



EBULEN CONSULT

SOLAR PV ROOF-MOUNT RACKING FRAME ENGINEERING CERTIFICATE

ANTAI FLUSH-MOUNT SYSTEM WITH 355B RAIL, L-FOOT & KL700 CLAMPS

Prepared for:

Antai Technology Co., Ltd.

30F, W Square

1801 Huandao East Rd,

Siming District

Xiamen, China

February 10, 2023

Ref: E22110958

OVERVIEW

This structural engineering certificate is issued for Antai Solar Roof Flush-mount racking system with 355B rail, L-foot bracket and non-penetrative roof clamp fixing, which have been assessed against relevant Australian Standards and regulations. The assessment is carried out based on sound engineering methodologies. Assessment specifications and findings are given in the following sections.

AUSTRALIAN STANDARDS

- AS/NZS 1170.0:2002 – Structural design actions, Part 0: General principles
- AS/NZS 1170.1:2002 (R2016) – Structural design actions, Part 1: Permanent, imposed and other actions
- AS/NZS 1170.2:2021 – Structural design actions, Part 2: Wind actions
- AS/NZS 1664:1997 – Aluminum Structures

ASSESSED PV RACKING FRAME PARTS

The following products by Antai Technology Co., Ltd. are assessed against relevant Australian Standards and building regulations based on the specified conditions.

Part Category	Included Parts	Part Material
Rail	ATL-TYN-355B	AL 6005-T6
Rail Splice	ATL-TYN-304/54	AL 6005-T6
Tin Interface Bracket	ATL-FWNY-05	AL 6005-T6
Inter/End Panel Clamp Kit	ATL-FWNY-09	AL 6005-T6
	ATL-GN-003	AL 6005-T6
	ATL-CG-018	AL 6005-T6
Klip Lock Roof Clamp	ATL-TYN-25/26	AL 6005-T5

ASSESSMENT CONDITIONS

- Solar PV system design life of 25 years
- Wind region A, B, C, D
- Terrain category 2.0, 2.5, 3.0
- Ultimate wind recurrence interval of 200 years
- Maximum average roof height of 20m
- Solar PV panel assessed: 2300mm x 1200mm, 2100mm x 1100mm, 2000mm x 1100mm, 1700mm x 1100mm
- Self-weight of the solar PV panel and racking frame is 0.15kPa-0.18kPa
- Solar PV panel is supported by minimum 2 rails
- The clamps capacities are taken from below testing reports: No.MT-15/317 by Melbourne Testing Services (MTS) Pty Ltd, dated 26/05/2015
- The clamps have been assessed with the Lysaght Klip Lok 700 roof sheeting
- Product details are taken from the drawing set provided by Antai Technology Co., Ltd. as listed in the above component table
- Installation to be carried out strictly in accordance with the manufacturer's installation guidelines

IMPORTANT NOTES

- ***This certification is issued based on assessments of solar PV racking frame system and its fixing connection to building roof. It has not considered the structural capacity of building structure and solar PV panel due to uncertainty of generic application. The installer must use the data tables as references only.***
- ***The attached spacing tables must be read in conjunction with foot notes and general notes.***
- ***The certificate shall be read as a whole. Any section, text, image, table extracted from this certification is not valid stand-alone.***
- ***This certification shall be reviewed and revalidated by the structural engineer after two years from the date of issue or if any applicable standard is updated.***

CONCLUSION

The above-mentioned solar PV roof-mount racking frame system by Antai Technology Co., Ltd. is found structurally sound against relevant Australian Standards following the engineering recommendations in this certification. Installation shall be conducted following the manufacturer's guidelines.

Certified by:



Zhichao Zhang
B.Eng (Civil), M.Eng (Structural)
MIEAust, NER, RPEV, RPEQ



ABN: 20 646 315 013
INFO@EBULENCONSULT.COM.AU
C307, LEVEL 3, 175 MAROONDAH HWY,
RINGWOOD, VIC 3134
0452 197 595

APPENDIX A – INSTALLATION GUIDELINE

Interface Spacing Table for Terrain Category 3, $h/d \leq 0.5$ (Unit: mm)									
Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$
A	Internal Zone	1700	1700	1700	1700	1700	1700	1669	1700
	Intermediate Zone	1391	1549	1391	1549	1186	1318	1049	1165
	Edge Zone	1005	1115	1005	1115	862	955	765	847
	Corner Zone	646	714	646	714	557	615	496	547
B1	Internal Zone	1432	1596	1432	1596	1221	1357	1079	1198
	Intermediate Zone	908	1006	908	1006	779	862	692	766
	Edge Zone	664	734	664	734	572	632	510	562
	Corner Zone	432	477	432	477	374	412	333	367
B2	Internal Zone	1280	1424	1280	1424	1094	1214	968	1074
	Intermediate Zone	816	903	816	903	701	775	624	689
	Edge Zone	598	661	598	661	516	569	460	507
	Corner Zone	390	430	390	430	338	372	301	332
C	Internal Zone	806	892	806	892	693	766	616	681
	Intermediate Zone	522	576	522	576	450	497	402	443
	Edge Zone	386	425	386	425	334	367	298	328
	Corner Zone	253	279	253	279	220*	242*	196*	216*
D	Internal Zone	511	564	511	564	441	487	394	434
	Intermediate Zone	334	368	334	368	289	319	259	285
	Edge Zone	248*	273	248*	273	215*	237*	192*	212*
	Corner Zone	164*	180*	164*	180*	142*	156*	127*	140*

NOTES:

- * denotes the situations where the wind load is more than 5KPa and the installation safety is compromised.
- Definition of Terrain Category is given in General Note 1.
- Notion of Roof Zone is given in General Note 2.
- The Roof pitch angle is given in reference to horizontal. The value of Φ shall be determined and measured by following the figure in Note 3
- The spacing table is based on the fixing condition specified in General Note 7.
- For $0.5 < h/d < 1.0$ cases, the spacing value can be obtained by linear interpolation between $h/d \leq 0.5$ and $h/d \geq 1$ data with the same TC

Interface Spacing Table for Terrain Category 3, $h/d \geq 1$ (Unit: mm)									
Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$
A	Internal Zone	1452	1626	1452	1626	1238	1383	1094	1220
	Intermediate Zone	920	1024	920	1024	790	878	702	779
	Edge Zone	673	747	673	747	580	643	516	572
	Corner Zone	438	485	438	485	378	419	338	374
B1	Internal Zone	946	1053	946	1053	812	903	721	801
	Intermediate Zone	610	676	610	676	526	583	468	519
	Edge Zone	450	498	450	498	389	430	347	384
	Corner Zone	295	326	295	326	255	282	228*	252
B2	Internal Zone	850	945	850	945	730	811	649	721
	Intermediate Zone	550	609	550	609	474	525	423	468
	Edge Zone	406	449	406	449	351	388	313	347
	Corner Zone	267	295	267	295	231*	255	206*	228*
C	Internal Zone	543	602	543	602	469	519	418	462
	Intermediate Zone	355	393	355	393	307	339	274	303
	Edge Zone	263	291	263	291	228*	252	204*	225*
	Corner Zone	174*	192*	174*	192*	151*	166*	135*	149*
D	Internal Zone	348	385	348	385	301	333	269	297
	Intermediate Zone	229*	253	229*	253	198*	219*	177*	196*
	Edge Zone	170*	188*	170*	188*	148*	163*	132*	146*
	Corner Zone	113*	124*	113*	124*	98*	108*	88*	97*

NOTES:

- * denotes the situations where the wind load is more than 5KPa and the installation safety is compromised.
- Definition of Terrain Category is given in General Note 1.
- Notion of Roof Zone is given in General Note 2.
- The Roof pitch angle is given in reference to horizontal. The value of Φ shall be determined and measured by following the figure in Note 3
- The spacing table is based on the fixing condition specified in General Note 7.
- For $0.5 < h/d < 1.0$ cases, the spacing value can be obtained by linear interpolation between $h/d \leq 0.5$ and $h/d \geq 1$ data with the same TC

