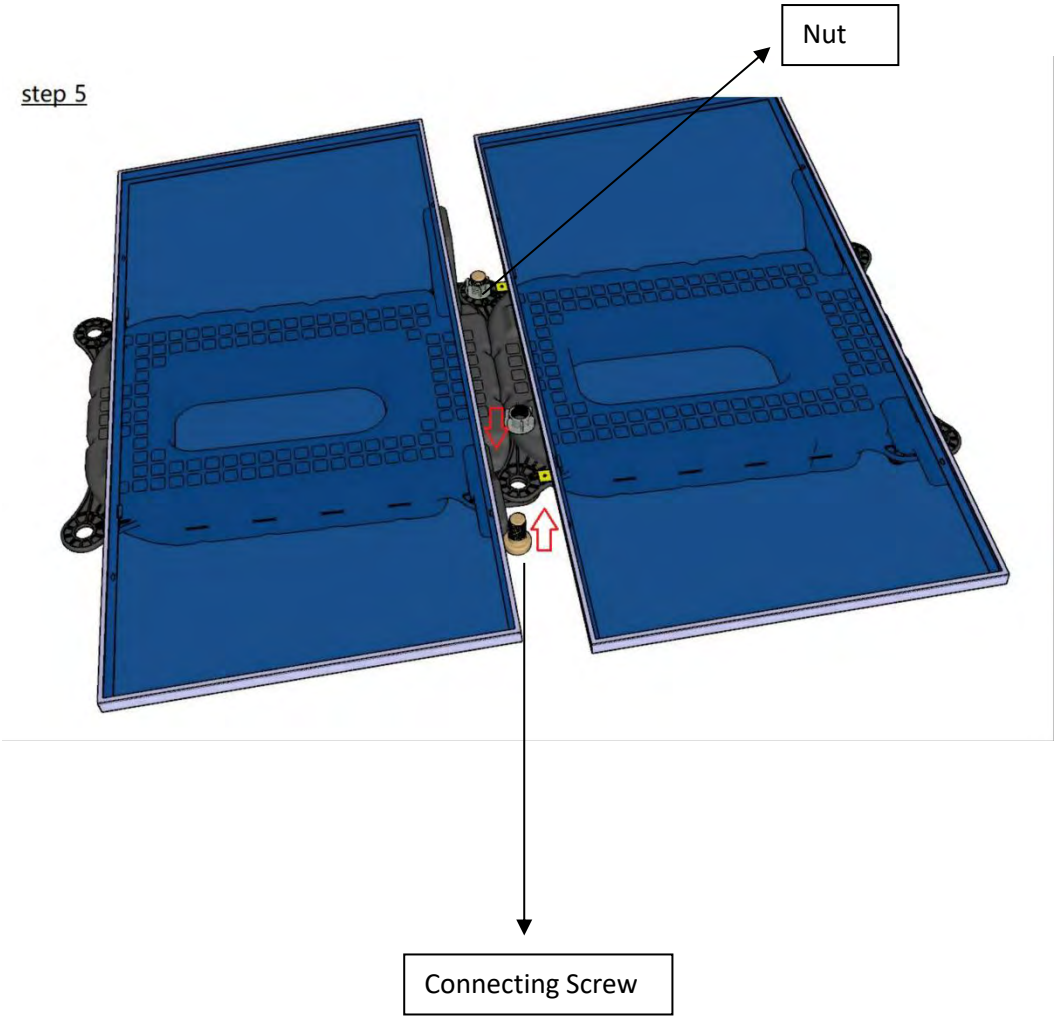
Step 3) Connect a Support float on panel float B on each side and Fasten Nuts under lugs

Refer to the image below

Step 4) Lift the photovoltaic module and place it on panel float B such that they perfectly align together on all fours points， next screw the module with stainless steel screw M8

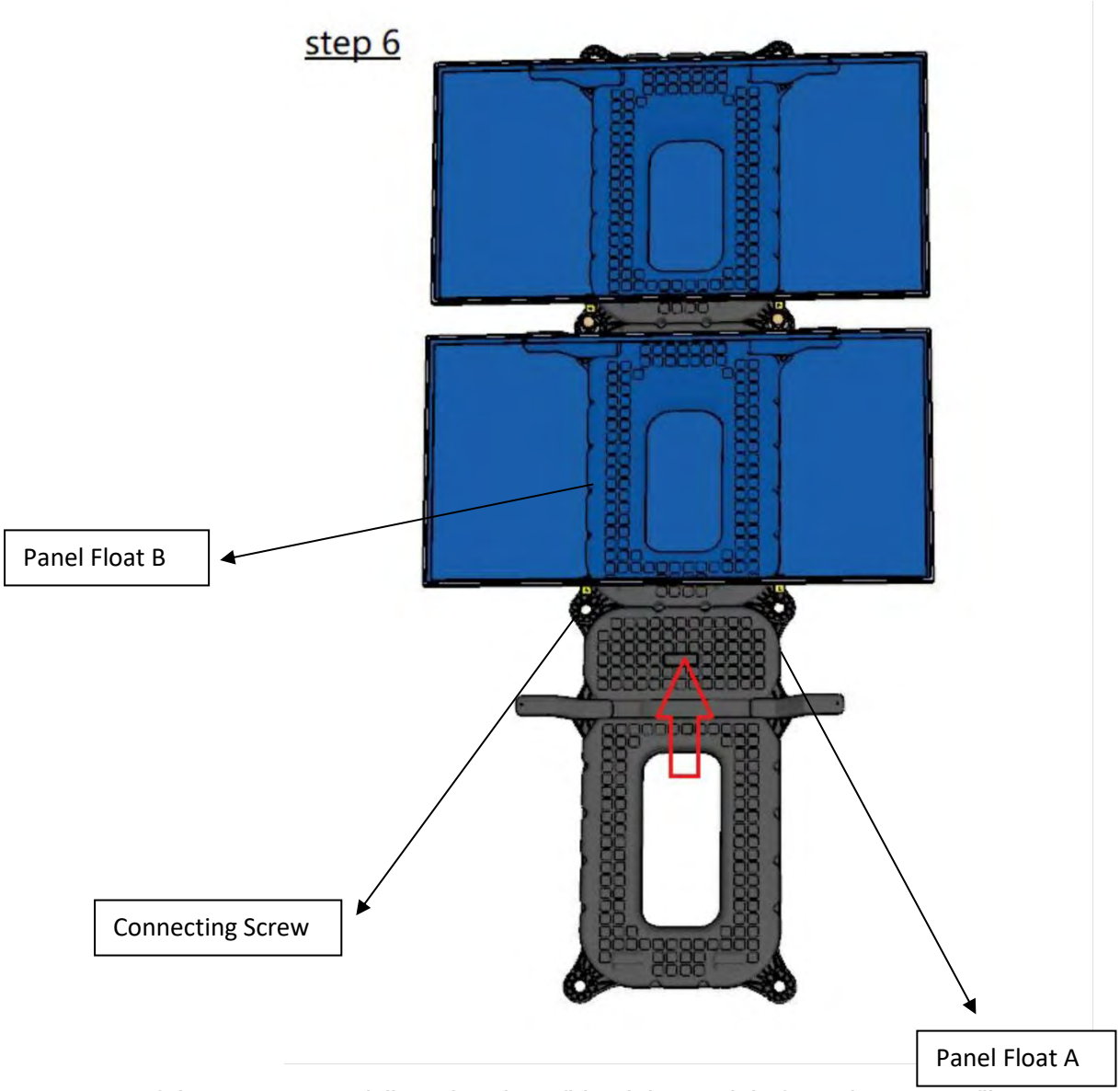


Step 5) Repeat the process to mount another module on panel float B and then using the connecting screw and nuts, join two panel float B on land

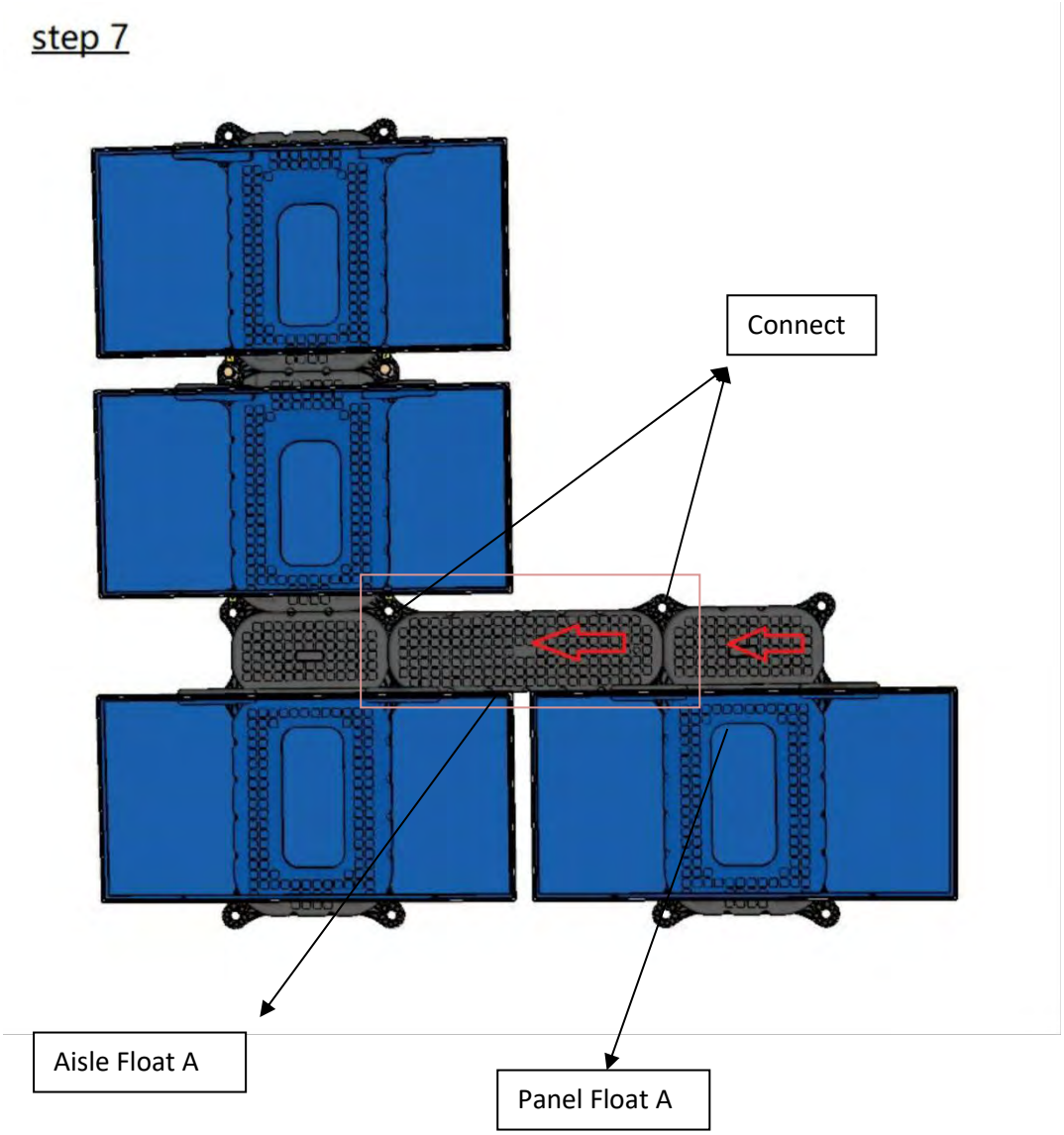


Step 6) Now, follow step 1-3 and mount a photovoltaic module on panel float A

After mounting a module on panel float A, connect panel float A to panel float B as below

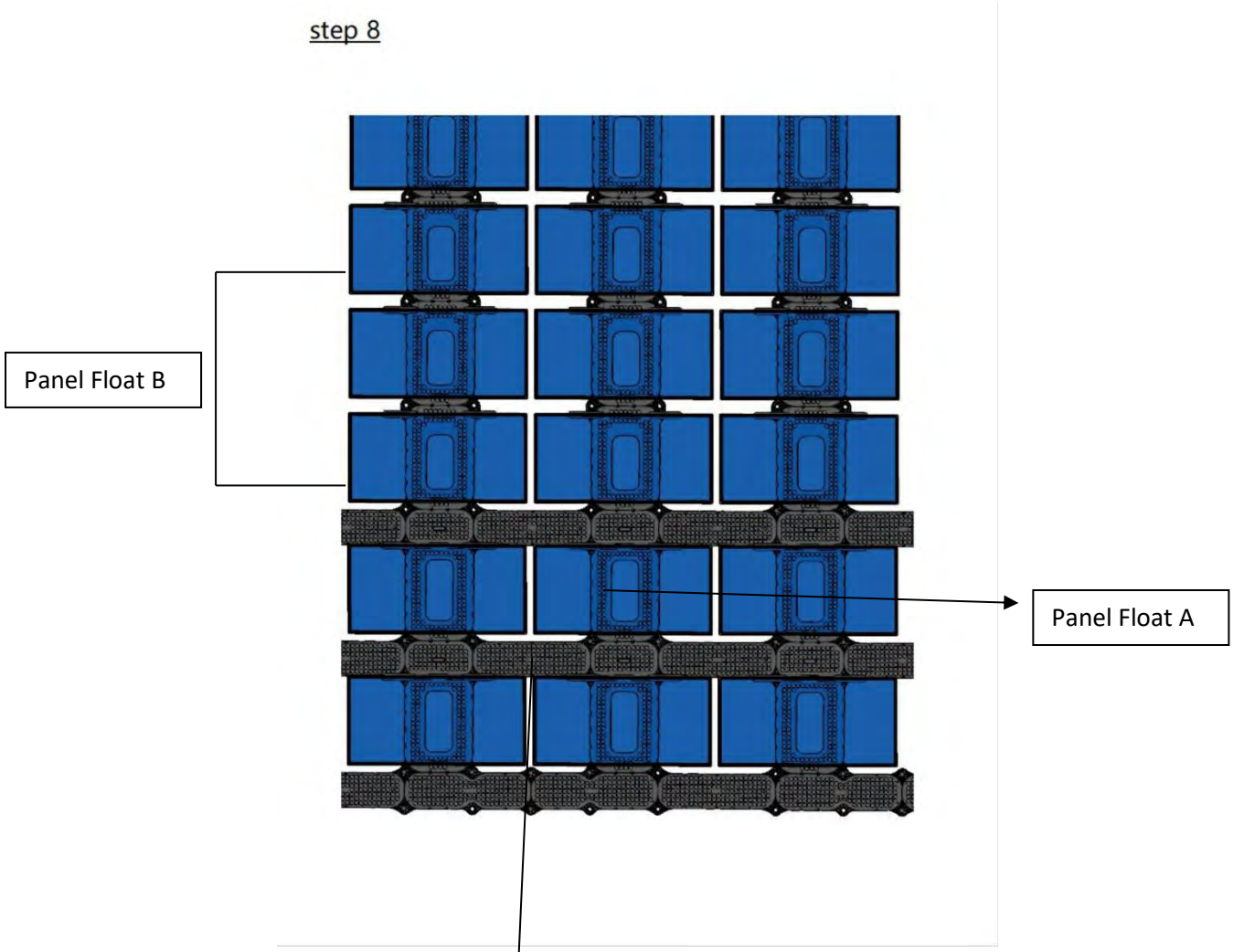


Step 7) After connecting Panel Float A with Panel Float B, Connect an Aisle Float A between two Panel Float A

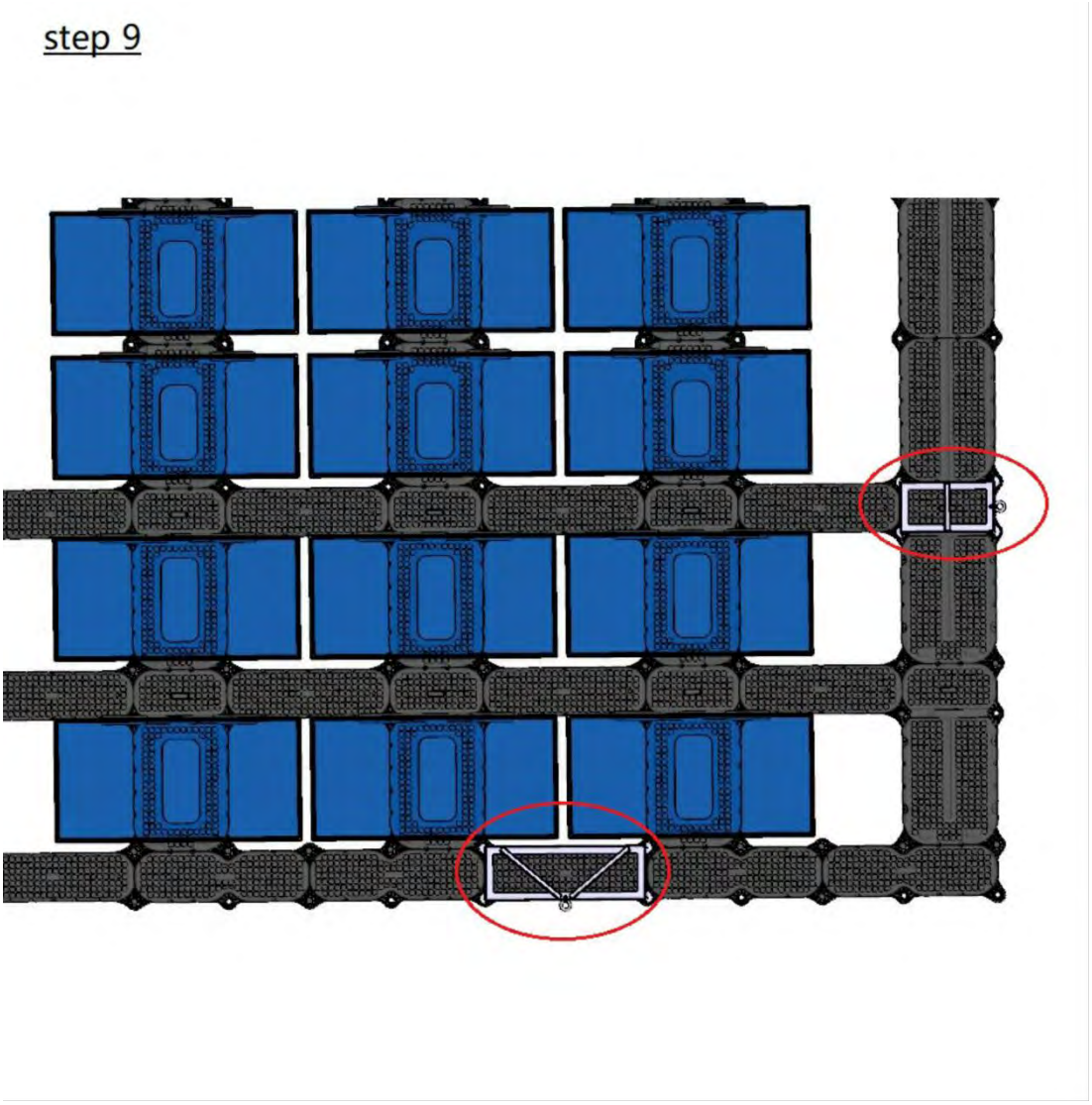


Step 8) The bottom of each array will have two rows with panel float A. After that, each row will have three rows of panel float B, followed by one row of panel float A. This procedure will be followed till the assembly reaches the top of array as per the drawing.

Repeat the steps above 1-7, and form an array as per the drawing. There should be four modules after every walkway. There should be three panel float B after every panel float A in vertical alignment. There should be one aisle float A between each panel float A in horizontal alignment. Refer to image below.



Step 9) Final step is installation of anchor line nuts as per drawing, We need to push float array into water gradually.



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Float Installation Manual - Adtech Systems Ltd

ADTECH
SYSTEMS LIMITED

Version - 2 Date: 02nd December, 2019

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A. Float Specification:

1

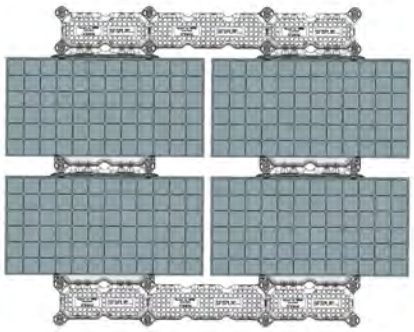


Figure 1

Big Walkway		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Average Wall Thickness (in mm)	3
	Design Weight (in kg)	4
	Max Use Buoyancy (in kg/sq.m)	180
	Dimension (in mm)	As per approved drawing
	Manufacturing Process	Blow Molding
	Function	• Forms maintenance walkways • Non-Slippery Surface

Small Walkway		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Average Wall Thickness (in mm)	3
	Design Weight (in kg)	3
	Max Use Buoyancy (in kg/sq.m)	180
	Dimension (in mm)	As per approved drawing
	Manufacturing Process	Blow Molding

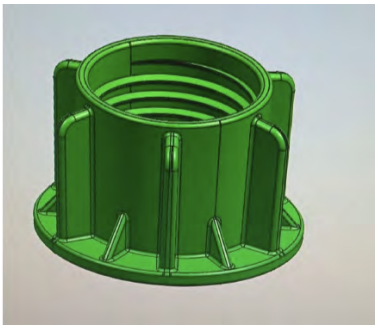
	Function	• Forms maintenance walkways • Non-Slippery Surface

Connecting Float		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Average Thickness	3mm
	Design Weight	7.5
	Max Design Buoyancy (in kg/sq.m)	180
	Dimension	As per approved drawing
	Manufacturing Process	Blow Molding
	Function	Give Support to the PV module

Support Piece		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Average Thickness	3mm
	Design Weight	1.2
	Design Buoyancy	-
	Dimension	As per approved drawing
	Manufacturing Process	Blow Molding
	Function	Give an Optimum degree 5 to the panel

Equipment Float		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Average Thickness	3mm
	Design Weight	8
	Design Buoyancy (in kg/sq.m)	180
	Dimension	As per approved drawing
	Manufacturing Process	Blow Molding
	Function	For the Cable arrangement and junction box location

Note - All dimensions and weights provided have a tolerance of +/- 5%

HDPE Nut		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Design Weight	55g
	Dimension	D80*50
	Manufacturing Process	Injection Molding
	Function	Holding the Support Float

Sleeve		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Design Weight	2g
	Dimension	D17*26
	Manufacturing Process	Injection Molding
	Function	Alignment of SS nut&bolt

HDPE Gasket		
	Raw material	High Density Polyethylene (HDPE),with UV stabilizer
	Design Weight	29g
	Dimension	D85*14
	Manufacturing Process	Injection Molding
	Function	Spacer between the walkway.

Note - All dimensions and weights provided have a tolerance of +/- 5%

B. Panel Fixing Hardware:

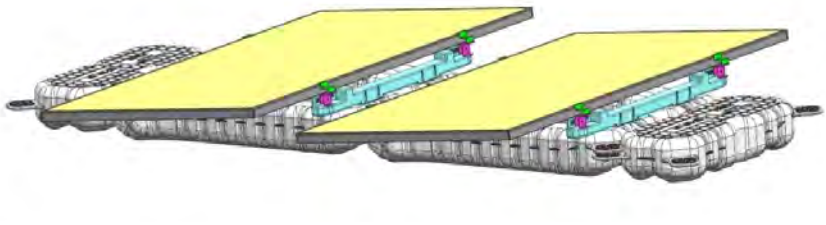


Figure 2

Upper clamp(Top Right and Left)		
	Raw material	Anodized Aluminum
	Count per panel	2 sets
	Technical Features	Length 50 mm Hole Ø9 mm
	Manufacturing Process	Aluminum Extrusion
	Function	Holding the Solar panels and it is connected to the “L” profile of the Support float

Lower clamp(Bottom Left and Right)		
	Raw material	Anodized Aluminum
	Technical Features	Length 50mm Hole Ø9 mm
	Count per Panel	2 sets
	Manufacturing Process	Aluminum Extrusion
	Function	Holding the Solar panels and it is connected to the “L” profile of the Connecting float

Nut ,Bolt and washer		
	Raw material	Stainless steel
	Count / module	Nut 8 Bolt 8 Plain Washer 16 Spring Washer 8

	Type	M8- SS 304
	Function	Holding the Solar panels and it is connected to the “L” profile of the Connecting float

C. Mooring clamps and Lines

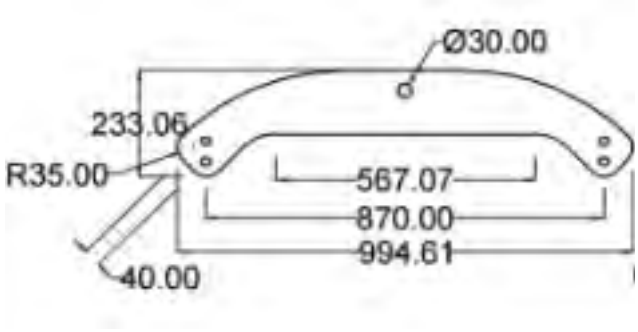


Figure 3

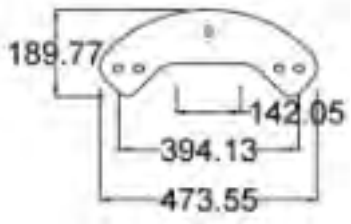


Figure 4

D. Tools and Tackles Required:

1. Injection Nut Wrench (drawing of Injection Nut can be provided on request)
2. M12 and M8 Nut Wrench
3. Drilling Machine

E. Instructions for Installation:

1. **Solar Panel Installation:**

The solar module is connected to the connecting float on the bottom side and support float on the top side. The panels are connected to the floats using Al. extruded clamps connected at the 4 designated points on the float using SS304 - M8 hardware.

