



**EBULEN CONSULT**

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

**ANTAI FLUSH-MOUNT SYSTEM WITH 355B RAIL, L-FOOT & LL305 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 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
Longline 305 Roof Clamp	ATL-TYN-307/308	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. 20-0250 by Melbourne Testing Services (MTS) Pty Ltd, dated 22/06/2020
- The clamps have been assessed with the Lysaght Longline 305 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.

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## 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	1660	1700
	Intermediate Zone	1383	1541	1383	1541	1180	1312	1044	1159
	Edge Zone	1000	1109	1000	1109	857	950	761	842
	Corner Zone	643	711	643	711	554	612	494	545
B1	Internal Zone	1425	1588	1425	1588	1214	1350	1074	1192
	Intermediate Zone	903	1001	903	1001	775	858	689	762
	Edge Zone	661	730	661	730	569	629	507	560
	Corner Zone	430	474	430	474	372	410	332	365
B2	Internal Zone	1274	1417	1274	1417	1088	1208	964	1068
	Intermediate Zone	811	898	811	898	698	771	620	686
	Edge Zone	595	658	595	658	513	567	457	505
	Corner Zone	388	428	388	428	336	370	300	330
C	Internal Zone	801	887	801	887	689	762	613	677
	Intermediate Zone	519	573	519	573	448	494	400	440
	Edge Zone	384	423	384	423	332	366	296	326
	Corner Zone	252	278	252	278	218*	240*	195*	215*
D	Internal Zone	509	561	509	561	439	484	392	432
	Intermediate Zone	333	367	333	367	288	317	257	283
	Edge Zone	247*	272	247*	272	214*	236*	191*	211*
	Corner Zone	163*	179*	163*	179*	142*	156*	127*	139*

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 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	1445	1618	1445	1618	1232	1376	1089	1214
	Intermediate Zone	915	1019	915	1019	786	873	698	775
	Edge Zone	670	743	670	743	577	640	514	569
	Corner Zone	436	482	436	482	376	417	336	372
B1	Internal Zone	941	1048	941	1048	808	898	717	797
	Intermediate Zone	607	673	607	673	523	580	466	516
	Edge Zone	447	495	447	495	387	428	345	382
	Corner Zone	293	324	293	324	254	281	227*	251
B2	Internal Zone	846	940	846	940	727	807	646	717
	Intermediate Zone	547	606	547	606	472	523	421	466
	Edge Zone	404	447	404	447	349	386	312	345
	Corner Zone	265	293	265	293	230*	254	205*	227*
C	Internal Zone	540	599	540	599	466	516	416	460
	Intermediate Zone	353	391	353	391	305	338	273	302
	Edge Zone	262	290	262	290	227*	251	203*	224*
	Corner Zone	173*	191*	173*	191*	150*	166*	134*	148*
D	Internal Zone	346	383	346	383	299	331	267	296
	Intermediate Zone	228*	252	228*	252	197*	218*	176*	195*
	Edge Zone	170*	187*	170*	187*	147*	162*	132*	145*
	Corner Zone	112*	124*	112*	124*	97*	107*	87*	96*

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 ≤ 0.5 (Unit: mm)										
Wind Region	Height & Roof Pitch		H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
	Roof Zone		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	1542	1700	1404	1565
	Intermediate Zone		1242	1382	1095	1216	974	1080	891	987
	Edge Zone		901	999	798	883	711	787	652	721
	Corner Zone		582	642	517	570	462	510	424	468
B1	Internal Zone		1279	1423	1127	1252	1001	1111	916	1015
	Intermediate Zone		815	902	722	798	644	712	591	652
	Edge Zone		598	660	531	586	475	524	436	481
	Corner Zone		390	430	347	382	311	342	286	315
B2	Internal Zone		1145	1272	1011	1121	899	996	823	911
	Intermediate Zone		733	811	650	718	580	641	533	588
	Edge Zone		539	595	479	528	428	472	394	434
	Corner Zone		352	388	313	345	281	309	259	285
C	Internal Zone		724	801	642	709	573	633	526	581
	Intermediate Zone		470	518	418	461	374	412	344	379
	Edge Zone		348	383	310	341	278	306	256	281
	Corner Zone		229*	252	204*	225*	183*	201*	169*	185*
D	Internal Zone		461	508	410	452	367	404	337	372
	Intermediate Zone		302	332	269	296	241*	265	222*	244*
	Edge Zone		224*	247*	200*	220*	180*	198*	165*	182*
	Corner Zone		148*	163*	132*	145*	119*	131*	109*	120*

