



**Dr. S. Arul Jayachandran**

Professor

Date : 17-08-2021

**TO WHOMSOEVER IT MAY CONCERN**

**Dwg / Doc. Ref : TPS-PUMP-10MMS-TR-F-001**

This is to certify that the design and analysis for 10 module mounting structure (TPS-PUMP-10MMS-TR-F-001) being offered by M/s Tata Power Solar Systems Limited is reviewed. The design and analysis work submitted by M/s Tata Power Solar Systems Limited is validated to withstand wind upto up to 150km/hr wind speed and is complying to the tender requirements.

Thanking You

Yours Sincerely

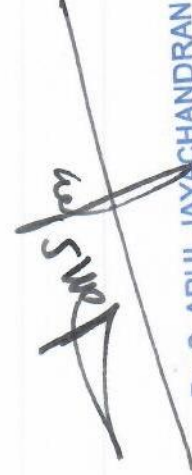
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## ANNEXURE 1

### TPSSL DESIGN IMPROVEMENT SUMMARY FOR MNRE-2019 MMS STRUCTURES


**Table 1.0**

Sl. no.	Short Description	MNRE - 2019	Improved design																				
1	Additional cross members provided.	No cross beam structural members provided in MNRE 2019 MMS designs. The purlins are carrying weight of the rafters.	Additional cross beam members have been provided to avoid excess deflection and stresses. This feature is absent in the MNRE design. The complete behaviour of the structure has been modelled and analysed on STAAD-Pro software.																				
2	Top Plate Gussets.	4 nos. Gussets provided on top plate of the structure.	8 nos. Gussets provided on the top plate of the structure.																				
3	Structural Material Strength	<div>MNRE - 2019 guidelines for yield strength :<table><tr><th>Component</th><th>MNRE Yield Strength</th></tr><tr><td>Purlins</td><td>250 MPa</td></tr><tr><td>Rafters</td><td>240 MPa</td></tr><tr><td>Base Column</td><td>240 MPa</td></tr><tr><td>Supporting Tubes</td><td>240 MPa</td></tr></table></div>	Component	MNRE Yield Strength	Purlins	250 MPa	Rafters	240 MPa	Base Column	240 MPa	Supporting Tubes	240 MPa	<div>TPSSL design uses High Yield Strength materials for better safety margins :<table><tr><th>Component</th><th>TPSSL Yield Strength</th></tr><tr><td>Purlins</td><td>350 MPa</td></tr><tr><td>Rafter</td><td>310 MPa</td></tr><tr><td>Base Column</td><td>310 MPa</td></tr><tr><td>Supporting Tubes</td><td>310 MPa</td></tr></table></div> <div>All materials grades used in the structure are as per IS standards.</div>	Component	TPSSL Yield Strength	Purlins	350 MPa	Rafter	310 MPa	Base Column	310 MPa	Supporting Tubes	310 MPa
Component	MNRE Yield Strength																						
Purlins	250 MPa																						
Rafters	240 MPa																						
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Rafter	310 MPa																						
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Sl. no.	Short Description	MNRE - 2019	Improved design																
4	Dimensions of main structure members	<p>Base pole and Supporting pipes are main load bearing member for the structure.</p> <p>MNRE 2019 guidelines :</p> <table><tr><th>Component</th><th>MNRE Diameter</th></tr><tr><td>Base Pole Diameter</td><td>139 mm</td></tr><tr><td>Supporting Pipe 1 dia.</td><td>41 mm</td></tr><tr><td>Supporting Pipe 2 dia.</td><td>33 mm</td></tr></table>	Component	MNRE Diameter	Base Pole Diameter	139 mm	Supporting Pipe 1 dia.	41 mm	Supporting Pipe 2 dia.	33 mm	<p>TPSSL has used larger diameter base pole and Supporting Pipes for high strength and low deflections :</p> <p>TPSSL Design :</p> <table><tr><th>Component</th><th>TPSSL Diameter</th></tr><tr><td>Base Pole Diameter</td><td>152 mm</td></tr><tr><td>Supporting Pipe 1 dia.</td><td>42.4 mm</td></tr><tr><td>Supporting Pipe 2 dia.</td><td>33.7 mm</td></tr></table>	Component	TPSSL Diameter	Base Pole Diameter	152 mm	Supporting Pipe 1 dia.	42.4 mm	Supporting Pipe 2 dia.	33.7 mm
Component	MNRE Diameter																		
Base Pole Diameter	139 mm																		
Supporting Pipe 1 dia.	41 mm																		
Supporting Pipe 2 dia.	33 mm																		
Component	TPSSL Diameter																		
Base Pole Diameter	152 mm																		
Supporting Pipe 1 dia.	42.4 mm																		
Supporting Pipe 2 dia.	33.7 mm																		
5	Slenderness Ratio of Base pole	Slenderness ratio of MNRE Design Base pole is 31.433.	Base pole is an important load bearing member for the structure. Slenderness ratio of TPSSL Base pole is 57.16. Hence there is more bucking strength for TPSSL Base pole.																
6	Pile design.	MNRE is silent on pile design guidelines.	Pile length designed as per IS 2911 with 300% safety margin considering utilization of the pile in clayey soil. Full 1.9m deep length steel structure column provided for sub-surface pile with surface anchors for adhesion to pile cap.																
7	Theft proofing.	J-bolt type bolted foundation, which can be easily dismantled with a spanner and thus prone to theft easily.	Central mounting column which is the heaviest component of the structure has been designed as a fully embedded structure. This cement embedded structure cannot be dismantled easily and thus discouraging theft.																
8	Land Utilization.	MNRE has given guidelines for module mounting structures. The guidelines requires combination of 4MMS , 6MMS and 8MMS only. Combination of MMS and foundations required will be more in case of MNRE recommended structures since number of modules per structure is lesser.	Tata Power Solar Ltd has alternatively developed 10MMS structure. The number of modules per structure in TPSSL design are more compared to MNRE structure hence require lesser number of structural combinations and foundations. Thus leaving more productive land for agricultural utilization.																



