



TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW



PS-439-1454

Rev No: 00

COPYRIGHT AND CONFIDENTIAL

The information on this document is the property of Bharat Heavy Electricals Limited. It must not be used directly or indirectly in anyway detrimental to the interest to the company.

**TECHNICAL SPECIFICATION
FOR
DESIGN, MANUFACTURING, SUPPLY,
SUPERVISION
OF
ERECTION
AND COMMISSIONING
OF
TRACKER SYSTEM
FOR
NREL BIKANER 200 MW GROUND MOUNTED
SPV PROJECT
AT
BIKANER, RAJASTHAN**

Revision details: 00	Prepared by: VKC  ವಿಜಯ್ ಕೆ ಚೌಧರಿ, ಹಿರಿಯ ವ್ಯವಸ್ಥಾಪಕ (ಪಿವಿ - ಇಂಜಿನಿಯರಿಂಗ್) विजय के चौधरी, वरिष्ठ प्रबंधक (पीवी - इंजीनियरिंग) VIJAY K CHOUDHARY, Sr. Manager (PV-Engg.) BHEL-SBD, Bengaluru - 560 012	Checked & Approved by: PM  ಪುನಮ್ ಮಿಶ್ರಾ, ಅಪರ ಪ್ರಧಾನ ವ್ಯವಸ್ಥಾಪಕರು (ಇಂಜಿನಿಯರಿಂಗ್ ಮತ್ತು ಪ್ರಾಜೆಕ್ಟ್ ಸಂಸ್ಥಾಪನೆ) पुनम मिश्रा, अपर महाप्रबंधक (पीवी इंजीनियरिंग एवं पी एस एस) PUNAM MISHRA, AGM (PV-Engg & BESS) BHEL-SBD, Bengaluru - 560 012	Date: 13.04.2026
-------------------------	---	--	---------------------



1.0 INTRODUCTION

The PV modules shall be mounted on metallic structures called Module Mounting Structures (MMS) having adequate strength and appropriate design, which can withstand the load of the modules and design wind pressure. Modules shall be mounted on non-corrosive support structures with Automatic motor powered Realtime East-West tracking. This document describes the technical specification for design, manufacturing, supply, supervision of erection and commissioning of Tracker system.

2.0 BRIEF SCOPE OF DESIGN, SUPPLY AND WORKS

2.1. DESIGN

- I. Design, Engineering and approval from End customer of complete Tracker system along with all accessories.
- II. Design, Engineering and approval from End customer of MMS material for Tracker system including foundation design.
- III. Design validation of Foundation design by supervision of trial pile testing at site. Trial Pile testing will be conducted by BHEL's Sub-contractor.

2.2. SUPPLY OF TRACKER SYSTEM

- I. Tracker System along with all accessories, Connections, tools & Consumables and mandatory spares specified.
- II. Module mounting structure components and all associated accessories, as applicable.
- III. Any auxiliary requirement of trackers system for regular functioning or maintenance to be supplied.

2.3. WORKS & SERVICES:

- I. Demonstration of erection methodology and supervision during complete erection of Tracker system at site. Erection works shall be done by BHEL's Sub-contractor.
- II. Commissioning, trial run and acceptance test of Tracker system.
- III. Comprehensive AMC of complete Tracker system including all accessories on yearly basis for specified period.



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

Based on above scope of design, supply and works, a BOM will be prepared for providing quotations. Detailed specification and scope elaborated in relevant section of the specification and its enclosures which are the integral part of the specification.

**2.4.BHEL SCOPE OF WORK (NOT INCLUDED IN SCOPE OF TRACKER
VENDOR):**

- I. Trail Pile Testing, Foundation works & Mechanical Installation of Trackers shall be done by BHEL's Subcontractor under supervision of tracker supplier.
- II. Dry Robotic Cleaning system shall be installed by BHEL's Subcontractor. Tracker system should be compliant for dry robotic cleaning system. The robots shall run cleaning cycle while tracker is in stow position, so all necessary coordination/communication will be provided by tracker manufacturer to Dry Robotic Cleaning Sub contractor, wherever required.
- III. Supply of PV Module by End Customer (NREL).