The following are the components used for the connection:

A. L clamp (Bridge Clamp)
B. Upper Base Clamp
C. Lower Base Clamp
D. SS304 M8 - Nut, Bolt, Spring Washer and Plain Washer (2)

Installation Recommendations:

A. It is recommended to use a table for the module assembly on the float and to conduct the installation check for the same
B. Ensure the DC cables on the module are opened and loose before mounting the module on the float

Installation Procedure:

A. Place a rubber mat on top of the table
B. Place the Connecting Float on the rubber mat so that the portion where the Support Piece will be connected is exposed from the table
C. Connect the Support Piece on the Connecting Float and use the D80*50 nut to screw the Support Piece to the Connect Float (need to add torque info) (as shown)

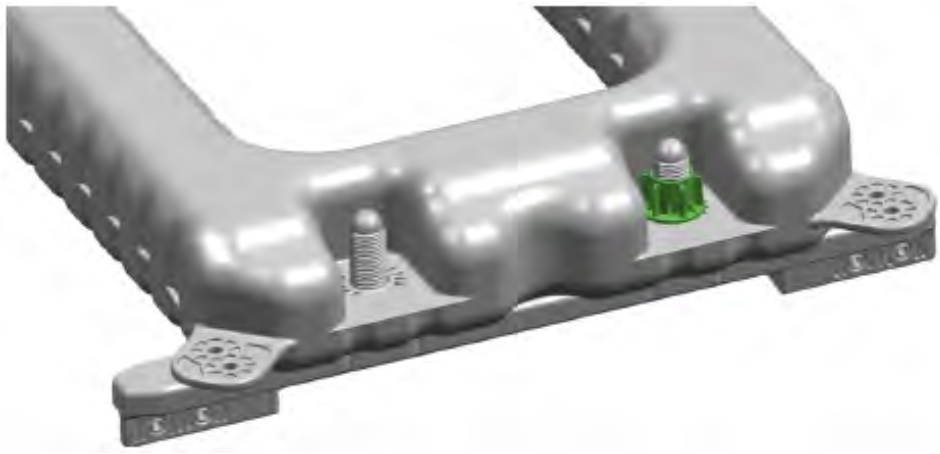


Figure 5

D. Connect the 2 Lower Base Clamps to the bottom of the Connecting Float (as shown) using SS304 M8

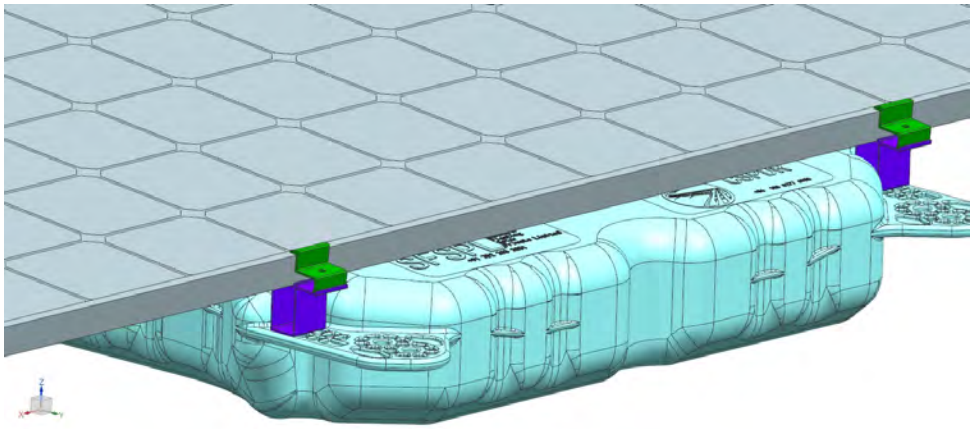


Figure 6

E. Connect the 2 Upper Base Clamps to the top of the Support Float (as shown) SS304 M8

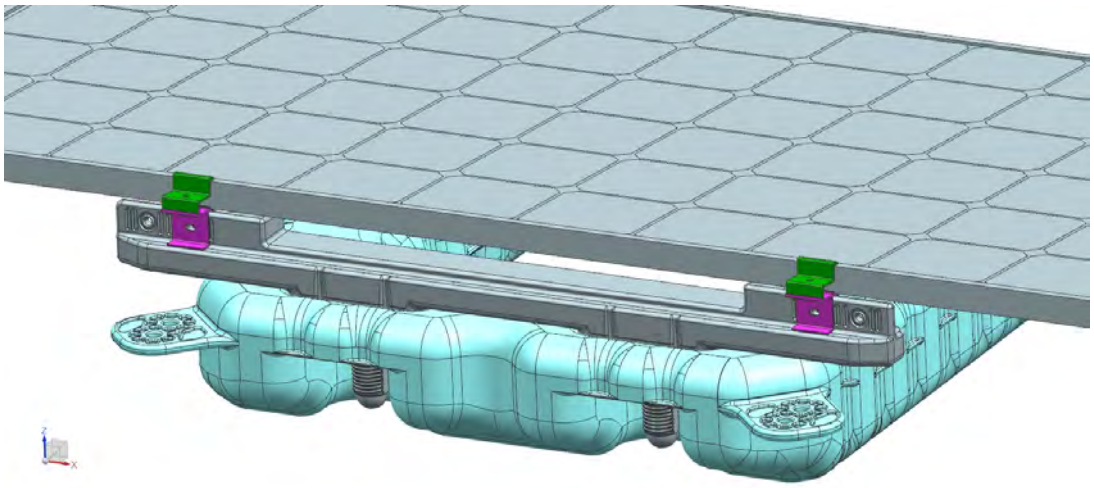


Figure 7

F. Connect the 4 L Clamp (Bridge Clamp) to the Lower Base Clamps and Upper Base Clamps loosely using SS304 M8

G. Take care to mount the panel on the float making sure that the midpoint of the panel is aligned with midpoint of the Connecting Float
H. Tighten the M8 fasters on the L Clamp after placing the module to ensure the module is tightened (mention torque)

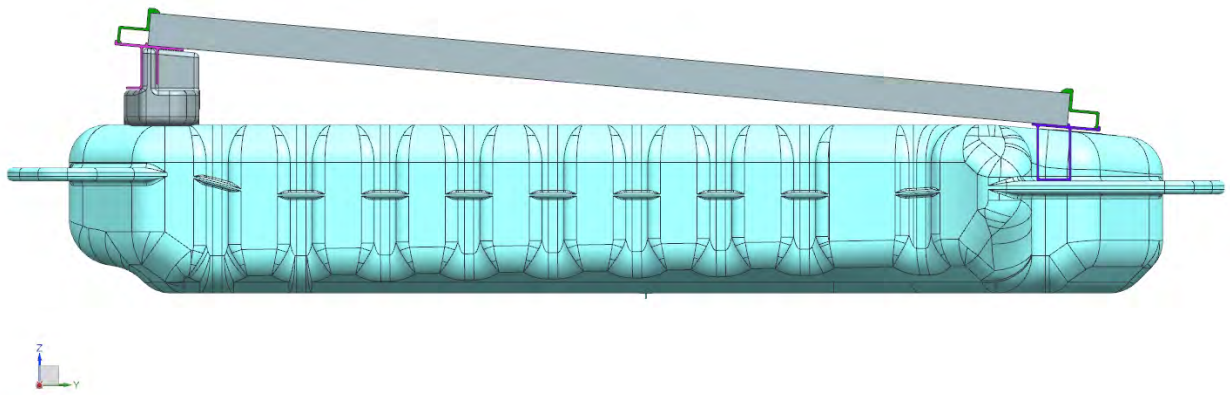


Figure 8

2. **Float Interconnection:**

Typically our floating structures are designed to have one row of Walkways at the periphery on the top and bottom portion and columns of Equipment Float at the periphery on the left and the right of the floating solar system. The Connecting Floats are installed inside the peripheral layers.

The following are the components used:

A. Connecting Float (CF)
B. Equipment Float (EF)
C. Small Walkway Float (SWF)
D. Big Walkway Float (BWF)
E. Support Piece (SP)
F. SS304 M12 - Nut, Bolt, Spring Washer and Plain Washer (2)

Installation Recommendations:

A. Ensure sufficient quantity of all floats are available to complete the portion of the total floating system which you wish to assemble

B. Ensure sufficient quantity of fasteners, sleeves and gaskets are available to complete the portion of the total floating system which you wish to assemble

C. Ensure that anchoring spreader bar is connected correctly to the outer peripheral floats before pushing into the water

D. Start the assembly from the last row onwards to ensure ease of installation while pushing into the water

E. While pushing the floats into the water, ensure not to exert excessive force on the ears of the float which may damage the same

F. Split the total assembly into sections and complete each section on the ground and then connect the completed sections together in the water to ensure proper connectivity. We recommend connecting 2-3 rows at any point of time on the shore and tugging a maximum of 5 rows by connecting both ends to ropes connected to the tug boat (say with a 10 HP motor)

G. Create a smooth surface at an angle of approximately 20 degree to help sliding the connected floats into the water. The platform should be lined with smooth plates or rubber sheets to avoid scratching of the floats with the ground

H. Use the logo on the floats as well as orientation marking on each float to ensure the correct orientation of the floats is followed during interconnection of the same

Float Installation Procedure:

A. Check the design of each float to see the height differences of the ears marked on the side of each float (as marked in orange)

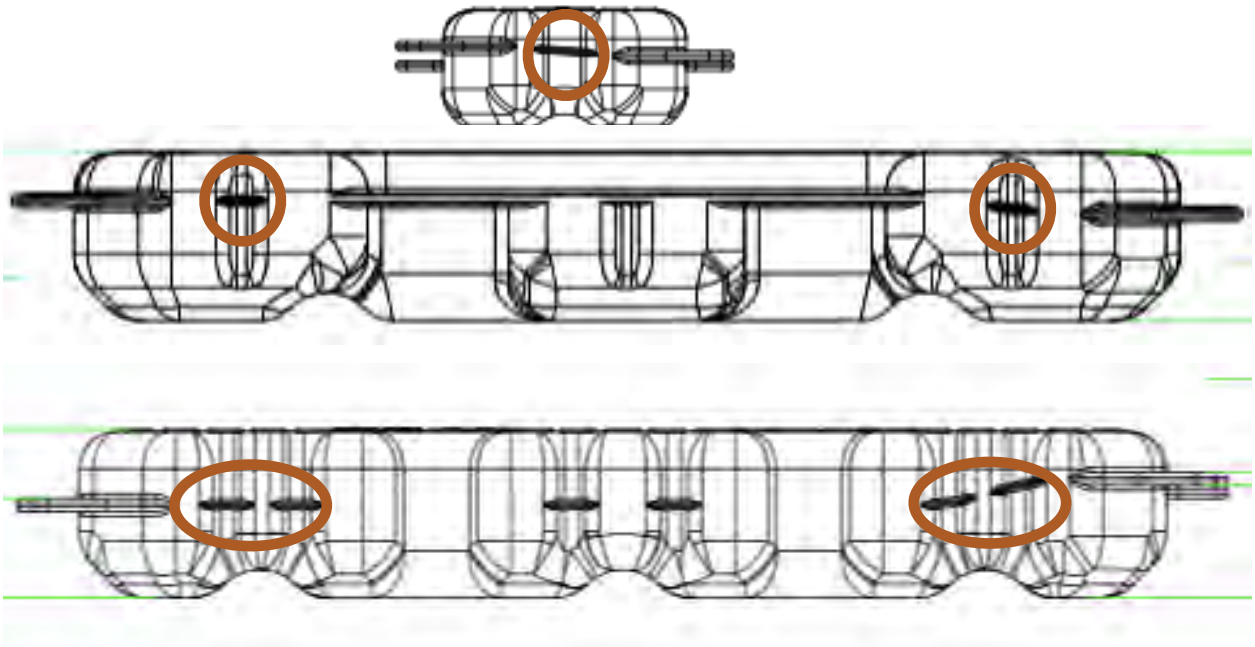


Figure 9

B. The assembly is to be started from the right most corner of the entire plant (with panels facing towards you - assume you are standing on south side facing north side with panels facing south (towards you)).

C. Test assemble 2 to 3 rows of floats first before tightening any fasteners to check alignment and use the sleeve in the holes of the ears to align the holes for inserting M12 nut

D. Connect the SWF such that the bottom right ear and the top right ear of the SWF always come on the bottom of the interconnecting ears. The bottom left ear of the SWF will be in the middle and top left ear of the SWF will be on the top

E. Connect the EF/CF in front of the SWF such that the top ears of EF/CF always come at the top of the interconnection of ears and the bottom ears always come at the middle of the interconnection of ears

F. Keep in mind that when 2 EF/CF are connected together the top ears of the second EF/CF will come on top of the bottom ears of the first EF/CF

G. Connect the BWF such that the right ears are always on the bottom of the interconnection of ears and the bottom left ear is in the middle and top left ear is in the top of the interconnection of ears

Connection Points Table

Small Walkway	**Interconnection Ear Position**		**Interconnection Ear Position**
Top Right Ear	Bottom	**Top Left Ear**	Top
Bottom Right Ear	Bottom	**Bottom Left Ear**	Middle
Big Walkway	**Interconnection Ear Position**		**Interconnection Ear Position**
Top Right Ear	Bottom	**Top Left Ear**	Top
Bottom Right Ear	Bottom	**Bottom Left Ear**	Middle
Panel Float/ Equipment Float	**Interconnection Ear Position**		**Interconnection Ear Position**
Top Right Ear	Top	**Top Left Ear**	Top
Bottom Right Ear	Middle	**Bottom Left Ear**	Middle

H. The above procedure can be repeated to connect all the floats together
I. Take care to align all holes with sleeve before connecting M12 fasters

Figure 10

J. Connect 3 rows on the shore and then push the assembly such that the floats touch the water surface
K. Connect the adjacent rows on the shore and push the assembly into the water
L. Tow the portion of assembly complete to the project location

M. Repeat the steps given above for the next portion of the assembly and then tow this assembly to the project location and interconnect at the location
N. The ears for the interconnecting points will align as provided above during the interconnection of the 2 floating portions
O. These steps may then be repeated to complete the entire assembly

3. Junction Box Installation Procedure:

A. Place the Equipment Float on the table
B. Mount the additional structure on the equipment float using the 4 M12 holes
C. Now mount your junction box on the structure and connect the equipment float on the array as described above

Figure 11

4. Electrical Connections Procedure:

A. While forming each row of the array of floaters, one must interconnect the module to module looping of DC Cables and use UV resistant cable ties on the hole provided on the supporting float or on the modules based on the available cabling length
B. Ensure to complete the module to module earthing looping during the connection of each row on the ground

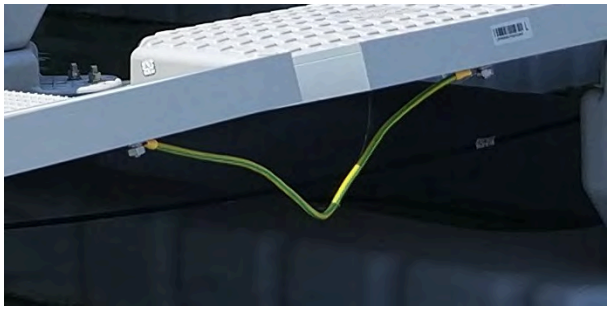


Figure 12

C. Take care to ensure that the loose ends of the cables do not touch with water when floated out and also to ensure the cables are properly tied using UV resistant cable ties to ensure no cables touch the water surface

Figure 13

D. The cables can then be taken on either cable tray or flexible conduits to the shore through equipment floats

Figure 14

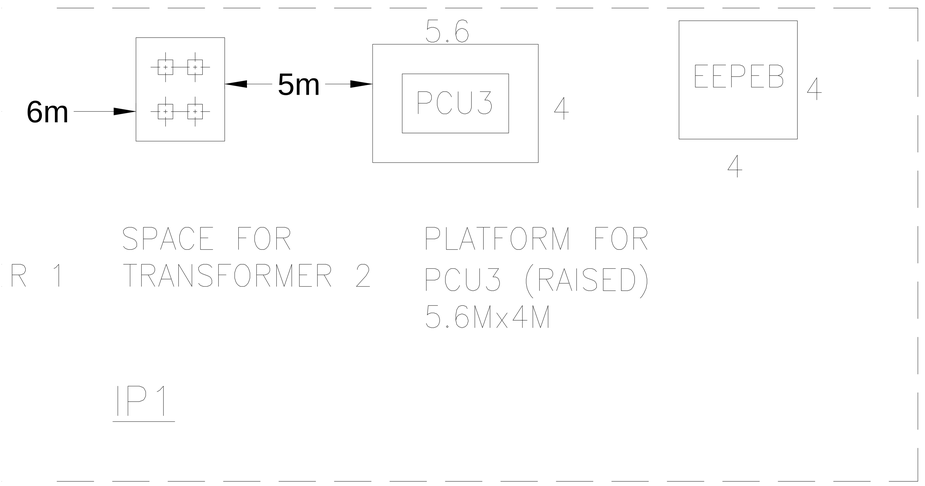
5. Installation Checklist:

- Check the connection of the injection nut with support piece on the connecting float
- Check if the solar panel is aligned to the centre of each connecting float so as to have equal overhang on both sides
- Check if aluminium clamps are tightened properly using the M8 hardware to the panel
- Check if aluminium clamps are tightened properly using the M8 hardware with the float
- Check that all interconnection ears are connected as per this manual
- Check the correct tightening of the M12 hardware at each interconnecting point
- Check the if the anchoring / mooring spreader bars are connected as per design to the peripheral floats using interconnection ears
- Check to ensure that the module to module looping of the DC cable and Earthing is done properly before pushing the floats into the water
- Check to ensure the cables are sufficiently spaced above the water by use of cable ties to ensure no damages to the cable
- Check the floats for any damages during assembly before pushing the arrangement into the water

6. Safety Recommendations:

A. It is recommended to always use life jackets while boarding and walking on the floating platform
B. While connecting the floats please ensure to always connect the floats properly before floating into the water
C. During regular maintenance ensure that the connections of the floats are checked for any disparity
D. All cables being used in the solar system must have sufficient slack to prevent damage due to motions and variations in level of water
E. Follow the relevant standards for lighting protection and system earthing
F. All cables used must be water proof as complete contact with water may not be avoided. Having this in mind, please ensure cable management systems are used to provide sufficient distance from water by use of cable ties
G. Cable conduits used to take cables from the floating island to the shore shall be water proof to avoid unnecessary risk during evacuation

H. The floating structure shall not be approached by untrained manpower and shall not be approached without personal safety equipment such as jackets and helmets



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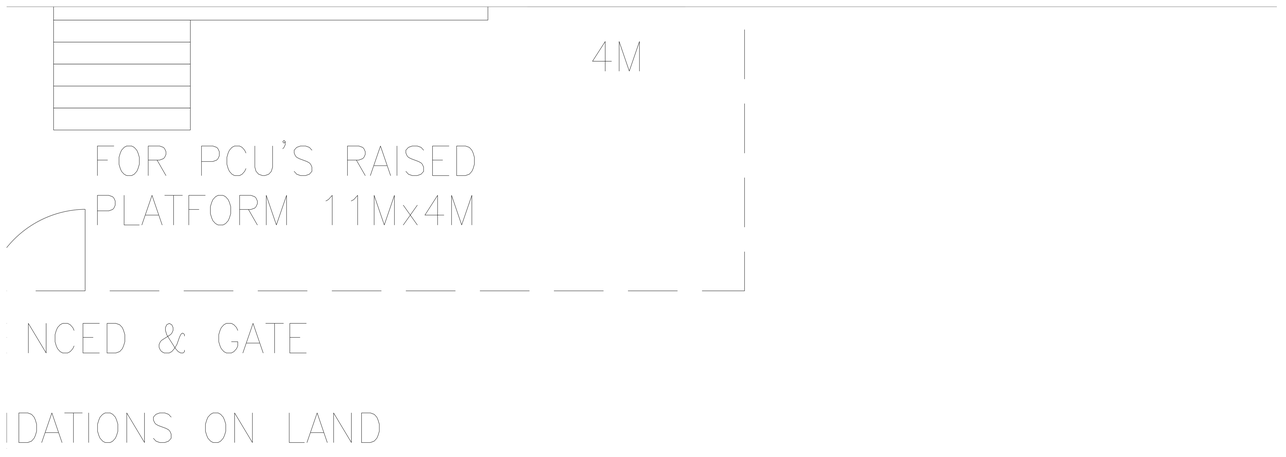

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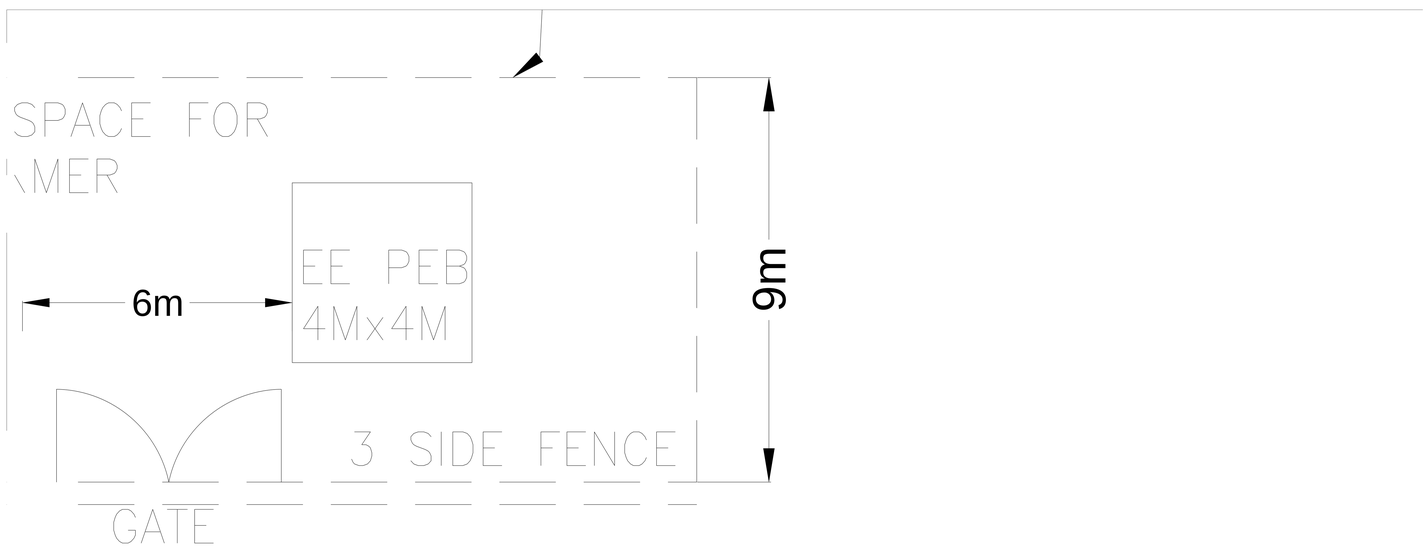

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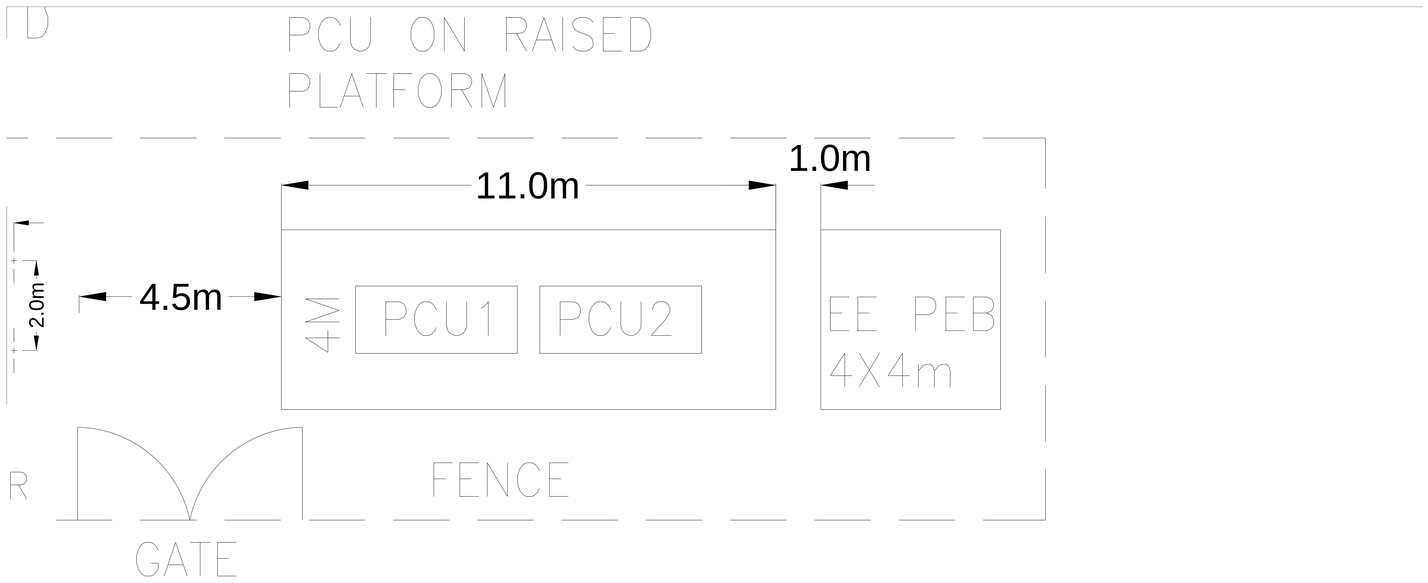

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IP4

D-3 GENERAL CIVIL WORKS

1. GENERAL

This chapter covers the Specific technical and functional requirements.