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 ≥ 1 (Unit: mm)										
Wind Region	Height & Roof Pitch		H<5m		5m<H<10m		10m<H≤15m		15m<H≤20m	
	Roof Zone		Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°	Φ < 10°	10° ≤ Φ ≤ 15°
A	Internal Zone		1297	1450	1143	1275	1015	1131	928	1033
	Intermediate Zone		826	918	731	812	653	724	599	664
	Edge Zone		605	672	538	596	481	533	442	489
	Corner Zone		395	437	351	389	315	348	290	320
B1	Internal Zone		849	944	752	835	671	744	615	682
	Intermediate Zone		549	608	488	540	436	483	401	444
	Edge Zone		405	449	361	399	323	357	297	329
	Corner Zone		266	294	237*	262	213*	235*	196*	216*
B2	Internal Zone		763	848	677	751	604	670	554	614
	Intermediate Zone		495	548	440	487	394	436	362	401
	Edge Zone		366	405	326	361	292	323	269	297
	Corner Zone		241*	266	215*	237*	193*	213*	177*	196*
C	Internal Zone		489	542	435	481	389	431	358	396
	Intermediate Zone		320	354	285	315	256	283	235*	260
	Edge Zone		238*	263	212*	234*	190*	210*	175*	193*
	Corner Zone		157*	173*	140*	155*	126*	139*	116*	128*
D	Internal Zone		314	347	280	309	251	277	231*	255
	Intermediate Zone		207*	228*	184*	204*	165*	183*	152*	168*
	Edge Zone		154*	170*	137*	152*	123*	136*	114*	125*
	Corner Zone		102*	113*	91*	100*	82*	90*	75*	83*

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, $h/d \leq 0.5$ (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	1437	1602	1285	1429	1205	1340
	Intermediate Zone		1122	1247	910	1009	818	906	769	852
	Edge Zone		817	904	666	736	600	663	565	624
	Corner Zone		529	584	433	478	391	431	369	407
B1	Internal Zone		1155	1283	936	1038	841	931	791	876
	Intermediate Zone		739	817	603	667	544	600	512	566
	Edge Zone		543	600	445	491	402	443	379	418
	Corner Zone		355	391	292	321	264	290	249	274
B2	Internal Zone		1035	1149	841	931	756	837	712	787
	Intermediate Zone		665	735	544	600	491	541	462	510
	Edge Zone		490	540	402	443	363	400	342	377
	Corner Zone		321	353	264	290	239*	263	225*	248
C	Internal Zone		657	726	537	593	485	535	457	504
	Intermediate Zone		428	472	351	387	317	350	299	330
	Edge Zone		317	349	261	287	236*	260	223*	245*
	Corner Zone		209*	230*	172*	189*	156*	171*	147*	162*
D	Internal Zone		419	462	344	379	311	343	294	323
	Intermediate Zone		275	303	227*	249	205*	225*	193*	213*
	Edge Zone		205*	225*	169*	186*	153*	168*	144*	159*
	Corner Zone		135*	149*	112*	123*	101*	111*	95*	105*

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, $h/d \geq 1$ (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		1171	1307	949	1057	852	948	802	891
	Intermediate Zone		749	832	611	678	551	611	519	575
	Edge Zone		550	610	451	499	407	451	384	425
	Corner Zone		359	398	296	327	267	295	252	279
B1	Internal Zone		770	855	628	697	566	628	533	591
	Intermediate Zone		499	553	409	453	370	409	349	386
	Edge Zone		369	408	303	335	274	303	259	286
	Corner Zone		243*	268	200*	221*	181*	200*	171*	189*
B2	Internal Zone		693	769	566	628	511	566	481	533
	Intermediate Zone		450	499	370	409	334	369	315	348
	Edge Zone		333	369	274	303	248	274	234*	259
	Corner Zone		219*	242*	181*	200*	164*	181*	155*	171*
C	Internal Zone		445	493	365	404	330	365	311	344
	Intermediate Zone		292	322	240*	265	217*	240*	205*	226*
	Edge Zone		217*	240*	179*	197*	162*	179*	153*	169*
	Corner Zone		143*	158*	118*	131*	107*	118*	101*	112*
D	Internal Zone		286	316	235*	260	213*	235*	201*	222*
	Intermediate Zone		189*	208*	155*	172*	141*	155*	133*	147*
	Edge Zone		141*	155*	116*	128*	105*	116*	99*	109*
	Corner Zone		93*	103*	77*	85*	70*	77*	66*	73*