3.0 PROJECT INFORMATION:

Name of the Project	Development of 200 MW grid connected solar PV projects at Bikaner, Rajasthan
Plant Capacity	Block-X: 200MW at ISTS Point of Interconnection
Location of Site	Kalasar, Bikaner, Rajasthan
Nearest Town	Bikaner (55 kms)
Nearest Highway/Major Road	Suratgarh - Chattargarh - Bikaner Road
Nearest Railways Station	Bikaner Junction (55 km)
Nearest Commercial Airport	Bikaner Airport, Bikaner -- 45 kms Jodhpur International Airport – 280 kms
Indicative Coordinate	28°21'41.01"N, 73°17'3.44"E

4.0 AREA AVAILABILITY: As per Vicinity Map

Land will be provided by NTPC REL on “as is where is basis” (Approx. 5 acres/MW). Land being provided may or may not be on a contiguous basis. Land will be, in general levelled with an average slope of 10% and local slope of up to 15%. Thus, major cutting / filling is not envisaged, in general, except for the practical / localized issues. Topography survey and levelling (to the slope mentioned above) will be done by Owner through another contract



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

which is going on in parallel. Tracker OEM to design their system as per above mentioned slopes.

For Area Auto Cad Drawing and KMZ File, please put an e-mail to vijayk.choudhary@bhel.in mentioning tender reference.

5.0 SITE SPECIFIC DATA:

Corrosive category	Non-coastal (Minimum C3) However, for sub-structures, the chemical aggressiveness of sub soil & ground water shall be as per approved geotechnical investigation report and IS: 456; based on which measures against corrosion shall be adopted. Pollution from industries/factory /mines etc shall also be considered while deciding the corrosion category depending on the level of pollution to which location is exposed.
PV Module	Min. 600 Wp Bifacial
PV Module Characteristic*	2384 mm (+/- 10mm) x 1134mm (+/- 5mm) 33.8 kg (Approx. weight) 15.85 A (Isc) 14.97 A (Imp) Bifacial gain of 5% to be considered over and above Isc value mentioned above for component and cable sizing. 29 modules in series (600 Wp)
PV Module Hole distance*	For 600Wp 400 mm / 1400 mm (long edge) 1082 to 1099 mm (short edge)
No. of Module/String	29 Nos.
Additional Parameters*	Bifaciality factor – 80% Rear Shading factor - 5% Rear mismatch factor – 10%
Minimum Pitch	6.0 m Considering minimum 600 Wp Modules
Thermal Loss Factor (Uc, Uv)	Uc-29 Watts/m ² -K Uv-0.0 Watts/m ² -K
Tracker	1P Single axis E-W Tracker
Design Clearance for Tracker	The minimum design clearance (at the highest tilt angle) between the lower edge of the modules and the developed ground level shall be 400 mm for Single Axis Tracker based system.
Rainfall	Heaviest rainfall in one hour (in mm): 48.8 mm Or As per Nearest city / town (as mentioned in Appendix-A of IRC:SP:13-2004.)
Seismic data & design criteria	Provisions of IS 1893 (Part 1) shall be followed.



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

Basic Wind Speed for Design	47 M/s.
Design Wind Pressure, min, Pd	890 N/m ²
Comprehensive AMC	10 Years from Project COD
Tentative DC Capacity of the Project*	260 MWp

* Above Block DC capacity is considering DC:AC ratio 1.3 and nominal module Wp of 600 Wp. Even in case of change in nominal Wp of supplied PV module, the number of PV modules for erection shall remain same as calculated above and the DC capacity of the project shall be revised accordingly.

In this project, End Customer will supply the PV Module. End Customer will try to provide the exact PV Module characteristics including datasheet and other documents by 7 to 9 months after the award of LOA to Tracker Bidder. There might be slight changes in the dimensions, weight and Isc as per the actual PV Module compared to the inputs provided above. Tracker bidder to suitably design the Tracker system to consider such minor changes.

Bidder to submit tentative array layout & Basic proposed design including Type of tables, Bill of Material, design loads, pile reactions etc. for the project in line technical specification & details given in this document along with offer. Electrical Equipment like PCUs, Transformers, HT Panel are to be placed in between arrays. 13 Nos of IR rooms each consists of 1 No of 17.6 MVA Inverter transformer + 4 PCU+1 HT PANEL for 200 MW. The approx. Size of the block shall be 35 M X 35 M. Bidder to prepare array layout considering the same.

6.0 SPECIAL TECHNICAL CONDITIONS FOR PROJECT:

6.1 Painting of Steel Surfaces embedded in Concrete:

For the portion of Steel surfaces completely embedded in Concrete as reinforcement or otherwise for foundation systems, 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). However, for proprietary member of tracker-based MMS, Bidders proposal w.r.t. corrosion protection would be accepted subject to OEM certification.



6.2 Foundation System design:

6.2.1 Foundation system for tracker system shall be designed and adopted as per approved geotechnical investigation report and relevant IS standard. The general requirements for the foundation system to be adopted, are as given below.

6.2.1.1 All structures/ equipment shall be supported either on suitable open foundation (isolated, combined, raft) or pile foundation depending on type of structures/ facilities, sub-strata, topography, etc.

6.2.1.2 If the encountered sub-strata is black cotton soil, the same shall be either replaced up to the full depth of black cotton soil or expansive soil shall be stabilized by suitable treatment.