The design calculations and drawings for RCC structure, PEB Inverter Rooms, Steel structure, foundation system, road work, drainage, etc. shall be submitted for prior approval of NTPC before commencement of construction. The construction methodology for road works, drains shall be also be submitted for NTPC approval before start of works.

All design of RCC and Steel structures shall be carried as per IS: 456 and IS 800 respectively and other specific code as applicable to specific structures.

2. CMCS, INVERTER ROOMS, SECURITY ROOM:

The following structures shall be designed and provided by the bidder:

(I) **CMCS Building**: For the operation and maintenance of SPV Plant one Central Monitoring and Control Station (CMCS) with 33 KV switchgear room shall be provided. The CMCS building shall consist of the following:

1. Air conditioned SCADA Room
2. Inverter, battery room, ACDB and 33 KV Switchgear Room,
3. Store Room.
4. Supervisor room.
5. Toilets (Male and female).
6. Pantry.

Inverter(s), battery room, ACDB and 33 KV Switchgear room shall be based on manufacturer recommendation, easy passage of O&M persons and cable trench layout required. The CMCS shall be RCC framed structure with bricks/concrete blocks masonry walls. The CMCS shall have entry lobby and portico with roof for vehicle stoppage.

The minimum size & requirements of the CMCS Building & all items shall be as per tender drawing **5742-004-POC-A-003**.

(II) **Inverter Rooms**: Inverter rooms consist of PCU's, LT panels, batteries, etc. shall be provided based on manufacturer recommendation, easy passage of O&M persons and cable trench layout required. The inverter rooms shall be RCC building.

The battlery and its associated equipment shall be suitably segregated inside the Inverter room with proper ventilation arrangement.

The equipment inside the inverter room shall be placed so as to provide sufficient space for their maintenance.

The layout, design and drawings for all RCC structure, etc. and foundation system shall be approved from NTPC before start of works. The buildings and allied works shall be designed to meet national building code **2005** requirements.

2.1 **Specification for RCC Building for CMCS and Inverter room.**

The CMCS building shall be made of RCC framed structure with bricks/concrete blocks masonry walls. The thickness of outer masonry walls shall be minimum 230mm in case of bricks and minimum 200mm thick in case of concrete blocks. The following detailed specification shall also be followed for RCC works:

2.1.1 **Floor Finishes**

Switchgear/Inverter rooms	: Cement concrete flooring with ironite hardener.
SCADA room	: Heavy duty vitrified ceramic tiles
Battery room	: Acid Alkali resistance tile flooring or acid alkali resistant epoxy coating over concrete flooring with ironite hardener
Lobby	: Heavy duty vitrified ceramic tiles and skirting
Toilet	: Heavy duty anti-skid ceramic Tiles and dodo 210 mm
Steps	: Kota stone/Granite- 20 mm thick
Store room	: Cement concrete flooring with ironite hardener.

Flooring for air conditioned areas area shall be provided with vitrified ceramic tiles of size 600X 600 mm of min 9 mm thickness, laid with 3 mm ground joints as per approved pattern. Cement concrete flooring shall conform to IS 2571.

The floor finish for toilet shall be vitrified ceramic anti-skid tiles and Dado glaze ceramic tiles upto 2.1m shall be used. The normal size of Ceramic tiles shall be 300 mm X 300 mm X 9 mm and shall comply IS: 15622.

Finish floor level of all building shall be minimum 600 mm above from Finish graded level.

2.1.2 **False Celling**

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

2.1.3 **Roof Finishes**

Roof of the Building shall consist of Cast-in-situ RCC slab with decking sheet (RCC slab with permanent formwork) The slab formwork decking sheet shall be permanently colour coated profile sheet with minimum 0.6mm thickness of grade SS255 as per ASTM A653M / grade G250 as per AS 1397 coated with zinc of class designation Z275 or aluminium zinc alloy of class designation AZ150 or similar. The decking sheet shall meet the strength, deflection and other functional requirements.

Bidder can also provide Roof of the building as Cast-in-situ RCC slab conforming to Indian code.

The roof of the building shall be water proof with Polymeric membrane type waterproofing as per DSR 2013, Items no. 22.16. The roof shall be designed for minimum superimposed load to 150 kg/m2.

For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with PVC/RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface. The roof of all building shall be projecting out by at least 750 mm all around the building for its external walls protection from rain water and parapet wall above the roof beam. Height of parapet wall shall be minimum 300 mm above top of roof level. Structural steel hand railings of minimum 700mm height shall also be provided over the parapet wall.

The bidder shall also provide rain water harvesting system consisting of ground water recharge pits for CMCS building roof.

2.1.4 **View point**

RCC terrace of CMCS building shall also work as view point. View point shall be used for security purposes and viewing gallery. Suitable RCC half landing staircase shall be provided for access to roof of the RCC CMCS building.

2.1.5 **Windows, Doors, Ventilators and Rolling Shutters**

Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings, and all windows and ventilators of CMCS building shall have, powder coated (minimum thickness of powder coating 50 micron) aluminum framework with glazing. Window shall be provided with suitable aluminum grill.

All doors of toilet areas shall be of steel framed solid core flush shutter as per IS 2202. Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However, for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20 m.

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

Rolling shutter (Mechanical gear operated). Rolling shutters shall be fabricated from 18-gauge steel and machine rolled with 75 mm rolling centers with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS: 2108 and shall be designed to withstand a wind load without excessive deflection. Metal rolling shutters and rolling grills as IS: 6248

2.1.6 **Glazing**

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

For single glazed aluminium partitions and doors, toughened float glass of 10 mm thickness shall be used. All glazing work shall conform to IS: 1083 and IS: 3548.

The glass to used should be from reputed brand / manufacturer and as approved by NTPC. The glass should be free from distortion and thermal stress.

2.1.7 **Paintings of wall and ceilings**

Internal wall surfaces: SCADA room All other rooms in plant buildings	-Acrylic Emulsion -Acrylic Distemper
External faces of walls:	-Exterior emulsion paint
Walls of battery room	-Acid alkali resistant paint, an exposed wall above Dado -2100 mm high Dado of acid alkali resistant tiling.
All Ceiling	-Acrylic Distemper

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

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

Ceiling of all rooms except Battery room shall be white washed. The ceiling of Battery room (if provided) shall be acid/alkali resistant paint. CMCS building outside colors of paining shall be similar to PEB painting colors.

A standard color scheme for the different buildings/structures shall be prepared by the Contractor and the approval of the Owner shall be obtained, before commencement of work.

2.1.8 **Plumbing and sanitary**

CMCS building room shall have attached toilet for both gender. Each toilet shall have the following minimum fittings of ISI approved of reputed brand (subject to approval from Engineer in charge).

a) Wall mounted WC (Western type) 390 mm high with toilet paper roll holder and all fittings.
b) Wall mounted Urinal (430 x 260 x 350 mm size) with all fittings for male toilet only.
c) Wash basin (550 x 400 mm) above platform with all fittings.
d) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing.
e) CP brass towel rail (600 x 20 mm) with C.P. brass brackets.
f) Soap holder and liquid soap dispenser.

Wash basin provision for hand wash shall also be provided in **battery room**.

All fittings, fastener, grating shall be brass with chromium plated as per relevant IS code. Necessary plumbing lines shall be provided for CMCS room building and Security room near main gate.

The bidder shall design & provide packaged sewerage treatment plant/septic with soak pit for CMCS and Security room assuming that a total of 15 people shall use the facility. The waste water/effluents from the sewerage plants/septic tank shall meet the state pollution board requirement.

2.2 **Water Supply**

GI pipes of Medium quality conforming to IS 1239 (Part I-1990) or CPVC pipes conforming to IS 15778 shall be used for all portable hot and cold water distribution supply and plumbing works.

The Syntax or equivalent make PVC storage water storage tank conforming to IS: 12701 shall be provided over the roof of the CMCS with adequate capacity for 10 No person and 24 hr requirement, complete with all fitting including float valve, stop cock etc. The capacity of the tank shall be minimum 500 liters.

2.3 **Plastering**

All external surfaces shall have 18 mm cement plaster in two coats, under layer 12 mm thick cement plaster 1:5 and finished with a top layer 6 mm thick cement plaster 1:6 (DSR 2013-13.11).

White cement primer shall be used as per manufacturer's recommendation.

At least one coat of plaster shall be applied to interior walls by hand or mechanically, to a total thickness of 12 mm using 1:6, 1 cement and 6 sand. Plastering shall comply to IS: 1542, IS: 1661, IS: 1630. Oil bound washable distemper on smooth surface applied with minimum 2 mm thick Plaster of Paris putty for control room. Plaster of Paris (Gypsum Anhydrous) conforming to IS: 2547 shall be used for plaster of paris punning.

2.4 **Masonry Work**

Brick works shall be using at least class designation 7.5 of approved quality as per IS: 1077, IS: 2212 and IS: 3495. Concrete blocks shall be of minimum compressive strength of 7.5 N/mm2 and shall be of Grade-A as per IS: 2185. Stone masonry work with hard stone in building works, foundation, plinth and drains shall be Coursed Rubble or Random Rubble masonry work with stone of good quality and durability. The masonry surface shall be plastered with minimum 18mm plaster in case of CMCS walls. The stone masonry work shall be in line with IS: 1597, IS: 1122 and IS: 1126.

The cement mortar for all kind of masonry work shall be in the ratio 1 cement and 6 sand by weight.

Bricks/blocks required for masonry work shall be thoroughly soaked in clean water tank for approximately two hours. Brick shall be laid in English bond style. Green masonry work shall be protected from rain. All masonry work shall be kept moist on all the faces for a period of seven days.

Bricks of class designation 50 and 35 may be permitted to have slight distorted & rounded edges provided no difficulty shall arise on this account in laying of uniform courses in non-load bearing structures and shall be subjected to approval of NTPC. Tolerances on dimensions up to +/- 8% shall be permitted. Dimension test to be carried out as per IS code.

The external wall for the building shall be 230 mm thick walls and internal wall 230/115 thick as per requirements. The external wall of CMCS facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.

Use of fly ash brick for masonry shall be subjected to approval of NTPC.

Suitable damp proof course shall be provided the proportion of cement, sand & aggregate shall be 1:2:4 using 6 mm down stone chips with a water proofing admixtures. The thickness of damp-proof course shall be minimum 40 mm.

2.5 **Reinforced Concrete Structure, Allied Works and Foundation**

All RCC works shall be design mix as per IS: 456-2000. For structural concrete items, Ordinary Portland cement (43 Grade) conforming to IS: 8112 and Fly ash based Portland pozzolana cement conforming to IS: 1489 (Part-1) shall be used for superstructure. Type of cement for sub-structures shall be decided based on the final Soil Investigation report.

Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.

Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116

Reinforcement steel shall be of high strength deformed TMT steel bars **with corrosion inhibitors, Corrosion Resistant Steel (CRS) re-bars, Fusion Bonded Epoxy Coated (FBEC) re-bars or Zinc Coasted re-bars** of grade minimum Fe-500 shall conform to IS: 1786. Ductile detailing in accordance with IS: 13920 shall be adopted for superstructure and substructure of all RCC buildings / structures. Dense concrete around reinforcement, provision of thick covers, and addition of corrosion protection with re-bars shall be provided to the RCC structures.

The following minimum grades of concrete for design mix and nominal mix shall be adopted for the type of structures noted against each unless not specified elsewhere.

M 30 - All RCC structural elements above and below ground level, precast concrete, foundation, cable trench, oil pit, Grade Slab, Paving, culverts & road.

M-20 (Equivalent nominal Mix of 1:1.5:3) * - Plain Concrete Cement

The bidder shall carry out the design mix of M-30 grade concrete on priority. The design mix shall be approved from NTPC before start of work.

In case Geotechnical investigations requires any special kind of cement or higher grade of concrete, the same shall be provided.

The foundation system shall be made which transfer loads safely to the soil for the module mounting structures, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. No foundation allowed on back filled soil and the foundation depth to reach upto NGL.

All loads shall be considered in line with IS: 875. Seismic loads for design shall be in accordance with IS: 1893 and relevant Standards.

IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must be complied for reinforcements. IS: 5525 and SP: 34 shall be followed for reinforcement detailing.

A minimum 75 mm thick PCC shall be provided below RCC wherever RCC is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS: 456.

2.6 **Structural Steel**

All structural steel design shall be carried out as per IS 800. Structural steel shall conform IS 2062, Pipe shall be as per medium/high grade of IS 1161, Chequered plates shall conformed to 3502 and Hollow steel sections for structural use shall conform to IS: 4923.

2.7 **Grouting**

Cement mortar (1:2) grout with non-shrink additives shall be used for grouting below base plate of column. The grout shall be high strength grout having a minimum characteristic compressive strength of min 30 N/mm2 at 28 days.

3.0 **Transformer Yard Civil Works**

Transformer and equipment's foundations shall be founded on piles/isolated spread footings depending on the final geotechnical investigation report.

Transformer foundations shall have its own pit which would cover the area of the transformer and cooler banks, so as to collect any spillage of oil or oil drainage in case of emergency. The oil pit shall be filled with granite stones of 40 mm size uniformly graded.

The bidder can propose soak pit under Transformer or Burnt oil pit at a distance connected to transformer soak pit depending upon oil quantity in Transformers. It shall be sized to accommodate oil volume of the transformer connected to it, without backflow. Gravel filled level under transformer shall be in accordance with FGL outside pit and transformer bottom level.

The area around the transformer and equipment's shall be covered with gravel and galvanized chain link fence of height min 1.8 m with fence posts and gates shall be provided. All fence posts shall be 50X50X6 MS angles spaced at 2.5m c/c distance and all other specification mentioned in Tender drawing **5742-004-POC-A-004** shall be followed. M.S. angle posts shall conform to IS: 2062. The portion of the fence covering towards rail track shall be made of removable type for movement of transformer during erection /removal. In addition, a small gate, 1.2 m wide shall be provided for man entry. The transformer yard fencing work shall conform to CEIG requirements.

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

4.0 **Pipe /Cable Racks & Trenches**

Trenches shall be constructed in reinforced cement concrete of M-20 grade of wall thickness min 150 mm. The top of trenches shall be kept at least 100 mm above the gravel level so that rain water does not enter the trench. Trench walls shall not foul with the foundations.

Outdoor Cable Trenches: RCC cable trenches shall be constructed in the switchyard and pre-cast RCC removable covers with lifting arrangement, edge protected with suitable galvanized angle iron designed to withstand self-weight of top slab + concentrated load of 150 kg at center of span on each panel.

Indoor Cable Trenches: RCC indoor cable trenches shall be provided with 50X50X4 mm angles grouted on the top edge of the trench wall for holding minimum 6 mm thick mild steel checkered plate covers (600 mm in length except at ends & bends) conform to IS: 3502 with lifting arrangement. Angle or channels shall also be grouted at distances of 600 mm across the indoor cable trenches to support the checkered plates.

Trench Drainage: The trench bed shall have a slope of approx. 1/500 along the run & 1/250 perpendicular to the run. In case straight length exceeds 30 m, suitable expansion joint shall be provided at appropriate

distances. The expansion joint shall run through vertical wall and base of trench. All expansion joints shall be provided with approved quality PVC water stops. Suitable drainage at lowest point of the trench shall be provided.

5.0 **ROAD AND PATHWAY**

5.1 **Road:** The approach road to the Solar Power Plant shall originate from the main approach road and connect to all Inverter rooms, CMCS building and gates. Approach road shall be 3.0 meter wide with 1meter wide shoulder on both side. Red moorum/brick, minimum 100 mm thick shall be provided for shoulder. The crown of the road shall be minimum 150 mm above FGL. The final finished roads shall have a camber of 1 in 50.

The minimum road section shall be as follows:

1) Topping: Wearing course of premix carpet 20 mm thick.
2) WBM, compacted 75 mm thick (Grade-III).
3) WBM, compacted 100 mm thick (Grade-II).
4) Granular Sub-base, compacted 150mm thick granular sub-base (Gr-I).
5) Sub-grade under road and its shoulders shall be compacted to achieve 95% or more of standard proctor's MDD. CBR value of the sub grade level should be minimum 4%. If actual CBR is less than 4% in a particular stretch then GSB thickness shall be increased suitably.

The methodology of road construction with material specifications shall be in line with IRC/MORTH and shall be submitted for approval before starts of works. Road works shall be carried out as per tender drawing **5742-004-POC-A-002**

6.0 **DRAINAGE SYSTEM:**

Surface drainage system shall be designed considering “maximum hourly rainfall intensity” at the site area considering latest 25 years return period however the minimum value of “maximum hourly rainfall intensity” shall be maintained as 60 mm in the drainage system design. The minimum value of surface run off coefficient shall be considered as 0.6 in the design of drainage system. The drainage system shall be designed as per the IRC specifications and prevailing industry practices. The drainage scheme shall be designed considering the bidder’s plot area and nearby catchment area contributing to the plot drains. Drainage scheme with detention ponds which allows for groundwater recharge & maintains the existing drainage pattern as far as possible is desired. A network of open drains shall be designed & provided to carry surface run off. The drains shall be trapezoidal or rectangle section lined with concrete slabs/brick

masonry/stone masonry/stone slabs. The minimum thickness of these lining shall be 115mm for brick masonry, 75mm thick for concrete slab, 150mm thick for stone masonry and 100mm thick for stone slab.

Grade level shall be fixed with due reference to highest high flood level of the receiving body of water. Laying of Hume pipe shall be in line with IS: 783.

7.0 ELECTRIFICATION OF BUILDING

Electrification of all building shall be carried out as per IS 732-1989, IS: 4648-1968 and other relevant standards.

8.0 LIST OF APPLICABLE INDIAN STANDARDS:

Indian codes, and/or standards shall govern, in all the cases wherever they are available. In case of a conflict between such codes and/or standards and the specifications, the stringent provisions shall govern. Such codes and/or standard referred to shall mean the latest revision, amendments/changes adopted and published by the relevant agencies. In case of any further conflict in this matter the same shall be referred to the Engineer-in-charge, whose decision shall be final and binding.

Other internationally acceptable standards shall be accepted, only if, no Indian Standards are existing. However, other standards also will be accepted if the Contractor establishes that the works are meeting the requirements of Indian Standards also.

A brief list of Indian Standards applicable to these works is as below:

General

IS: 875-I	Code of Practice for Design Dead Loads for Building and Structures
IS: 875-II	Code of Practice for Design Imposed Loads for Building and Structures
IS: 875-III	Code of practice for design loads (other than earthquake) for buildings and structures.
IS: 1893	Criteria for earthquake resistant design of structures.
IS: 4326	Code of Practice for earthquake resistant design and construction of buildings

Foundations

IS: 1080	Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
IS: 1904	Code of practice for structural safety of building foundations
IS: 2950	Code of practice for design and construction of raft foundations.
IS: 4091	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles
IS: 6403	Code of Practice for determination of bearing capacity of shallow foundations
IS: 8009	Code of Practice for foundation settlement calculations
IS: 2911	Design & Construction of Pile Foundation - Code of Practice

Concrete Structures

IS: 456	Code of practice for plain and Reinforced concrete
IS: 3370	Code of practice for concrete structures for the storage of liquids.
IS: 3414	Code of Practice for design and installation of joints in buildings
IS: 5525	Recommendation for detailing of reinforced concrete works
IS: 6313	Code of practice for anti-termite measures in buildings
IS: 13920	Ductile detailing of Reinforced Concrete Structures subjected to Seismic forces
IS: 1904	Code of practice for design and construction of foundations in soils general requirements

Steel Structures

IS: 800	Code of practice for use of structural steel in general building construction
IS: 801	Code of practice for use of cold-formed light gauge steel structure members
IS: 802	Code of Practice for use of Structural Steel in over Head Transmission Line Towers.
IS: 806	Code of practice for use of steel tubes in general building construction.
IS: 808	Dimensions for hot rolled steel beam, column channel and angle section
IS: 811	Specification for Cold Formed Light Gauge Structural Steel Sections

IS: 813	Scheme of symbols for welding
IS: 1079	Hot Rolled carbon Steel Sheet and Strip - Specification
IS: 2062	Hot Rolled Medium and High Tensile Structural Steel - Specification
IS: 4923	Hollow steel sections for structural use.
IS 1161	Steel tubes for structural purpose
IS: 2721	Galvanized steel chain link fence fabric - Specification

Painting and Coating

IS: 4736	Hot-dip zinc coatings on mild steel tubes
IS: 4759	Hot-dip zinc coatings on structural steel and other allied products – Specification
IS:1868	Anodic coatings on aluminum and its alloys
IS 2395-I	Painting of Concrete, Masonry and Plaster Surfaces - Code of: Operations and Workmanship
IS 2395-II	Code of practice for painting concrete, masonry and plaster surfaces: Schedule
IS 1477-I	Code of Practice for Painting of Ferrous Metals in Buildings: Pre-treatment
IS:1477-II	Code of practice for painting of ferrous metals in buildings: Painting

Water supply and sanitary

IS: 1239	Mild steel tubes and tubulars and other wrought steel fittings
IS: 1172	Code of basic requirements for water supply, drainage and sanitation
IS: 1742	Code of Practice for building drainage
IS: 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS: 15778	Chlorinated polyvinyl chloride pipes for potable hot and cold water distribution supplies
IS: 16088	Chlorinated polyvinyl chloride pipes for automatic sprinkler fire extinguishing system
IS: 10124	Fabricated PVC fittings for potable water supplies
IS: 4985	Un-plasticized PVC pipes for potable water supplies

IS: 13592	Un-plasticized Polyvinyl Chloride (PVC-U) Pipes for Soil and Waste Discharge System Inside and Outside Buildings Including Ventilation and Rainwater System
IS: 12818	Un-plasticized polyvinyl chloride (PVC-U)screen and casing pipes for bore/tubewell
IS: 2470	Code of Practice for installation of septic tanks

Miscellaneous

IS: 1905	Code of Practice for structural use of un-reinforced masonry
IS: 3067	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
SP: 6	Handbook for structural engineers (all parts)
SP: 7	National Building Code of India
SP: 16	Design Aids for reinforced concrete to IS:456
SP: 20	Handbook on masonry design and construction
SP: 22	Explanatory handbook on codes for earthquake engineering
SP: 24	Explanatory handbook on Indian Standard Code of Practice for plain and reinforced concrete
SP: 25	Handbook on causes and prevention of cracks in buildings
SP: 32	Handbook on functional requirements of industrial buildings
SP: 34	Handbook of concrete reinforcement & detailing
IRC: 37	Guidelines for design of flexible pavements
IRC: 42	Guidelines on Road Drainage
IRC: 58	Guidelines for the design of rigid pavements for highways
IRC: 73	Geometric design of roads

GENERAL DESIGN DATA

A. **VICINITY MAP**:

B. **WIND**: Basic wind speed shall as per Cl. 2.0 of Chapter A-2.

C. **SEISMIC** shall be as per IS: 1893 (Part-1)

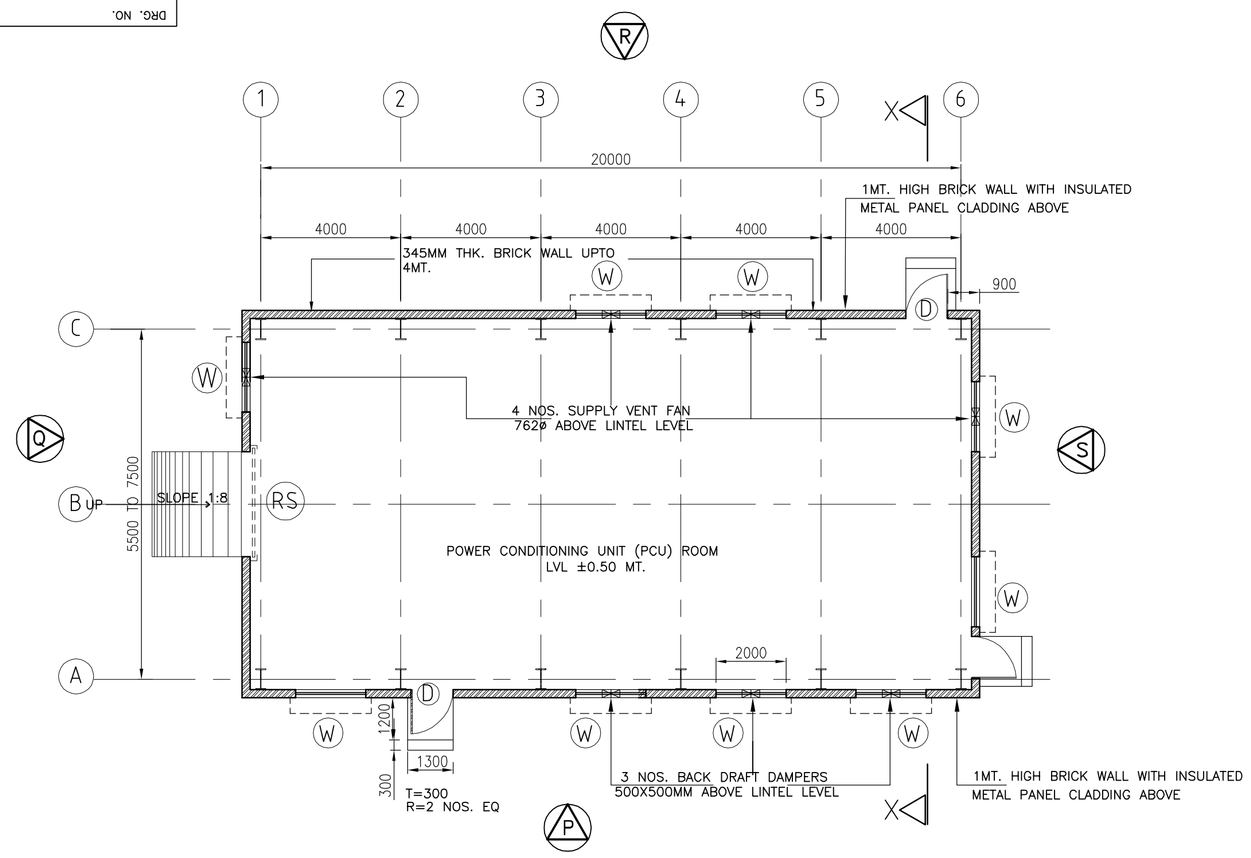
D. The **CMCS building** shall consist of the following with area:

