

27 February 2019

Project number: V002_AP

POWERSTONE SOLAR MOUNTING TECHNOLOGY Pty Ltd
No. 221 Luoyang East Road
Taicang City
Jiangsu Province China, 215400

Dear Sir,

RE: POWERSTONE ROOF MOUNTING FOR PORTRAIT ORIENTATED
TILT MOUNTED SOLAR PANELS .

As requested, we have reviewed the structural adequacy of the Aluminum support framing components as detailed in the drawings issued by POWERSTONE. We have design investigated for the Aluminum Railing as shown below. The section of the railing is shown below.

The panels in landscape orientation are supported by two rows of railing. The railings are supported by the legs which are fixed directly to the rafters, purlins or concrete roof. The spacing of the roof fixing in Terrain Category 2 shall be limited as tabulated below in tables 1.1, 1.2, 10.1 & 10.2 for 1700 long panels and 2.1, 2.2, 20.1 & 20.2 for 2100 panels. Refer to Figure C on page 3 for wind regions as defined in AS1170.2.



Figure A Rail Detail and Configuration.

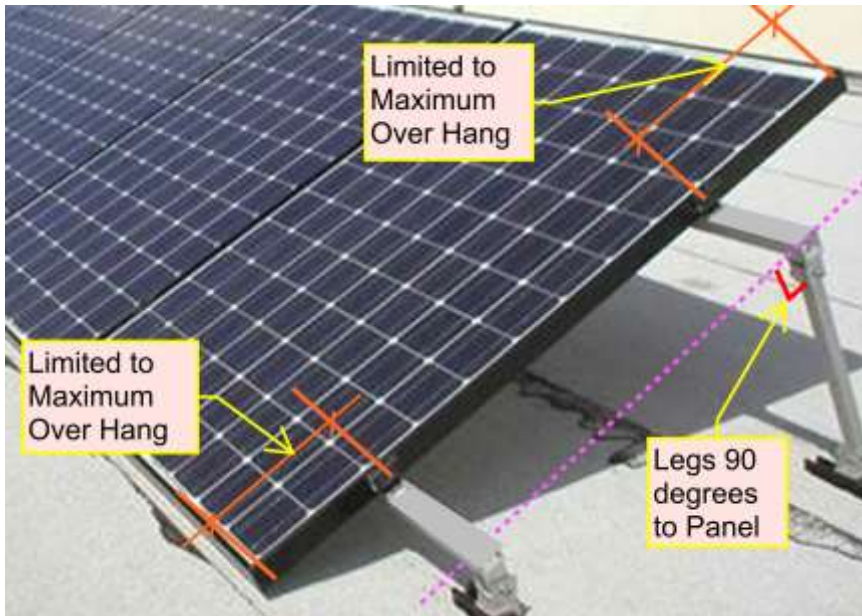


Figure B Criteria for the configuration.