6.2.1.3 Shallow foundation shall not rest in black cotton soil.

6.2.1.4 All foundation system shall be designed in accordance with the latest revisions of relevant Indian Standards. For short pile foundation, method by B. B. Broms shall be followed for calculating lateral resistance and lateral deflection of a pile.

6.2.1.5 Bidder shall furnish design of piles for approval of BHEL/End Customer.

6.2.1.6 Level of Ground water table for design purpose shall be considered as per the recommendation of geotechnical investigation report.

6.2.1.7 Minimum depth of foundation shall be 1.0 m below ground level.

6.2.2 Top of concrete/ height of collar for MMS foundation shall be minimum 150 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. 300 mm dia.)

6.2.3 In desert areas where sand erosion is anticipated, depth of pile shall be increased beyond designed depth by minimum 300 mm or envisaged depth of erosion, whichever is higher.

6.2.4 Testing of piles and interpretation of pile load test results shall be carried out as per the stipulations of IS: 2911 (Part-4). Contractor shall obtain approval for the pile load test scheme before undertaking the pile load test.

6.3 Since the site is located in a desert area, sandstorms are common. Therefore, the dust-proof design should consider the deposition of sand particles on sensitive electronic equipment or sensors.



7.0 MANDATORY TECHNICAL REQUIREMENTS/DOCUMENTS TO BE SUBMITTED BY THE BIDDER ALONG WITH TECHNICAL BID:

- I. Bidder should be an OEM of Tracker System. A self-declaration along with details of manufacturing facilities to be submitted.
- II. Bidder to submit details of Type of tables, tentative Bill of Material, General Arrangement, pile reactions etc. for the project in line technical specification & details given in this document along with offer.
- III. Tentative array Layout for the project
- IV. Indicative MQP and FQP of the Tracker System.
- V. Tentative list of BOIs along with approved vendors.

8.0 TECHNICAL SPECIFICATIONS FOR TRACKER SYSTEM

8.1. GENERAL

The Tracker System shall be of proven design capable of tracking Sun's path actively, intended to maximize the energy output from PV Module. Design shall be based in accordance with the site climatic conditions and seismic loads, soil characteristics, thermal loads caused by expected fluctuations of materials and ambient temperatures and the minimum required design wind speed.

8.2. CODES AND STANDARDS

The Tracker system must conform to the latest edition of any of the following IEC/ equivalent standards for Tracker system design qualification and type approval.

CODES	Description
UL 2703	Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels or equivalent
UL 3703	Standard for Solar Trackers or equivalent
IEC 62817:2014+ AMD1:2017 CSV	Photovoltaic systems – Design qualification of solar trackers
IS 875: Part 1 & 2	Code of practice for the design loads for buildings and structures-
IS 875: Part 3	Code of practice for the design loads for buildings and structures-Wind Loads



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

IS 800: 2007	Code of practice for use of structural steel in general building construction
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
IS 1868	Anodic Coatings on Aluminium and its Alloys

Equivalent National and International standard/code would also be acceptable for Design of Module Mounting structures (MMS) with trackers.

8.3. DESIGN

8.3.1. Tracker System

- Only Single axis East-West real time tracking
- Configuration - Single row (1P)
- Tracker Range of Movement (ROM): +/- 45 degrees or better
- DC Self-powered drive system with battery backup of 3 days autonomy.
- Individual row-level bi-directional control
- Redundant communication (wireless) for individual Trackers
- Stow configuration: optimal Angle, as per aero elastic instability analysis.
- Design wind speed as per site specific documents.
- Suitable material for corrosion category compliance as per Corrosion map of India, EN ISO 14713, EN ISO 1461, EN ISO 12944-5 or ASTM 123.
- Operational temp: -10 to 50 degree Celsius.
- Comprehensive Integration to Plant SCADA with Tracker system to be done. Any communication cable, if required shall be provided and laid by Vendor only. BHEL SCADA to show all parameters of tracker system.
- Cleaning - Compliant with robotic module cleaning

8.3.2. MMS Design

I) Design Loads:

A. Dead Load: The load obtained by summing up the weight of modules and self-weight of Structure including Purlins, rafter/beams, tracker system, 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 seasonal module mounting structure as well as Tracker System.

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

i. It must be done from an institute of repute having suitable wind tunnel facility (IITs / SERC Chennai or equivalent level institute in India).

ii. If the study is done by any reputed international facility, the study results must be vetted by the wind domain expert at any of the IITs / SERC like institutes in India.

