



**EBULEN CONSULT**

# **SOLAR PV ROOF-MOUNT RACKING FRAME ENGINEERING CERTIFICATE**

**ANTAI FLUSH-MOUNT SYSTEM WITH 355B RAIL, L-FOOT & KL406 CLAMPS**

Prepared for:

**Antai Technology Co., Ltd.**

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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 has 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
Clip Lock Roof Clamp	ATL-TYN-19/20	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 406 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:



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## APPENDIX A – INSTALLATION GUIDELINE

**Interface Spacing Table for Terrain Category 3, h/d ≤ 0.5 (Unit: mm)**

Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°
A	Internal Zone	1700	1700	1700	1700	1700	1700	1586	1700
	Intermediate Zone	1322	1472	1322	1472	1127	1253	997	1107
	Edge Zone	955	1060	955	1060	819	907	727	805
	Corner Zone	614	679	614	679	529	585	472	520
B1	Internal Zone	1361	1517	1361	1517	1160	1290	1026	1139
	Intermediate Zone	863	956	863	956	741	820	658	728
	Edge Zone	631	698	631	698	544	601	484	535
	Corner Zone	411	453	411	453	355	391	317	349
B2	Internal Zone	1217	1354	1217	1354	1040	1154	921	1021
	Intermediate Zone	775	858	775	858	667	737	593	655
	Edge Zone	569	628	569	628	490	541	437	482
	Corner Zone	371	409	371	409	321	353	286	315
C	Internal Zone	766	848	766	848	658	728	586	647
	Intermediate Zone	496	547	496	547	428	472	382	421
	Edge Zone	367	404	367	404	317	349	283	312
	Corner Zone	241	265	241	265	209*	230*	187*	205*
D	Internal Zone	486	536	486	536	420	463	374	412
	Intermediate Zone	318	350	318	350	275	303	246	271
	Edge Zone	236*	260	236*	260	205*	225*	183*	201*
	Corner Zone	156*	171*	156*	171*	135*	149*	121*	133*

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 ≤ 0.5 and h/d ≥ 1 data with the same TC

**Interface Spacing Table for Terrain Category 3, h/d ≥ 1 (Unit: mm)**

Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
		Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°
A	Internal Zone	1381	1546	1381	1546	1177	1314	1040	1160
	Intermediate Zone	874	973	874	973	751	834	667	741
	Edge Zone	640	710	640	710	551	611	491	544
	Corner Zone	416	461	416	461	360	398	321	355
B1	Internal Zone	899	1001	899	1001	772	858	685	761
	Intermediate Zone	579	643	579	643	500	554	445	493
	Edge Zone	427	473	427	473	369	409	330	365
	Corner Zone	280	310	280	310	243	268	217*	240
B2	Internal Zone	808	898	808	898	694	771	617	685
	Intermediate Zone	522	579	522	579	451	499	402	445
	Edge Zone	386	427	386	427	334	369	298	329
	Corner Zone	253	280	253	280	219*	242	196*	217*
C	Internal Zone	516	572	516	572	445	493	397	440
	Intermediate Zone	337	373	337	373	292	323	261	288
	Edge Zone	250	277	250	277	217*	240	194*	214*
	Corner Zone	165*	182*	165*	182*	143*	158*	128*	141*
D	Internal Zone	331	366	331	366	286	316	256	282
	Intermediate Zone	218*	240	218*	240	188*	208*	169*	186*
	Edge Zone	162*	179*	162*	179*	140*	155*	126*	139*
	Corner Zone	107*	118*	107*	118*	93*	103*	83*	92*

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 ≤ 0.5 and h/d ≥ 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	1669	1700	1474	1644	1342	1495
	Intermediate Zone	1187	1320	1046	1162	930	1032	851	943
	Edge Zone	861	954	762	843	679	751	623	689
	Corner Zone	556	614	494	545	441	487	406	447
B1	Internal Zone	1222	1359	1077	1196	957	1061	875	970
	Intermediate Zone	778	862	689	763	615	680	564	623
	Edge Zone	571	631	507	560	453	500	416	459
	Corner Zone	372	410	331	365	297	327	273	301
B2	Internal Zone	1094	1215	965	1071	859	952	786	871
	Intermediate Zone	700	774	621	686	554	612	509	562
	Edge Zone	515	568	457	505	409	451	376	414
	Corner Zone	336	371	299	330	268	296	247	272
C	Internal Zone	691	765	613	678	548	605	503	555
	Intermediate Zone	449	495	399	440	358	394	329	362
	Edge Zone	332	366	296	326	265	292	244	269
	Corner Zone	219*	241	195*	214*	175*	192*	161*	177*
D	Internal Zone	440	485	391	431	350	386	322	355
	Intermediate Zone	288	318	257	283	230*	254	212*	233*
	Edge Zone	214*	236*	191*	210*	172*	189*	158*	174*
	Corner Zone	142*	156*	126*	139*	113*	125*	104*	115*