Sl No:	Room	Minimum Area
1	Air conditioned SCADA Room	16 sqm
2	Inverter, battery room, ACDB and 33 KV Switchgear Room	manufacturer recommendation
3	Store Room	25 sqm
4	Supervisor room	12 sqm
5	Toilets (Male and female)	16 sqm
6	Pantry	05 sqm

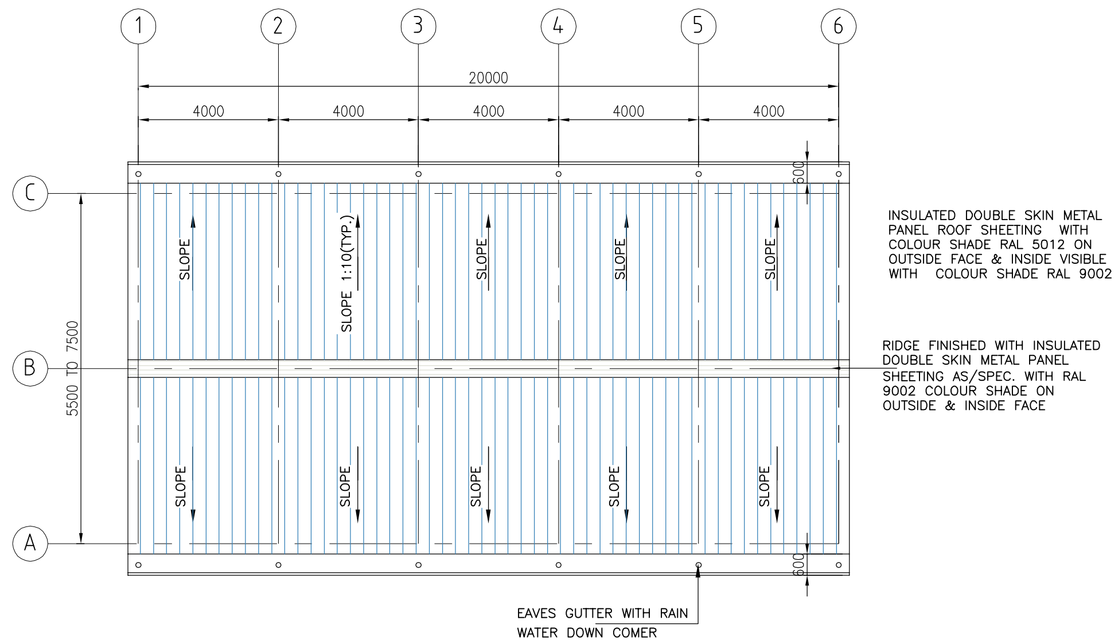
E. ALL BUILDINGS ARE OF RCC.

Rooms: Inverter rooms. All buildings are of **RCC/PEB.**

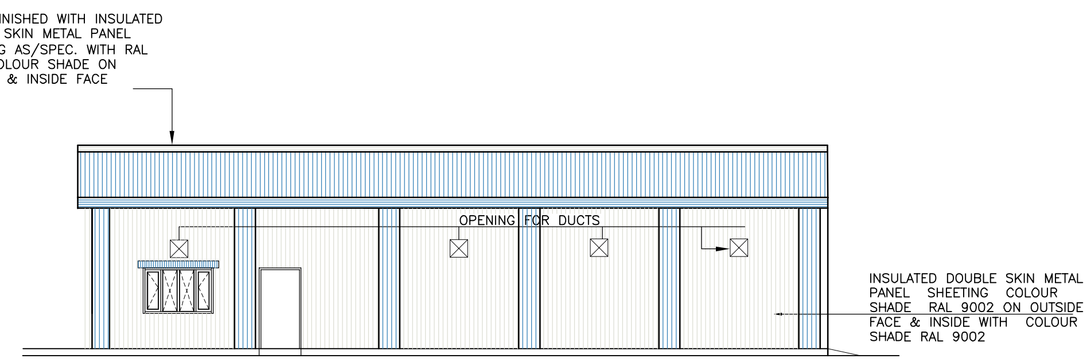
As per NTPC Technical Amendment



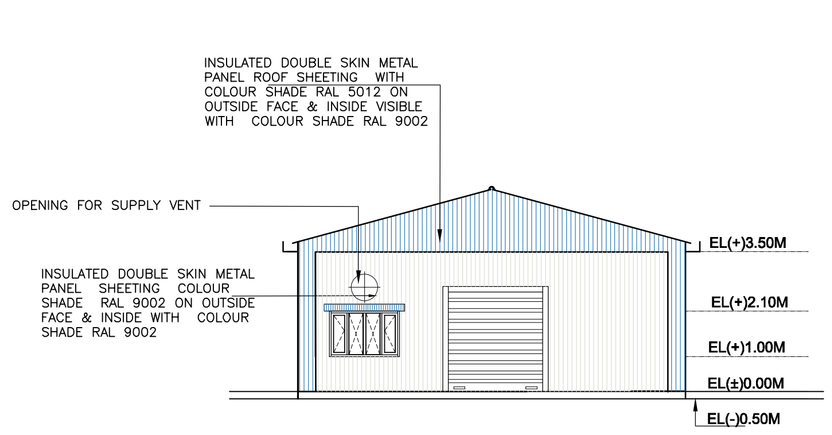
PLAN AT ± 0.0 MTS. LVL.



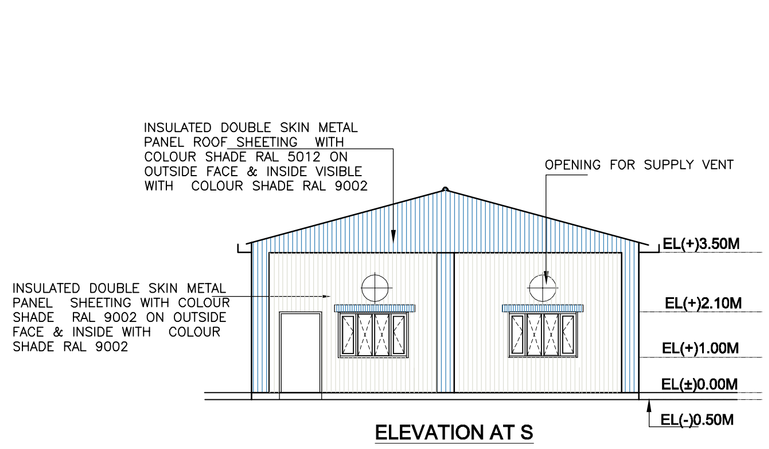
ROOF PLAN



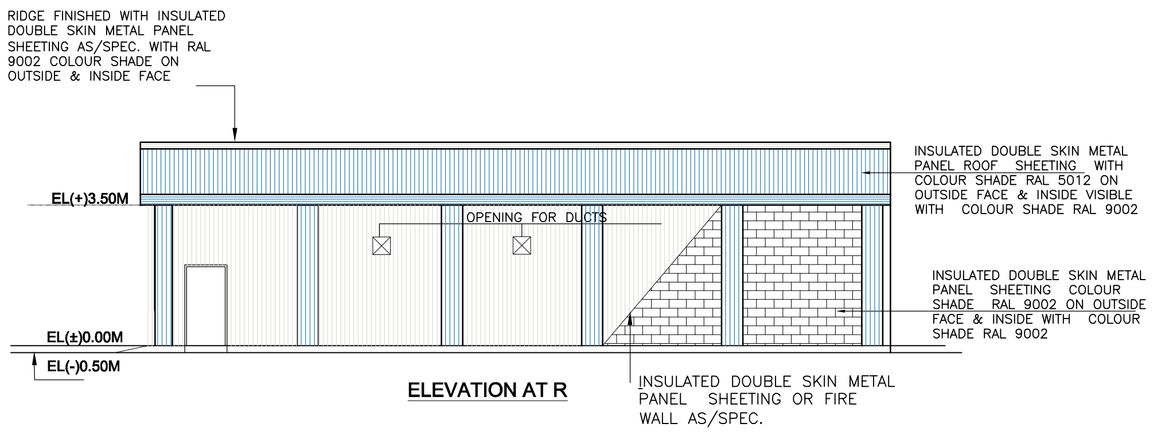
ELEVATION AT P



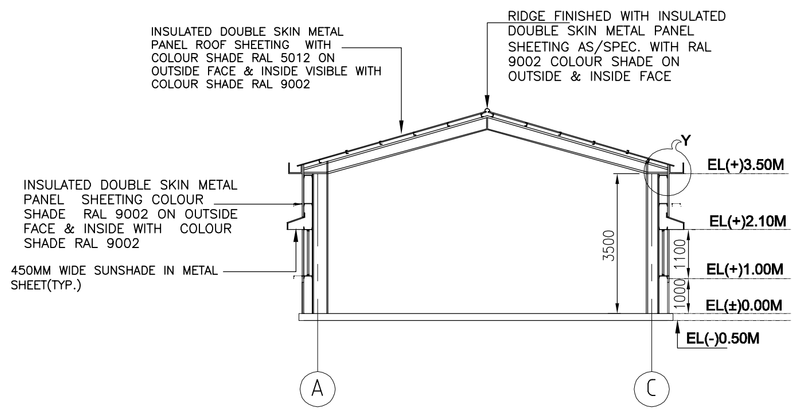
ELEVATION AT Q



ELEVATION AT S



ELEVATION AT R



SECTION AT X-X

DOOR/ROLLING SHUTTER/WINDOWS/VENTS/DUCTS

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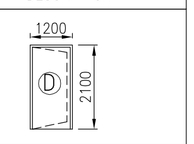
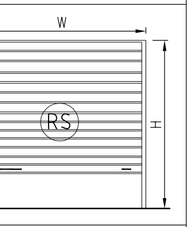
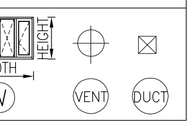
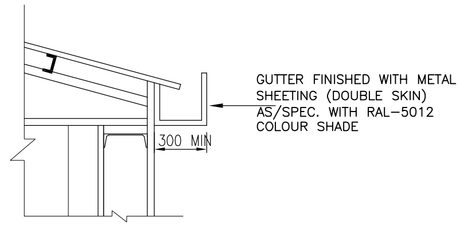
D	1200X2100	0.00	2100	
RS	REFER NOTE 5 & 6	0.00	H	
WINDOWS VENTILATORS DUCTS	REFER NOTE 5 AND 6.			



DETAIL AT Y

NOTES:-

1. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METERS.
2. DRAWING SHALL NOT BE SCALED ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.
3. ANY DOUBT OR DISCREPANCY IN THE DRAWING SHALL BE BROUGHT TO THE NOTICE OF THE ENGINEER-IN-CHARGE BEFORE EXECUTING THE WORK.
4. WORK SHALL BE CARRIED OUT BASED ON DETAIL WORKING DRAWINGS TO BE PREPARED BY THE VENDOR & GOT APPROVED FROM NTPC, BEFORE EXECUTION.
5. OPENING FOR ROLLING SHUTTER, DUCT'S AND VENTILATOR'S SHALL BE AS PER INVERTER (PCU) MANUFACTURER RECOMMENDATIONS AND VENDOR DESIGN SUBJECT ON NTPC APPROVAL.
6. LOCATIONS OF DOOR, ROLLING SHUTTER, WINDOWS, VENTS & DUCTS ARE INDICATIVE ONLY. VENTILATIONS AND DUCTS SHALL BE DESIGN CONSIDERING HEAT CALCULATION OF PEB ROOM.
7. REFER TECHNICAL SPECIFICATION FOR PEB-INVERTER ROOM IN CIVIL WORKS.

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	GEOTECH	REDG	ELEC.	APPD.	DATE
A		RAM	AT						14.08.18
		CLEARED BY							

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NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
(ENGINEERING DIVISION)

PROJECT: DEVELOPMENT OF 22MW FLOATING SOLAR AT RGCCPP KAYAMKULAM

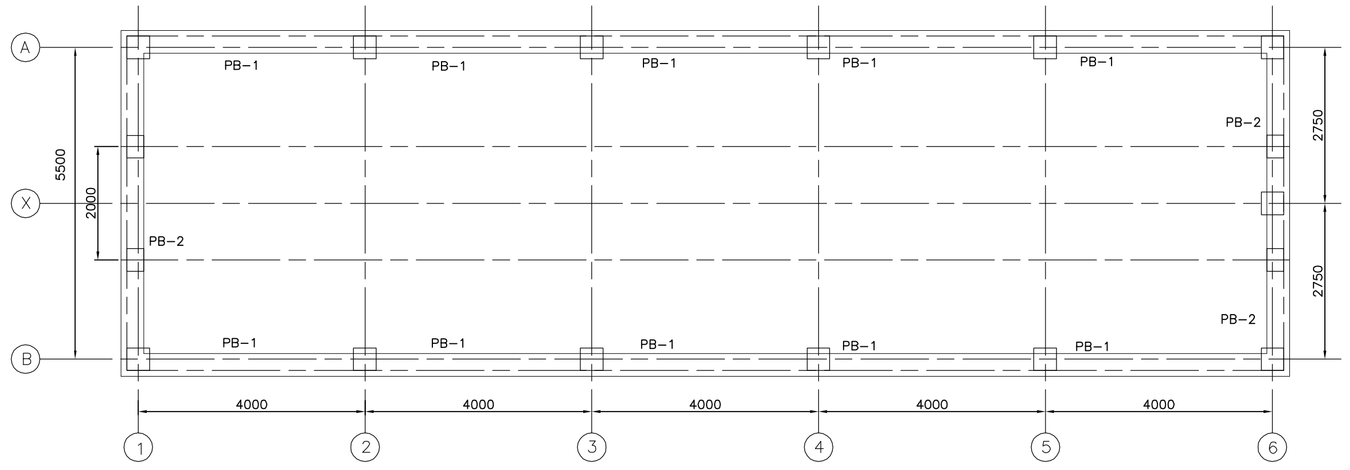
TITLE: PEB INVERTOR ROOM

SIZE	SCALE	DRG. NO.	REV.NO.
		5742-004-POC-A-005	A

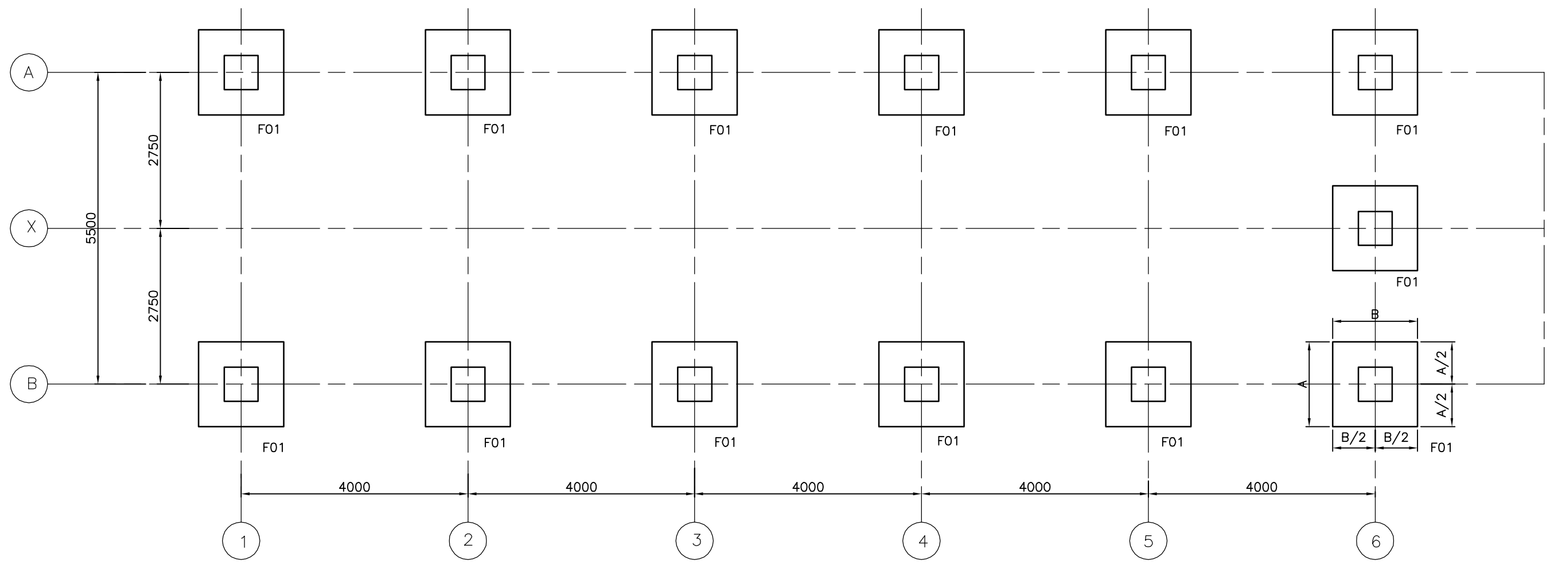
SHEET 1 OF 3

DRG. NO.

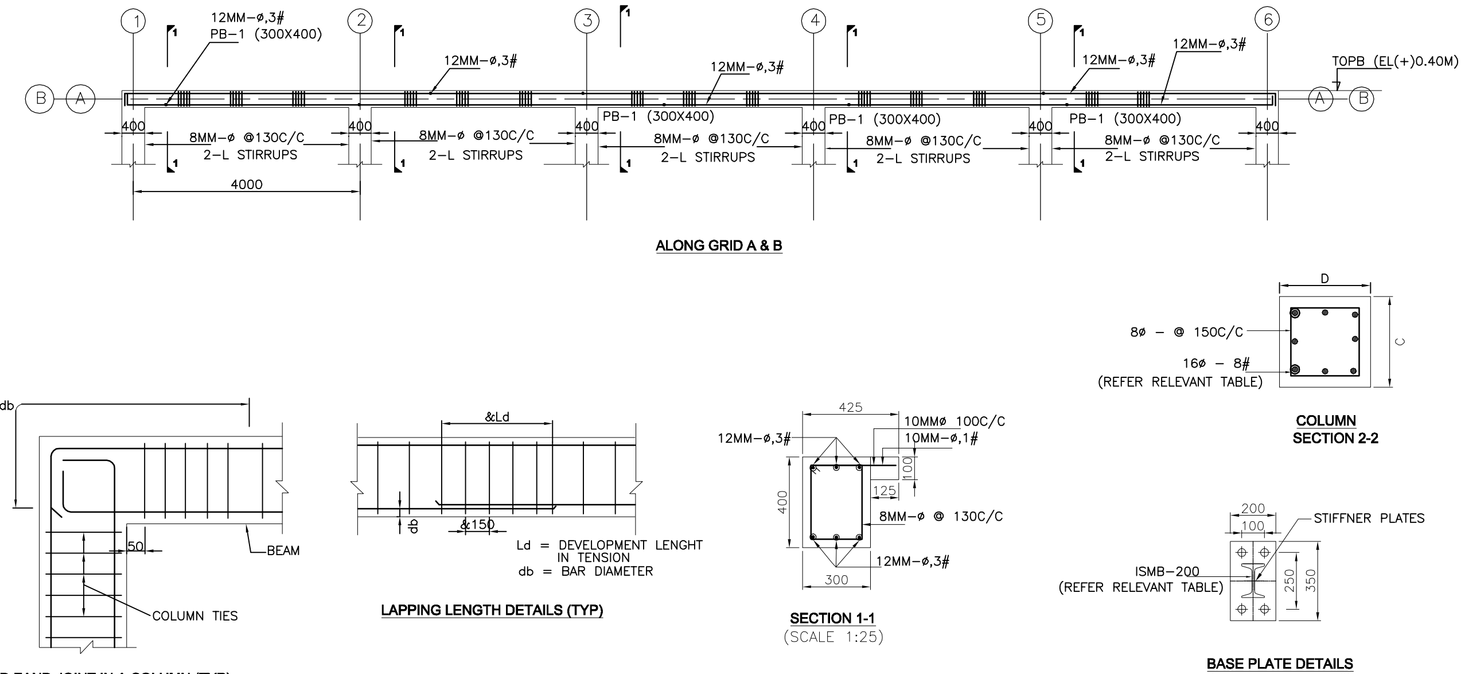
REV. NO.