II) 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. Vertical Deflection and Horizontal Sway Limits:

Limiting Deflection: The limiting permissible vertical deflection for structural steel members shall be as per following:

a) Maximum vertical deflection in purlin = $\text{Span} / 180$,

b) Maximum vertical deflection in rafter (cantilever span) = $\text{Span} / 180$ and

c) Maximum lateral deflection in column/vertical post = $\text{Height} / 240$



d) All deflection limits can also be as per the serviceability limit defined by the module manufacturer & tracker manufacturer OR the proposed deflection limits duly approved by the module manufacturer during detailed Engineering.

8.4. REQUIREMENTS

- a) Tracker system shall be followed by either means of sun's positioning algorithm or optimization algorithm with a minimum tracking accuracy of $\pm 2^\circ$ between the pointing vector of the sun and the pointing vector of the modules.
- b) The tracker system shall have back tracking algorithm to avoid inter-row shading and optimizing irradiance collection for both row avoidance shading and diffuse light optimization. For Diffuse light optimization GHI sensors are also acceptable.
- c) All local tracking controls shall be mounted on the tracking structure. A suitable arrangement/bellows shall be provisioned to protect actuator assembly from extreme outdoor harsh condition, dust and UV rays.
- d) In case of failure of supply, the arrays should return to the stow position. Bidder shall supply a tracking mechanism with an inbuilt feature for meeting the requirement.
- e) Suitable redundancy in sensing and auxiliary power supply shall be provided for fail-safe stowing of trackers. Redundancy in control is also desirable for the safe operation of trackers. Detail of the scheme for various redundancy shall be finalized at the time of detailed engineering.
- f) Safety measures such as stop devices shall be applied to ensure personal safety.
- g) Tracker shall be equipped with safety features like, auto high wind stow to the designed angular position and shall have uninterrupted communication with monitoring console/station. It should be capable of sending alarms to the monitoring station in case of failure or abnormal operations of the tracker systems.
- h) For each row an earthing cable shall be installed to interconnect all metallic parts of foundation, tracker structure and PV modules of each table. In case of Self Grounded Tracker declared by OEM, no need of earthing cables to be provided.
- i) Tracker design shall also include a provision for fastening DC cables to the structure each 500mm without causing tearing or fluttering of cables.
- j) Tracker shall able to track as per proposed stow strategy supported by Wind Tunnel test.
- k) Tracker Torque Tubes should be galvanized in accordance with, ISO 1461, ISO 14713, ISO 9223, or relevant standard as per Corrosive Category of proposed Solar PV Site.

8.5. MODULE MOUNTING ARRANGEMENT



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

a) Module mounting structures shall be designed to withstand the extreme weather conditions in the area. The site design wind speed factors k_1 , k_2 , k_3 and k_4 and pressure coefficient shall conform to IS 875 (Part-3): 2015 or as per a Wind Tunnel Study from a reputed national/international facility, for the design of MMS. However, design wind pressure to be considered for design, shall not be taken less than the minimum wind pressure “pd” as mentioned in the Technical Specification.

If the Bidder is going for wind tunnel test for the design and analysis of complete MMS and solar tracker system following shall be ensured.

i. It must be done from an institute of repute (IITs / SERC or equivalent) in India)/ international facility.

ii. Bidders must ensure that offered tracker has proven design with wind tunnel test simulating actual site conditions. The analysis and design shall be completed within one months from the actual date of issue of LOA.

iii. Test results and design must comply with relevant Indian/ International codes.

iv. The design shall be shown in STAAD pro or similar commercially available software for further checking of BHEL/End Customer as and when required.

b) The structural material and design shall be as per Design Criteria for Module Mounting Structures (MMS). The structural Material Yield Strength and Minimum Design Thickness can be as per “Proprietary Design” of Tracker supplier, and It shall conform to Indian / international codal design provisions. The Proposed Solar PV tracker system same should be certified for successful performance of MMS and tracker system by designer for its design life of 25 Years after COD.

c) The design and the calculations for the MMS and the foundation system shall be submitted for prior approval of BHEL/End Customer before the commencement of construction and shall be based on the soil Geotechnical Investigation report.

e) The Structure shall be designed and analyzed in accordance with finite element method, the fundamental principles of Engineering using commercially available software (such as STAAD pro or similar), with dead load and wind load considered as per IS: 875 (Part 1& 3, respectively) or as per Wind Tunnel study done from a reputed national/international facility. Analysis shall be done as per appropriate load combinations preferably as per IS codes.

f) The Structure must be provided with limit switches to control the rotation of the frame.



g) Vendor to submit .shd file of Tracker system or key parameters of tracker system required for Energy simulation in PV Syst Software.

h) All nuts & bolts or clamps shall be of Stainless steel, Aluminium or Metal Alloy type for a module to structure connection, and other structural bolts shall be of grade HDG 5.6 or 8.8 or exclusively designed for solar tracker systems by manufacturers. Which should suffice the design life for 25 years and more for Corrosive Category proposed for Solar Park and confirm to Indian / international code provision.