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  $\Phi$  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	1239	1385	1092	1218	970	1081	887	987
	Intermediate Zone	789	877	699	776	623	692	572	634
	Edge Zone	578	642	514	569	459	509	422	467
	Corner Zone	377	417	336	371	301	333	277	306
B1	Internal Zone	811	902	718	798	641	711	588	652
	Intermediate Zone	524	581	466	516	417	461	383	424
	Edge Zone	387	429	345	381	309	341	284	314
	Corner Zone	254	281	227*	250	203*	225*	187*	207*
B2	Internal Zone	729	810	646	718	577	640	530	587
	Intermediate Zone	473	524	420	465	376	416	346	383
	Edge Zone	350	387	311	344	279	309	257	284
	Corner Zone	230*	254	205*	226*	184*	203*	169*	187*
C	Internal Zone	467	518	415	460	372	412	342	378
	Intermediate Zone	306	338	272	301	244	270	225*	248
	Edge Zone	227*	251	203*	224*	182*	201*	167*	185*
	Corner Zone	150*	166*	134*	148*	120*	133*	111*	122*
D	Internal Zone	300	332	267	295	240	265	220*	244
	Intermediate Zone	197*	218*	176*	194*	158*	175*	146*	161*
	Edge Zone	147*	162*	131*	145*	118*	130*	109*	120*
	Corner Zone	97*	107*	87*	96*	78*	86*	72*	79*

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  $\Phi$  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 <= 0.5 (Unit: mm)**

Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H<=15m		15m<H<=20m	
		Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°
A	Internal Zone	1700	1700	1373	1530	1227	1366	1151	1280
	Intermediate Zone	1072	1191	870	964	782	865	735	814
	Edge Zone	780	864	636	703	573	633	540	596
	Corner Zone	505	558	414	457	374	412	353	389
B1	Internal Zone	1103	1226	894	991	804	890	756	836
	Intermediate Zone	706	781	576	637	520	574	490	540
	Edge Zone	519	573	425	469	384	423	362	399
	Corner Zone	339	374	279	307	252	278	238	262
B2	Internal Zone	989	1098	804	890	723	800	680	752
	Intermediate Zone	635	702	520	574	469	517	442	487
	Edge Zone	468	516	384	423	347	382	327	360
	Corner Zone	306	337	252	278	228*	251	215*	237
C	Internal Zone	628	694	513	567	463	511	436	481
	Intermediate Zone	409	451	336	370	303	334	286	315
	Edge Zone	303	333	249	274	225*	248	213*	234*
	Corner Zone	199*	219*	164*	181*	149*	164*	140*	154*
D	Internal Zone	400	442	329	362	297	327	280	309
	Intermediate Zone	263	289	216*	238	196*	215*	185*	203*
	Edge Zone	195*	215*	161*	177*	146*	160*	138*	151*
	Corner Zone	129*	142*	107*	117*	97*	106*	91*	100*

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<=0.5 and h/d>=1 data with the same TC

**Interface Spacing Table for Terrain Category 2, h/d >= 1 (Unit: mm)**

Wind Region	Height & Roof Pitch Roof Zone	H<5m		5m<H<10m		10m<H<=15m		15m<H<=20m	
		Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°
A	Internal Zone	1119	1249	907	1009	814	906	766	851
	Intermediate Zone	715	795	584	648	526	584	496	550
	Edge Zone	526	583	431	477	389	430	367	406
	Corner Zone	343	380	282	312	255	282	241	266
B1	Internal Zone	735	817	600	666	541	600	509	565
	Intermediate Zone	477	528	391	433	353	391	333	368
	Edge Zone	353	390	290	321	262	290	247	273
	Corner Zone	232*	256	191*	211*	173*	191*	163*	180*
B2	Internal Zone	662	735	541	600	488	540	460	509
	Intermediate Zone	430	476	353	391	319	353	301	333
	Edge Zone	319	352	262	290	237	262	224*	247
	Corner Zone	210*	232*	173*	191*	156*	173*	148*	163*
C	Internal Zone	425	471	349	386	315	349	297	329
	Intermediate Zone	279	308	229*	254	208*	229*	196*	216*
	Edge Zone	207*	229*	171*	189*	155*	171*	146*	161*
	Corner Zone	137*	151*	113*	125*	102*	113*	97*	107*
D	Internal Zone	273	302	225*	249	204*	225*	192*	212*
	Intermediate Zone	180*	199*	149*	164*	134*	148*	127*	140*
	Edge Zone	134*	148*	111*	122*	100*	111*	95*	105*
	Corner Zone	89*	98*	73*	81*	66*	73*	63*	69*

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<=0.5 and h/d>=1 data with the same TC