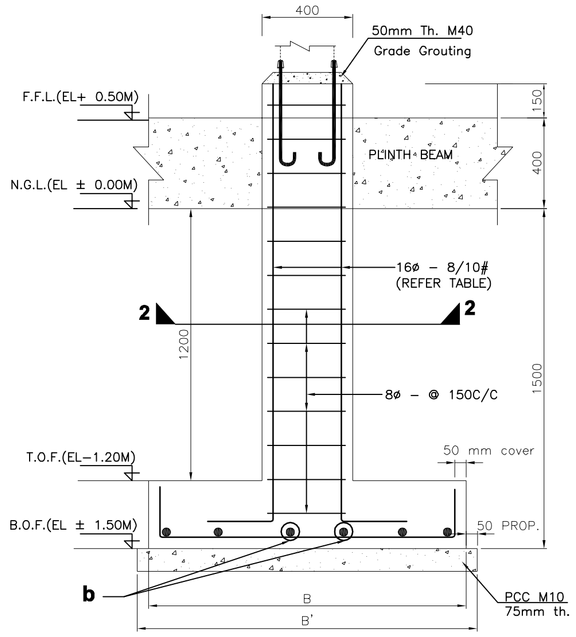
PLINTH BEAM PLAN AT ELEVATION +0.40M



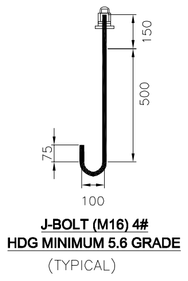
FOUNDATION FOR INVERTER ROOM
AT EL. (- 1.20M)



ALONG GRID A & B

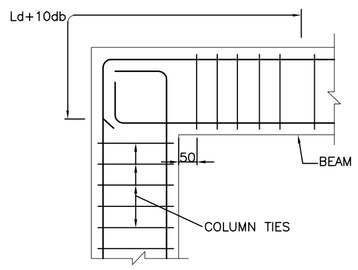


SECTION 1-1
FOUNDATION DETAILS



J-BOLT (M16) 4#
HDG MINIMUM 5.6 GRADE
(TYPICAL)

COLUMN
SECTION 2-2



FIXED EAND JOINT IN A COLUMN (TYP)

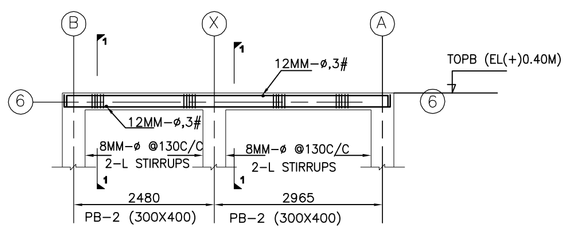
LAPPING LENGTH DETAILS (TYP)

SECTION 1-1
(SCALE 1:25)

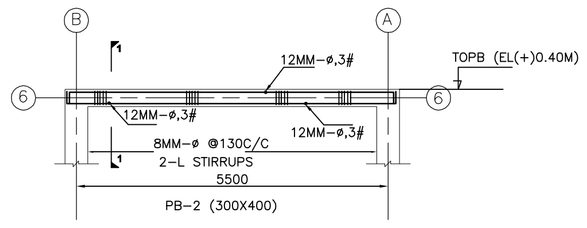
BASE PLATE DETAILS
(18ø - HOLE, 4#)

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS OTHERWISE SPECIFIED.
2. GRADE OF CONCRETE SHALL BE M-30 WITH 20mm DOWN GRADED AGGREGATES
3. REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BAR OF GRADE Fe500 CONFORMING TO IS:1786
4. MIN CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS FOOTING - 50MM , COLUMN - 50MM, PLINTH BEAM-50MM, SLAB-20MM.
5. LAP LENGTH SHALL BE 50D WHERE D IS THE DIA OF THE SMALLER BAR BEING LAPPED
6. LAPPING OF BARS SHALL BE SUITABLY STAGGERED AND IN NO CASE MORE THAN 50% BARS SHALL BE LAPPED AT ANY SECTION.
7. ALL HOOKS, BENDS, LAPS AND SPLICES SHALL BE AS PER RELEVANT IS CODE
8. BIDDER MAY CHOOSE BUILDING SPAN (C/C) FROM 5.5M TO 7.5M. FOUNDATION DETAILS HAVE BEEN MENTIONED FOR DIFFERENT RANGES OF SAFE BEARING CAPICITY(SBC). FOUNDATION COLUMN PEDESTAL, BASE PLATE, REINFORCEMENT DETAILS. SIZES ETC.SHALL BE DECIDED BASED ON TABLE-1 & TABLE-2 CONSIDERING THE SBC AND C/C SPAN. IN CASE OF SBC LESS THEN 5 T/SQM, FOUNDATION SHALL BE DESIGN BY BIDDER CONSIDERING PROJECT SPECIFIC CONDITIONS AND SHALL BE SUBMITTED FOR NTPC APPROVAL.
9. NO FOUNDATION SHALL BE LAID ON BACK FILLED SOIL.
10. IF ROCK IS ENCOUNTERED AT SHALLOW DEPTH THEN FOUNDATION MAY BE PLACED AT TOP OF ROCKY STRATA, HOWEVER IN NO CASE DEPTH OF FOUNDATION SHALL BE LESS THAN 1M. SBC SHALL BE DECIDED BY GEOTECHNICAL INVESTIGATION WORK CARRIED OUT BY CONTRACTOR AND APPROVAL BY NTPC IN GEOTECHNICAL INVESTIGATION REPORT.
11. DRAWING SHALL NOT BE SCALED. ONLY WRITTEN DIMENSION SHALL BE FOLLOWED.
12. PERIPHERAL GARLAND DRAIN SHALL BE MADE ALL AROUND THE PEB INVERTOR ROOMS AND CONNECTED TO NEAR BY DRAINS.
13. 750MM WIDE PLINTH PROTECTION WITH 75MM THK. PCC LAID OVER WELL COMPACTED 75MM DRY BRICK BALLAST ALL AROUND THE PEB ROOM IN LINE WITH TECHNICAL SPECIFICATION.
14. THE FGL OF PEB ROOM SHALL BE MINIMUM 500MM ABOVE SURROUNDING NGL.
15. ALL STRUCTURAL STEEL MEMBERS SHALL BE GALVANISED.THE THICKNESS OF GALVANIZATION SHALL BE IN LINE WITH IS4759. HOWEVER MINIMUM THICKNESS OF GALVANIZATION SHALL BE MAINTAINED AS 85 MICRON FOR ALL MEMBERS.
16. BIDDER SHALL SUBMIT THE DETAILED FABRICATION DRAWING AND PUFF PANAL DETAILS (DEVLOPED BASED ON NTPC TENDER DRAWING AND TECHNICAL SPECIFICATION) FOR NTPC INFORMATION BEFORE START OF WORK. ALL WORKS SHALL BE EXCUTED IN LINE WITH APPROVED DRAWING'S.
15. ALL BRACINGS LIKE BRC-1,BRC-2 SHALL BE CONTINUED IN EVERY ALTERNATE BAY IN CASE THE NO. OF BAYS ARE INCREASED. THE NO OF BAYS MAY BE REDUCED BASED ON BIDDER REQUIREMENT MAINTAINING THE BRACING IN EVERY ALTERNATE BAY. BIDDER SHALL ENSURE THAT THE BRACING IN BOTH THE DIAGONAL DIRECTIONS ARE PORVIDED IN PEB.
18. THE OPENINGS SHOWN IN PEB ARE TENTATIVE VENDOR SHALL FINALIZE THE SAME DURING DETAILED ENGG. BASED ON NTPC APPROVAL. VENTILATIONS AND DUCTS SHALL BE DESIGN CONSIDERING HEAT CALCULATION AND SUBMIT FOR NTPC APPROVAL BEFORE EXECUTION/MANUFACTURING.
19. THE SIZES OF FOUNDATION MENTIONED IN TABLE-1 FOR DIFFERENT RANGES OF SBC ARE MINIMUM SIZE TO BE ADOPTED BY BIDDER.
20. THE SIZES OF STRUCTURAL STEEL MEMBERS IN TABLE-2 ARE MINIMUM SIZES TO BE ADOPTED FOR DIFFERENT RANGES OF SPAN.



PLINTH BEAM ALONG GRID-6



PLINTH BEAM ALONG GRID-1

TABLE -1, PART-A (FOR SPAN S=5.5M)

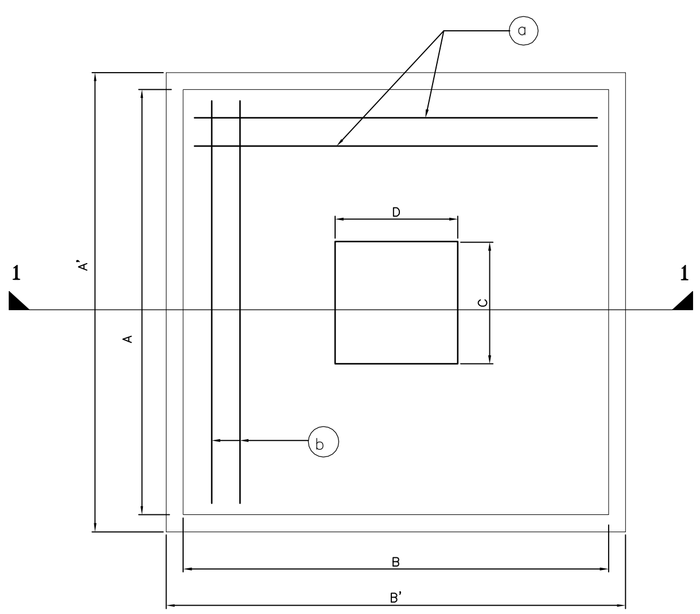
FOUNDATION REINFORCEMENT SCHEDULE										
S.NO.	SBC (IN T/SQM)	COLUMN	A	A'	B	B'	T	a	b
1	20 < = SBC	F01	1400	1500	1400	1500	300	12ø - @250c/c	12ø - @250c/c
2	10 <=SBC < 20	F01	1800	1900	1800	1900	325	12ø - @250c/c	12ø - @250c/c
3	7 <=SBC < 10	F01	2000	2100	2000	2100	350	12ø - @200c/c	12ø - @200c/c
4	5 <=SBC < 7	F01	2200	2300	2200	2300	375	12ø - @200c/c	12ø - @200c/c

TABLE -1, PART-B (FOR 5.5M < SPAN < = 6.5M)

FOUNDATION REINFORCEMENT SCHEDULE										
S.NO.	SBC (IN T/SQM)	COLUMN	A	A'	B	B'	T	a	b
1	20 < = SBC	F01	1500	1600	1500	1600	325	12ø - @250c/c	12ø - @250c/c
2	10 <=SBC < 20	F01	1900	2000	1900	2000	350	12ø - @250c/c	12ø - @250c/c
3	7 <=SBC < 10	F01	2100	2200	2100	2200	375	12ø - @200c/c	12ø - @200c/c
4	5 <=SBC < 7	F01	2300	2400	2300	2400	400	12ø - @200c/c	12ø - @200c/c

TABLE -1, PART-C (FOR 6.5M < SPAN < = 7.5M)

FOUNDATION REINFORCEMENT SCHEDULE										
S.NO.	SBC (IN T/SQM)	COLUMN	A	A'	B	B'	T	a	b
1	20 < = SBC	F01	1600	1700	1600	1700	350	12ø - @250c/c	12ø - @250c/c
2	10 <=SBC < 20	F01	2000	2100	2000	2100	375	12ø - @250c/c	12ø - @250c/c
3	7 <=SBC < 10	F01	2200	2300	2200	2300	400	12ø - @200c/c	12ø - @200c/c
4	5 <=SBC < 7	F01	2400	2500	2400	2500	400	12ø - @200c/c	12ø - @200c/c



FOOTING PLAN (TYPE F01)

TABLE -2

SPAN (S)	COLOUMN / RAFTER	BASE PLATE SIZE	PEDESTAL SIZE	MAIN RAINFORCEMENT OF PEDESTAL
S = 5.5M	ISMB 200	350X200	400X400	16ø-8NOS
5.5M< S <=6.5M	ISMB 250	400X225	450X400	16ø-8NOS
6.5M< S <= 7.5M	ISMB 300	450X250	500X400	16ø-10NOS

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TITLE: PEB INVERTOR ROOM

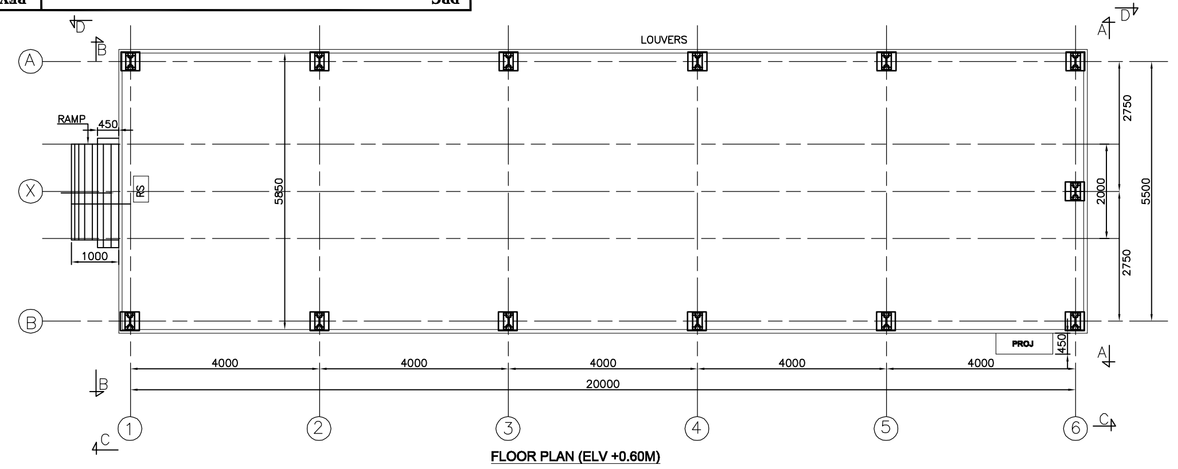
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	GEOTECH	REDG	ELEC.	APPD.	DATE
A		RAVI	AT						14.08.18
			CLEARED BY						

SIZE | SCALE | DRG. NO. 5742-004-POC-A-005 | REV.NO. A

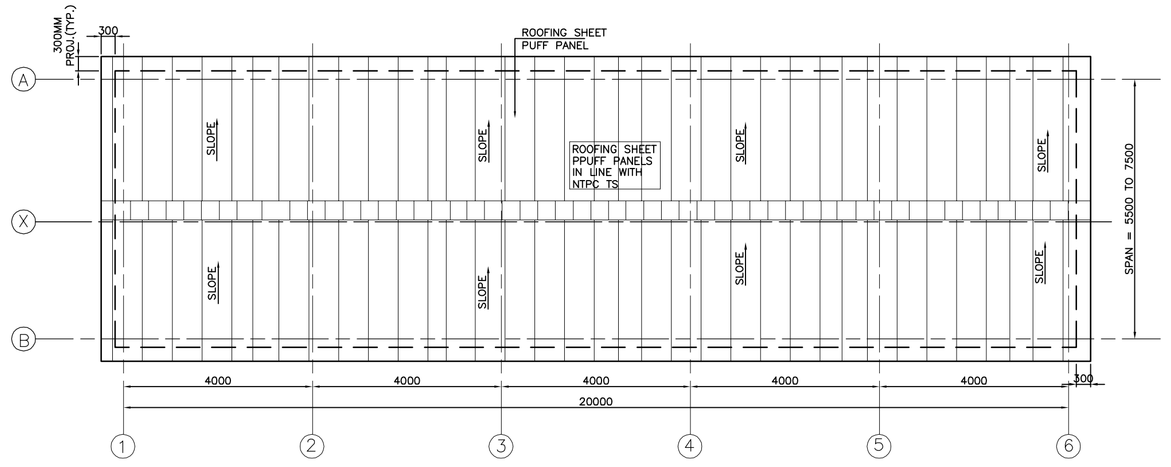
SHEET 2 OF 3

DRG. NO.

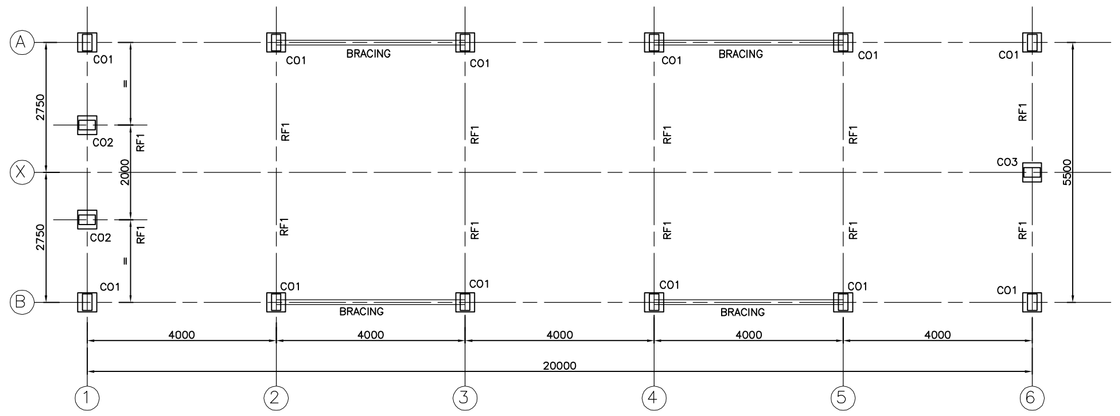
REV. NO.



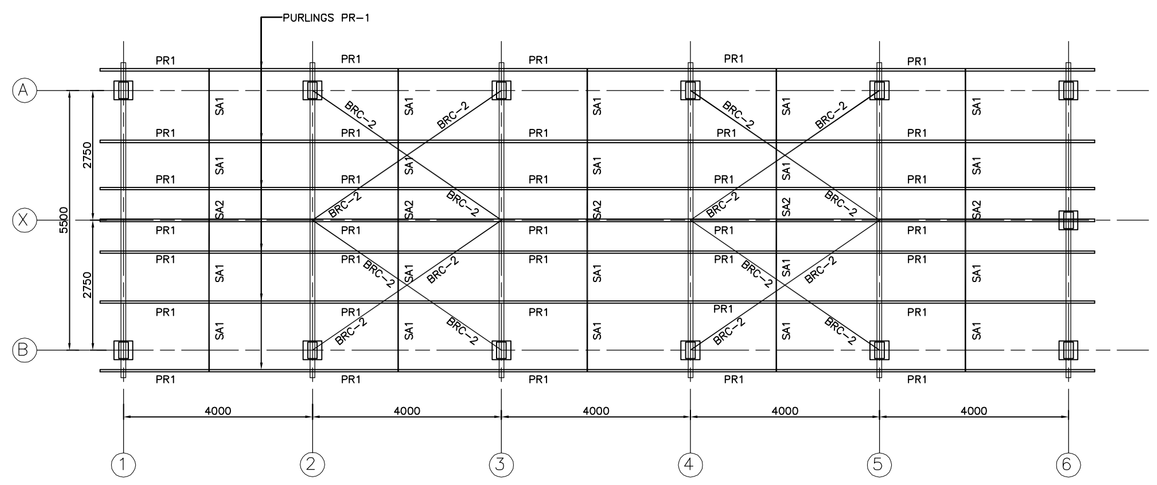
FLOOR PLAN (ELV +0.60M)



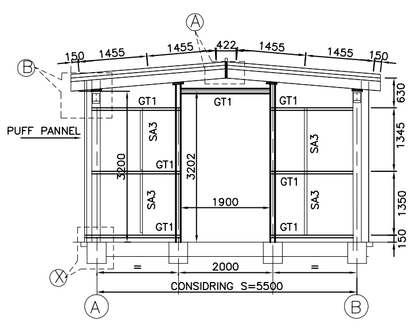
ROOF PLAN



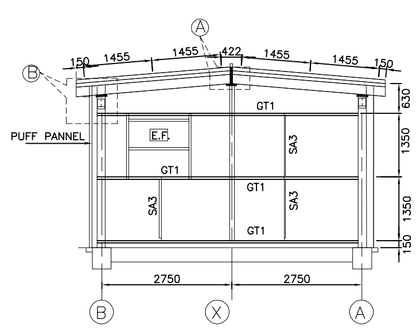
SIDE BRACING PLAN



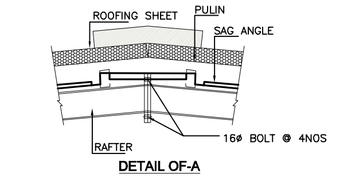
PURLINGS PLANS & TOP BRACING PLAN



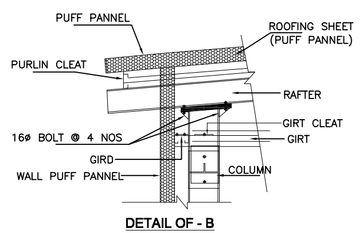
GABLE END ELEVATION ALONG GRID-1



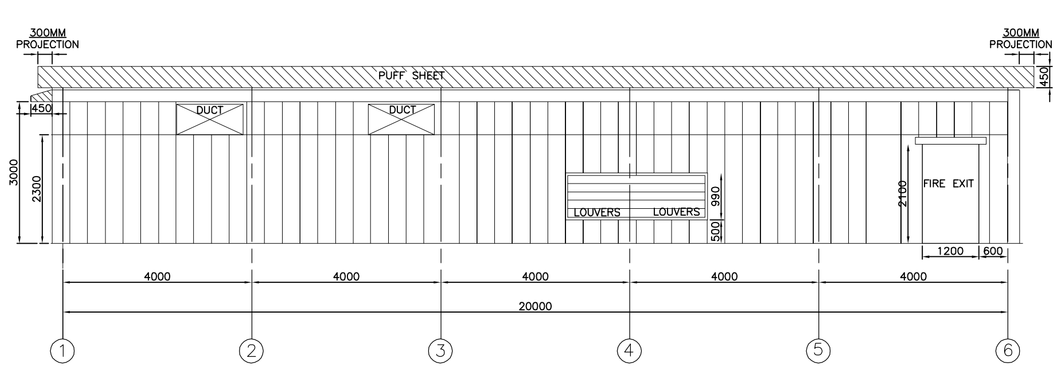
GABLE END ELEVATION ALONG GRID-6



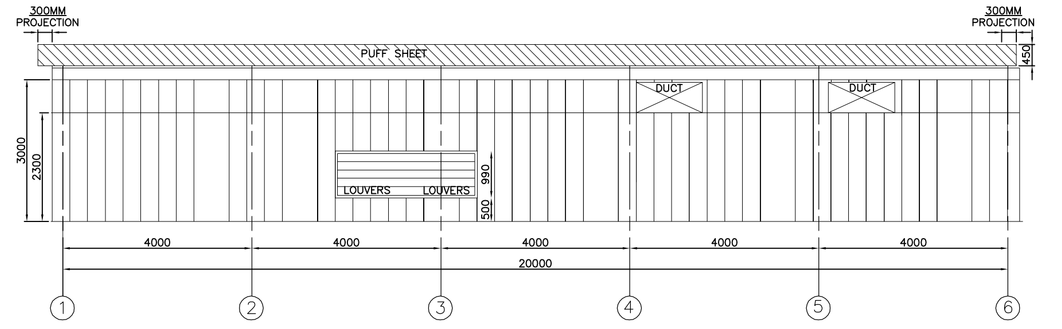
DETAIL OF-A



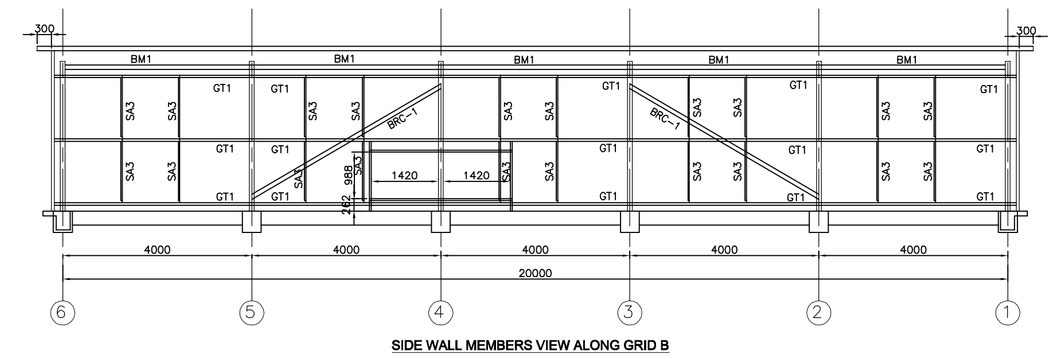
DETAIL OF - B



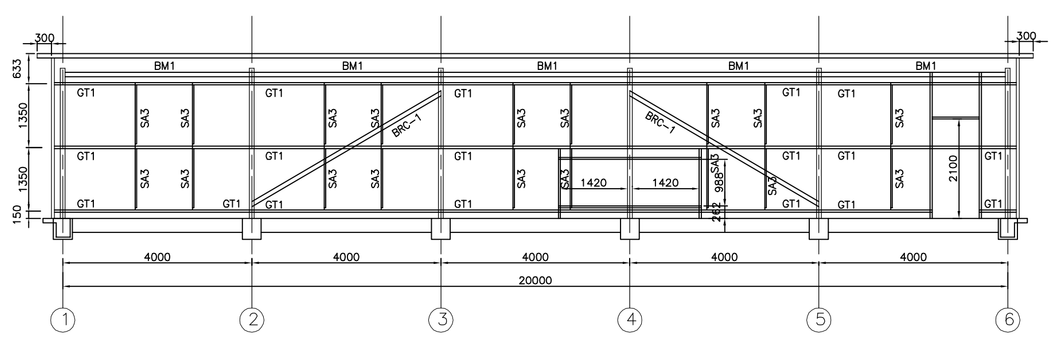
SIDE WALL ELEVATION ALONG GRID-B



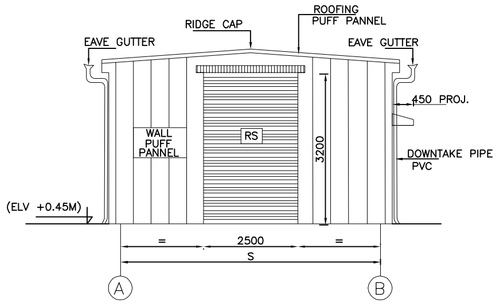
SIDE WALL ELEVATION ALONG GRID-A



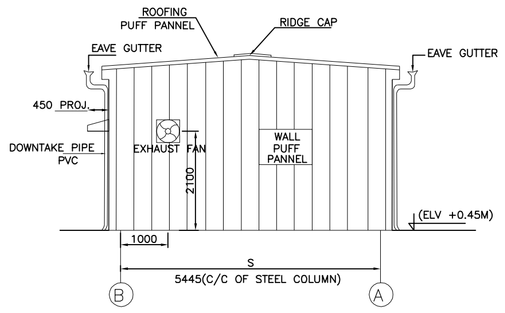
SIDE WALL MEMBERS VIEW ALONG GRID B



SIDE WALL MEMBERS VIEW ALONG GRID A



GABLE END ELEVATION ALONG GRID-1



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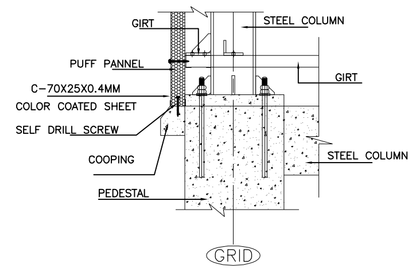
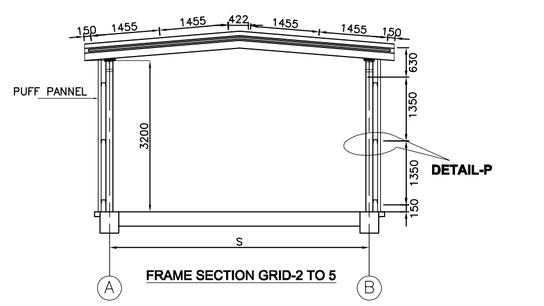
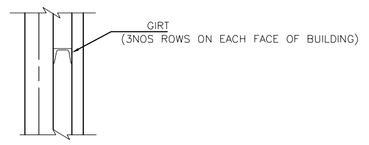


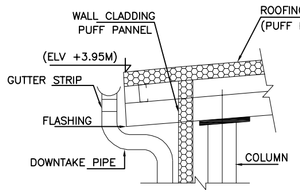
DETAILS OF -X
FLOOR & PUFF PANEL CONNECTION DETAIL



DETAIL-P
FRAME SECTION GRID-2 TO 5



DETAIL-P



DETAIL OF - B

TABLE -2, BILL OF MATERIAL

S.NO.	PART MARK	DESCRIPTION	SPAN (S)			SHAPE	MATERIAL SPECIFICATION	GRADE OF MATERIAL	GALVANIZATION COATING THICKNESS
			S = 5.5M	5.5M< S <=6.5M	6.5M< S <= 7.5M				
1	PR1	C-PURLIN *	100x50x20x3.15	100x50x20x3.15	100x50x20x3.15		COLD FORM	350	AS PER IS 4759
2	GT1	C-GIRT	100x50x20x3.15	100x50x20x3.15	100x50x20x3.15		COLD FORM	350	AS PER IS 4759
3	RF1	RAFTER	ISMB-200	ISMB-250	ISMB-300		HOT ROLLED	250	AS PER IS 4759
4	CO1	COLUMN	ISMB-200	ISMB-250	ISMB-300		HOT ROLLED	250	AS PER IS 4759
5	CO2	COLUMN	ISMB-200	ISMB-250	ISMB-300		HOT ROLLED	250	AS PER IS 4759
6	CO3	COLUMN	ISMB-200	ISMB-250	ISMB-300		HOT ROLLED	250	AS PER IS 4759
7	SP1	STRUT ANGLE	ANGLE-65x65x5	ANGLE-65x65x5	ANGLE-65x65x5		HOT ROLLED	250	AS PER IS 4759
8	BM1	BEAM HEADER	ISMB-150	ISMB-150	ISMB-150		HOT ROLLED	250	AS PER IS 4759
9	SA-1	SAG ANGLE	50X50X3	50X50X3	50X50X3		HOT ROLLED	250	AS PER IS 4759
10	SA-2	SAG ANGLE	50X50X3	50X50X3	50X50X3		HOT ROLLED	250	AS PER IS 4759
11	SA-3	SAG ANGLE	50X50X3	50X50X3	50X50X3		HOT ROLLED	250	AS PER IS 4759
12	BRC-1,BRC-2	STRUT PIPE	89MM (OD)	89MM (OD)	89MM (OD)		HOT ROLLED	250	AS PER IS 4759

* PURLIN SPACING SHALL BE MAINTAINED AS MAXIMUM 1450 MM FOR ALL SIZES OF SPANS.