8.6. PROTECTION AGAINST CORROSION & UV

Appropriate measures shall be considered, as required, to protect the structure, foundation, and all components against corrosion during the expected lifetime of the Plant. Structural steel shall be hot dip galvanized as per ISO 1461 (or BS 729), EN 10346, ISO 14713, IS 4759, ISO 9223 and as per Corrosive Category of proposed Solar PV Site.

Non-metallic materials placed outdoors shall be UV and sand resistant and withstand high ambient temperature operation regimes as per the climatic conditions over the whole Plant design lifetime, and where materials are specified in any part of this RFP, those characteristics are to be considered as a minimum requirement. Metallic materials are not explicitly required to be UV resistant but in case protective coating is required, this shall be UV and sand resistant.

All materials used for steel structures or structural elements shall be of high quality, free from defects likely to undermine the strength and duration of service of the Plant.

8.7. BEARING

a) The bearing should be type tested for operation cycles which solar plant will go through in its life of 25 years.

b) Preferably there should not be any lubrication in the bearing, but if there is any, then it should be maintenance free. No cleaning should be needed.

c) The bearing should also be resistant to dust, water, salt aerosol and any other external parameters.

8.8. MOTOR AND ACTUATOR

a) The motor should be IP 65 or better and it should be powered by reliable supply to drive the link through gear or hydraulic/electric actuator.



- b) The temperature rises in the motor during operation specified in IS12802: 1989 should not be more than approximately 10°C.
- c) The location and moisture or fumes shall not seriously interfere with the operation of the motor.
- d) The severity of vibration for the motors shall be within the limits specified in IS 12075: 1987.

8.9. CONTROLLERS

- a) Trackers should have an industrial grade system for its automatic control and operations. For all outdoor controllers, it should be housed in IP-65 enclosure.
- b) Battery back-up should be provided for Controller and motor for at least 15 minutes with power pack cum UPS. Alternatively, the bidder can provide backup power from the UPS of inverter room or CMCS room. Bidder to inform Aux. power consumption requirement to BHEL during detailed engineering.
- c) The controller must be enabled with a feature of stowing during highspeed winds. Trackers should move to the wind stow positions automatically when high wind speed values are trigger from the NCUs.
- d) The Real Time Clock (RTC) of the trackers shall have a facility to be time synchronized with SCADA on Network Time Protocol (NTP).
- e) A suitable communication link between the master controller of tracker and tracker SCADA system shall be arranged. The software for communication and analysis shall be provided by the tracker supplier. Tracker SCADA shall be interfaced with solar SCADA on an open protocol such as MODBUS/MODBUS TCP.
- f) Battery back-up should be provided for Controller and motor as per design specified above. Alternatively, the bidder can provide backup power from the UPS of inverter room or CMCS room.

8.10. STUDIES/REPORTS

The following studies, and reports shall be submitted by the Bidder for the offered solution. The studies and reports shall provide a positive outcome of the respective tests, designs, and concepts for the utilization of the proposed single axis tracker system in the Project:

- a) Stow strategy control system: The Tracker supplier is solely responsible for the definition and implementation of a proper stow strategy, which clearly demonstrates and guarantees



the safe operation of the tracker during all wind events with speed up to and including the maximum one defined as per local structural code. The following points, including but not limited to, should be made available as part of the safety stow strategy:

- Tracker inclination and orientation at safety stow position
 - Maximum wind speed in [m/s] as [3-sec gust / 10min average] defined at 10m height which the tracker can withstand in working position
 - Stow alarm function and wind speed at which it is triggered
 - Safety strategy during installation / commissioning
 - In case that batteries are used, which is the minimum charge level required in order to reach safety stow position
 - Security of communication protocols required for the active stow
 - Time requirement to move the tracker from working position into stow position considering also safety factors
 - System redundancies that help to minimize risk of failure. Emergency system in case of tracking or measurement defects
 - Dynamic analysis and tests along with static coefficients based on the actual tracker configuration, stiffnesses and geometry
 - Aeroelastic instability analysis for the proposed tracker structure to show that the stow angle will not result in aeroelastic instability
 - Definition of tolerances, maximum terrain inclinations North-South, East- West
- b) Wind tunnel tests from a recognized wind expert institute (CPP Wind Engineering, RWDI or an alternative experienced institute subject to approval by the Off taker).
- c) Independent Engineers Bankability review report from reputable agencies like Black and Veatch, DNV, IITs or other premier institutions/agencies.
- d) Structure design review document from any IIT civil/Structural certifying department, if required.

