Installation of solar modules including civil & structural work and unification with the existing solar plants at MES-Fort Williams, Kolkata

IMPORTANT NOTE:

"CONTRACTORS ARE REQUESTED TO VISIT ALL THE SITES IN PERSON AND THEN SUBMIT THEIR BEST OFFER. ANY TYPE OF DENIAL /OBJECTION WILL NOT BE ENTERTAINED AFTER FINALIZATION OF ORDER."

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1. **Introduction:** -

BHEL has installed 500 KWp capacity of rooftop solar power plants at three of the buildings located on the premises of Fort William – Kolkata. Details of equipment installed at the sites are given below: -

Sl. No.	Items Description	Unit	Qty
(A)	**Royal Barrack (200 KWp)**		
1	PV Modules, 250 Watt	Nos.	800
2	Inverters (50 KWp)	Nos.	4
3	DCDB (50 KWp)	Nos.	4
4	ACDB (50 KWp)	Nos.	4
5	LT panel (320 Amp, 415 V)	Nos.	1
6	DC Cabling	Lot	1
7	AC Cabling	Lot	1
8	Cable Tray	Lot	1
9	Supply & installation of Surveillance System	SET	1
10	Lightning Protection (CEC type)	SET	1
11	Firefighting System	SET	1
(B)	**South Barrack (150 KWp)**		
1	PV Modules, 250 Watt	Nos.	600
2	Inverters (50 KWp)	Nos.	3
3	DCDB (50 KWp)	Nos.	3
4	ACDB (50 KWp)	Nos.	3
5	LT panel (250 Amp, 415 V)	Nos.	1
6	DC Cabling	Lot	1
7	AC Cabling	Lot	1
8	Cable Tray	Lot	1
9	Supply & installation of Surveillance System	SET	1
10	Lightning Protection (CEC type)	SET	1
11	Firefighting System	SET	1

(C)	**North Barrack (150 KWp)**		
1	PV Modules, 250 Watt	Nos.	600
2	Inverters (50 KWp)	Nos.	3
3	DCDB (50 KWp)	Nos.	3

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4	ACDB (50 KWp)	Nos.	3
5	LT panel (250 Amp, 415 V)	Nos.	1
6	DC Cabling	Lot	1
7	AC Cabling	Lot	1
8	Cable Tray	Lot	1
9	Supply & installation of Surveillance System	SET	1
10	Lightning Protection (CEC type)	SET	1
11	Firefighting System	SET	1

In July 2020, Eastern Coast experienced a cyclone named Amphlan which caused severe damage at the site. 70 Nos. of modules uprooted and got damaged and need replacement. However, plants are under operation and maintenance. Details of the damage that occurred at the site are given below: -

		Module	Structure	Pedestal
South Barrack	Damage	22 Nos.	-	3 Nos.
	Dislocated	0	-	29 Nos.
North Barrack	Damage	16 Nos.	5 Set	-
	Dislocated	12 Nos.	-	108 Nos.
Royal Barrack	Damage	18 Nos.	-	-
	Dislocated	2 Nos.	-	118 Nos.
	TOTAL	**70 Nos.**	**5 Set**	**258 Nos.**

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Annexure-I

SCOPE OF WORK

"Installation of solar modules including civil & structural work and unification with the existing solar plants at MES-Fort Williams, Kolkata".

The Scope of work includes: -

(i) Dismantling of damaged solar modules including disposal within the premises of Fort William- Kolkata, as per instruction given by the Engineer in charge.

(ii) Safe handling, carriage, and lifting of new solar modules to the roof manually or through machines.

(iii) Fixing/installation of new modules in lieu of damaged modules including rectification of module mounting structure, if required.

(iv) Supply(if, required), fabrication & installation of module mounting structure (galvanized), if required, as per specification expressed under clause no: 2 of Annex-II.

(v) Fixing of dislocated modules and Casting of new pedestals with M-20 Grade concrete including shuttering, supply, and application of reinforcement steel.

