E-1 TOPOGRAPHY SURVEY AND SOIL INVESTIGATION

1.0 General

The proposed area for SPV and BESS system is marked in tender drawing NETRA-GC-PROPOSED AREA-TD-001. It is suggested that the bidder must visit the site and do survey for quantum of civil work required for site preparation and various civil works to be carried as per scope of work. Attempt should be made to use the natural contour of the land for SPV however for BESS and transformer the site may be required to be levelled as per bidder's requirement.

2.0 Topographical Survey (if required)

The Bidder will carry out the Topographical Survey and preparation of Plans (Maps) and report of the entire area for locating the Solar PV and BESS project and its other systems.

Latitude and Longitude: The work shall be carried out in UTM grids system.

3.0 Geotechnical Investigation Scheme (if required)

a. The Bidder shall carry out geotechnical investigation for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings.

b. The Bidder shall obtain the approval for the field and laboratory testing scheme before undertaking the geotechnical investigation work.

c. Bidder shall carry out the design of foundation etc. based on the approved geotechnical report.

d. Field test shall include but not be limited to Boreholes, Standard Penetration Test (SPT), collection of disturbed and undisturbed soil samples (UDS), Trial Pits (TP), collection of water samples, Electrical Resistivity Test (ERT) etc.

e. On completion of all field and laboratory work, the Bidder shall submit a Geotechnical investigation report for approval. The Geotechnical investigation report shall contain field and laboratory observations/ data/ records, analysis of results and recommendations on type of foundation for different type of structures envisaged for all the areas of work.

f. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc. shall also be covered in the report, as applicable.

g. Geotechnical investigation work shall be got executed by the Contractor through the Enlisted agencies, refer Appendix-1 of Chapter 2-B, Sub-section -2.

h. Foundation System: Foundation system for various facilities shall be designed and adopted as per approved geotechnical investigation report.

E-2 SITE LEVLLING AND GRADING

1.0 Site levelling works involves the following works:

1.1 Site leveling works/scheme shall match with the specific functional requirement of Solar PV optimum generation and manufacturers recommendation for BESS system considering the full utilization of the plot area for the desired capacity

1.2 Site grading level shall be fixed with due reference to site drainage of the whole area, existing drainage pattern and system requirements.

1.3 Based on the spot level, contour survey done and meeting above requirements, bidder can propose different site grade levels. The site levelling may be carried in patches/blocks. Bidder may also propose the site leveling and grading matching with the natural topography of the land considering the optimized use of the land, Bidder shall ensure that no water ponding and flooding occurs in the low lying areas & effective drainage is provided in the whole plot area, in all kind of site levelling and grading or plant at natural topography schemes, bidders has to provide proper and effective drainage system in line with “Drainage System” chapter. The site levelling and grading scheme incorporating the above aspects shall be submitted to NTPC for prior approval.

1.4 Complete project is to be leveled by cutting and filling of the soil to attain same horizontal level. Before start of the work the bidder has to carry out the topography survey of the proposed area and submit the report for proposed cutting and filling work to NTPC for approval. Single final level is to be achieved without using any additional soil.

1.5 All buildings and other structures as per the requirement of project shall be constructed in levelled area. No foundation shall be allowed on back filled soil and in that case the depth of foundations shall reach up to NGL. Final Level will be approved in detail engineering.

E-3 DESIGN OF MODULE MOUNTING STRUCTURE & CIVIL WORKS

1.0 Design criteria for module mounting structure (MMS)

The design calculations and drawings for MMS shall be submitted for prior approval of NTPC before the commencement of construction. The construction methodology for MMS, seasonal tilt mechanism and its foundations shall be also be submitted for NTPC approval before the start of works.

2.0 Design Loads:

A. Dead Load: The load obtained by summing up the weight of modules and self-weight of Structure including Purlins, rafter/beams, Bracings, struts, columns, necessary fittings, etc. to be added as a Dead load.

B. Wind Load: The wind load (positive and negative) normal to surface on the modules and wind load on the structural members.

C. The concept of wind tunnel studies may be considered in the design philosophy for fixed and seasonal module mounting structure.

If the Bidder is going for wind tunnel study for the design and analysis of complete fixed and seasonal MMS following has to be ensured.

i. It must be done from an institute of repute (IITs in India).
ii. If the study is done by any reputed international facility the study results must be vetted by any of the IITs in India.

3.0 Design Parameters:

A. MMS design & analysis to be done on computer software (preferably STAAD) and the Bidder shall submit a write-up on the computer program used and its input (soft format) and output data for review and approval.

B. An increase in allowable stresses of structural materials should not be considered during design and analysis.

C. Wind pressure for following loads shall be considered as follows:

(1) Dead Load of steel with all members, fittings & panels.
(2) Load due to fair wind direction on design tilt angles of solar mounting structural members.
(3) Load due to adverse wind direction on design tilt angles of solar mounting structural members.
(4) Load on the side face of mounting structural members.

D. Wind pressure coefficient, load and load combination shall be as per Indian standards (latest revision) such as IS: 875, IS: 800, IS 801.