9.0 QUALITY ASSURANCE PLAN (QAP) & INSPECTION:



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

- 9.1. Detailed Material Quality Plan (MQP) for Tracker system and its accessories shall be submitted within 7 days from the manufacturing clearance for BHEL/End Customer's approval.
- 9.2. The Tracker and all its accessories shall be inspected by an authorized representative of BHEL/End Customer/TPI at Manufacturer's/Supplier's premises before dispatch as per approved QAP (Quality Assurance Plan) of manufacturing. The items shall only be dispatched after issue of Material Dispatch Clearance Certificate (MDCC).
- 9.3. Bidder to raise inspection call 7 days in advance. The inspection call should contain BBU ref., QAP ref., internal test reports, RMTC etc. for review.
- 9.4. For Erection & Commissioning works, a detailed Field Quality Plan (FQP) shall be submitted within 7 days from the manufacturing clearance for BHEL/End Customer approval. The FQP shall detail out for all the works, equipment, services, quality practices and procedures etc in line with the requirement of the technical specifications to be followed by the BHEL Sub Contractor at site. Tracker Vendor has to supervise and ensure follow of FQP during Installation works.

10.0 WARRANTY FOR TRACKER SYSTEM:

- 25-year lifetime design (at least) considering local ambient conditions and in respect of all standards for the PV modules support structures and foundations.
- 5-year warranty starting with the Project Commercial Operation Date (COD) for the complete mounting structure including but not limited to the design, material, substructure, power unit and other parts of Tracker system.
- 25 years for corrosion protection.

11.0 TRIAL PILE TESTING AT SITE:

Trial pile testing at site shall be conducted by BHEL's Subcontractor under supervision of Tracker Supplier at site. The scope covers conducting Initial and Routine Pile Load Tests (vertical compression, lateral, and pull-out) as per IS:2911 (Part 4)-1985. Tracker supplier has to inform Trial Pile testing procedure, pile data viz no. of piles, dia., depth, Trial pile location etc. to BHEL in advance for preparation of Trial pile by BHEL's Subcontractor. Casting of pile shall be done by BHEL's Subcontractor. Tracker Supplier representative may be present at site for verification of the process. Vertical compression tests will be



carried out using the maintained-load method with hydraulic jacks reacting against a kentledge platform, applying loads up to 2.5 times the working load for initial tests and 1.5 times for routine tests. Lateral and pull-out tests will involve applying horizontal and uplift forces respectively with required factor of safety as per IS 2911. Trial Pile test procedure to be submitted by Tracker supplier for approval of BHEL/End Customer. Load displacement curves and detailed test reports shall be submitted for all tests for approval of BHEL/End Customer. Approval of Trail pile test is responsibility of Tracker supplier only. In case, Tracker representative will not be present at site for supervision of trial pile testing, the reports submitted by BHEL's subcontractor is binding on tracker supplier and any change in design/supply on account of trial pile testing results will be done by tracker supplier without any cost implications.

12.0 TRAINING OF EMPLOYERS PERSONNEL

The bidder shall provide training (free of cost) to the personnel of BHEL, End Customer & BHEL's O & M Subcontractor for 15 man-days at his works and at site for design, erection, testing, commissioning and O&M. Expenses towards travel, lodging, and boarding and other expenses for the personnel shall be borne by BHEL/End Customer/BHEL's O & M Subcontractor.

13.0 SUPERVISION OF INSTALLATION & COMMISSIONING:

- 13.1. Foundation works & Mechanical Installation of Trackers including PV Modules shall be done by BHEL's Subcontractor under close supervision of Tracker supplier.
- 13.2. Tracker Supplier to depute sufficient nos. of expert, experienced, qualified and competent person for supervision works at site based on project size requirement.
- 13.3. Before start of erection work, the tracker supplier will provide their detailed erection manual and provide demonstration & Training on Erection of MMS & Tracker to BHEL's Sub contractor for each step of erection for minimum one of each type of Table offered (e.g. Far Interior, Interior, Exterior, Corner etc. as applicable) approved for the project.
- 13.4. Further Supervision of Erection works shall be done in such a way by Tracker Supplier so that no re-installation/modification occurs in Trackers system later. A joint protocol between Tracker Supplier and BHEL's Erection Sub contractor duly certified by BHEL's Representative shall be done periodically and used for payment of supervision of erection works.



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

- 13.5. In case PV Module is not received at site before completion of erection works, then erection works shall be deemed complete after all other components except PV Module for payment purpose. However, the scope of tracker supplier supervision includes supervision of erection of PV Modules also.

14.0 CONNECTIONS:

Supply of all connections for Tracker system including PV Modules connections/fasteners/clamps shall be in the scope of Tracker Supplier only.