(vi) Dismantling of existing APP membrane layered for waterproofing, within a perimeter of 1 meter surrounding the pedestal. Disposal of the garbage within the premises of Fort William- Kolkata, as per instruction given by the Engineer in charge.

(vii) Laying new APP Membrane including one coat of primer as specified in clause no: -, onward.

(viii) Rectification of existing inverter shed at North & South Block, if required.

(ix) Rectification of existing DCDB including modification of internal wiring, replacement of faulty items, etc. if required.

(x) Rectification of existing ACDB including modification of internal wiring, replacement of faulty items, etc. if required.

(xi) Replacement of a damaged solar cable of 4 Sqmm, single core copper conductor solar cable, with the new cable. the supply of new cable shall be in the scope of the contractor's part of the work.

(xii) Replacement of a damaged uPVC conduit pipe (different sizes) with the newly supplied uPVC conduit pipe. The supply of new uPVC pipe shall be in the scope of the contractor's part of the work.

(xiii) Supply and installation of galvanized earth strip of 25 x 3 Sqmm as specified under clause no: -10 of Annex-II.

(xiv) Incorporation of newly placed modules within the existing plants, integration & Synchronization of solar energy, and testing of the plants.

(xv) FQP to be followed while execution and protocols may be prepared as required by the plan (enclosed).

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Annexure-II

TECHNICAL SPECIFICATION

1. Unloading, safe storage and movement of supplied items received at the site: -

a) Contractor shall organize all necessary resources such as labour, machinery and tools, cranes, hydra, forklifts, transportation trucks/ trolleys, lifting accessories, etc. for the safe handling, carriage, and lifting of BHEL supplied items from the transport vehicle reaching identified location at the site and subsequent movement to storage yards/sheds.

b) Similar arrangements shall also be made by contractor for movement of the stored items from storage yards/sheds to the exact construction locations within the project site.

c) Contractor shall maintain proper registers/ files/ records of invoices, LRs, delivery challans, material receipt certificates etc. Also, proper records shall be maintained to keep track of material entry (for storage) and material issue (for construction).

d) All such documents shall be suitably preserved for further handing over to BHEL.

e) Safety of items shall be in contractor scope. Accordingly, contractor will make all requisite arrangements for safe storage and preservation of supplied materials including items issued by BHEL.

f) All the equipment shall be handled very carefully to prevent any damage or loss. No untested wire ropes / slings etc. shall be used for the movement of material. The equipment shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the stores shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at site.

g) The material received shall be properly inspected for any damage caused during transit and the Goods Receipt Document of the Transporter shall be acknowledged after verifying the condition of goods received. Any damage shall be immediately reported to BHEL. In cases when such information is not given to BHEL in time – it will be presumed that material was received in good condition by contractor and damage may have taken place at a later stage. Such damage or loss shall be attributable to the contractor.

h) Contractor shall ensure that while lifting slings shall be put over the points indicated on the equipment or as indicated in the manufacturer's drawings. Slings/shackles of proper size shall be used for all lifting and rigging purposes. All care shall be taken to safeguard the equipment against any damage.

i) Contractor shall be responsible for examining all the plants and materials issued to him and notify the Engineer immediately of any damage, shortage, discrepancy, etc. before they are moved out of the stores/storage area. The contractor shall be solely responsible

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for any shortages or damages in transit, handling, storage and erection of the equipment once received by him.

j) The contractor shall maintain an accurate and exhaustive record-detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the engineer at any time.

k) All the material in the custody of contractor and stored in the open or dusty locations must be covered with suitable weather proof covering material wherever applicable and shall be blocked up on raised level above ground.

l) The contractor shall hand over all parts / materials supplied by BHEL and remaining extra over the normal requirement with proper identification tags and measurements to BHEL before site closure. Such intimation will be given in writing to BHEL well in time.

m) It shall be the responsibility of the contractor to keep the work / storage areas in neat, tidy and working conditions. All surplus/unusable packing and other materials shall be removed and deposited at location(s) as identified within the project premises.

n) All suitable lifting arrangement and local transport arrangement within premises for material handling at stores/yard/siding of BHEL/Customer/Contractor are included in scope.

o) Minor items (supply/installation/modification) such as Gland, lugs, nut bolt etc. required for finishing completed and satisfactory working plant shall be done by contractor.