TENTATIVE DETAIL OF OPENING

R.S.	ROLLING SHUTTER	1900X3200	1. NOS
F.E.	DOOR	1200X2100	1. NOS
E.F..	EXHUAST FAN	1500X3000	3. NOS
	LOUVERS	3000X970	2. NOS

NOTES

1 ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS OTHERWISE SPECIFIED.
2 GRADE OF CONCRETE SHALL BE M-30 WITH 20mm DOWN GRADED AGGREGATES
3 REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BAR OF GRADE Fe500 CONFORMING TO IS:1786
4 MIN CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS FOOTING - 50MM , COLUMN - 50MM, PLINTH BEAM-50MM, SLAB-20MM.
5 LAP LENGTH SHALL BE 50D WHERE D IS THE DIA OF THE SMALLER BAR BEING LAPPED
6 LAPPING OF BARS SHALL BE SUITABLY STAGGERED AND IN NO CASE MORE THAN 50% BARS SHALL BE LAPPED AT ANY SECTION.
7 ALL HOOKS, BENDS, LAPS AND SPLICES SHALL BE AS PER RELEVANT IS CODE
8 BIDDER MAY CHOOSE BUILDING SPAN (C/C) FROM 5.5M TO 7.5M. FOUNDATION DETAILS HAVE BEEN MENTIONED FOR DIFFERENT RANGES OF SAFE BEARING CAPICITY(SBC). FOUNDATION COLUMN PEDESTAL, BASE PLATE, REINFORCEMENT DETAILS. SIZES ETC.SHALL BE DECIDED BASED ON TABLE-1 & TABLE-2 CONSIDERING THE SBC AND C/C SPAN. IN CASE OF SBC LESS THEN 5 T/SQM, FOUNDATION SHALL BE DESIGN BY BIDDER CONSIDERING PROJECT SPECIFIC CONDITIONS AND SHALL BE SUBMITTED FOR NTPC APPROVAL.
9 NO FOUNDATION SHALL BE LAID ON BACK FILLED SOIL.
10 IF ROCK IS ENCOUNTERED AT SHALLOW DEPTH THEN FOUNDATION MAY BE PLACED AT TOP OF ROCKY STRATA, HOWEVER IN NO CASE DEPTH OF FOUNDATION SHALL BE LESS THAN 1M. SBC SHALL BE DECIDED BY GEOTECHNICAL INVESTIGATION WORK CARRIED OUT BY CONTRACTOR AND APPROVAL BY NTPC IN GEOTECHNICAL INVESTIGATION REPORT.
11 DRAWING SHALL NOT BE SCALED. ONLY WRITTEN DIMENSION SHALL BE FOLLOWED.
12 PERIPHERAL GARLAND DRAIN SHALL BE MADE ALL AROUND THE PEB INVERTOR ROOMS AND CONNECTED TO NEAR BY DRAINS.
13 750MM WIDE PLINTH PROTECTION WITH 75MM THK. PCC LAID OVER WELL COMPACTED 75MM DRY BRICK BALLAST ALL AROUND THE PEB ROOM IN LINE WITH TECHNICAL SPECIFICATION.
14 THE FGL OF PEB ROOM SHALL BE MINIMUM 500MM ABOVE SURROUNDING NGL.
15 ALL STRUCTURAL STEEL MEMBERS SHALL BE GALVANISED.THE THICKNESS OF GALVANIZATION SHALL BE IN LINE WITH IS4759. HOWEVER MINIMUM THICKNESS OF GALVANIZATION SHALL BE MAINTAINED AS 85 MICRON FOR ALL MEMBERS.
16 BIDDER SHALL SUBMIT THE DETAILED FABRICATION DRAWING AND PUFF PANAL DETAILS (DEVLOPED BASED ON NTPC TENDER DRAWING AND TECHNICAL SPECIFICATION) FOR NTPC INFORMATION BEFORE START OF WORK. ALL WORKS SHALL BE EXCUTED IN LINE WITH APPROVED DRAWING'S.
15 ALL BRACINGS LIKE BRC-1,BRC-2 SHALL BE CONTINUED IN EVERY ALTERNATE BAY IN CASE THE NO. OF BAYS ARE INCREASED. THE NO OF BAYS MAY BE REDUCED BASED ON BIDDER REQUIREMENT MAINTAINING THE BRACING IN EVERY ALTERNATE BAY. BIDDER SHALL ENSURE THAT THE BRACING IN BOTH THE DIAGONAL DIRECTIONS ARE PORVIDED IN PEB.
18 THE OPENINGS SHOWN IN PEB ARE TENTATIVE. VENDOR SHALL FINALIZE THE SAME DURING DETAILED ENGG. BASED ON NTPC APPROVAL. VENTILATIONS AND DUCTS SHALL BE DESIGN CONSIDERING HEAT CALCULATION AND SUBMIT FOR NTPC APPROVAL BEFORE EXECUTION/MANUFACTURING.
19 THE SIZES OF FOUNDATION MENTIONED IN TABLE-1 FOR DIFFERENT RANGES OF SBC ARE MINIMUM SIZE TO BE ADOPTED BY BIDDER.
20 THE SIZES OF STRUCTURAL STEEL MEMBERS IN TABLE-2 ARE MINIMUM SIZES TO BE ADOPTED FOR DIFFERENT RANGES OF SPAN.

एन टी पी सी लिमिटेड
NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
(ENGINEERING DIVISION)

PROJECT: DEVELOPMENT OF 22MW FLOATING SOLAR AT RGCCPP KAYAMKULAM

TITLE: PEB INVERTOR ROOM

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	GEOTECH	REDG	ELEC.	APPD.	DATE
A		RAVI	AT						14.08.18
			CLEARED BY						

SIZE | SCALE | DRG. NO. 5742-004-POC-A-005 | REV.NO. A
SHEET 3 OF 3

SAFETY PLAN

PROJECT- 22 MW FLOATING SOLAR PV PROJECT
NTPC, KAYAMKULAM

Doc ref. No.: BHEL:NTPCKYM:HSE:01 Rev. 00 Dated 12.03.2020

Rev. 01 dated 19.05.2020

PREPARED BY:

PV SYSTEM ENGINEERING

AND

HSE DEPARTMENT

BHEL EDN BANGALORE

HSE POLICY

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- Ensuring compliance with applicable legislation, regulations and BHEL systems.
- Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/ substitution/reduction/control.
- Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, contractors and suppliers on HSE issues.
- Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- Communicating this policy within BHEL and making it available to interested parties.

Atul Sobti
Chairman & Managing Director

June 5, 2018

Creating BHEL of tomorrow

BHARAT HEAVY ELECTRICALS LIMITED

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this Safety Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during execution of the 22 MW Floating Solar Project. This document shall be followed by M/s BHEL, Sub-Contractors & all persons at site at all installation and servicing sites. In case customer specific documents are to be referred, the same will be followed in conjunction with this document.

2.0 APPLICATION

The document is applicable for execution of the 22 MW Floating Solar Project and it is expected that Client and Sub-contractor are committed to the following guidelines:

- Ensure that the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment at the worksite.
- Ensure compliance at all times with the relevant statutory and contractual Safety requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including contractors in respects of Safety.
- Establish effective communication on SAFETY matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps. Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent authority.
- Ensure timely provision of resources to facilitate effective implementation of SAFETY requirements.
- Ensure continual improvements in SAFETY performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.

3.0 TERMINOLOGIES

❖ INCIDENT

Work- related event(s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred.

❖ **NEAR MISS**

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as “Near-Miss incident”.

❖ **MAN-HOURWORKED**

The total number of employee hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labors. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the period covered by the number of hours worked per day. The total number of workday for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

❖ **FIRST AID CASES**

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time. Please refer Format 03 for requirement of items with respect to treatment for First Aid Cases.

❖ **LOST TIME INJURY**

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

❖ **MEDICAL CASES**

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

❖ **TYPE OF INCIDENT / ACCIDENT & THEIR REPORTING:**

The three categories of Incident / accident are as follows:

- **Non-Reportable Cases:**
  An accident, where the injured person is given medical help and discharged for work without counting any lost time.

- **Reportable Cases:**

  In this case the injured person is disabled for 48 hours or more and is not able to perform his duty.

- **Injury Cases:**

  These are covered under the heading of non-reportable cases. In these cases the accident caused injury to the person, but he still continues in his duty.

❖ **TOTAL REPORTABLE FREQUENCY RATE**

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula read as:

$$\frac{\text{Number of Reportable LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

❖ **SEVERITY RATE**

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

$$\frac{\text{Days lost due to LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

❖ **INCIDENCE RATE**

Incidence Rate is the Number of LTI per one thousand manpower deployed.

$$\frac{\text{Number of LTI} \times 1000}{\text{Average number of manpower deployed}}$$

❖ **MANAGEMENT REPRESENTATIVE:** Representative from Project Head

❖ **OCP:** Operation Control Procedures

❖ **PPE:** Personal Protective Equipment

4.0 ROLES & RESPONSIBILITIES

4.1 SAFETY CO-ORDINATOR

- Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, and other tools and tackles. Record observations as per Format 01 on a weekly basis.
- Facilitate inclusion of safety elements into Work Method Statement.
- Highlight the requirements of safety through Tool-box / other meetings.
- Conduct investigation of all accident/dangerous occurrences & recommend appropriate safety measures.
- Advice & co-ordinate for implementation of SAFETY permit systems & OCPs. Convene SAFETY meeting & minute the proceedings for circulation & follow-up action.
- Plan procurement of PPE & Safety devices and inspect their healthiness.
- Facilitate administration of First-Aid
- Facilitate screening of workmen and safety induction.
- Conduct fire drill and facilitate emergency preparedness
- Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- Notify site personnel for non-conformance to safety norms observed during site visits / site inspections.
- Recommend to Site In charge for immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
- To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.

4.2 ALL EMPLOYEES

- To adopt safe working practices
- To take corrective action and preventive action in case any non-conformity is observed on product / process / system with respect to Occupational Health, Safety and Environment.
- To report all incidents including near miss to Safety Coordinator.
- In case any particular activity / work has extremely high consequential risk or high environmental impact, the employee shall bring it to the notice of Site In charge before starting the work.

- To ensure that the workers are engaged by the contractor for the job after undergoing induction training.
- To ensure that the persons engaged in his area, follow the safety rules like using appropriate PPEs.
- To get involved in exercises like Job Safety Analysis and Work Permit System.
- To engage licensed electricians for site electrical works.
- To report any incident including near misses or safety lapses immediately to Safety Coordinator
- To support/co-operate with audit team members as & when safety audits are carried out.
- To involve in investigation, if any incident occurs in his work area.
- To participate in safety promotional programmers'.
- To attend the safety committee meeting, if he is a member/invitee
- To ensure that only suitable Tackles & Plants and qualified persons are engaged.

5.0 SUB-CONTRACTOR REPRESENTATIVE AT SITE

- Shall fill-up agreement form for compliance to relevant safety Plan for Site Operations.
- Shall ensure fulfillment of relevant safety requirements of 22 MW floating solar Project and practice very strictly in his area of work in consultation with his concerned engineer and the Safety Coordinator.
- Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- Shall not engage any employee below 18 years.
- Shall arrange for all necessary PPEs like life jackets, safety helmets, belts, safety shoes, face shield, high visibility vest, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in BOCW Rules and Regulations.
- Shall ensure that all Tackles & Plants engaged are tested for fitness and have valid certificates from competent authorities.
- Shall adhere to the instructions laid down in Operation Control Procedures (OCPs Point No 8)
- Shall ensure that person working above 3.3 meter should use Safety Harness tied to a life line/stable structure.
- Shall ensure that materials are not thrown from height. Caution to be exercised to prevent fall of material from height.
- Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /Safety Coordinator of the 22 MW floating solar Project.
- Shall ensure that adequate illumination is arranged during all the time.
- Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- Shall ensure display of adequate signage/posters on HSE.
- Shall ensure that mobile phone is not used by workers while working.
- Shall ensure conductance of mock drill, induction training and training on the site.
- Shall ensure good housekeeping.
- Shall ensure adequate valid fire extinguishers are provided at the worksite.

- Shall ensure adequate drinking water at work site
- Shall ensure adequate emergency preparedness.

5.1 DEPLOYMENT OF TOOLS & PLANTS

- As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable.
- The machinery and equipment to be employed for this purpose shall include but not limited to the following:

o Mobile cranes.
o Side Booms.
o Forklifts.
o Grinding machine.
o Drilling machine.
o Air compressors.
o Welding machine.
o Generator sets.
o Dump Trucks, tractors.
o JCBs,Excavators.
o Hand tools.
o Road Rollers
o Vibration Compacters
o Boring Machine
o Chipping Machines
o Hammer Machines
o Breakers
o Boats
o Floating Machinery

5.2 DEPLOYMENT OF MANPOWER

- As a measure to ensure that manpower being mobilized to the construction site is fit and competent for safe working, screening arrangement shall be made by the sub-contractors to fulfill contractual as well as legislative requirement.
- Examination of medical fitness shall be conducted through qualified medical professional for all workers to be deployed. The Medical Examination reports are maintained by the Safety Coordinator of BHEL.
- Gate pass is linked with medical check-up fitness certificate and compulsory completion of safety induction training. For under water works valid diving certificates are compulsory.

5.3 DEPLOYMENT OF PPEs

The following matrix recommends usage of minimum PPEs against the respective job. The PPEs shall conform to the relevant standards as listed in the reference under clause 3.0 and bear ISI mark. All the PPEs shall be periodically checked for its quality before issue by safety coordinator. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be repaired/ replaced. The issuing agency shall maintain register for issue and receipt of PPEs. The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front. The body harnesses shall be serial numbered.

Sl.no	Type of work	PPEs (Subject to applicability of process)
1	Concrete, asphalt mixing	Nose mask, hand glove, apron and gum boot
2	Welders/Grinders/ Gas cutters	Welding/face screen, apron, hand gloves. Helmet fitted with welding shield is preferred for welders
3	Stone/ concrete breakers	Safety goggles, hand gloves
4	Electrical Work	Rubber hand glove, Electrical Resistance shoes
5	Insulation Work	Hand gloves
6	Work at height	Double lanyard full body harness, Fall arrestor (specific cases)
7	Grit/Sand blasting	Blast suit, blast helmet, gloves
8	Painting	Plastic gloves, respirator for spray Painting)
9	Work on water for PV floaters, floating system	Life jackets, Rescue Boat with trained rescue team.
10	Work in water for anchoring and mooring system	SCUBA apparatus, Rescue Boat with trained rescue team

Rescue boat with trained and authorized boat operators with rescue team shall be available at site all the time till all persons involved reach the shore.

Besides the PPEs mentioned above, the persons shall use helmet and safety shoe. The visitors shall be issued Helmet and any other PPEs as deemed appropriate for use in the area of work.

❖ **Color Code for Helmets:**

1. Workmen: Yellow.
2. Safety staff: Green.
3. Engg, supervisor, visitor, site in charge: White.

5.4 MEDICAL FACILITIES

➢ **FIRST AID PROVIDER**

- Every injury shall be treated, recorded and reported.
- Refresher course on first aid shall be conducted as necessary.

- List of qualified first aiders and their contact numbers should be displayed at major locations by safety Coordinator.

➢ **FIRST AID BOX**

- First aid facilities shall be provided and maintained.
- The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact number to be displayed on the box.
- The first aid box shall be distinctly marked with a Red Cross on white background.
- Details of contents of first aid box is given in Format No.02
- Monthly inspection of First Aid Box shall be carried out by the Site In charge as per format no 02.

➢ **HEALTH CHECKUP**

The persons engaged at the site shall undergo health checkup as per the **format no 03** before induction.

a. Height workers
b. Drivers/crane operators/riggers
c. Confined space workers
d. Shot/sandblaster
e. Welding and NDE personnel.
f. Divers for under water activity

➢ **PROVISION OF EMERGENCY VEHICLE**

A vehicle shall be stationed exclusively at workplace to handle emergencies. This shall be by way of tying up with customer's medical centre /local hospitals/ sub-contractors by mutual aid agreement.

6.0 SAFETY TRAINING & AWARENESS

❖ **SAFETY INDUCTION TRAINING**

All persons entering into project site shall be given safety induction training by the Safety Coordinator of 22 MW floating solar Project. In-house induction training subjects shall include but not limited to:

- Briefing of the Project.
- Safety objectives and targets.
- Site safety rules.
- Site safety hazards
- First aid facility.
- Emergency Contact No.
- Accident reporting.
- Fire prevention and emergency response.

- Proper safety wear & gear must be issued to all the workers being registered for the induction.
- They must arrive fully dressed in safety wear & gear to attend the induction.
- Any one failing to conform to this safety wear & gear requirement shall not qualify to attend.
- Risk of Drowning

Each employee shall undergo safety induction training.

❖ **TOOL BOX TALK**

- Tool Box talk shall be conducted by Safety Coordinator to work groups prior to the start of work. The agenda shall consist of the following:
- Details of the job being intended for immediate execution.
- The relevant hazards and risks involved in executing the job and their control and mitigating measures.
- Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
- Risk of drowning while working in water
- Recent non-compliances observed.
- Appreciation of good work done by any person.
- Record of Tool box talk shall be maintained as per format no 06

❖ **TRAINING ON HEIGHT WORK**

Training on height work shall be imparted to all workers working at height by in- house/external faculty. The training shall include following topics:

- Use of PPEs
- Use of fall arrester, life line.
- Safe climbing through monkey ladders.
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue at height.

❖ **TRAINING ON WORK IN WATER**

Training on working in water shall be imparted to all workers working in water by in- house/external faculty. The training shall include following topics:

- Use of PPEs
- Risk of drowning
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue in case of accidents.

❖ **SAFETY PROMOTION-SIGNAGE, POSTERS**

➢ **Display of safety posters and banners.**

- Site shall arrange appropriate posters, banners, slogans in local/Hindi/, English languages at workplace

➢ **Display of safety signage**

- Appropriate safety signage shall be displayed at the work area to aware workmen and passersby about the work going on and do's and don'ts to be followed.

➢ **Safety awareness program/safety training program**

- Site will arrange safety awareness program periodically on different topics including medical awareness for all personnel working at site.

- Safety Coordinator shall arrange training program based on site condition

7.0 SAFETY COMMUNICATION

❖ **MONTHLY SAFETY REPORTING**

- Safety information of Site shall be reported monthly through Monthly Site safety report (MSR) as per format 04.

- The period of reporting shall be 1st of each calendar month.

8.0 OPERATIONAL CONTROL

Permit applicant shall apply for work permit of particular work activity before starting of the work in the format 13.

8.1 EXCAVATION WORK SAFETY:

Excavation permit shall be taken before the start of the excavation work as per depth limits.

- Avoid damage / personal injury during excavation work at sites.
- Ensure proper barricading by ribbon or Hard barricading of the excavated area.
- Proper side slopes of the excavation as per the type of soil should be maintained.
- Where side slopes cannot be provided due to space constraints before excavation, sheet piling must be done to prevent the collapse of earth.
- As soon as the job is completed, immediate back filling to be done.
- No personnel be allowed within the swing area of mechanical excavator when work is in progress.
- Proper lighting to be arranged when the excavation is carried out at night.
- Excavated earth to be dumped/ stored in a designated place only.
- Surplus earth to be transported and disposed in the authorized area.

- Site safety department to identify all possible hazard areas related to excavation work and ensure control.
- Use proper PPE"s.
- Ensure adequate caution signs are displayed in the area of operation.

8.2 FLOATING WORK SAFETY

Floating work permit shall be taken before the start of any work in water.

- Ensure working with a partner or team when working around or on water. Preferably at least two people need to be in sight of each other at all times.
- Availability of communication devices to be ensured before going to work in water.
- Proper provision for first aid to be ensured.
- The availability of water rescue boat with team shall be ensured.
- Use of suitable personal buoyancy equipment, such as lifejackets shall be ensured.
- All persons who are going to work in water must trained to understand clearly any procedures in place and what action they must take to protect themselves, including in an emergency.

9.0 WORK PERMIT SYSTEM

- The following activities shall come under Work Permit System

a. Height working of 3.3 metre and above

b. Excavation more than 1.5 meter depth

c. Heavy lifting by machinery on land

d. Works of floaters involving activity in water other than shore

- "Safety Procedure for Work Permit System" shall be followed while implementing permit system.
- Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work in the format 13.
- Permit signatory shall check that all the control measures necessary for the activity are in place and issue the permit to the permit holder.
- Permit holder shall implement and maintain all control measures during the period of permit
- He will close the permit after completion of the work. The closed permit shall be archived with safety personnel of site.
- Permission for Works in water shall be permitted after checks related to compliance to wearing PPEs, availability of safety boat

10.0 HOUSEKEEPING

- Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.

- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations. Sufficient waste bins shall be provided at different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from higher location.
- Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- Fabricated steel structures, pipes & piping materials shall be stacked properly.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power lines.
- Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

11.0 WASTE MANAGEMENT

❖ STORAGE AND COLLECTION

- Different types of rubbish/waste should be collected and stored separately.
- Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- Rubbish should not be left or allowed to accumulate on construction and other workplaces.
- Construction rubbish should not be burnt near working site.

❖ SEGGREGATION

- Earmark the scrap area for different types of waste.
- Store wastes away from building.
- Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- Clinical and first aid waste stored and incinerated separately.

❖ DISPOSAL

- Sufficient containers and scrap disposal area should be allocated.
- All scrap bin and containers should be conveniently located.
- Provide self-closing containers for flammable/spontaneously combustible material.
- Keep drainage channels free from choking.
- Maintain a schedule for collection and disposal of waste.

12.0 WARNING AND SIGNS

- Appropriate sign to be displayed at scrap storage area
- No toxic, corrosive or flammable substance to be discarded into common sewage system.
- Waste disposal shall be in accordance with best practice.

13.0 EMERGENCY PREPAREDNESS AND RESPONSE (EPR)

❖ **DEFINITION**:

An emergency occurring at site is one that may affect work at site and / or may cause serious injuries, loss of life, extensive damage to property.

❖ **OBJECTIVE:**

This EPR aims at putting into place the system for early identification of the situation, classification and setting into motion action by the concerned Action teams to mitigate the situation and normalize the area.

❖ **NATURE OF EMERGENCIES AT SITE:**

Emergencies during the course of execution of Floating SPV Project is likely from following exigencies:

1. Fire: Fire can take place at site at storage area, DG powerhouse, site offices and other areas at site.

2. Water body related accidents: Drowning, slippage, Fall in water.

3. Medical emergencies: A medical emergency refers to any situation in which a person(s) requires medical intervention. Medical emergencies include complications from medical conditions and work injuries. Having trained staff and effective emergency response procedures will reduce the impact of a medical emergency on the individual and the organization.