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

**General Notes**

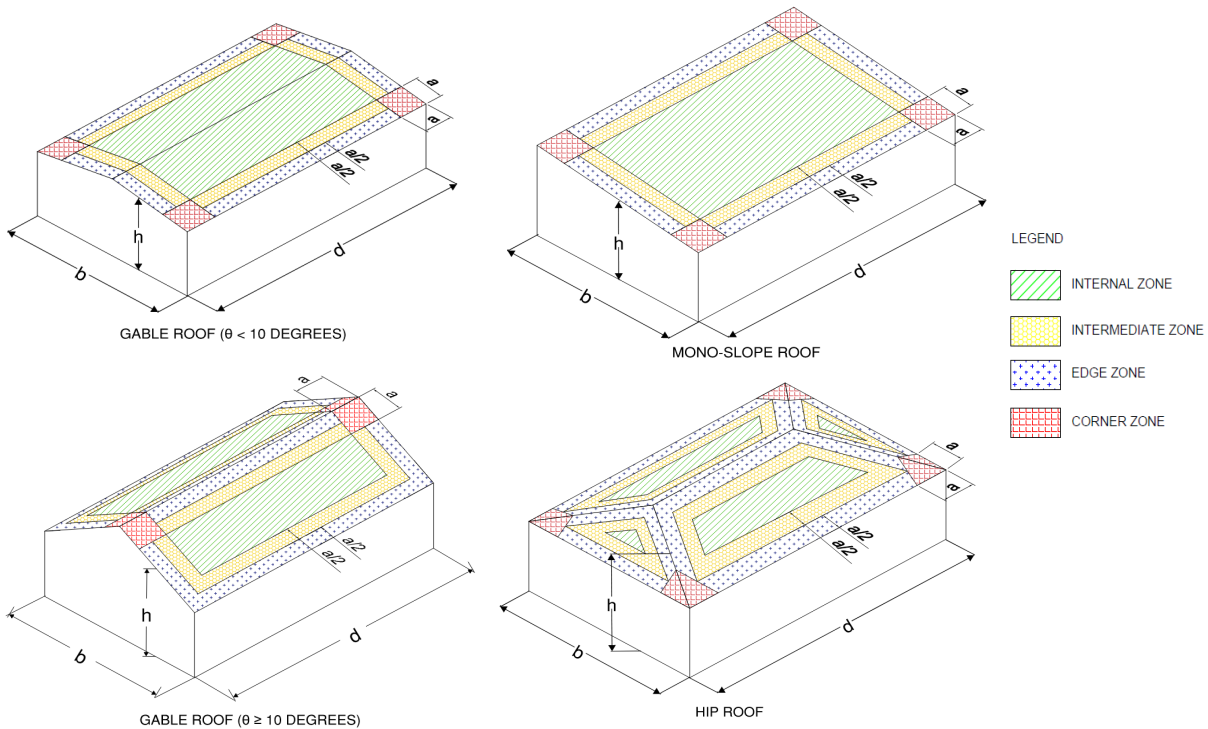
**Note 1** Terrain Category 3 (TC 3) denotes terrain with numerous closely spaced obstructions having heights generally from 3m to 10m. The minimum density of obstructions shall be at least the equivalent of 10 house-size obstructions per hectare.

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)



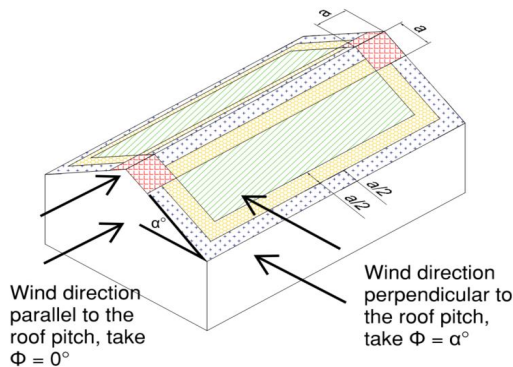
Refer to AS/NZS 1170.2:2021 – Chapter 5.4.4 for more accurate Roof Zone notion and cases.

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

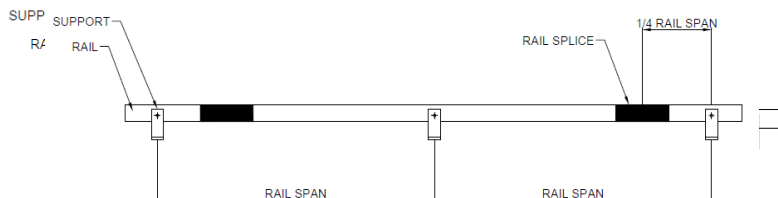
Note: "h" represents the average roof height. Average roof height = (pitch height - gutter height)/2

**Note 3** The pitch angle  $\Phi$  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.20-0250 by Melbourne Testing Services Pty Ltd, dated 22/06/2020. This test was carried out using Lysaght Longline 305 Non-penetrative roof sheeting clamps. Other roof sheeting products are not covered in this assessment. **The clamps must be mounted over purlins and lapped roof sheeting ribs. No clamp is allowed to be installed on full 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.