2. Installation of Modules: -

Contractor shall do the installation of the SPV module as per the approved layout design of BHEL. Contractor shall implement the interconnection as per these drawings. Required number of nuts and bolts for the installation of Modules shall be supplied by contractors. These will be **made of SS 304 material - NUTS, BOLTS, AND PLAIN WASHERS.** Installation activity shall include placing on base, bolting, clamping with Structure material, Ferrule Marking near String. Other fasteners like Clamp, brackets, M6 Screws shall also be supplied as required additionally.

Series interconnection of SPV modules to form strings

Contractor shall interconnect the SPV modules as follows:

a) Each module is fitted integrally with a junction box having positive and negative polarity cables (4 Sqmm).

b) Positive cable of one module shall be connected to the negative cable of the adjacent module. **The cables have MC4 type of connectors to be supplied by contractor**. One polarity cable has male type connector, while the other has female type connector.

c) This way, modules shall be connected in series. Each set of connections is called as a series string. Series formation may change as per approved layout and design.

Interconnection of SPV module strings to string inverters

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a) Contractor shall connect each series string of 17-20 SPV modules (as per drawing approved) to the DCDB/string inverter using 1Cx 4 cable DC cable supplied by BHEL.

b) MC4 connectors shall have a rating of 1000VDC (IEC), a rated current of 30A, Type approved by TUV Rhineland for product safety. **MC4 connector shall be supplied by Contractor without additional cost.**

Required number of MC-4 Connectors each set having a pair of male and female parts, to join both the cables along with ferrules shall be supplied by Contractor.

3. Rectification/ Fabrication & Installation of Module Mounting Structure (including supply, if Required): -

The contractor shall be responsible for the rectification of the damaged module mounting structure. The installation of the Module Mounting is to be carried out as per the layout design to be provided after the award of work. The required number of nuts and bolts for the erection of Modules shall be supplied by the contractor.

Wherever structure or part thereof is difficult to rectify, new structural parts shall be supplied by a contractor with the meeting of all technical requirements and with the approval engineer in charge.

Wherever welding is to be carried out, the contractor shall arrange for proper grinding and cleaning of the weld surfaces, followed by the application of Metal primer and Metallic aluminum paint. Pre-Galvanized parts shall be sprayed with Zinc spray after work.

Structural material shall be corrosion resistant and electrolytically compatible with the material used in module frame, fasteners, nuts, and bolts and will be made of hot dip Galvanized steel, Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 80 microns on steel as per IS-5905.

The required number of nuts and bolts for the installation of MMS shall be supplied by contractors.

Note: NUTS, BOLTS, AND PLAIN & SPRING WASHERS shall be made of SS 304.

4. Pedestals / Civil Foundation: -

The contractor shall be responsible for the fixing dislocated pedestal and casting new pedestals.

The basic specification calls for Cement Concrete will be as per the drawing. The contractor shall require to clean the area on the roof wherever concreting to be done, before starting the civil work.

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Cement shall be good ISI Portland cement of reputed make. Cement bags shall bear ISI certification mark and date of manufacture. The sand shall be river sand, clean & free from organic impurities. C.C. concrete shall be mixed well in watertight platform in proportion as specified all ingredients in required proportion shall be mixed, first dry & than required quantity of water shall be added. Mixing shall be turned over twice or thrice, so that surface of the coarse aggregate coated with cement & concrete shall be used within half an hour of mixing. Any quantity remaining unused after an hour of mixing will not be allowed to use. The casted pedestals shall be cured minimum for ten days and up to twenty-eight days after completion of work. It shall keep well-watered & shall be protected from the direct heat of sunlight by means of wet gunny bags.