E. Design analysis and the forces on MMS (Compressive force, uplift force, shear and moment) shall be used for the design of foundation system.

F. Seasonal Tilting MMS type: Mechanized arrangement for lifting MMS during seasonal tilting shall be provided with MMS. The lifting forces shall be transferred only through rafter/beam for lifting the MMS during seasonal tilt with a suitable hook, clamp, etc. and fixed at rafter/beam.

4.0 Materials Specification & Coating for Structural Steel Works:

A. Hot-rolled/Cold-formed steel sections:						
Members	**Reference code**	**Yield strength, min, MPa**	**Non Coastal**		**Coastal Area**	
			Coating, Reference code	**Min Thickness (mm)**	**Coating Reference code**	**Min Thickness (mm)**
Column/ Vertical Post	IS 2062 IS 1079	250	80 micron (IS 4759) (minimum)	2.5	110 micron (IS 4759) (minimum)	3.0
Bracing/Rafter/ Beam/Purlin				2.0		
Steel Tubes in all sections	IS 1161	240		2.0		
Hollow Steel in all sections	IS 4923	240		2.0		
Coupler/Plate/Cleat Splice/Sag Angle	IS 2062	250		2.0		2.0
		Yield strength, MPa	**Coating Class Designation**			
Rafter/ Beam/ Purlin (Pre-Galvanized steel sections)	ASTM A653M/ IS 1079	255-380	Z600 (ASTM A653M/ IS 277)	1.6	Not recommended in coastal areas	
NOTE:	1. Minimum elongation % shall be as per relevant Standard and Code. 2. Materials shall be fabricated in the shop. 3. Minimum coating requirement mentioned above in the table. 4. All structural calculations of cold formed steel section for checking the adequacy for strength and deflection criteria is to be done taking into consideration the maximum permissible negative tolerance over specified BMT ie the lower limit of BMT is to be considered. 5. The tolerance on Base Metal Thickness (BMT) thickness of steel shall be as given in IS 1852.					

B. Hot-dip Aluminium-Zinc alloy metallic coated sheet steel strip and sheet sections:					
Members	**Reference code**	**Yield strength, MPa**	**Coating Class Designation**	**Min Thickness (mm)**	**Coastal Area**
Purlin (Top Hat Sections)	ASTM A792M/ IS 15961	250 - 450	AZM150 (ASTM A792M)(IS 15965)	0.9	Not recommended in coastal areas
NOTE:	1. Minimum elongation % shall be as per relevant Standard and Code. 2. Materials shall be fabricated in the shop. 3. Minimum coating requirement mentioned above in the table. 4. All structural calculations of cold formed steel section for checking the adequacy for strength and deflection criteria is to be done taking into consideration the maximum permissible negative tolerance over specified BMT ie the lower limit of BMT is to be considered. 5. The tolerance on Base Metal Thickness (BMT) thickness of steel sheets and coils shall be as given in IS/ISO 16163.				

Painting of Steel Surfaces embedded in Concrete: For the portion of Steel surfaces completely embedded in Concrete as reinforcement, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).

C. Bidder shall also use principles governing design that shall prevent or reduce the risks of corrosion as per IS 9172 and relevant IS codes.

5.0 Connections:

Sl No	Connection	Grade
1	Solar PV module to purlin/structure connection.	SS304, A2-70
2	Bolts required to loose and tighten seasonally for seasonal tilting in the module mounting structure.	
3	Other structural fixed connections.	HDG 5.6 & 8.8
4	Foundation Anchoring.	HDG 4.6

Note: Fastener shall conform to IS 1367

In the ground mounting structure system with seasonal tilt arrangement, the column post and rafter/beam at seasonal tilt point of rotation shall be preferably hinged plate and bolt system.

6.0 Foundation System

Top of concrete/ height of collar for MMS foundation shall be minimum 300 mm above Finish ground level. The proposed foundation system for MMS shall be based on findings/results of the approved geo technical investigation report. Following kind of foundation may be provided:

1. Short pile foundation (Min. 300mm dia.)
2. Rock anchor with concrete collar (Min. 700 sq.cm.)
3. Isolated, strip or raft foundation

E-4 CIVIL & STRUCTURE WORKS – GENERAL DESIGN CRITERIA

1.0 General

The layout, design and drawings for Buildings, Structure and foundation system, pathways, road work, drainage cable gallery/ cable trench etc shall be approved from NTPC before the start of works. Design of RCC and Steel structures shall be carried as per IS 456 and IS 800 respectively. Structure design to be vetted by structural engineer before submission to NTPC for approval

2.0 For the Operation and Maintenance of SPV Plant one single storied **Central Monitoring and Control Station (CMCS)** accommodating following shall be provided:

1. Air-conditioned SCADA Room for Solar and BESS
2. Inverter, battery room, ACDB and Switchgear Room.
3. Air-conditioned Control Room
4. Toilets (Male and female).

3.0 Bidder to adhere to the equipment's manufacturers requirements for development of layout. The CMCS may be RCC structure with bricks/concrete blocks masonry walls.