Sr. No.	Connection	Grade
1	Solar PV module to MMS connection	SS304, A2-70
2	Other Structures	As per Site specific requirement

- A. SS304 Fasteners (nuts, bolts, washers and U-bolts) shall be of corrosion resistant austenitic steel. SS 304 Fasteners shall have a good anti-seize finish with proper wax coating for better durability and firm resistance to all types of failures.
- B. All fasteners shall be provided according to the connection design requirement. All bolts shall be tightened with designed torque mechanically immediately after the erection of MMS to avoid any possible damage due to any incidental storm during the erection stage. This is to be ensured during supervision of erection works.
- C. One set of fasteners shall consist of one hexagonal head nut, one hexagon shape bolt, and two plain washers & 1 spring washers. The bolts and nuts with inbuilt washers may also be provided.

15.0 COMPREHENSIVE ANNUAL MAINTENANCE CONTRACT (CAMC)

Bidder has to furnish comprehensive AMC on yearly basis from the date of Project Commercial Operation Date (COD) for period specified in Project specific document. Comprehensive AMC shall include all preventive maintenance and breakdown maintenance including replacement of any component to ensure that equipment is working satisfactorily as per design/system requirement. Bidder has to depute sufficient no. of persons at site during CAMC period as per project size requirement. During



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

CAMC period, the OEM is required to respond within one working day through telecom or any electronic means. This CAMC shall include the following but not limited to:

- I. Attending to and resolving any breakdown/fault of the tracker system.
- II. Periodic maintenance for checking the Tracker condition and any other maintenance needed to maintain healthiness of Tracker system. The bidder shall be responsible for supply of all spare parts, repairs / replacement of any defective equipment at his own cost as required from time to time during the CAMC period.
- III. Bidder shall maintain a minimum stock of each component of Tracker system and its accessories as spare at site during complete CAMC Period for maintenance of the system as per requirement. Bidder to replenish the spares if consumed and maintain minimum stock at any time during CAMC period.
- IV. Checking of tracker system components periodically for its wear and tear.
- V. Preventive maintenance and checks for complete tracker system.
- VI. Mandatory quarterly to assess the Tracker system for any failure or any sign which may lead to subsequent failure. Vendor to send the assessment report to BHEL/End customer through email.
- VII. Replacement of equipment/spare parts/ updating of softwares being phased out is also included in bidder's scope.

In case of severe breakdown of the system, OEM has to send their expert representative within 72 hours. For the minor faults not hampering the generation, the OEM has to get the fault rectified within 7 working days. Failure from the OEM to adhere the activity and the time schedule may lead to BG encashment. Any PV module damage due to the malfunction of tracker will be attributable to the tracker supplier only.

16.0 DELIVERY SCHEDULE:

Sr. No.	Item Description	Delivery Schedule
A. Design Submission & Approval		From date of firm PO
1	Design & Approval of complete Tracker systems along with all its accessories, MMS including Foundation from End Customer.	1 Months



**TECHNICAL SPECIFICATION FOR DESIGN,
MANUFACTURING, SUPPLY, SUPERVISION OF
ERECTION AND COMMISSIONING OF TRACKER
SYSTEM FOR NREL BIKANER 200 MW**

PS-439-1454

Rev No: 00

B. Supply (Progressively)		
2	Tracker System & Module mounting arrangement along with all accessories, tools & Consumables and Mandatory Spares as per final BOQ of approved design.	1st lot of vertical post & Its Coupler/extension piece of minimum 30 MWp shall be supplied within 45 days from Manufacturing clearance. Subsequently after that all balance supplies to be completed within 5 Months from manufacturing Clearance.
C. Works and services (Progressively)		
3	Supervision of erection during complete erection of Tracker system	Within 1 week from the date of receipt of Tracker material at site up to completion of erection works
		From Completion of Erection Works
4	Commissioning, trial run and acceptance test of Tracker system.	2 Months