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**SUB : TPSSL DESIGN IMPROVEMENT SUMMARY FOR MNRE-2019 MMS STRUCTURES**

The Tata Power Solar Systems Ltd drawing / document no. TPS-PUMP-10MMS-TR-F-001 was reviewed by us and compared along with the Module Mounting Structural designs provided in MNRE-2019 document issued via circular number F.No.41/3/2018-SPV-Division. The description of the TPSSL documents is as follows:

SL. No.	Configuration / Size	Document No.	Contents
1	10 Module Mounting System (MMS)	TPS-PUMP-10MMS-TR-F-001	<ul style="list-style-type: none"><li>• Report for STAAD-Pro analysis as per IS standard.</li><li>• Wind Load Calculations as per IS 875</li><li>• Pile Foundation Design as per IS standard.</li><li>• Structural drawings of the Module Mounting System.</li></ul>

The above mentioned TPSSL document have been duly certified by us vide certificate dated 13-07-2021 which form a part of this document and shall be read in conjunction with these certificate. The improvements and advantages of the TPSSL designed structure in comparison to MNRE-2019 design have been mentioned in the Table 1.0 of Annexure 1 of this document.

**LIST OF ANNEXURES TO THIS DOCUMENT:**

ANNEXURE 1	TPSSL DESIGN IMPROVEMENT SUMMARY FOR MNRE-2019 MMS STRUCTURES	PAGE 2 TO 3
ANNEXURE 2	ABOUT BANGALORE UNIVERSITY	PAGE 4 TO 6
ANNEXURE 3	CREDENTIALS OF THE EVALUATOR	PAEG 7 TO 8

Thanking You

Yours Sincerely

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DATE: 17-08-2021

**SUB: TPSSL DESIGN IMPROVEMENT SUMMARY FOR MNRE-2019 MMS STRUCTURE**

The Tata Power Solar Systems Ltd drawing/document no. TPS-PUMP-8MMS-TR-F-001 was reviewed by us and compared along with the Module Mounting Structural designs provided in the MNRE-2019 document issued via circular number F.No.41/3/2018-SPV-Division. The description of the TPSSL documents is as follows :

Sl. No.	Configuration / Size	Document No.	Contents
1	8 Module Mounting System (MMS)	TPS-PUMP-8MMS-TR-F-001	<ul style="list-style-type: none"><li>• Report for STAAD-Pro analysis as per IS standard.</li><li>• Wind Load Calculations as per IS 875</li><li>• Pile Foundation Design as per IS standard.</li><li>• Structural drawings of the Module Mounting System.</li></ul>

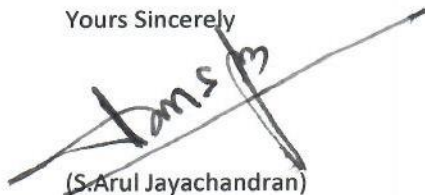
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(S.Arul Jayachandran)