Interface Spacing Table for Terrain Category 2.5, $h/d \leq 0.5$ (Unit: mm)									
Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$
A	Internal Zone	1700	1700	1700	1700	1550	1700	1411	1573
	Intermediate Zone	1249	1389	1101	1223	979	1085	895	992
	Edge Zone	906	1004	802	887	715	791	655	724
	Corner Zone	585	646	519	573	464	512	427	470
B1	Internal Zone	1285	1430	1133	1258	1006	1117	920	1020
	Intermediate Zone	819	906	725	802	647	715	594	656
	Edge Zone	601	663	533	589	477	526	438	483
	Corner Zone	392	432	349	384	312	344	287	316
B2	Internal Zone	1151	1279	1016	1127	904	1001	827	916
	Intermediate Zone	736	815	653	722	583	644	535	591
	Edge Zone	541	598	481	531	430	475	396	436
	Corner Zone	354	390	315	347	282	311	260	286
C	Internal Zone	727	805	645	713	576	636	529	584
	Intermediate Zone	472	521	420	463	376	415	346	381
	Edge Zone	350	385	311	343	279	307	257	283
	Corner Zone	230*	253	205*	226*	184*	202*	169*	186*
D	Internal Zone	463	511	412	454	369	406	339	373
	Intermediate Zone	303	334	270	298	242*	267	223*	245*
	Edge Zone	226*	248*	201*	221*	180*	199*	166*	183*
	Corner Zone	149*	164*	133*	146*	119*	131*	110*	121*

NOTES:

- * denotes the situations where the wind load is more than 5KPa and the installation safety is compromised.
- Definition of Terrain Category is given in General Note 1.
- Notion of Roof Zone is given in General Note 2.
- The Roof pitch angle is given in reference to horizontal. The value of Φ shall be determined and measured by following the figure in Note 3
- The spacing table is based on the fixing condition specified in General Note 7.
- For $0.5 < h/d < 1.0$ cases, the spacing value can be obtained by linear interpolation between $h/d \leq 0.5$ and $h/d \geq 1$ data with the same TC

Interface Spacing Table for Terrain Category 2.5, $h/d \geq 1$ (Unit: mm)									
Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$
A	Internal Zone	1304	1457	1149	1282	1020	1137	933	1039
	Intermediate Zone	830	923	735	816	656	728	602	667
	Edge Zone	609	675	540	599	483	535	444	491
	Corner Zone	397	439	353	391	316	350	291	322
B1	Internal Zone	853	949	755	839	674	748	618	686
	Intermediate Zone	552	611	490	543	438	485	403	446
	Edge Zone	407	451	363	401	325	359	299	330
	Corner Zone	268	296	238*	263	214*	236*	197*	217*
B2	Internal Zone	767	852	680	755	607	673	557	618
	Intermediate Zone	497	551	442	490	396	438	364	403
	Edge Zone	368	407	328	362	294	325	270	299
	Corner Zone	242*	267	216*	238*	194*	214*	178*	197*
C	Internal Zone	492	545	437	484	391	433	360	398
	Intermediate Zone	322	356	287	317	257	284	237*	261
	Edge Zone	239*	264	213*	236*	191*	211*	176*	194*
	Corner Zone	158*	174*	141*	156*	126*	140*	117*	129*
D	Internal Zone	315	349	281	311	252	278	232*	256
	Intermediate Zone	208*	229*	185*	205*	166*	184*	153*	169*
	Edge Zone	155*	171*	138*	153*	124*	137*	114*	126*
	Corner Zone	102*	113*	91*	101*	82*	91*	76*	84*

NOTES:

- * denotes the situations where the wind load is more than 5KPa and the installation safety is compromised.
- Definition of Terrain Category is given in General Note 1.
- Notion of Roof Zone is given in General Note 2.
- The Roof pitch angle is given in reference to horizontal. The value of Φ shall be determined and measured by following the figure in Note 3
- The spacing table is based on the fixing condition specified in General Note 7.
- For $0.5 < h/d < 1.0$ cases, the spacing value can be obtained by linear interpolation between $h/d \leq 0.5$ and $h/d \geq 1$ data with the same TC

Interface Spacing Table for Terrain Category 2, $h/d \leq 0.5$ (Unit: mm)									
Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$
A	Internal Zone	1700	1700	1444	1610	1291	1437	1211	1347
	Intermediate Zone	1128	1253	915	1014	822	910	773	856
	Edge Zone	821	909	669	740	603	666	568	627
	Corner Zone	531	587	436	480	393	434	371	409
B1	Internal Zone	1161	1290	941	1043	845	936	795	880
	Intermediate Zone	743	822	606	670	547	604	515	568
	Edge Zone	546	603	447	493	404	445	381	420
	Corner Zone	357	393	293	323	265	292	250	275
B2	Internal Zone	1041	1155	845	936	760	841	715	791
	Intermediate Zone	669	739	547	604	493	544	465	513
	Edge Zone	492	543	404	445	365	402	344	379
	Corner Zone	322	355	265	292	240*	264	226*	249
C	Internal Zone	660	730	540	596	487	538	459	506
	Intermediate Zone	430	474	353	389	319	351	301	331
	Edge Zone	319	351	262	289	237*	261	224*	246*
	Corner Zone	210*	231*	173*	190*	157*	172*	148*	163*
D	Internal Zone	421	465	346	381	313	344	295	325
	Intermediate Zone	276	304	228*	251	206*	227*	194*	214*
	Edge Zone	206*	226*	170*	187*	154*	169*	145*	159*
	Corner Zone	136*	149*	112*	123*	102*	112*	96*	105*