Cement shall be procured by Contractor conforming to BIS: 8112 and / or BIS: 1489 Specification latest edition or higher Grade. The cement shall be procured directly from the reputed manufacturers/ stockiest as per approved list of BHEL/Customer. Relevant vouchers and test certificates will be produced as and when required. The cement shall be stored by the Contractor in such suitable covered and lockable stores, well protected from climate and atmospheric effects. The cement go-down shall be constructed by the Contractor as per the drawing in CPWD specifications at his own cost. The cement will remain under double lock, one from NBCC and the other from Contractor. The cement in bags shall be stored in go-downs in easy countable position. Cement bags shall be used on a first in first out basis. Cement stored for beyond 90 days will be required to be tested at Contractors cost, before use in works.

Concrete shall consist of cement, sand & graded stone in required proportion. Coarse aggregate for all concrete shall be graded crushed hard granite, trap or basalt stone and shall conform to the requirements. All materials shall be carefully & accurately measured in measuring box. Cement shall either be weighed or used in full bags. The required quantity of water shall be added by measuring in water cans. Concrete shall be mixed by mixer machine. Before any concrete is placed in position, all loose pieces of Timber, Stones, saw dust etc. shall be removed from the work. No concrete mixed 30 minutes' prior of placing in form shall be accepted. Proper water cement ratio shall be observed.

Mechanical mixing method shall be adopted for mixing of concrete. The mechanical needle vibrator or other approved methods shall be adopted for compaction of the mix. The concrete consolidation shall be through & no honeycomb work (rough, pitted surface or voids in concrete) shall be allowed.

All the formwork shall be provided by the Contractor at his cost & shall be thoroughly wetted before the concrete is placed in position. Formwork shall be of approved quality. Where timber is used, the face in contact with concrete shall be plain & made smooth. All the joints in formwork shall be perfectly close to prevent the loss of cement slurry from concrete. After the form works are complete, the Contractor shall get it checked for strength, suitability & levels. For this advance, intimation shall be given for inspection.

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A sufficient number of frameworks/shuttering shall be maintained by the contractor at the site to match the pace of the work required at the site.

Steel Reinforcement: -
Mild steel bars of 6- 8 sqmm shall be used for the reinforcement in the pedestals as per the drawing to be provided to the contractor. The contractor shall be responsible for the supply of MS bars.

J-Bolts –Supply & fixing:
The anchor bolts (J bolt) shall be sunk into the wet concrete by hand immediately after the concrete slab is poured. The anchor shall be standing straight and projecting, as the concrete hardens. 4/as per drawing Nos. of J-bolt of straight length shall be used general of 200mm/as per drawing in addition to bent portion at the unthreaded end as per standard and may change as per MMS design. These bolts are threaded at the top, for about two inches, and the rest of the bolt is smooth. The diameter of J bolt shall be as per the drawing and TWO nos. nuts each and suitable washers shall be supplied with each bolt. The arrangement shall be as per Drawing.

It is essential that a template or a plastic sleeve is used to hold the bolts in place until the concrete sets up enough to support the weight of the bolt. Using a template will help keep the bolts straight, plumb, and the correct distance from each other.
Note: J-bolt shall be made of Galvanized steel and Nuts and the washer shall be made of SS304.

Pull out Test (If required)
Pull-out test of casted pedestals on roof shall be arranged by the contractor free of cost. Necessary arrangement to show that the pedestal is able to withstand the toppling load due to its dead weight and application of Nitto Bond. BHEL will specify the testing criteria based on roof conditions and local site conditions and based on its own design of civil pedestals. The selected locations where pull-out test shall be conducted shall be based on a decision taken by the BHEL site engineer and based on any specific customer requirement.
Note: If the dead weight/pedestal weight is equivalent or more than to the reaction weight as per STAAD calculation, pull-out test is not required. If adhesive material is being used between the roof surface and PCC to counter the reaction weight, then this test shall be conducted by the contractor.

Lifting
Cost of Lifting of pedestals or raw material of pedestals up to the roof level is included in the contractor's scope. No additional charges shall be payable for lifting.