## ANNEXURE 1

### TPSSL DESIGN IMPROVEMENT SUMMARY OVER MNRE-2019 MMS STRUCTURE

Sl. no.	Short Description	MNRE - 2019	Improved design																				
1	Structural Material Strength	<p>MNRE - 2019 guidelines for yield strength :</p> <table><tr><th>Component</th><th>MNRE Yield Strength</th></tr><tr><td>Purlins</td><td>250 MPa</td></tr><tr><td>Rafters</td><td>240 MPa</td></tr><tr><td>Base Column</td><td>240 MPa</td></tr><tr><td>Supporting Tubes</td><td>240 MPa</td></tr></table>	Component	MNRE Yield Strength	Purlins	250 MPa	Rafters	240 MPa	Base Column	240 MPa	Supporting Tubes	240 MPa	<p>TPSSL design uses high yield strength materials for better safety margins :</p> <table><tr><th>Component</th><th>TPSSL Yield Strength</th></tr><tr><td>Purlins</td><td>350 MPa</td></tr><tr><td>Rafter</td><td>310 MPa</td></tr><tr><td>Base Column</td><td>310 MPa</td></tr><tr><td>Supporting Tubes</td><td>310 MPa</td></tr></table> <p>All materials grades used in the structure are as per IS standards.</p>	Component	TPSSL Yield Strength	Purlins	350 MPa	Rafter	310 MPa	Base Column	310 MPa	Supporting Tubes	310 MPa
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Base Column	310 MPa																						
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2	Slenderness ratio of base pole	MNRE-2019 design Base pole has a slenderness ratio of 31.41.	TPSSL design Base pole has a slenderness ratio of 64.98, much higher than MNRE base pole. Hence there is better bucking strength compared to MNRE design.																				
3	Pile design	MNRE is silent on pile design guidelines.	Pile length designed as per IS 2911 with 300% safety margin considering utilization of the pile in clayey soil. Full 1.9m deep length steel structure column provided for sub-surface pile with surface anchors for adhesion to pile cap.																				
4.	Stress and Deflection	Structure to be designed as per IS 875. MNRE does not mention anything on deflection limits of the structure.	Structure designed as per IS 875 for a wind velocity of 150kmph. Deflection and stresses are within specified limits.																				
5	Theft proofing.	J-bolt type bolted foundation which can be easily dismantled with a spanner and thus prone to theft easily.	Central mounting column which is the heaviest component of the structure has been designed as a fully embedded structure. This cement embedded structure cannot be dismantled easily and thus discouraging theft.																				

Table 1.0

  
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Date: 17-08-2021

**TO WHOMSOEVER IT MAY CONCERN**

**Dwg / Doc. Ref : TPS-PUMP-N-MNRE-6MMS-F-002**

This is to certify that the design and analysis for 6 module mounting structure (TPS-PUMP-N-MNRE-6MMS-F-002) being offered by M/s Tata Power Solar Systems Limited is reviewed. The design and analysis work submitted by M/s Tata Power Solar System Limited is validated to withstand upto 150km/hr wind speed and is complying to the tender requirements.

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DATE: 13-07-2021

**SUB : TPSSL DESIGN IMPROVEMENT SUMMARY OVER MNRE-2019 MMS STRUCTURE**

The Tata Power Solar Systems Ltd drawing / document no. TPS-PUMP-N-MNRE-6MMS-F-002 was reviewed by us and compared along with the Module Mounting Structural designs provided in MNRE-2019 document issued via circular number F.No.41/3/2018-SPV-Division. The description of the TPSSL documents is as follows:

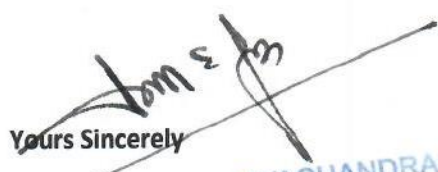
Sl. No.	Configuration / Size	Document No.	Contents
1	6 Module Mounting System (MMS)	TPS-PUMP-N-MNRE-6MMS-F-002	<ul style="list-style-type: none"><li>• Report for STAAD-Pro analysis as per IS standard.</li><li>• Wind Load Calculations as per IS 875</li><li>• Pile Foundation Design as per IS standard.</li><li>• Structural drawings of the Module Mounting System.</li></ul>

The above mentioned TPSSL document have been duly certified by us vide certificate dated 13-07-2021 which form a part of this document and shall be read in conjunction with these certificate. The improvements and advantages of the TPSSL designed structure in comparison to MNRE-2019 design have been mentioned in the Table 1.0 of Annexure 1 of this document.

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2	Slenderness ratio of Base pole	MNRE-2019 design Base pole has a slenderness ratio of 31.41.	TPSSL design Base pole has a slenderness ratio of 62.29, much higher than MNRE Base pole. Hence there is better bucking strength compared to MNRE design.																				
3	Deflections and Stress	Structure to be designed as per IS 875. MNRE does not mention anything on deflection limits of the structure.	Structure designed as per IS 875 for a wind velocity of 150kmph with maximum stress ratio 75 % for 6MMS structure. No members are 100% loaded. Structure designed not only with minimum deflections but also with stress considerations which are complying with IS standards.																				
4	Pile design.	MNRE is silent on pile design guidelines.	Pile length designed as per IS 2911 with 300% safety margin considering utilization of the pile in clayey soil. Full 1.8m deep length steel structure column provided for sub-surface pile with surface anchors for adhesion to pile cap.																				

  
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Sl. no.	Short Description	MNRE - 2019	Improved design
5	Seasonal tilt angle positions	MNRE 2019 does not prescribe standard tilt angle positions for the structure.	TPSSL design has three seasonal tilt angle positions 0, 15 and 20 degrees. Thus the structure can be tilted as per season for better tapping of solar energy.
6	Theft proofing.	J-bolt type bolted foundation which can be easily dismantled with a spanner and thus prone to theft easily.	Central mounting column which is the heaviest component of the structure has been designed as a fully embedded structure. This cement embedded structure cannot be dismantled easily and thus discouraging theft.

  
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