NOTES:

1. * denotes the situations where the wind load is more than 5KPa and the installation safety is compromised.
2. Definition of Terrain Category is given in General Note 1.
3. Notion of Roof Zone is given in General Note 2.
4. The Roof pitch angle is given in reference to horizontal. The value of Φ shall be determined and measured by following the figure in Note 3
5. The spacing table is based on the fixing condition specified in General Note 7.
6. For $0.5 < h/d < 1.0$ cases, the spacing value can be obtained by linear interpolation between $h/d \leq 0.5$ and $h/d \geq 1$ data with the same TC

Interface Spacing Table for Terrain Category 2, $h/d \geq 1$ (Unit: mm)									
Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$	$\Phi < 10^\circ$	$10^\circ \leq \Phi \leq 15^\circ$
A	Internal Zone	1177	1314	954	1062	857	953	806	896
	Intermediate Zone	753	836	615	682	554	614	522	578
	Edge Zone	553	613	453	502	409	453	386	427
	Corner Zone	361	400	297	328	269	297	253	280
B1	Internal Zone	774	860	631	701	569	631	536	594
	Intermediate Zone	502	556	411	455	372	411	350	388
	Edge Zone	371	410	305	337	276	305	260	288
	Corner Zone	244*	269	201*	222*	182*	201*	172*	190*
B2	Internal Zone	696	773	569	631	513	569	484	536
	Intermediate Zone	453	501	372	411	336	371	317	350
	Edge Zone	335	371	276	305	249	276	235*	260
	Corner Zone	221*	244*	182*	201*	165*	182*	155*	172*
C	Internal Zone	447	495	367	406	332	367	313	346
	Intermediate Zone	293	324	241*	267	218*	241*	206*	228*
	Edge Zone	218*	241*	180*	198*	163*	180*	154*	170*
	Corner Zone	144*	159*	119*	131*	108*	119*	102*	112*
D	Internal Zone	287	318	237*	262	214*	237*	202*	223*
	Intermediate Zone	190*	209*	156*	173*	141*	156*	134*	147*
	Edge Zone	141*	156*	117*	129*	106*	117*	100*	110*
	Corner Zone	94*	103*	77*	85*	70*	77*	66*	73*

NOTES:

1. * denotes the situations where the wind load is more than 5KPa and the installation safety is compromised.
2. Definition of Terrain Category is given in General Note 1.
3. Notion of Roof Zone is given in General Note 2.
4. The Roof pitch angle is given in reference to horizontal. The value of Φ shall be determined and measured by following the figure in Note 3
5. The spacing table is based on the fixing condition specified in General Note 7.
6. For $0.5 < h/d < 1.0$ cases, the spacing value can be obtained by linear interpolation between $h/d \leq 0.5$ and $h/d \geq 1$ data with the same TC