**General Notes**

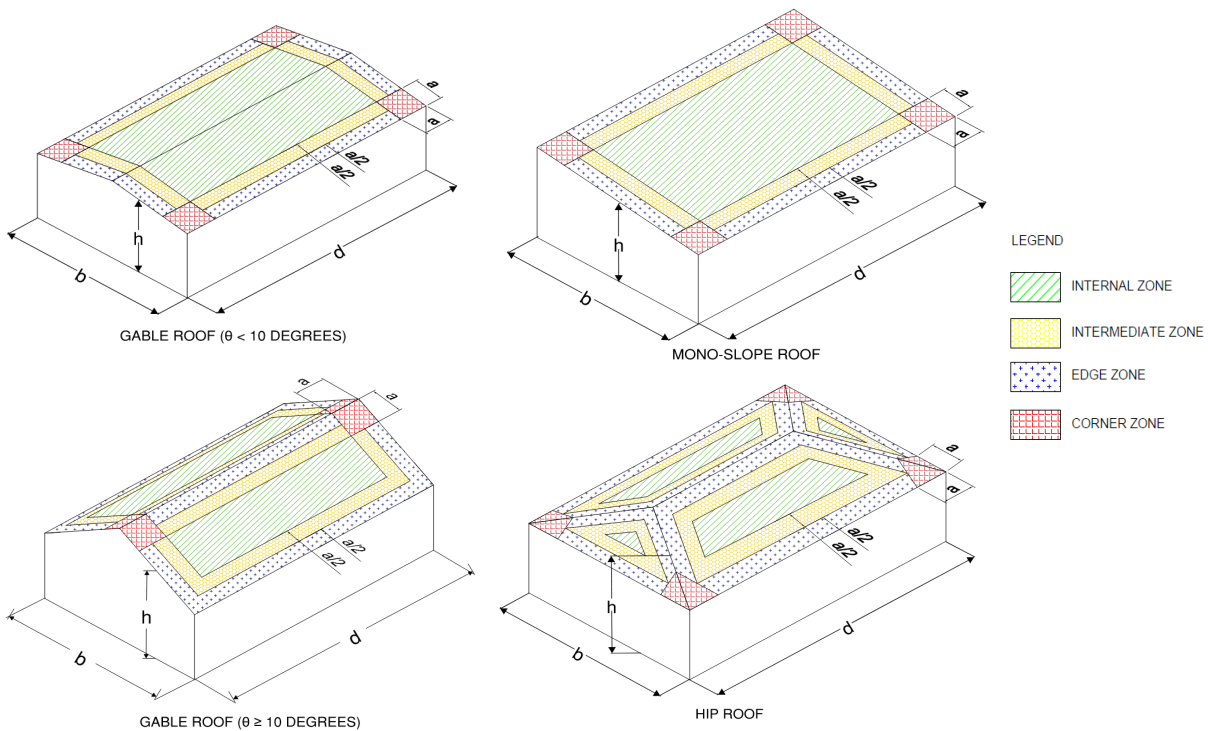
**Note 1** Terrain Category 3 (TC 3) denotes terrain with numerous closely spaced obstructions having heights generally from 3m to 10m. The minimum density of obstructions shall be at least the equivalent of 10 house-size obstructions per hectare.

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)



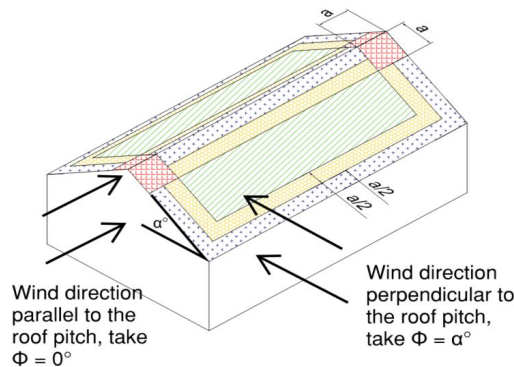
Refer to AS/NZS 1170.2:2021 – Chapter 5.4.4 for more accurate Roof Zone notion and cases.

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) ≥ 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

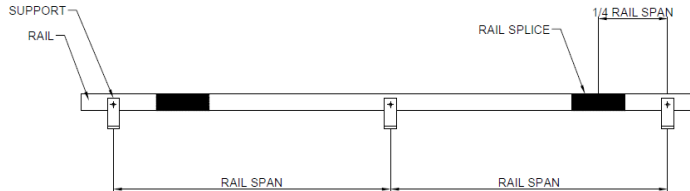
Note: "h" represents the average roof height. Average roof height = (pitch height - gutter height)/2

**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 406 Non-penetrative roof sheeting clamps. Other roof sheeting products are not covered in this assessment. **The clamps must be mounted over purlins and on full roof sheeting ribs. No clamp is allowed to be installed on lapped roof sheeting ribs.**

**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>=1" table
2. Find fixing spacing **S2** from "h/d<=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.