17.0 MANDATORY SPARES REQUIREMENT OF PROJECT:

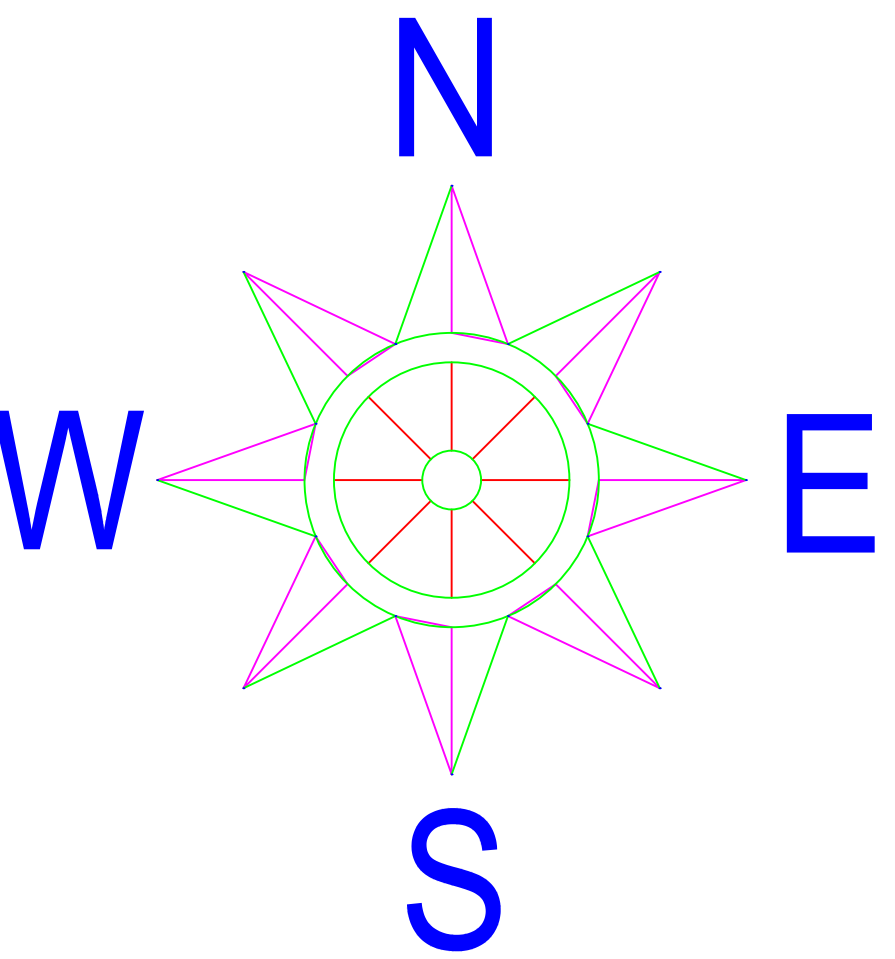
Following mandatory spares are required for this project:

Sr. No.	Item Description	Quantity of Spares w.r.to final BOQ of approved design.
1	Tracker motor	0.25% of total population for each type.
2	Battery pack (if applicable)	0.25% of total population for each type.
3	Control box (with all components including cards)	0.25% of total population for each type.
4	Bearings (if applicable)	0.25% of total population for each type.
5	All type of sensors	0.25% of total population for each type.
6	Driving mechanism	0.25% of total population for each type.

The BOQ of Mandatory spares shall also be submitted for approval to BHEL/End Customer with design documents.

ENCLOSURES:

1. Vicinity Map



Notes:

1. General
- a. The tender drawings shall be read in conjunction with the provision of Technical Specifications.

b. The details show in drawing are suggestive and for tender purpose only.

c. PSS for power evacuation with proposed corridor is envisaged at location as shown in Tender Drawings. PSS would be constructed by NTPC REL.

d. Land will be provided on “as is where is” basis and bidders are advised to visit the site location to appraise themselves with the site conditions.

e. The land boundaries shown are tentative and may vary to some extent during actual execution based on the land acquisition. However the Land will be provided approximately to the tune of 5 Acres / MW.
2. Reference Data for Project Site
- a. Bidder shall conduct The topographical survey and Geo-technical investigation to finalize the Layout as per the actual topography & Geo-technical Data .

b. Layout of Roads (Apart from the already Built Roads) will be finalized as per actual layout to be finalized during detailed Engineering.
3. Site Specific Considerations
- a. Some Roads, Drains & other Amenities are already built by NTPC REL at site. Bidders would be required to plan their layout considering the same.

b. All Internal road & drains are deemed to be in Scope of Work of respective bidder.

c. All arrangements as necessary to take up the project construction work, are in bidder's scope as per provisions of Tender Documents.

d. Water and Construction power are under the scope of Bidder and hence are to be considered by bidder for the given projects, as per their respective requirements, while planning for the project site activities.

e. Block layout has been marked for area reserved for PSS . However, Detailed planning w.r.t actual sizing and locations with in the block, would be carried out during detailed Engineering stage.

FOR REFERENCE PURPOSE ONLY

NTPC Renewable Energy Ltd

(A GOVERNMENT OF INDIA ENTERPRISE)
(ENGINEERING DIVISION)

VICINITY MAP CUM BLOCK LAYOUT

BALANCE OF SYSTEM (BOS) PACKAGE FOR
DEVELOPMENT OF 200MW GRID CONNECTED SOLAR
PV PROJECT AT BIKANER, RAJASTHAN

Prep.: SSSG

SCALE

NTS

DRG.

NO.

5800-004(BOS2)-POC-A-001

R0