4.0 The minimum size & requirements of the CMCS Building & all items shall be finalized during detailed engineering. However for the purpose of cost estimation the bidder should consider the size sufficient enough to accommodate items listed in point 2 above. The CMCS may have internal partitions as required to accommodate different internal component.

5.0 Inverter rooms will have PCU's / PCS, LT panels etc. based on bidders/manufacturer recommendation, easy passage of O&M persons and cable trench layout required. The battery 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.

6.0 The SCADA of BESS if provided separately by the bidder may be accommodated in the CMCS with proper ventilation arrangements.

7.0 The buildings and allied works shall be designed to meet **NATIONAL BUILDING CODE** (SP: 07 2016) requirements. Finish floor level of all building/rooms shall be minimum 450 mm above from Finish graded level.

8.0 The CMCS building should have vitrified tiles flooring, ventilation and air conditioning as required along with internal lighting arrangements

9.0 SPECIFICATION FOR RCC BUILDING (CENTRAL MONITORING AND CONTROLS STATION (CMCS) AND OTHER RCC/MASONRY STRUCTURE

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 roof shall be designed for a minimum superimposed load to 150 kg/m2.

10.0 Transformer Yard Civil Works

a) Transformer and equipment's foundations shall be founded on piles/isolated spread footings depending on the final geotechnical investigation report. Metering yard equipment's structures shall be designed as per IS 801 and IS 800.

b) 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.

c) 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 the oil volume of the transformer connected to it, without backflow. The Gravel-filled level under transformer shall be in accordance with FGL outside pit and transformer bottom level.

d) 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. The portion of the fence covering towards rail track shall be made of a removable type for movement of the transformer during erection /removal. In addition, a small gate, 1.2 m wide shall be provided for an entry. The transformer yard fencing work shall conform to CEIG requirements.

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

11.0 PIPE /CABLE RACKS & TRENCHES

a) The conventional methods of cables laying and installation shall conform to IS 1255 for laying direct in ground, drawing in ducts, laying on racks in air, laying on racks inside a cable tunnel and Laying along buildings or structures, etc.

b) Outdoor RCC Cable Trenches: RCC outdoor cable trenches in switchyard area shall be provided with pre-cast RCC removable covers with lifting arrangement. The top of outdoor trenches shall be kept at least 100 mm above the gravel level so that rainwater does not enter the trench.

c) Indoor RCC Cable Trenches: RCC indoor cable trenches shall be provided with 50X50X5 mm angles grouted on the top edge of the trench wall for holding minimum 6 mm thick mild steel checkered plate covers conform to IS: 3502 with lifting arrangement.

d) RCC cable trenches shall be constructed with wall thickness minimum 100 mm.

e) Trench Drainage: The trench bed shall have a slope of approx. 1/500 along the run & 1/250 perpendicular to the run. Incase 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 the trench. All expansion joints shall be provided with approved quality PVC water stops. Suitable drainage at the lowest point of the trench shall be provided.

12.0 PLANT DRAINAGE SYSTEM

a) Surface drainage system shall be designed considering 'Heaviest rainfall in one hour in mm'. 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.

b) The drainage scheme shall be designed considering the catchment areas contributing to the existing drains, solar plant gradients and solar PV array layout. As per plant drainage requirement, a network of open drains shall be designed & provided to carry surface runoff. The drains shall be trapezoidal, triangular rectangle section made of earthen type lining (Compacted Earth Lining) and hard surface lining (stone masonry/pitched, Boulder, Precast cement concrete/stone slab, in-situ cement lime/concrete lining, soil cement lining, etc.)

c) Bidders can also propose suitable detention pond, recharge dugwells, recharge pits, recharge trenches, and recharge soak ways for quick disposal of storm water in the vicinity of the solar block/plot.

d) Provision of culverts and their design to be submitted separately. The road on the culvert portions of the drains shall be concrete road.

e) All Buildings shall be provided with plinth protection all around, sloped towards side drains. Plinth Protection shall be 75mm mm thick PCC laid over well compacted 75mm well grades brick ballast base. Building peripheral drains shall be stone masonry/brick masonry/concrete works. These side drains shall be connected to area drains by either open drains or combination of open drains and underground pipes.

f) 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.

F. SAFTEY

SAFETY MANAGEMENT

1) Bidder shall submit the Safety Plan and the Safety Coordination Procedure as per the requirement of Attachment No: 18 Section-VII of the bidding documents.

2) During the execution of the contract, the bidder and its sub vendor (if any) shall follow safety procedures for the safety of the personnel and the equipments during erection, testing, commissioning, operation and the maintenance during the contract period as per the regulatory requirements and as per the recommendation of the original equipment manufacturer.

3) All the expenses, charges towards compliance of the safety norms bythe bidder as per the Safety Plan, Safety Policy, and the Safety Coordination Procedures are deemed to be included in the bid price. No additional claims shall be entertained towards meeting the safety requirements.

G. QUALITY ASSURANCE