Preparation of Roof
Marking on the roof for the placement of the pedestal shall be done by the contractor as per the approved layout.

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Pedestals shall be placed after placement of the NITO BOND on the roof. For a particular type of surfaces like waterproofed roofs etc. – NITO BOND may not be required. In such cases – the contractor will give prior intimation in writing to BHEL that NITO BOND is NOT being applied by them. Unless such intimation is given – the contractor will be presumed to have used NITO BOND in all cases and this will be part of the site inspection by the BHEL team.
Marked surface to be prepared by cleaning the roof with a wire brush after that NITO BOND shall be applied on the prepared roof.

Supply of NITOBOND (If applicable) is in the scope of the Contractor.

5. Application of APP Membrane: -

The contractor shall be responsible for the supply of APP membrane, laying & dismantling of existing APP membrane as per the instruction given by the engineer in charge.

APP modified polymeric membrane having 3 mm thick APP (Atactic polypropylene polymer) modified per fabricated five-layer, weight should not be less than 3.6kg/sqm waterproofing membrane, black finished reinforced with non-woven polyester matt @ 170Gsm laid over bituminous primed surface @ 0.4 ltr/sqm by torching method with 100mm side and end lap on another layer, membrane shall be laid using a butane torch and sealing all joints, etc. completed all as directed by Engr-in-Charge.

6. Rectification of Inverter Shed: -

The existing shed of inverters is made of steel members such as angle, wire mess, and perforated steel sheet.

The contractor shall be responsible for the rectification of the structure of the shed and will supply additional structure free of cost if required. Machines, tools & tackles, and consumables that will be used in fabrication work shall be arranged by the contractor on his own.

The contractor shall also be responsible for cleaning up the site after fabrication /rectification work.

7. Rectification/modification of DCDB and ACDB: -

DCDB is provided in the PV yard for the connecting cables from solar string to string inverter. DCDB is dustproof, vermin and weatherproof compiling IP 65 degrees of protection. DCDB has fuses (1500 V DC), MCCB (10-16 Amp), SPD (Type-II,10 KA), Din rail, connectors, etc.

ACDB is located between the inverter and LT panel where AC power is feeding to the

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grid. Similar to DCDB, ACDB has also provided IP 65 degrees of protection. The inside equipment of ACDB are MCB (100 Amp), SPD (10 KA, Type-II), MFM, Busbar, etc.

The contractor shall respond to check each and every ACDB & DCDB Installed at the site and will change faulty items if found. The contractor shall also check the internal wiring of each and every DCDB/ACDB and will make rectifications wherever required.

8. Supply & Laying of Solar Cable (DC Cable): -

Solar cable shall be supplied by the contractor. DC cable must be supplied with the compliance of EN- 50618, TUV-2 Pgf 1169/08.2007.

The contractor shall also be responsible for the laying of DC cable to connect the newly fixed modules with the existing string. The wiring shall be done in the same manner as it is laid on the site. Marking/identification is a must and to be carried out by the contractor. For this, sufficient ferrule to be provided at the site.

MC4 connector, cable lugs, cable gland, ferrules, cable ties, tags, etc. shall be in part of the contractor's scope of work. Marking/identification is vital on both ends of a cable.

9. Supply & Laying uPVC Conduit Pipe: -

In the existing setup, uPVC pipe (different sizes) has been used in the DC cabling of the plants. However, over the course of time, it has been damaged in some places and needs replacement.

The contractor shall be responsible for the supply of uPVC pipe in confirmation of ISI mark & latest IS 16205- part-24, and will lay in the same manner as it has been laid in the existing setup, wherever it is required.

10. Supply & Laying Earthing Strip: -

Plants are provided with sufficient earth protection. GI strip of 25 x3 Sqmm (galvanized) has been used to earth equipment such as Modules, DCDB, ACDB, inverters, lightning arresters, etc.

The contractor shall be checked the earthing arrangement for the plants and will lay earthing strip wherever it's required.

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Supply of earthing strip (25x3 sqm) shall be part of the contractor's scope of work.