General Notes

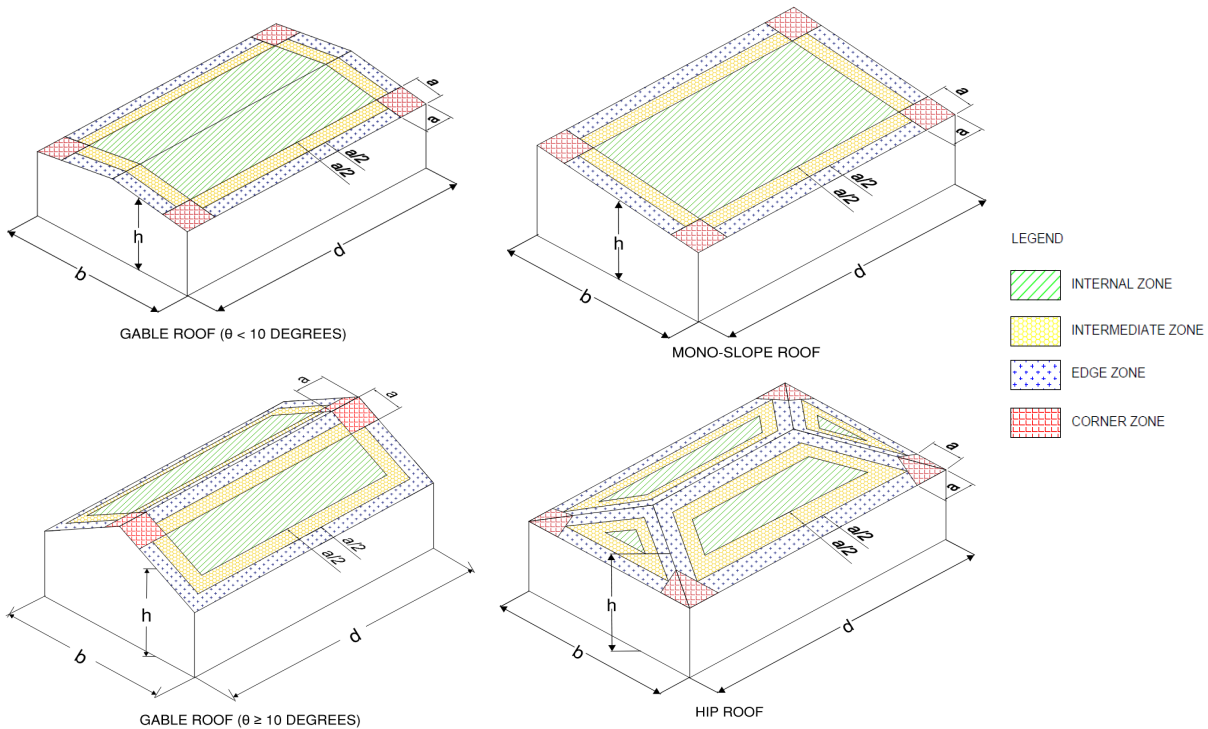
Note 1 Terrain Category 3 (TC 3) denotes terrain with numerous closely spaced obstructions having heights generally from 3m to 10m. The minimum density of obstructions shall be at least the equivalent of 10 house-size obstructions per hectare.

Terrain Category 2.5 (TC 2.5) denotes terrain with some trees or isolated obstructions, terrain in developing outer urban areas with scattered houses, or large acreage developments with more than two and less than 10 buildings per hectare.

Terrain Category 2 (TC 2) denotes open terrain, including grassland, with well-scattered obstructions having heights generally from 1.5m to 5m, with no more than two obstructions per hectare.

Refer to AS/NZS 1170.2:2021 - 4.2.1 for Terrain Category definitions.

Note 2 Notion of Roof Zone examples are shown in the following figures. (Note: As specified by Antai Technology Co., Ltd., this certificate is limited to 4-zone scenario only and it is not applicable for 2-zone scenarios. Refer to AS/NZS 1170.2:2021 section B6.1 for 2 zone scenario)



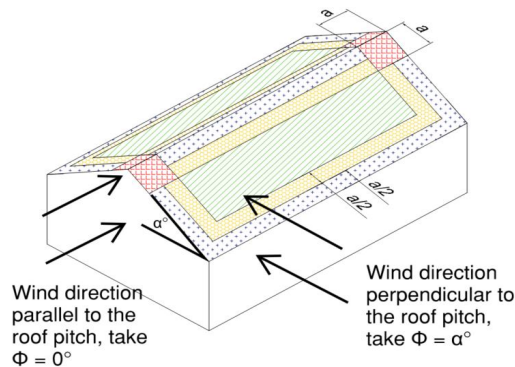
Refer to AS/NZS 1170.2:2021 – Chapter 5.4.4 for more accurate Roof Zone notion and cases.