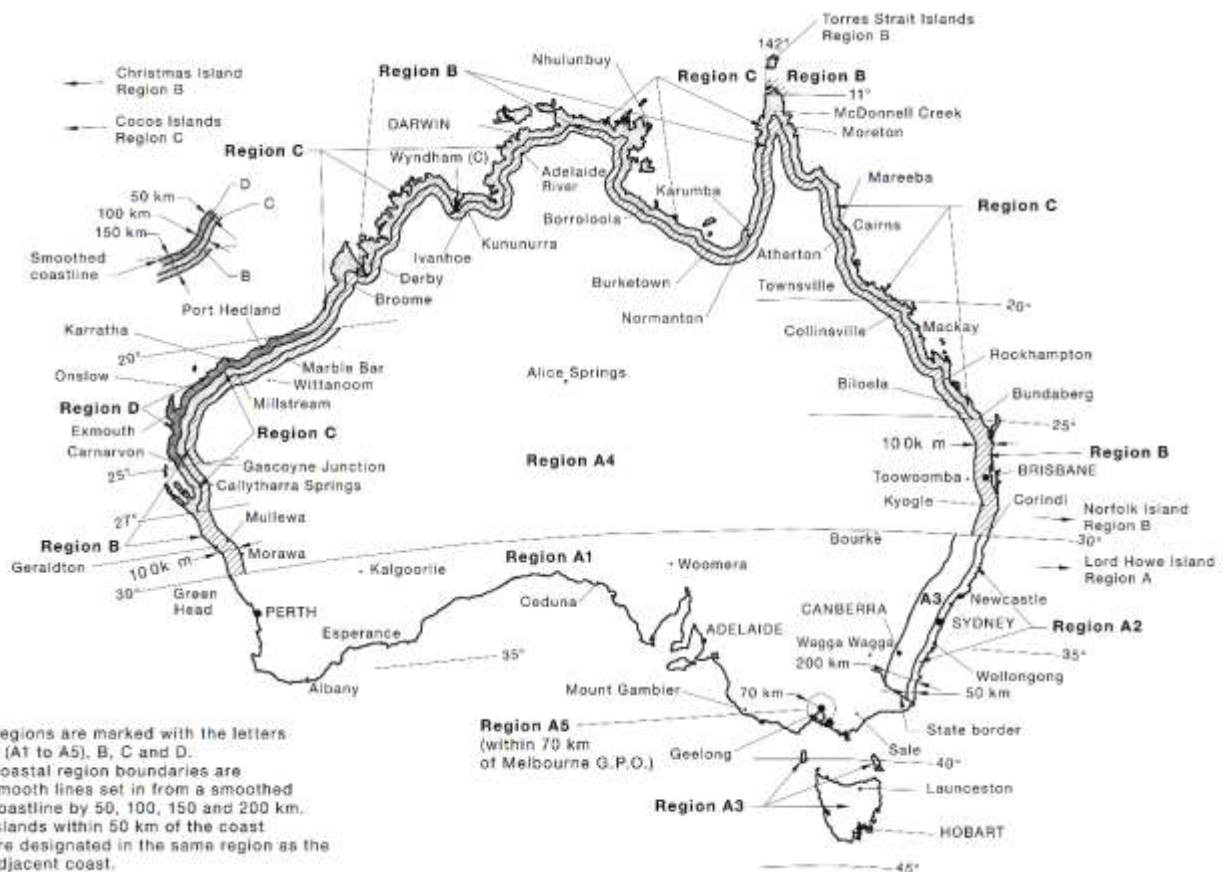


Figure C Wind Regions. AS1170.2

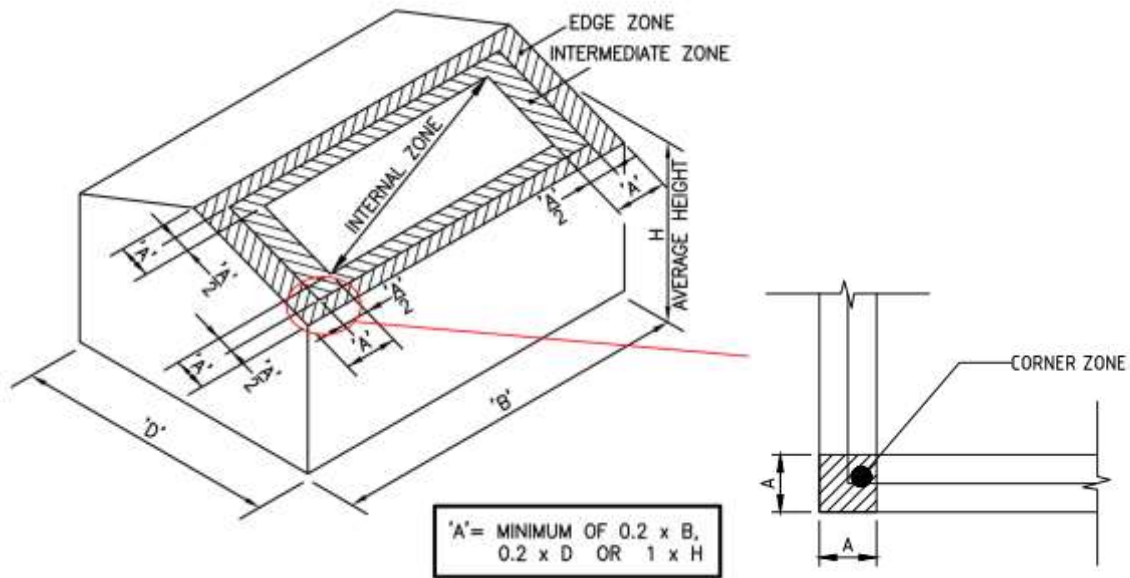


Figure D - Zones. AS1170.2 (See Note 5 on Page 11)