❖ **MODE OF OPERATION IN EMERGENCY:**

i. **Raising an Alarm:**

In the event of emergency, the security guard on duty/work supervisor will identify the nature of emergency and raise an alarm.

ii. **Assessment of The Emergency Situation**

Assessing the Emergency situation is to be done primarily by the concerned work supervisor. He assesses the situation and convey information regarding the Emergency situation to BHEL Safety Coordinator and the BHEL Site In-charge and other important persons whose Telephone numbers are given as below, as feel necessary based on assessment of situation:

EMERGENCY CONTACT NOS		
Sr. No.	Name of person Agency	Contact Nos.
1	BHEL Project In-charge	
2	BHEL Safety Coordinator	
3	BHEL site/Area in-charge / Incident Controller	
4	Bhel EPC Vendor In-charge Contact no.	
5	NTPC CISF emergency contact	
6	NTPC Fire Fighting Department Contact	
7	Kayamkulam Fire Fighting Department Contact no.	
8	NTPC Medical Centre Contact	
9	Identified Hospitals Names : with address and no. and approx. distance	
10	BHEL Emergency site vehicle Driver :	

BHEL Site Incharge in consultation with the BHEL Project Incharge will take decision on any additional resources required from outside in handling the situation. Depending on level of emergency, his job will involve co-ordination of rescue and other emergency activities on site and liaison with the respective authorities (Fire services and Hospitals) for assistance in firefighting, hospitalization etc.

iii. **Termination of the Emergency:**

When the conditions causing Emergency are brought under control and residual situation can be tackled by the site's internal resources, Site Incharge will announce termination of emergency situation and inform the project In-charge and concerned NTPC officials.

❖ **EMERGENCY MITIGATION PROCEDURE:**

1. Fire Incident:

- The emergency alarm to be raised by the concern work supervisor/security guard on duty.
- After quick assessment of situation, work supervisor shall communicate to the concern persons.
- The available personnel at site will aid the fire suppression system with the available fire extinguishing equipment
- activating water pumping sets for spraying, as available
- Provide first aid to injured persons, if any
- Suspend all operations at that area of site
-Shut off the main power supply
- Evacuation of all contractors, visitors and motor vehicles on the site to a safe distance from the site at the identified assembly point at site
- Provide access for the special equipment of the Fire Safety to sources of water
- Provide assistance to the personnel of the Fire Safety with the extinguishing of the fire;

2. Water Incident:

- Immediate information about incident to be given to BHEL site In charge and Safety Coordinator by Work Supervisor
- Information to rescue team to point in water and bringing the affected person/s to shore
- Information to BHEL emergency Vehicle for shifting of injured to nearest hospital

3. Medical emergencies:

- Immediate information about incident to be given to BHEL site in charge and Project in charge by Work Supervisor
- First Aid to be given, if possible
- Information to BHEL emergency Vehicle for shifting of injured to nearest hospital

The EPP shall be tested once in two months through Mock drills as per Format No. 14 and 15.

14.0: FIRE SAFETY PROCEDURE

1. Site-in-charge / Safety Coordinator will make periodical review of the site Fire Protection, Prevention Preparedness, Site conditions and available fire protection equipment.

2. A mutual aid agreement with local Fire station for availability of Fire tender shall be made.
3. It is very imperative good contact with Local fire station for availability of Fire tender in case of emergencies, in additional to their own fire equipment.
4. Fire Protection, Prevention and Preparedness Inspections - The Contractor /Sub-Contractor will be required to make frequent fire prevention inspections of his work site and operating facilities. Deficiencies will be corrected at once.
5. Emergency telephone number to be displayed at all important places.

15. CONTROL OF DOCUMENTS

All documents shall be controlled as per safety Procedure for Document Control and on water, in water have maintain required documents, certificates.

16.0 SAFETY INSPECTION

Inspection on safety for different activities being carried out at site shall be done to ensure compliance to safety requirements. Before start the work ensure all required PPEs on water, in water and other working locations.

❖ DAILY SAFETY CHECKS

Site Supervisors or safety Supervisors of BHEL's subcontractors are to conduct daily site safety inspection around work activities and premises to ensure that work methods and the sites are maintained to the acceptable standard.

❖ INSPECTION OF PPE

- PPEs shall be inspected by Safety Coordinator at random once in a week as per **Format no 07 for** its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- The applicable PPEs for carrying out particular activities are listed below.
- The IS standard to be complied to, for different PPEs, is given as follows:

RELEVANT IS-CODES FOR PERSONAL PROTECTION

IS: 2925 – 1984	Industrial Safety Helmets.
IS: 4770 – 1968	Rubber gloves for electrical purposes.
IS: 5557 – 1969	Industrial and Safety rubber knee boots.
IS: 5983 – 1978	Eye protectors.
IS: 9167 – 1979	Ear protectors.
IS: 3521 – 1983	Industrial Safety Belts and Harness
IROS (or MMD)	Life jackets/Vests

❖ INSPECTION OF TOOLS & PLANTS

- A master list of Tools & Plants shall be maintained by each subcontractor.
- All Tools & Plants being used at site shall be inspected by Safety Coordinator once in a month as per Format no 08 for its healthiness and maintenance.
- The Tools & Plants which require third party inspection shall be checked for its validity during inspection.
- The certificate of Tools & Plants shall be monitored as per Format no 09

❖ INSPECTION OF CRANES AND WINCHES

- Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- Cranes and Winches shall be inspected by Safety Coordinator once in a month as per Format no 10 for healthiness, maintenance and validity of third party inspection and SWL shall be displayed.
- The date of third party inspection and next due date shall be painted on cranes and winches.

❖ INSPECTION ON HEIGHT WORKING (ONLY FOR CMCS AS APPLICABLE)

- Inspection on height working shall be conducted by Safety representative of Construction agency before start of work to ensure safe working condition including provision of
    - o Safety Harness
    - o Fencing and barricading
    - o Warning signage
    - o Covering of opening
    - o Proper scaffolding with access and egress.
    - o Illumination
- Inspection on height working shall be conducted once in a week by Safety Coordinator as per format no 11
- Height working shall not be allowed during adverse weather.

❖ INSPECTION ON ELECTRICAL INSTALLATION /APPLIANCES

- Ensure proper earthing in electrical installation. Verify values per month.
- Use ELCB with 30 mille amps sensitivity at electrical booth.
- Electrical installation shall be properly covered at top where required
- Use appropriate PPEs while working
- Use portable electrical light < 24 V in confined space and potentially wet area.
- Monthly inspection shall be carried out for all ELCBs/RCCBs.

17. 0 MONTHLY SAFETY REVIEW MEETING

- Site shall hold SAFETY review meeting every month to discuss and resolve SAFETY issues of site and improve SAFETY performance. It will also discuss the incidents occurred since previous meeting its root cause and corrective action and preventive action.

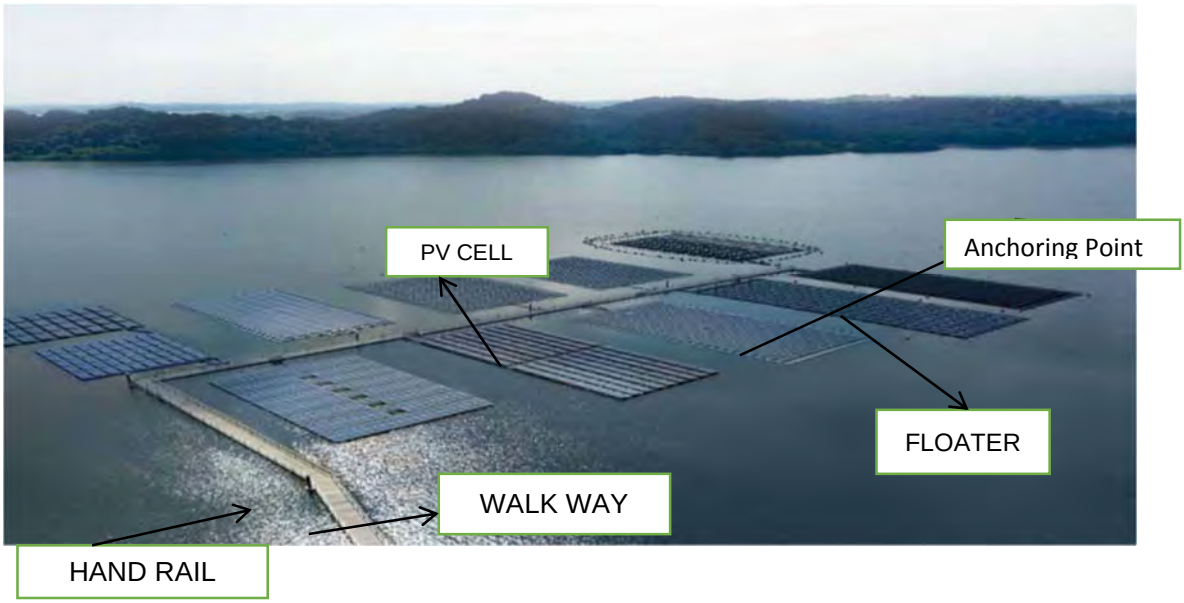
- The meeting shall be chaired by Site In charge, convened by Safety Coordinator and attended by all head of sections (HOS), Site In charge of Subcontractors and Safety representative of Subcontractors.

- MOM on the discussion will be circulated to the concerned for implementation.

18.0 TYPICAL DEPICTION OF FLOATING SOLAR PV SYSTEM (FOR GENERAL REFERENCE)

FLOATING SOLAR POWER ERECTION SAFETY

(Floating platform Under construction)



❖ **SYSTEM COMPONENTS**:

1. Solar PV modules for conversion of solar radiation to electrical energy/
2. Anchoring systems: Anchoring system refers to permanent under-water structure to secure floating platforms.
3. Pontoon: A pontoon is floatation device with enough buoyancy to float by itself as well as with a heavy load.
4. Floats: Multiple plastic hollow floats with effective buoyancy to self-weight ratio are combined over and over again, forming a giant pontoon. The floats are typically made of HDPE (high density polyethylene), known for its tensile strength, maintenance free property.
5. Mooring system: A mooring system usually refers to any permanent structure on the banks to which floats are secured.
6. Cables and connectors: Electricity is drawn from the solar array and transported to the land. Therefore, the power can be fed to the grid or stored in batteries.

19.0 RISKS AND HAZARD:

1. Identified as per Job Risk Assessment exercise and HIRA Documents attached based on planned construction activities. In case of requirement for erection or civil work of type not envisaged, JSA/HIRA for the same will be prepared and NTPC approval obtained to commence the activity.

❖ **PRECAUTIONS:**

1. As mentioned in enclosed HIRA Documents.

20.0 SITE RECORDING FORMATS: Enclosed

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HAZARD IDENTIFICATION AND RISK ASSESMENT (HIRA)	
Job Task: Tree felling and vegetation clearance	**Equipment #:** Hydra/Crane/JCB
Project/Location: 22 mw Floating Solar Project, NTPC, Kayamkulam	**Analysis done by: PV System Engg. Reviewed by: BHEL-HSE**
PPE required: Safety helmet, vest, shoes, hand gloves, goggles etc.	**Date Initiated: Revised date:**
Emergency Plan: Yes	
Tools used: Hand operated Power saws, Cutting tools	**Chemicals used:** Yes

Sequence of Job Steps	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Entry to forest area (Area Survey)	1.Common Natural Hazard : A) Snake Bite, Insect bites like mosquitoe, Honey bee sting etc B) Falling branches, trees C) Fall, trip	1. Injuries 2. Fatality 3. Property damage 4. Man days lost	1. Before entry to the forest check for valid permit, and submit all documents of workers like medical fitness certificates, Group insurance, etc. 2. Briefly discuss about the job and identify line and markings of area or path of work before commencing 3. Organize for presence of a local representative/employee from forest department before start of work. 4. Exercise caution while carrying out work and before commencement of works address the workers to be always careful. 5. Work is allowed during day hours only 6. Field First aid box along with required medical kit (incl. snake anti dot, insect repellant cream) shall be available near the site 7. Awareness of types of snakes in the vicinity (poisonous/ non-poisonous) by way of display of charts	Safety knee height shoes (Gumboot) Safety Helmet, Safety goggles, Safety vest, Hand gloves, Full body protective apron ,Nose mask

Sequence of Job Steps	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Cutting and shifting of heavy trees with the help of sawing machine, crane & rigging activity.	1.Pinching points. 2.Failure of lifting tools and tackles due to use of damaged / under capacity tools and tackles. 3. Failure of sawing machine. 4. Hit by load due to swinging. 5. Tree fall or collapse. 6.Electric shock 7. drowning due to sinking in swamp/ loose soil and falling in deep pits 8) Fall of logs during loading 9) Toppling of machinery due to loose soil 10) contact with Overhead live electric cable	1. Cut injuries 2. Man days lost 3. Serious injuries 4. Fatality	1.Check Submit all TPI certificates and check for proper working of cutting all machines 2.Critical Lift Permit and Lifting plan shall be prepared if use more than one crane, 75% of capacity of crane or above 50 MT material. 3. Ensure presence of an experienced and competent foreman/Signalman/Rigger. 4. Ensure that workmen keep their hands / leg away from pinching points. Proper communication & co-ordination with coworker. 5. Ensure proper supervisoin. 6. Ensure to use of certified and tested lifting tools and tackles with proper capacity. 7a. Safe working load should be displayed on all matl handling eqpt. 7. Softener or packing shall be provided in between slings and structural member. 8. While lifting ensure no one comes under suspended load. 9. Ensure use of tag lines to control the load. 10. Lifting affected area to be cordon off & caution sign to be posted to avoid unauthorized entery. 11. Only authorized operatior with valid licence to operate the crane.Authorized signal man with wearing reflective jacket shall be engaged. 12. Normal Lift Permit and Lifting plan shall be prepared if lifting Above 5 MT. 13. Daily Inspection checklist of crane/JCB/Cutting machine shall be ensured by users. 14. Stationary type Machinery shall be located in leveled platform and the same shall be ensured by the site engineer. 15.Ensure that soil bearing capacity is adequate to bear the load of machinery 16. Keep cutting tools sharp and in good condition. 17. Avoid work with oily hands. 18. Precautions for swamp/ loose soil / deep pits, etc.	Safety Knee height shoes(Gumboot), Safety Helmet, Safety goggles, Safety vest, Hand gloves, Reflective jacket, rain coat,
Housekeeping	1. Chances of fire during friction 2. Slip Trip Fall	1. Injuries 2. Fatality 3. Chances of damage natural balance.	1. Clean area properly 2. Not to dump bushes and trees in work area 3. Carry out stacking in designated area in orderly manner for further disposal.	Safety shoes (Gumboots), safety Helmet, Vest, goggles, Hand gloves.

Date	Reviewed By sub-contractor and or their authorized competent person		Is any additional precautions to be taken for the day
	Job Supervisor / Engineer	Safety Officer	

HAZARD IDENTIFICATION AND RISK ASSESMENT (HIRA)	
Job Task: Erection of materials and over all site work	**Equipment #:** Hydra/Crane, Welding M/c,
Project/Location: 22 MW Floating Solar Project, NTPC, Kayamkulam	**Analysis done by: PV System Engineering Reviewed by: BHEL- HSE**
PPE required: Safety helmet, vest, shoes, hand gloves, etc. (IS standard) **Emergency Plan:** Yes	**Date Initiated:** **Revised date:**
Tools used: Gas cutting set, Chain pulleys, Sling, D-shackle, Bow shackle.	**Chemicals used:** NO

Job activities/Work	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Structural materials shifting and Lifting.	1. Pinching of leg/hands of workmen while handling 2. Structural members. 3. Swinging of load. 4. Poor weather condition. 5. Overloading of crane. 6. Unauthorized operation of crane by helper.	1. Head injuries. 2. Cut injuries 3. Man days lost 4. Property damage. 5. Chances of Fatality	1. Pre work cautioning & proper Permit must be followed before starting the work. 2. Ensure that workmen keep their body parts away from pinching points. 3. Ensure proper stacking of Structural members. 4.While fit up work structural member must be secured safely. 5. Experienced rigger and signalman should be assigned. Ensure competence Validation card. 6. Ensure use of tag lines at both ends to control the load. 7. Use crane/Hydra within the capacity and do not over load. 7a. Safe working load should be displayed on all matl handling eqpt. 8. Avoid work in poor visibility / poor weather condition / Raining and in heavy wind. 9. Affected area to be cordon off and caution sign to be posted to avoid unauthorized entry. 10. Only authorized operatior with valid licence to operate the crane.	Safety shoes, Safety Helmet, Safety goggles, Safety vest, Hand gloves.
	7.Failure of lifting tools and tackles due to use of damaged / under capacity tools and tackles.	1. Serious injuries. 2. Property damage.	1. Only single person signaling to the hydra/crane operator. 2. Ensure to use of certified and tested lifting tools and tackles with proper capacity, color code &identification number. 3. While lifting ensure no one comes under suspended load. 4. Barricading the area.	

Job activities/Work	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Erections of structural materials with the help of crane& rigging activity.	1.Pinching points. 3.Failure of lifting tools and tackles due to use of damaged / under capacity tools and tackles. 4. Hit by load due to swinging.	1. Cut injuries. 2. Serious injuries. 3. Property Damage.	1. Critical Lift Permit and Lifting plan shall be prepared if use more than one crane, 75% of capacity of crane or above 50 MT material. 2. Ensure experience and competent of foreman/Signalman/Riggers. 3. Ensure that workmen keep their hands / leg away from pinching points. Proper communication & co-ordination with coworker. 4.Ensure proper supervisoin. 5. Ensure to use of certified and tested lifting tools and tackles with proper capacity. 6. Softener or packing shall be provided in between slings and structural member. 7. While lifting ensure no one comes under suspended load. 7a. Safe working load should be displayed on all matl handling eqpt. 8. Ensure use of tag lines to control the load. 9.Lifting affected area to be cordon off & caution sign to be posted to avoid unauthorized entery. 10. Only authorized operatior with valid licence to operate the crane.Authorized signal man with wearing reflective jacket shall be engaged**.** 11.Normal Lift Permit and Lifting plan shall be preparediflifingAbove 5 MT. 12.Daily Inspection checklist of crane/hydra shall be ensured by users.	Safety shoes, Safety Helmet, Safety goggles, Safety vest, Hand gloves. Full body harness.

Job activities/Work	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Erection/Dismantling of Scaffolding (Only for CMCS area)	1. Dropped objects 2. Slips, trips and falls 3. Striking against 4. Collapse 5.Fall of scaffold structure	1. Falling from height. 2. Head injuries. 3. serious injuries. 4. property Damage.	1.Performing group shall conduct check of tool box relevant to the job before the work start 2. Use tools belt for containment of loose objects 3. Secure the tubes, planks and other objects when lifting/lowering 4. Barricade the work area and place sign boards 5. Do not climb with components 6. All scaffold platforms shall be fully boarded, fixed with toe boards & handrails, boards to be secured/lashed 7. Ensure area is not congested. 8. Maintain safe distance from energized power lines and heat sources 9. Ensure that only authorized/certified personnel are engaged in erecting & dismantling scaffolding 10. Examine all scaffold components prior to use 11. Scaffold should be inspected & tagged by competent person prior to use 12. Only essential personnel are allowed to access on scaffold	Safety shoes, Safety Helmet, Safety goggles, Safety vest, Hand gloves, Full body harness and fall arrester
Work at height (Only for CMCS area)	1. Fall of person. 2. Fall of materials (hand tools, Nut, bolts etc.) 3. Slippery approach. 4. Fall of person.	1. Head injuries 2. Break bones fall from height 3. Fatality. 4. Property damage.	1. Safety Net shall be provided if required. 2. Ensure proper Access and Work platform. 3. All scaffolds must be checked before use by Civil works supervisor and cleared before use.	Safety shoes, Safety Helmet, Safety googols, Safety vest, Hand gloves. Full body harness.

Job activities/Work	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Gas cutting and Welding work	1.Fire and Explosion 2. Burn injury due to fire spatters. 3.Eye injury to nearby workers 4.Welding fumes 5.Person injury due to fall of gas cylinders while transporting	1. Property damage due to cylinder blast 2. Burn injuries due to fire.	1.Ensure flash back arrester /NRV on cylinder and torch side & fire blanket. 2. The combustible material shall be removed from site before starting the job. 3. No welding cable shall pass over the combustible materials/cylinders. 4. Provide fire extinguisher. 5. Check the leakage of cylinder with soap solution. 6. Hot work permit should be taken and Fire watch person should be identified & only authorized person allow to work. 7. Fire blanket must be provided to protect falling of hot spatters at height or barricaded the area. 8. Ensure safety goggles to all workers. 9. Especially Black goggles for Welder's helper. 10. Provide suitable face protection mask for welders. 11. Use gas cylinders trolley for internal shifting of gas cylinders. 12. Fixed the valve caps while shifting/storing the gas cylinders. 13. O2 and LPG Gas cylinders shall be stored separately chained and secured. 14. Cylinders must be stored in shed to avoid direct sun light exposure. 15. Ensure safe storage of diesel fuel if any	Safety shoes, safety helmet, gloves, goggles. Face shield.
Electrical work	1.Electrical Shock 2.Electrocution 3.Fire	1. Shock due to improper insulation. 2. Property damage. 3. Fatality.	1. Electric supply should be taken through ELCB of 30mA sensitivity. 2. All power cables should be protected from damage by improper laying. 3. All m/c and panel board should be protected against rain. 4. Proper Earthing shall be provided to all electrical equipment. 5. Ensure all portable power tools are tested and inspected by concern electrical engineer. 6. D.B Should not be overloaded.	Safety shoes, safety helmet, Rubber gloves, goggles.

Job activities/Work	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Removal Of Lifting Arrangement	1. Cut injury. 2. Fall of materials/objects from height.	1. cut injuries 2. serious damage. 3. property damage. 4.vertical reinforcement collapse may cause.	1. Trained and Authorized person only allow to perform the job. 2. All tools & tackles should be tightening by rope to prevent fall from height. 3. Safe lowering procedure should be ensured. 4 The area must be cordon off. 5. Life line must be provided for anchoring safety harness.	Full body harness, Safety shoes, safety helmet, gloves, goggles
Excavation Work by JCB/manually	1. Excavated depth greater than1.5 mtr. 2. Failure of breaks. 3. Dumper moving. 4. Soil collapse.	1. Serious head, hand or eye injuries. 2. Workers falling in to the depth. 3. Heavy earth mover heat by person, 4. Unknown person heat by dumper.	1. Install hard barricade around the excavated area. 2. No person allowed in during the excavation by JCB. 3. Work area clearance certificate and excavation permit must be taken before starting the work. 4. JCB inspection should be carried out before the job commencement 5. Use barrier tapes or safety net at edges in excavation area.	Safety shoes, safety helmet, goggles, hand gloves, vest.
Civil work	1. Slippery approach. 2. While work at height, fall hazard. 3. Electrical hazard for electric line/equipment's. 4. Sharp edges of construction materials.	1. Slip trip fall injuries requiring first aid. 2. Eye injuries. 3. Head injuries. 4. Property damage.	1. Preparation proper approach with proper slope, steps, hand railing. 2. Barricading the area. 3. Place safety posters in work area. 4. Inspection of all hand tools before use. 5. Working platform should be proper (board/proper ladder)	Safety shoes, safety helmet, goggles, gloves, full body harness, nose masks.
	5. Chemical component of cement.	5. Eye injuries, skin irritation		

Job activities/Work	Potential Hazards	Risk/Hazard Effect	Safety Precautions	PPE
Work on Water body (NTPC KAYAL)	1. Trip slip and fall hazard on floats 2. Chance of fall into water 3. Electrical hazard. 4. Effect of extreme weather condition such as Sun burn and heat stress.	1. Physical fall shock - chance of injury or fatality. 2. Fall from the work area in to the water resulting in suffocation or drowning. 3. Chance of fatality for over work and sun burn effect.	1. Before start the work check all documents (such as work permit, TPI certificates of all tools and tackles and test certificates of life saving boat. 2. Ensure all work men working in or very near to water to wear Life jackets 3. Ensure availability of rescue boat in water with spare life jackets and floatation air tubes 4. Make a proper approach into the water body with proper slope or steps 5. In case of emergency, rescue team consisting of expert swimmers and above rescue boat to be always prepared. 6. In case of underwater work such as diving related work, an expert for checking diving equipment prior to commencement of work and also he shall be present for observing and monitoring diving activity during dive sessions. 7. Arrangement to be in place to summon Ambulance on Call to site for emergency shifting of any injured person to the nearest hospital. 8. Ensure drinking water to avoid de-hydration 9. Ensure Wireless / mobile/ walky-talky arrangement between site to control room/office 10. Ensure non-contamination of water body during the activities	Safety shoes, safety helmet, goggles, hand gloves, Reflective life jackets. Certified and compliant Diving gear to be used by divers if required One dedicated Rescue boat with life jackets

Date	**Reviewed By sub-contractor and or their authorized competent person**		**Is any additional precautions to be taken for the day**
	Job Supervisor / Engineer	**Safety Coordinator**	

FORMATS USED IN SITE

SL. No.	Format Name	Format No.
01	Safety Check list cum compliance report	01
02	Inspection of First Aid Box	02
03	Health Check Up	03
04	Monthly Site Safety Report	04
05	Safety Induction Training	05
06	Tool Box Talk	06
07	Inspection of PPE	07
08	Inspection of T&Ps	08
09	Status of T&Ps	09
10	Inspection of Cranes and Winches	10
11	Inspection on Height Working	11
12	Inspection on Electrical installation.	12
13	Safe Work- Permit (For External Agency)	13
14	Mock Drill Format (Fire)	14
15	Mock Drill Format (Water Accident)	15

SAFETY CHECKLIST CUM COMPLIANCE REPORT

PROJECT:_____ CONTRACTOR:_ DATE:_____

OWNER :_____

INSPECTION BY:_____

Note : write 'NA' wherever the items is not applicable. Inspection to be completed once in a month.