11. Integration of modules & testing of the plants: -

The payments against particular testing items as listed in the BoQ shall be admissible only after completion of all the Pre-commissioning inspections/checks/tests as per the description given below:
Bidder shall organize all necessary tools/ measuring instruments required to operate the various electrical equipment at the time of commissioning: Digital megger 5KV with PI feature, Earth resistance tester, Phase sequence meter, Clamp meters, etc., discharge rods, etc.

A. Pre-commissioning inspections/checks/tests on the DC side
Bidder shall carry out the following minimum pre-commissioning checks:

a. Verification of firmness of SPV module interconnections (MC4).
b. Verification of firmness of DC cable terminations at the string level in line with the existing setup.
c. Verification of firmness of laid earthing strip (by the contractor) & connections with the existing setup.
d. Cable megger/ continuity check for DC power cables of strings which are subject to modification under this contract.
e. Measurement of open circuit voltage of individual strings for subjected strings.
f. Submission of test reports to BHEL for acceptance.

B. Pre-commissioning inspections/checks/tests on the AC side.
Basic checks
Tightness checks:

- Terminations of AC power cables at string inverters, data loggers, ACCB box, and LTPDB panels.
- Terminations of Control/ Instrumentation/ Data/ Communication cables wherever applicable.
- Terminations of earthing at all electrical equipment/ panels. Terminations of earth chambers of bidder scope

Electrical continuity checks
Megger (1kV) checks for all 1.1kV grade cables
AC/DC supply checks at TBs of all electrical panels/ DBs.

C. Pre-commissioning electrical tests:
String inverters

- DC & AC parameters such as voltage, current & power, etc.

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Annexure- III

LIST OF MAKE

S.No.	Items		Make
1.	DC Cable 1C x 4 Sqmm	:	Polycab/ havells /Lapp /KEI /RR Kabel /Apar
2.	DC Fuse (1000 Volt)	:	Reputed Make
3.	MCCB	:	L&T/ Siemens/ havells/ Anchor/ Schneider
4.	MCB	:	L&T/ Siemens/ havells/ Anchor/ Schneider
5.	SPD (Type-II, 10 KA)	:	L&T/ Siemens/ havells/ Anchor/ Schneider
6.	APP Membrane	:	Reputed make
7.	PVC Conduit	:	Reputed make
8.	MC 4 Connector	:	Reputed make

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Annexure-IV

Bill of Quantity

S.No.	Item Description	Unit	Quantity
1	Taking delivery from the Storage, lifting to the respective rooftops & replacement of damaged PV modules (including disposal of damaged modules at designated place) SS304 nut bolts & washer required shall be supplied free of charge.	Nos.	70
2	Supply & Installation of MC4 Connector	Nos.	70
3	Supply(if, required), fabrication & installation of module mounting structure (galvanized), as per the requirement (as per attached drawing).	Kg	2000
4	Modification of existing solar pedestals by increasing the size of the pedestal with M-25 Grade (1:1.5:3) concrete, as per the attached drawing, at roofs of all three (3) buildings including the cost of shuttering but excluding the cost of reinforcement steel.	Cum	30
5	Supply and installation of Reinforcement steel including, bending & placing in position before concreting for solar pedestals as per the drawing attached.	Kg	200
6	Dismantling of existing APP waterproofing sheet and disposal of waste at a designated place.	Sqm	200
7	Laying new APP waterproofing sheet with one coat of bituminous primer, wherever required.	Sqm	300
8	Supply and laying of damaged DC cable of 4 sqmm, Cu. including laying inside conduit pipes, wiring, and connecting from PV modules to the inverters including disposal of damaged cables, all complete, as per direction of engineer incharge.	Mtr	500
9	Supply and installation of UPVC Pipe of different sizes		
	Conduit UPVC 2 inch	Mtr	350
	UPVC 1 1/2 inch	Mtr	350
10	Supply and installation of 25X3 mm GI strip	Mtr	200
11	Commissioning of System after Rectification	LS	1

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