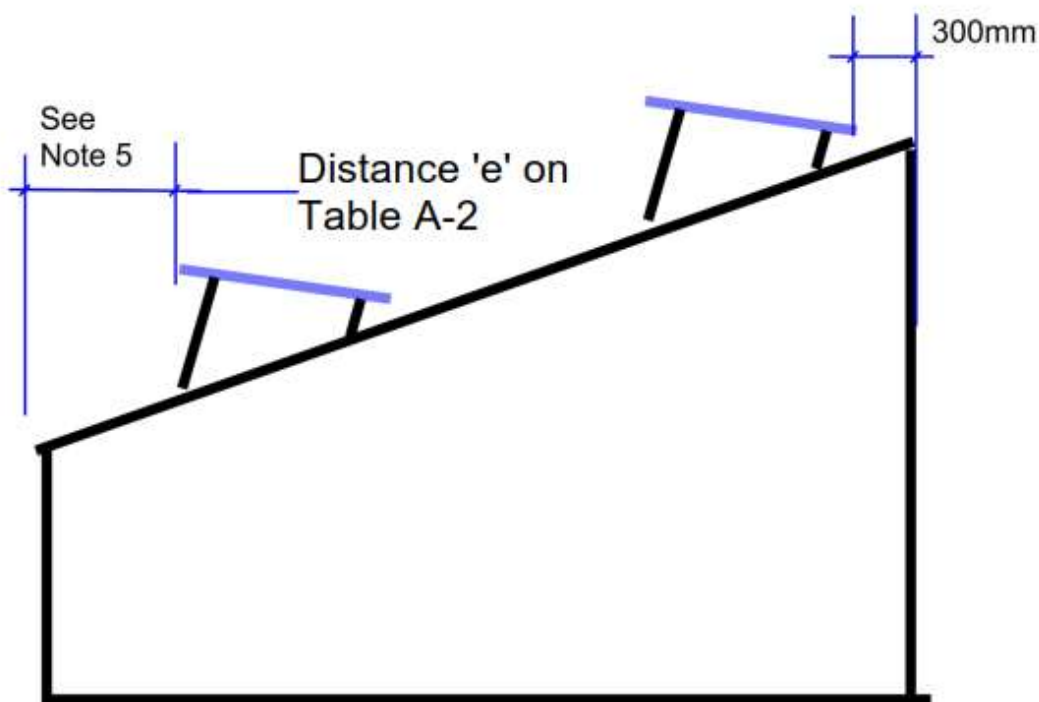


Figure E - Edge Clearance. (See Notes 5 & 6 on Page 13)
Refer to Tables A-1, A2 & A-3 to choose the appropriate spacing requirements.

Table A-1 Calculation of Edge, Intermediate and Corner Zones.

- | | | | |
|-----------------------|--------|--------------------|-------|
| 1. Building Height H: | ___ m. | Use Value of H | ___ m |
| 2. Building Width B: | ___ m. | Calculate 0.2 x B. | ___ m |
| 3. Building Depth D: | ___ m. | Calculate 0.2 x D. | ___ m |

Select the minimum Value of the three (3) results above.

A = ___ m. [The above calculated minimum value]

Edge Zone = Zone from the roof edge to 0.5 x A from the Roof Edge.
 Intermediate Zone = Zone from the end of Edge zone to A from the Roof Edge
 Corner Zone = A x A area at each of the roof corners.

- Edge & Intermediate zones need NOT be considered for small buildings where the minimum building width is less than 7100mm. (Refer to Tables A-2 and A-3 below). The tabulated Spacing for the internal zone can be used for all the zones.
- Corner zones are applicable only for large buildings where the minimum building width exceeds 14200 and the building height exceeds 3040. (Refer to Tables A-2 and A-3 below).
- Refer to Tables A-2 and A-3 to select the appropriate spacing requirement for each zone based on the value of 'A' as calculated above.

See Appendix A for an Example.

Table A-2 Local Pressure Amplification Zone			
Value of A (m) (Edge Zone width) Refer to Table A -1 above	Panel Installation Zones	Distance from solar panel To Roof Edge (e)m	Applicable Zones for Back Leg Spacing Requirement
$0 \leq A \leq 1.42$ (Building Dim. less than 7.1m)	Internal Zone	Intermediate/Edge/Corner Zone Not Applicable	Internal zone
	Intermediate Zone		
	Edge Zone		
	Corner Zone		
$1.42 \leq A \leq 2.84$ (Building Dim between 7.1 to 14.2m)	Internal Zone	$e > A$	Internal Zone
	Intermediate Zone	$e \leq A$	Intermediate Zone
	Edge Zone	Edge/Corner Zone Not Applicable	
	Corner Zone		
$A \geq 3.04$ (Building Dim. Exceed 14.2m)	Internal Zone	$e > A$	Internal Zone
	Intermediate Zone	$0.5A \leq e \leq A$	Intermediate Zone
	Edge Zone	$e \leq 0.5A$	Edge Zone
	Corner Zone	$e \leq A$ From both roof edge	Corner Zone
Panel Size 2000x1000			

Table A-3 Local Pressure Amplification Zone			
Value of A(m) (Edge Zone width) Refer to Table A -1 above	Panel Installation Zones	Distance from solar panel To Roof Edge (e)m	Applicable Zones for Back Leg Spacing Requirement
$0 \leq A \leq 1.31$ (Building Dim. than 6.52m)	Internal Zone	Intermediate/Edge/Corne r Zone Not Applicable	Internal zone
	Intermediate Zone		
	Edge Zone		
	Corner Zone		
$1.31 \leq A \leq 2.62$ (Building Dim between 6.52 to 13.04m)	Internal Zone	$e > A$	Internal Zone
	Intermediate Zone	$e \leq A$	Intermediate Zone
	Edge Zone	Edge/Corner Zone Not Applicable	
	Corner Zone		
$A \geq 2.62$ (Building Dim. Exceed 13.04m)	Internal Zone	$e > A$	Internal Zone
	Intermediate Zone	$0.5A \leq e \leq A$	Intermediate Zone
	Edge Zone	$e \leq 0.5A$	Edge Zone
	Corner Zone	$e \leq A$ From both roof edge	Corner Zone
Panel Size 1700x1000			

*'A' = the minimum value of 0.2B, 0.2D Or 1H, refer to figure D.

Panel Size	Terrain Category 2
1700x1000	1.1 & 1.2 (Page 6)
2000x1000	2.1 & 2.2 (Page 8)

Terrain Category 2 (TC2) Open terrain, including grassland, with well-scattered obstructions having heights generally from 1.5 m to 5 m, with no more than two obstructions per hectare, e.g. farmland and cleared subdivisions with isolated trees and uncut grass.

Table 1.1 Inclination 0 - 15 degrees					
Maximum spacing of the fixing of the Back legs mm					
Roof Height		Region A	Region B	Region C	Region D
5m	Internal Zone	1800	1410	840	500
	Intermediate Zone	1200	940	#N/A	#N/A
	Edge Zone	900	570		
	Corner Zone	600	470		
10m	Internal Zone	1650	1160	740	460
	Intermediate Zone	1100	770	490	#N/A
	Edge Zone	820	580	#N/A	
	Corner Zone	550	#N/A		
15m	Internal Zone	1530	1050	570	#N/A
	Intermediate Zone	1020	700	#N/A	
	Edge Zone	760	520		
	Corner Zone	510	#N/A		
20m	Internal Zone	1470	990	530	#N/A
	Intermediate Zone	980	660	#N/A	
	Edge Zone	730	490		
	Corner Zone	490	#N/A		
Panel size 1700 X 1000					

Terrain Category 2

#N/A : Failure of screw fixing to purlins.

Terrain Category 2 (TC2) Open terrain, including grassland, with well-scattered obstructions having heights generally from 1.5 m to 5 m, with no more than two obstructions per hectare, e.g. farmland and cleared subdivisions with isolated trees and uncut grass.

Table 1.2		Inclination 15-30 degrees				Terrain Category 2
Maximum spacing of the fixing of the Back legs mm						
Roof Height		Region A	Region B	Region C	Region D	
5m	Internal Zone	1140	760	450	#N/A	
	Intermediate Zone	760	500	#N/A		
	Edge Zone	570	#N/A			
	Corner Zone	#N/A				
10m	Internal Zone	930	550	410	#N/A	
	Intermediate Zone	620	#N/A	#N/A		
	Edge Zone	460				
	Corner Zone	#N/A				
15m	Internal Zone	850	#N/A	#N/A	#N/A	
	Intermediate Zone	560				
	Edge Zone	420				
	Corner Zone	#N/A				
20m	Internal Zone	800	#N/A	#N/A	#N/A	
	Intermediate Zone	530				
	Edge Zone	#N/A				
	Corner Zone					
Panel size 1700 X 1000						

#N/A : Failure of screw fixing to purlins.

Terrain Category 2 (TC2) Open terrain, including grassland, with well-scattered obstructions having heights generally from 1.5 m to 5 m, with no more than two obstructions per hectare, e.g. farmland and cleared subdivisions with isolated trees and uncut grass.

Table 2.1						Inclination 0 - 15 degrees		Terrain Category 2
Maximum spacing of the fixing of the Back legs mm								
Roof Height		Region A	Region B	Region C	Region D			
5m	Internal Zone	1700	1210	600	440			
	Intermediate Zone	1130	800	#N/A	#N/A			
	Edge Zone	850	600					
	Corner Zone	560	#N/A					
10m	Internal Zone	1480	990	560	#N/A			
	Intermediate Zone	980	660	#N/A				
	Edge Zone	740	#N/A					
	Corner Zone	490						
15m	Internal Zone	1330	890	520	#N/A			
	Intermediate Zone	880	590	#N/A				
	Edge Zone	660	440					
	Corner Zone	440	#N/A					
20m	Internal Zone	1260	840	480	#N/A			
	Intermediate Zone	840	560	#N/A				
	Edge Zone	630	#N/A					
	Corner Zone	#N/A						
Panel size 2000 X 1000								

#N/A : Failure of screw fixing to purlins.

Terrain Category 2 (TC2) Open terrain, including grassland, with well-scattered obstructions having heights generally from 1.5 m to 5 m, with no more than two obstructions per hectare, e.g. farmland and cleared subdivisions with isolated trees and uncut grass.

Table 2.2		Inclination 15 - 30 degrees			
Maximum spacing of the fixing of the Back legs mm					
Roof Height		Region A	Region B	Region C	Region D
5m	Internal Zone	970	560	#N/A	#N/A
	Intermediate Zone	640	#N/A		
	Edge Zone	480			
	Corner Zone	#N/A			
10m	Internal Zone	800	#N/A	#N/A	#N/A
	Intermediate Zone	530			
	Edge Zone	#N/A			
	Corner Zone				
15m	Internal Zone	640	#N/A	#N/A	#N/A
	Intermediate Zone	#N/A			
	Edge Zone				
	Corner Zone				
20m	Internal Zone	580	#N/A	#N/A	#N/A
	Intermediate Zone	#N/A			
	Edge Zone				
	Corner Zone				
Panel size 2000 X 1000					

Terrain Category 2

#N/A : Failure of screw fixing to purlins.



Our design investigation is based on the following Australian Standards and sections of Building Code of Australia relevant to structural issues.

- AS/NZS 1170.0-2002 Structural design Actions Part 0: General principles.
- AS/NZS 1170.2-2011(R2016) Structural design Actions Part 2: Wind actions.
- AS 1664.1-1997 Aluminum structures Part 1: Limit state design.
- AS/NZS 4673-2001 Cold Formed Stainless Steel.
- AS 1684.1-1999 Residential timber-framed construction - Design criteria.
- AS 1684.2-2010 Residential timber-framed construction - Non-cyclonic areas.
- AS 1684.3-2010 Residential timber-framed construction - Cyclonic areas.
- AS 1720.1-2010 Timber structures - Design methods.pdf.
- AS 3566.1-2002 Self-drilling screws for the building and construction industries.
- AS3566.2-2002 Part 2: Corrosion resistance requirements.
- ISO3506:1-2009 Mechanical Properties of Corrosion-Resistance Stainless Steel Fasteners.

Following design criteria has been used for the structural verification.

- Design Life 25 years
- Importance Level Type 2: Ordinary
- Annual Probability of exceedance 1/200
- Terrain Category to AS1170.2 2 & 3
- Service Deflection Not limited
- Snow loading Not considered
- Earthquake Loading Not considered
- Maximum Roof Pitch 7 degrees
- Aluminum Rails 6005 - T5
- Maximum dimensions of Solar panels.
 - 18 Kg panel 1700X1000
 - 25 Kg panel 2000X1000
- Panel Orientation Portrait.

Subject to the following qualifications we certify that the above-mentioned frames are structurally adequate and conform to the above Australian standards.

1. Each row of 1700/2000 long solar panels shall have a minimum of two rows of railing to support the panels. The upper railing is supported with back legs (struts). The struts are perpendicular to the panels (See figure B). The struts shall be directly fixed to the purlins or Rafters. The lower railing shall be fixed to the roof purlins with shorter legs of with a use of a base bracket.

2. The cantilever span of the panel shall not exceed 25% of panel length (ex 425mm for 1700 long). (See Figure B)
3. The cantilever span of the railing shall not exceed 33% of the adjacent spacing of the installed fixings.
4. The spacing of the rail fixings shall not exceed the recommended spacing and shall be reduced to match the location of the roof rafters or purlins.
5. Refer to Tables A-1, A-2, & A3, for the spacing requirements where the panel's longer legs are located within the edge/intermediate zones as defined in Clause 5.4.4 of AS1170.2. Edge distance 'e' is measure from the panel edge to the roof edge.
6. The set out of the intermediate, Edge, and corner zones shall be as specified in Tables A-1 A-2 and A-3.
7. The maximum spacing of the legs & fixing shall conform to the worst case if the panel spans across different zones (Internal, Intermediate, Edge & Corner). Example: Fixing for a panel located partly in the internal zone and partly in the intermediate zone shall be that for the intermediate zone.
8. All panels shall have a minimum clearance of 300 from the roof edge.
9. The deflection of the railing has not been controlled in the design. If defection has to be limited then spacing shall be reduced as advised by a practicing structural engineer.
10. The roofing to which the panels are to be installed shall conform to the relevant Australian Standards including AS1684, AS4440, AS1720, AS4100 and AS4600.
11. The buildings to which the panels are to be installed shall be of approved construction and conform to BCA and the relevant Australian Standards. The roof framing and the building shall be regularly maintained as required.
12. The installation of the framing shall conform to relevant Australian Standards, Manufacturer's specifications and good building practice.
13. Each fixing shall have a minimum 2 gauge 14 screws.
14. The screws used to attach the railing to the roof framing shall conform to AS3566, ISO 3506.1.
15. The cold formed steel purlins shall have a minimum base material thickness of 1.2mm in Regions A & B and 1.9mm in Regions C & D.
16. The Minimum Timber Joint Type classification shall be as follows:

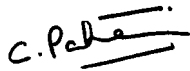
Wind Regions	Seasoned	Unseasoned	Joint Classification as in Tables H2.3 & H3.1 of AS1720.1.
A & B	JD1 to JD5	J1 to J4	
C & D	JD1 to JD4	J1 to J3	

17. Predrilled holes shall be used for all screw fixings into timber. The width of Timber purlins shall not be less than 35mm. The minimum embedment for each screw shall be 35mm.

18. Dissimilar metals shall be separated with a suitable inert material to prevent galvanic corrosion.
19. The installation and fixings shall be periodically inspected and maintained.
20. The following are excluded from this certification.
 - x Framing of the solar panel assembly.
 - x Material Testing and or Verification of test certificates for the materials and components.
21. The installation and fixings shall be periodically inspected and maintained.
22. We relied upon the material properties submitted by the manufacturer. Material Testing and or Verification of material property is excluded from our investigation.

Should you have any queries, please feel free to call Paheer on 9565-5558.

Yours faithfully,
SPAD PTY LTD



Paheer C Paheerathan
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Director

Appendix A

Example:

A building of 10.0 (B) x 8.0 (D) x 5.0 (H), located in TC 2, Region A,
 PV Panels: 2100x1100 Portrait inclined at 10degrees.

Step 1: Check A from Table A-1,

Building Height H:	5.0 m.	Use Value of H	5.0 m
Building Width B:	8.0 m.	Calculate 0.2 X B.	1.6 m
Building Depth D:	10.0 m.	Calculate 0.2 X D.	2.0 m

A= minimum {0.2b,0.2d H} = **1.6m**

Step 2: Find Spacing Requirements from Tables A-2 or A-3

Panel Size 2000X1000: Got to Table A-2.

A =1.6. i.e. $1.42 < A < 2.84$

Intermediate zone spacing will be applicable for a) Intermediate, b) Edge and c) Corner zones.

Step 3:

2000x1000 Panel , 0 to 15 deg inclination, in Terrain Category 2: Go to Table 2.1.

Spacing in internal zone = 1450

Spacing for all other zones = 967.