To determine the zone dimension "a", follow the steps:

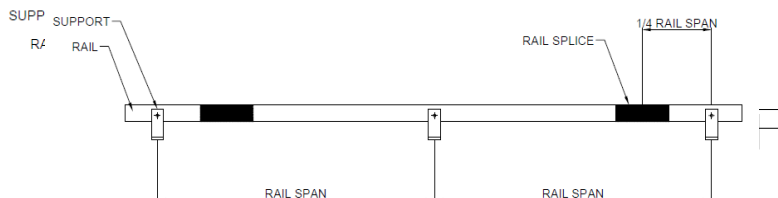
- 1) Determine building height (h), building length (b) and building width (d).
- 2) Determine (h/d) and (h/b)
- 3) If (h/b) or $(h/d) \geq 0.2$, a is the minimum of $0.2b$ or $0.2d$
- 4) If (h/b) and $(h/d) < 0.2$, a is equal to $2h$

Note: " h " represents the average roof height. Average roof height = (pitch height - gutter height)/2

Note 3 The pitch angle Φ in the spacing table shall be determined based on the wind direction and the roof pitch angle by following the figure illustration below.



Note 4 To ensure the fixing spacing in above tables are valid, rail splice connectors must not be installed at the support point or at the middle span point between two adjacent supports. It is recommended to install the connector at 1/4 span points from the supports.



Note 5 Number of panel clamps required per panel for installation:

		TC3			TC2.5			TC2		
		H≤10m	10m<H≤15m	15m<H≤20m	H≤10m	10m<H≤15m	15m<H≤20m	H≤10m	10m<H≤15m	15m<H≤20m
Region A	Internal	4	4	4	4	4	4	4	4	4
	Intermediate	4	4	4	4	4	4	4	4	4
	Edge	4	4	4	4	4	4	4	6	6
	Corner	4	6	6	6	6	6	6	8	8
Region B1&B2	Internal	4	4	4	4	4	4	4	4	4
	Intermediate	4	4	4	4	4	6	6	6	6
	Edge	6	6	6	6	6	8	8	8	8
Region C	Corner	8	8	8	8	10	10	10	10	NA
	Internal	4	4	4	4	4	6	6	6	6
	Intermediate	6	6	6	6	6	8	8	8	8
	Edge	6	8	8	8	8	10	10	10	10
Region D	Corner	10	10	NA	NA	NA	NA	NA	NA	NA
	Internal	6	6	6	6	6	8	8	8	8
	Intermediate	8	8	10	8	10	10	10	NA	NA
	Edge	10	10	NA	NA	NA	NA	NA	NA	NA
	Corner	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

1. NA denotes the situations where an excessive amount of panel clamps are required and the installation is no longer practical.
2. A site-specific engineering assessment must be carried out to determine the number of panel clamps required for situations not covered in this table.

Note 6 The provided installation spacing tables are based on maximum PV panel size of 2300mm x 1200mm with 2 rails per panel array. For other panel sizes and more rails, refer the below table for adjustment factors based on the given spacing tables.

Maximum Panel Size	Number of Rails	Spacing Adjustment Factor
2300x1200	3 rails	150%
2300x1200	4 rails	200%
2100x1100	2 rails	109%
2100x1100	3 rails	164%
2100x1100	4 rails	219%
2000x1100	2 rails	115%
2000x1100	3 rails	172%
2000x1100	4 rails	230%
1700x1100	2 rails	135%
1700x1100	3 rails	203%
1700x1100	4 rails	270%

Note: The maximum allowable fixing spacing shall not exceed 1700mm after applying the adjustment factors.

Note 7 The clamps capacities are taken from testing report No.MT-15/317 by Melbourne Testing Services Pty Ltd, dated 26/05/2015. This test was carried out using Lysaght KlipLok 700 Non-penetrative roof sheeting clamps. Other roof sheeting products are not covered in this assessment. **The clamps must be mounted over purlins.**

Note 8 Linear interpolation can be used for determining the spacing values between $h/d > 0.5$ and $h/d < 1$:

Example for $h/d=0.75$:

1. Find fixing spacing **S1** from " $h/d \geq 1$ " table
2. Find fixing spacing **S2** from " $h/d \leq 0.5$ " table
3. **Final Fixing Spacing for $h/d=0.75$:**

$$= S1 + \frac{0.75-0.5}{1-0.5} \times (S2 - S1)$$

Note: Linear interpolation can only be used between tables with the same Terrain Category and Roof Zone.

Note 9 All above-mentioned adjustment factors from different notes shall not be applied together to determine the final installation spacing. Factors from each note shall be applied independently. For multiple installation conditions change, please seek for the engineer's advice.