Item	Yes	No	Remarks	Action
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
PERSONNEL PROTECTIVE EQUIPMENTS				
Goggles; shields				
Face protection				
Hearing protection				
masks etc.				
Safety harness/belts				
EXCAVATIONS / OPENINGS				
Openings properly covered or barricaded, cordoned				
Excavations shored				
Excavations barricaded/ cordoned				
Overnight lighting provided				
SCAFFOLDING				
Fully secured and fastened				
Guard and intermediate rails in place				
Adequate shoring				
Adequate access				
LADDER				
Extension side rails 1 m above of landing				
Properly secured				
HOISTS, CRANES AND JCB				
Condition of cables and sheaf OK				
Condition of slings, chains, hooks OK				
Inspection & maintenance log maintained				
Outriggers used				
Signals observed and understood				
Qualified operators				
MACHINERY, TOOLS & EQUIPMENT				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				

				FORMAT 01 (Page 2 of 2)
TEMPORARY FACILITIES				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
FIRE PREVENTION				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
ELECTRICAL				
Proper wiring				
ELCB's provided				
HANDLING & STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
FLAMMABLE GASES AND LIQUIDS	NA			
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				
WORKING AT HEIGHT				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
ENVIRONMENT				
Lubricant waste/engine oils properly dispose.				
Waste from Canteen, offices, sanitation etc. disposed properly.				
Disposal of surplus earth, stripping materials, expired batteries, oily rag sand combustible materials done properly.				
HEALTH CHECKS				
Hygienic conditions at labor camps O.K.	NA			
Availability of first-aid Facilities				
Proper sanitation at site, office				
Arrangement of medical facilities.				
Measures for dealing with illness.				
Availability of potable drinking water for workmen & staff.				

RECORD OF REVISION

Page No.	Rev No.	Brief of Revision	Date
All	00	New procedure introduced	

FORMAT – 02 (Page 1of2)

INSPECTION OF FIRST AID BOX
(Check with KFR 1969)

Name of Site :	
Name of Sub-Contractor:	
Inspected by :	
Date of Inspection:	

Number of employees on the site:-____

Sl.No.	**Item**	**No. Available**	**Remarks**
1	No. of small sterilized dressings		
2	No of medium sized sterilized dressings		
3	No of large sized sterilized dressings.		
4	No of Larg sized sterilized burn dressinge s		
5	No of (15 grams) packets sterilized cotton wool		
6	No of pieces of sterilized eye pads in separate sealed packets.		
7	No of roller bandages 10 cm wide.		
8	No of roller bandages 5 cm wide.		
9	Whether tourniquet available		
10	Whether supply of suitable splints available.		
11	No of packets of safety pins.		
12	Whether kidney tray available		
13	Whether 4%-xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops available.		
14	Whether (60ml) bottle containing a two percent alcoholic solution of iodine available		
15	Whether (two hundred ml) bottle of mercurochrome (2 per cent) solution in water available.		

FORMAT – 02 (Page 2of2)

INSPECTION OF FIRST AID BOX

Sl.No.	Item	No. Available	Remarks
16	Whether 120ml bottle containing Sal volatile having the dose and mode of administration indicated on the label, available.		
17	Whether roll of adhesive plaster (6 cmX1 meter) available		
18	No of rolls of adhesive plaster (2 cmX1 meter)		
19	Whether snake bite lancet available.		
20	Whether (30 grams) bottle of potassium permanganate crystals available.		
21	Whether a pair scissors available		
22	Whether copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India available.		
23	Whether bottle containing 100 tablets (each of 5 grains) of aspirin available		
24	Whether Ointment for burns available		
25	Whether bottle of a suitable surgical anti septic solution available		

Signature of SAFETY Coordinator

FORMAT – 03(Page 1 of 1)

HEALTH CHECK UP: AS PER CERTIFICATE OF MEDICAL EXAMINATION

FORM-XI
Certificate of Medical Examination

Certificate No.:
Date:

1. Name:

Identification Marks:
1……..

2. ……

2. Father's name: ……

3. Sex: ……

4. Date of Birth, if available certificate age: ……

5. Physical Fitness:
I hereby certify that I have personally examined (name)…….
son/daughter/wife of ……. residing at …….
Who is desirous of being employed in building and construction work and his/her age as nearly as can be ascertained from my examination ……. years and he/she is fit for employment in ……as an adult/adolescent.

BP: Height: Sugar:

Pulse: Weight:

Eye Vision Test:

Left:

Signature/Left hand Thumb Impression of Building worker

Signature & Seal of Medical Inspector/CMO

……
……

Note: 1. Exact details of cause of physical disability should be clearly stated.

2. Functional/productive abilities should also be stated, if disability is stated.

FORMAT -04 (1 of 4)

MONTHLY SITE SAFETY REPORT

				Report Month:			
A) Accidents/Incidents Details:-							
a	**Lost time in Accidents**	**No. of incidents**	**Man Hours Lost**	**No.of People Involved**	**No. of contractors involved**	**Client persons if any**	**No.of persons reporting to Govt.**
	For the Month						
	Cumulative						
b	**Minor Injuries**						
	For the Month						
	Cumulative						
c	**Fires**	**No. of Near-Misses**	**No. of First-Aid cases**	**No. of persons injured**	**No. of equipment's damaged**	**No. of Fire reporting Outside**	
	For the Month						
	Cumulative						
d	**Other mishaps not covered in a, b, c.**	**No. of Near-Misses**	**No. of First-Aid cases**	**No. of persons injured**	**No. of equipment's damaged**	**Total near misses and First-Aid**	
	For the Month						
	Cumulative						

Signature of Head (Site office)

Signature of Site safety Coordinator

FORMAT -04 (2 of 4)

MONTHLY SITE SAFETY REPORT

A) Status of Deployment of Safety Coordinators & electricians by Agencies:

Description	Name	Qualification & Experience
Safety Coordinators		
Electricians		

B) Lifting Tools, Tackles, Equipment and Pressure Vessels:

Item	Nos. Deployed	Identification No.	Nos. Tested by competent person	Validity of Test Certificate
Winches				
Chain Blocks				
Wire Rope Slings				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

C) Reverse Horns in Construction Vehicles:

Item	Nos. Deployed	Nos. Having Functional reverse horns	Inspection Dates
Transit Mixers			
Hydra Cranes			
Dumpers/Trippers			
Backhoes			
Other Vehicles			

D) ELCBs:

No. Of ELCBs provided	Nos. Functional	When They were last Tested

Signature of Head (Site office)

Signature of Site safety -Coordinator

FORMAT – 04 (3 of 4)

MONTHLY SITE SAFETY REPORT

E) Electrical Earthing:

No. Of Earth resources	Whether Earthing provided to all equipment's	When they were last tested

F) Fire Extinguishers:

Name & designation of person responsible for maintenance of Extinguishers at different locations:(Individual Contractor's Safety Coordinators/Authorized executive).

FIRE EXITINGUISHERS AT ERECTION SITE & STORES:

TYPE	SIZE	QTY	HEALTHINESS	LOCATIONS
MECHANICAL FOAM				
WATER CO2				
DRY CHEMICAL POWDER (DCP)				
CARBON DIOXIDE				

G) Implementation of checklist, Work permits:

Item	During the Month	Major Deviations
Note:-Please attach photocopies of all filled Checklists & Work permits for that month.		

H) Personal Protective Equipment's Issued:

Item	Issued this Month	Nos. Issued up to the Month	Percentage of usage at site
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor/Safety rope			
Other PPEs			

Signature of Head (Site office)

Signature of Site safety -Coordinator

MONTHLY SITE SAFETY REPORT	**FORMAT – 04 (4 of 4)**

No. of Observations received in the month	No of points complied	Cumulative no. of non-complied Points

I) Training programs on safety during the month:

1)Tool-Box talks/ Pep-talks on Safety:

Date	Tool Box Talk - No of Participants	Safety Induction - No. of Participants	Topic
Date	**Tool Box Talk No of Participants**	**Safety Induction No. of Participants**	**Topic**

k) Other Safety initiatives / Safety Activities conducted at sites:

Signature of Head (Site office)

Signature of Site safety -Coordinator

FORMAT -05 (Page 1 of 1)

SAFETY INDUCTION TRAINING

Name of Site :	
Name of Sub-Contractor :	
Date :	
Name of Training coordinator: NTPC/BHEL	

Sl No.	Name	Designation	Organisation	Signature

Signature of safety Coordinator:

FORMAT -06(Page 1 of 1)

TOOL-BOX TALK

Sub-Contractors Name :	
Date :	

Topic	**Name of person delivered Tool Box Talk**	**No. of Participants attended**	**Remarks**

Signature of safety Coordinator:

FORMAT -07(Page 1 of 1)

PERSONAL PROTECTIVE EQUIPMENTS

Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Item	Issued this Month	Nos. Issued up to the Month	Percentage of usage at site
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor/Safety rope			
Life jackets			
Other PPEs			

Signature of safety coordinator:

FORMAT -08

INSPECTION OF T&Ps

Name of Sub-Contractor :	
Date of Inspection :	

Sl.No.	Description	Remarks	
1.0	Name of equipment		
2.0	Basic Information of equipment		
2.1	Specification		
2.2	Sr. No. of equipment		
2.3	Make		
2.4	Year of manufacture		
3.0	Major repairs / overhauls(Furnish details of work carried out)		Date(s) of major repair/overhaul
3.1	Repairs carried out at site		
4.0	Any performance test conducted	Yes/No	
5.0	Document Submitted	Yes/No	
6.0	Manufacturer's test / guarantee certificate	Available/ Not available	
7.0	Performance test	Done/ Not Done	
8.0	Acceptance Norms		
9.0	Committee Observations		
10.0	Date of next review (if accepted)		

Signature-Site Safety Coordinator	**Signature-Subcontractor/ Subcontractor's Safety Coordinator**

	FORMAT - 09(Page 1 of 1)
STATUS OF T&Ps	

Name of Site :	
Name of Sub-Contractor :	
Date of Inspection :	

Item	**Nos. Deployed**	**Identification No.**	**Nos. Tested by competent person**	**Validity of Test Certificate**
Winches				
Chain Blocks				
Wire Rope Slings				
Man Cages				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

Signature of safety Coordinator: **Signature-Subcontractor/ Subcontractor's Safety Coordinator**

Signature of BHEL Site Supervisor

INSPECTION OF CRANES AND WINCHES

Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Crane Reg. No(Make/Model) _____

Name of Driver/Operator _____

Sl.no.	Description	Observation	Measures
1	Valid Driving license		
2	Hook & Hook Latch		
3	Over Hoist limit switch		
4	Boom limit switch		
5	Boom Angle Indicator		
6	Boom limit cutoff switch		
7	Condition of Boom		
8	Condition of ropes		
9	Number of load lines		
10	Size and condition of the slings		
11	Stability of the cranes		
12	Soil Condition		
13	Swing Break And Lock		
14	Proper Break And Lock		
15	Hoist Break And Lock		
16	Boom Break And Lock		
17	Main Clutch		
18	Leakage in Hydraulic Cylinders		
19	Out riggers filly extendable		
20	Tire pressure		
21	Condition of Battery And Lamps		
22	Guards of moving and rotating parts		

23	Load chart provided		
24	Number and position of pedant ropes		
25	Reverse Horn		
26	Load Test Details		
27	Operator's fitness		
28	Pollution under control certificate		
29	Fire extinguisher of appropriate type.		
30	Training of the operator		

WINCH

Sl. No.	Description	YES	NO	NA
1	Has the copy of Third Party Inspection certificate been provided in winch machine shed?			
2	Is winch machine operator experienced enough to operate the winch machine?			
3	Is the winch machine operated by someone other than the winch machine operator?			
4	Is there guard provided in all moving parts like wheel and motor's shaft?			
5	Will it protect against unforeseen operational contingencies?			
6	Are brakes, clutch and locking arrangement working properly?			
7	Has it been ensured that the guard does not constitute a hazard by itself?			
8	Are the cranks and the connecting rods protected by guardrails?			
9	Is there provision for fully covered shed with wooden plank roof?			
10	Is wire rope free from any kind of damage or wear and tear?			
11	Is split pin provided for the protection of clutch and brake locking arrangement?			
12	Is pulley inspected by competent person and certified before use?			
13	Is pulley free from any wear and tear visually?			
	FORMAT -10(Page 1 of 3)			

14	Is winch rope barricaded with clipsheet for the protection of rope and person?			
15	Is the wire rope lubricated by cardium oil?			
16	Is there any friction in wire rope which may damage the wire rope rather than the rolling parts?			
17	Is there any oil leakage in the hydraulic system of the winch machine?			
18	Has it been ensured that the guard will not cause discomfort or inconvenience to operator?			
	Total Number of NO:			
	Total Number of NA:			
	% Compliance :			

Signature of safety Coordinator: **Signature-Subcontractor/ Subcontractor's Safety Coordinator**

Signature of BHEL Site Supervisor

FORMAT -11(Page 1 0f 2)

INSPECTION OF HEIGHT WORKING

Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Sl. No.	Descriptions	Observation (Yes/No)
1	All the workers have been explained safe work method?	
2	An established communication system has been established and explained to the workers.	
3	Adequate illumination has been ensured.	
4	Work area inspected prior to the start of the work.	
5	Area below the work place barricaded, particularly below hot work.	
6	Workers provided with bags /box to carry bolts, nuts and hand tools	
7	Arrangement for fastening hand tools made.	
8	All work platforms ensured to be of adequate strength and ergonomically suitable.	
9	Fabricated makeshift arrangements are checked for quality and type of material welding, anchoring etc.	
10.	Work at more than one elevation at the same segment is restricted.	
	ACCESS/EGRESS	
1	Walkways provided with handrail?	
2	All checkered plates, gratings properly welded/ bolted?	
3	Are ladders inspected and they are in good condition?	
4	Are ladders spliced?	
5	Are ladders properly secured to prevent slipping, sliding or falling?	
6	Do side rails extend 36” above top landing?	
7	Are built up ladders constructed of sound materials?	
8	Are rugs and cleats not over 12” on center?	
9	Metal ladders not used around electrical hazards.	
10	Proper maintenance and storage.	
11	Ladders placed at right slope.	
12	Ladders / staircases welded/ bolted properly.	

		FORMAT - 11(Page 1 0f 2)
13	Any obstruction in the stairs.	
14	Are landing provided with handrails, knee rails, toe boards etc.?	
15	Whether ramp is provided with proper slope.	
16	Proper hand rails / guards provided in ramps.	
	Housekeeping	
1	Walkways, aisles & all overhead workplaces cleared of loose material.	
2	Flammable materials, if any, are cleared.	
3	All the de shuttering materials are removed after de shuttering is done.	
4	Platforms and walkways free from oil/grease or other slippery material.	
5	Collected scrap are brought down or lowered down and not dropped from height.	
	PPE And Safety Devices	
1	Use of safety helmet, safety belts ensured for all workers	
2	Anchoring points provided at all places of work.	
3	Common lifeline provided wherever linear movement at height is required.	
4	Safety nets are use wherever required.	
5	Proper fall arrest system is deployed at critical workplaces.	

Signature of safety Coordinator **Signature-Subcontractor/ Subcontractor's Safety Coordinator**

Signature of BHEL Site Supervisor

FORMAT -12

INSPECTION OF ELECTRICAL INSTALLATION

Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Sr. No.	Contents	Yes/No	Remarks
A	**Cable**		
1.	Whether the condition of cable is checked?		
2.	Are cables received from other sites checked for insulation resistance before putting them into use?		
3.	Are all main cables taken either underground / overhead?		
4.	Are welding cables routed properly above the ground?		
5.	Are welding and electrical cables overlapping?		
6.	Is any improper joining of cables/wires prevailing at site?		
B	**DBs/SDBs**		
1.	Is earth conductor continued upto DB / SDB?		
2.	Whether DBs and extension boards are protected from rain / water?		
3.	Is there any overloading of DBs / SDBs?		
4.	Are correct / proper fuses & CBs provided at main boards and sub-boards?		
5.	Is energized wiring in junction boxes, CB panels & similar places covered all times?		
C	**ELCB**		
1.	Whether the connections are routed through ELCB?		
2.	Is ELCB sensitivity maintained at 30 mA?		
3.	Are the ELCB numbered and tested periodically & test results recorded in a logbook countersigned by a competent person?		
D	**Grounding**		

1.	Is natural earthing ensured at the source of power (main DB at Generator or Transformer)?		
2.	Whether the continuity and tightness of the earth conductor are checked?		
3.	Mention the gauge of the earth conductor used at the site.		
4.	Mention the value of Earth Resistance.		
E	**Electrically operated Machines or Accessories**.		
1.	Whether the plug top is provided everywhere.		
2.	Are all metal parts of electrical equipment and light fittings / accessories grounded?		
3.	Is there any shed or cover for welding machines?		
4.	Are halogen lamps fixed at proper places?		
5.	Are portable power tools maintained as per norms?		
6.	Any other information:		

Signature of safety Coordinator : **Signature-Subcontractor/ Subcontractor's Safety Coordinator**

Signature of BHEL Site Supervisor

Safe Work- -Permit (For External Agency)

Type of permit	Tick whichever is applicable
Height working of 3.3 metre and above at FSPV Site (Applicable for erection of communication towers/Electrical Towers, if any)	
Excavation more than 1.5 meter depth	
Heavy lifting by machinery (only on land)	
Works on Floating Platforms in Water	

Permit initiation

Permit no: _____ Date: _____

The following persons are here by engaged to undertake the above work (tick whichever is applicable) in the areas indicated below. The contractor and the workers will strictly adhere to the safety instructions contained in the annexure, as applicable.

Name of the work :-

Brief description of work:

Area/Location of work:

Period of work From _____ to _____

Time of work From _____ to _____

Name and Address of the contractor :

Work Order No. & Date

Details of Persons Engaged

Sl. No.	Name	Age	ESI No.	Id No.
1				
2				
3				
4				
5				

*The persons engaged are possessing certificate against Vertigo in their medical clearance certificate.

_____ _____

Signature of Contractor with contact no. Signature of BHEL Sup/Executive

Permit Clearance:

1.0 Clearance from – In-charge/ Services (BHEL)

_____
(Signature)

2.0 Clearance from Safety

_____
(Signature)

3.0 The above work is permitted subject to above clearance.

_____
(Signature of Site Incharge)/Authorised executive)

4.0 Permit Withdrawal / closure

4.1 The work has been completed, Men and Materials withdrawn. Intimation is given to Services Department and Concerned Supervisor / Area-Incharge

_____
(Signature of Executing Dept. Sup./Executive)

5.0 Withdrawal of Permit/Closure recordings

_____
(Signature of Safety Coordinator)

Note: Wherever Clearance Is Not Required, Write ‘Not Applicable’ (NA)

Annexure- Checklist for Work permit

Work Permit Checklist

A. Height working of 3.3 metre and above at FSPV Site (Applicable for erection of communication towers/Electrical Towers, if any)

Sl. No.	Criteria	Yes	No	NA	Remark
1	Have scaffolding/lacers/working platform been checked and provided.				
2	Is roof ladder /crawling board provided?				
3	Have safety belts and helmets inspected and provided.				
4	Is adequate illumination provided?				
5	Are safety nets erected at site to arrest falls when climbing up/down or moving at heights?				
6	Is barricading provided to avert fall of material down below.				
7	Is the work area clear and safe from overhead electrical lines/other protecting structures?				
8	Surrounding area checked.				
9	Have all combustibles within 35 ft. are removed and protected.				
10	Fire Fighting system readiness.				
11	Precautionary tags/ boards provided.				
12	Nearby working area, pipes checked for leakage and effectively protected against falling sparks.				
13	Condition of Hoses and Cylinders.				
14	Is he having phobia (Vertigo)				
15	All Employees involved have been informed of precautions.				
16	Work shall be closed before sunset.				
17	Ensure that continuous supervision				
18	Ensure that persons working at height should anchor harness to rigid support.				

B. Excavation more than 1.5 meter depth

Sl. No.	Criteria	Yes	No	NA	Remark
1	Cable route detection done at the place of excavation				
2	Free from water, hydrant, sprinkler pipes; telephone & sewer lines.				
3	Excavation work does not affect surrounding structures.				
4	Piling, shoring, bracing, walers and runners provided and of adequate strength to prevent cave in				
5	Excavated materials are placed >2 feet from edges of trench.				
6	Open sides of trench are barricaded to prevent fall .				

7	Warning signs are posted.				
	Annexures to Format-13 (Page 2 of 3)				
8	No person is working in trench during excavation.				
9	Suitable access to and egress from trench of 1.2 m and above is arranged.				
10	Banksman arranged				

C. Heavy lifting by machinery (only on land)

Sl. No.	Criteria	Observations	Measures
Readiness of Lifting Equipment:			
1	Over-Hoist Limit Switch		
2	Boom-Limit Switch		
3	Boom Angle indicator		
4	Boom-Limit cut-off switch		
5	Safe Load Indicator available		
6	Condition of boom		
7	Condition of Ropes		
8	Size and condition of the sling		
9	Stability of crane		
10	Soil Condition		
11	Swing Brake & Lock		
12	Propel Brake & Lock		
13	Hoist Brake & Lock		
14	Boom Brake & Lock		
15	Main clutch		
16	Leakage in hydraulic cylinders		
17	Out riggers fully extendible		
18	Tyre pressure		
19	Condition of Battery and Lamps		
20	Guards of moving and rotating parts		
21	Load chart provided		
22	Automatic Reverse horn/Swing Alarm (With nominal sound frequency)		
23	Load test details		
24	Fire Extinguisher in operators cabin		
Readiness of Lifting Slings:			
1	Tag number/ Identification number(with SWL marked)		
2	Validity		
3	Capacity & length of the Sling		
4	Check for any visual damaged outer sheath		
5	Check for any damages at the cuts/ threading		
6	Check for any damages at the eye portion of the sling		
7	Check the overall condition of the sling.		
8	Check for any twisted/ knotted condition		
9	Check the overall surface contour of the sling.		
10	Any Other Observations		

Readiness of Manpower/Area of work:					
	Annexures to Format-13 (Page 3 of 3)				
1	Operator Fitness and Licence				
2	Dedicated helper availability				
3	Work area to be cordoned off & caution sign to be posted to avoid unauthorized entry.				
4	PPEs availability for Manpower				
D.	**Works on Floating Platforms in Water**				
Sl. No.	**Criteria**	**Yes**	**No**	**NA**	**Remark**
1	Availability of life Jackets to all manpower going on water				
2	Availability of rescue boat in water with spare life jackets and floatation air tubes				
3	Safe access to floating platform from ground				
4	Availability of rescue team of expert swimmer, helper				
5	Arrangement of Emergency vehicle for quick shifting of any injured person to the nearest hospital.				
6	Availability of drinking water to avoid de-hydration				
7	Availability of communication sources such as Wireless / mobile/ walky-talky arrangement between site to control room/office				
8	For underwater work such as diving related work, Fitness of diving equipment				
9	Diver fitness and skill				
10	Training imparted to manpower for working on floating platform				

Signature of safety Coordinator : Signature-Subcontractor/ Subcontractor's Safety Coordinator

Signature of BHEL Site Supervisor

Format-14

MOCK DRILL FORMAT (FIRE)

VENUE/SITE: Date:

Time:

'FIRE MOCK-DRILL ON EMERGENCY SITE'

OBSERVATION SHEET

SL. NO.	PARTICULARS	DESIRED TIME (min.)	RECORDED TIME (min.)
A	INFORMATION TO IMPORTANT AGENCIES		
	Inform Emergency Main control room (NTPC-Security)	Immediate	
	Inform incident controller (BHEL Site In-Charge)		
	Inform Fire Pump House (by NTPC-Security)		
	Inform NTPC Safety (by BHEL Safety Coordinator)		
	Inform First Aid (by BHEL Safety)		
B	ARRIVAL OF THE SERVICE PERSONAL / ACTION		
	Incident controller reaching the site	5	
	Assembly of work teams at identified Assembly point at site	5	
	Safety personnel reaching the site/coordinating	5	
	NTPC-Security personnel reaching the site	5	
	Fire Guard/Engine reaching the site	5	
	Medical team reaching the site	5	
C	CLOSURE OF OPERATIONS		
	Rescue operation over (rescuing persons)	5	
	Fire-fighting operation over	5	

General Remarks:

Observation Name:

Designation:

Sign:

Format-15

MOCK DRILL FORMAT (WATER ACCIDENT)

VENUE/SITE: Date:
Time:

'WATER ACCIDENT MOCK-DRILL ON EMERGENCY SITE'

OBSERVATION SHEET

SL. NO.	PARTICULARS	DESIRED TIME (min.)	RECORDED TIME (min.)
A	INFORMATION TO IMPORTANT AGENCIES		
	Inform Emergency Main control room (NTPC-Security)	Immediate	
	Inform incident controller (BHEL Site In-Charge)		
	Inform Rescue Team (by work supervisor)		
	Inform BHEL Safety Coordinator (by work supervisor)		
	Inform NTPC Safety (by BHEL Safety Coordinator)		
	Inform First Aid (by NTPC-Security)		
B	ARRIVAL OF THE SERVICE PERSONAL / ACTION		
	Incident controller reaching the site	5	
	Safety personnel reaching the site/coordinating	5	
	NTPC-Security personnel reaching the site	5	
	Rescue team reaching the site	5	
	Medical team reaching the site	5	
C	CLOSURE OF OPERATIONS		
	Rescue operation over (rescuing persons)	5	

General Remarks:

Observation Name:

Designation:

Sign: