SOLAR PV ROOF-MOUNT RACKING FRAME ENGINEERING CERTIFICATE

ANTAI TILT LEG SYSTEM WITH 499 RAIL & SCREW FIXING

Prepared for:

Antai Technology Co., Ltd.

30F, W Square,

1801 Huandao East Rd,

Siming District

Xiamen, China

September 27, 2023

Ref: E22110958

EBULEN CONSULT
CLEAN ENERGY COUNCIL MEMBER

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

OVERVIEW

This structural engineering certificate is issued for Antai Solar Roof Tilt Leg racking system with 499 rail and penetrative screw 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
- AS/NZS 4600:2018 – Cold-Formed Steel Structures
- AS1720.1:2010 – Timber structures – Design methods
- AS3600:2018 – Concrete 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-499	AL 6005-T6
Rail Splice	ATL-TYN-304/54	AL 6005-T6
	ATL-CG-20	AL 6005-T6
Tilt Leg Kit	ATL-TYN-07	AL 6005-T6
	ATL-TYN-57	AL 6005-T6
	ATL-TYN-58	AL 6005-T6
	ATL-TYN-71	AL 6005-T6
	ATL-TYN-329	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

EBULEN CONSULT
CLEAN ENERGY COUNCIL MEMBER

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

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 solar PV panel and racking frame is 0.15kPa-0.18kPa
- Solar PV panel is supported by minimum 2 rails
- The racking rail capacity is taken as per the test report: No.XMML23090468_EN by BM Shenghe Testing Technology (Xiamen) Co., Ltd, dated 19/09/2023.
- Screw fixing pull-out has been checked with insert into minimum 35mm JD4 timber structure and steel structure with thicknesses of 1.2mm, 1.5mm, 1.9mm and 2.4mm
- Product details are taken from the drawing set provided by Antai Technology Co., Ltd. as listed in the above component table
- The pull-out capacity of Antai Tilt Leg kit is taken from Test Report No. XMIN22000964ML03_EN by SGS-CSTC Standards Technical Service Co., Ltd. Xiamen Branch. Dated at 16/09/2022
- 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, CPEng, RPEV, RPEQ

EBULEN CONSULT
CLEAN ENERGY COUNCIL MEMBER

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

EBULEN CONSULT

Interface Spacing Table for Terrain Category 3 (Unit: mm)														
Wind Region	Panel Tilt Angle / Roof Zone	H<5m			5m<H<10m			10m<H≤15m			15m<H≤20m			
		Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	
A	Internal Zone	1232	959	776	1232	959	776	1159	825	669	1103	734	596	
	Intermediate Zone	982	622	506	982	622	506	845	537	437	752	479	391	
	Edge Zone	721	460	375	721	460	375	622	398	325	555	356	290*	
	Corner Zone	471	303*	247*	471	303*	247*	407	262*	214*	364	234*	192*	
B1	Internal Zone	1010	639	520	1010	639	520	868	552	449	772	492	401	
	Intermediate Zone	654	418	341	654	418	341	564	362	295*	503	323	264*	
	Edge Zone	483	311*	254*	483	311*	254*	418	269*	220*	373	241*	197*	
	Corner Zone	318	205*	168*	318	205*	168*	275*	178*	146*	246*	159*	130*	
B2	Internal Zone	908	576	469	908	576	469	782	498	406	696	444	362	
	Intermediate Zone	590	378	308*	590	378	308*	510	327	267*	455	292*	239*	
	Edge Zone	437	281*	230*	437	281*	230*	378	244*	199*	338	218*	178*	
	Corner Zone	287*	186*	152*	287*	186*	152*	249*	161*	132*	223*	144*	118*	
C	Internal Zone	578	370	302*	578	370	302*	499	321	262*	446	287*	234*	
	Intermediate Zone	379	244*	200*	379	244*	200*	328	212*	173*	293*	189*	155*	
	Edge Zone	282*	182*	149*	282*	182*	149*	244*	158*	129*	218*	141*	116*	
	Corner Zone	186*	120*	99*	186*	120*	99*	161*	105*	86*	144*	94*	77*	
D	Internal Zone	371	239*	196*	371	239*	196*	322	207*	170*	287*	186*	152*	
	Intermediate Zone	245*	158*	130*	245*	158*	130*	212*	137*	112*	190*	123*	101*	
	Edge Zone	182*	118*	97*	182*	118*	97*	158*	103*	84*	142*	92*	75*	
	Corner Zone	121*	78*	64*	121*	78*	64*	105*	68*	56*	94*	61*	50*	

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. Panel tilt angle is given in reference to roof surface
5. The spacing table is based on the fixing condition specified in General Note 6.

Interface Spacing Table for Terrain Category 2.5 (Unit: mm)														
Wind Region	Panel Tilt Angle / Roof Zone	H<5m			5m<H<10m			10m<H≤15m			15m<H≤20m			
		Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	
A	Internal Zone	1182	866	702	1125	769	624	1073	687	558	996	631	513	
	Intermediate Zone	887	563	459	787	501	408	703	449	366	645	413	337	
	Edge Zone	653	417	340	580	372	303*	519	333	272*	477	307*	251*	
	Corner Zone	427	275*	225*	380	245*	200*	341	220*	180*	314	202*	166*	
B1	Internal Zone	912	579	471	809	515	419	722	461	376	663	424	346	
	Intermediate Zone	592	379	310*	527	338	276*	471	303*	248*	433	279*	228*	
	Edge Zone	438	282*	230*	390	251*	206*	350	226*	185*	322	208*	170*	
	Corner Zone	288*	186*	152*	257*	166*	136*	231*	149*	122*	212*	138*	113*	
B2	Internal Zone	821	522	425	729	465	379	651	416	340	598	383	313	
	Intermediate Zone	534	343	280*	476	306*	250*	426	274*	224*	392	252*	206*	
	Edge Zone	396	255*	209*	353	228*	186*	316	204*	167*	291*	188*	154*	
	Corner Zone	261*	169*	138*	233*	151*	123*	209*	135*	111*	192*	125*	102*	
C	Internal Zone	524	336	274*	466	299*	245*	417	269*	220*	384	247*	202*	
	Intermediate Zone	344	222*	181*	306*	198*	162*	275*	178*	145*	253*	164*	134*	
	Edge Zone	256*	165*	135*	228*	148*	121*	205*	133*	109*	189*	122*	100*	
	Corner Zone	169*	110*	90*	151*	98*	80*	135*	88*	72*	125*	81*	66*	
D	Internal Zone	337	217*	178*	300*	194*	159*	269*	174*	143*	248*	160*	131*	
	Intermediate Zone	222*	144*	118*	198*	128*	105*	178*	115*	94*	164*	106*	87*	
	Edge Zone	166*	107*	88*	148*	96*	79*	133*	86*	71*	122*	79*	65*	
	Corner Zone	110*	71*	58*	98*	64*	52*	88*	57*	47*	81*	53*	43*	

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. Panel tilt angle is given in reference to roof surface
5. The spacing table is based on the fixing condition specified in General Note 6.

EBULEN CONSULT

Interface Spacing Table for Terrain Category 2 (Unit: mm)													
Wind Region	Panel Tilt Angle / Roof Zone	H<5m			5m<H<10m			10m<H≤15m			15m<H≤20m		
		Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°	Φ < 15°	15° ≤ Φ < 25°	25° ≤ Φ ≤ 45°
A	Internal Zone	1136	787	638	1018	644	524	916	581	473	862	548	446
	Intermediate Zone	806	513	418	659	421	344	595	381	311*	560	359	293*
	Edge Zone	594	380	310*	487	313	256*	440	283*	231*	415	267*	218*
	Corner Zone	389	251*	205*	320	207*	169*	290*	187*	153*	273*	177*	145*
B1	Internal Zone	828	526	429	677	433	353	611	391	319	576	369	301*
	Intermediate Zone	539	346	282*	442	285*	233*	400	258*	211*	377	243*	199*
	Edge Zone	399	257*	210*	329	212*	173*	297*	192*	157*	280*	181*	148*
	Corner Zone	263*	170*	139*	217*	140*	115*	196*	127*	104*	185*	120*	98*
B2	Internal Zone	746	475	388	611	391	319	551	353	289*	520	333	272*
	Intermediate Zone	487	313	255*	400	258*	211*	361	233*	191*	341	220*	180*
	Edge Zone	361	233*	190*	297*	192*	157*	269*	174*	142*	254*	164*	134*
	Corner Zone	238*	154*	126*	196*	127*	104*	178*	115*	94*	168*	109*	89*
C	Internal Zone	477	306*	250*	392	252*	206*	354	228*	187*	334	216*	176*
	Intermediate Zone	313	202*	165*	258*	167*	137*	234*	151*	124*	221*	143*	117*
	Edge Zone	233*	151*	124*	192*	125*	102*	174*	113*	92*	164*	107*	87*
	Corner Zone	154*	100*	82*	127*	83*	68*	115*	75*	61*	109*	71*	58*
D	Internal Zone	307*	198*	162*	253*	164*	134*	229*	148*	121*	216*	140*	115*
	Intermediate Zone	203*	131*	108*	167*	108*	89*	152*	98*	80*	143*	93*	76*
	Edge Zone	151*	98*	80*	125*	81*	66*	113*	73*	60*	107*	69*	57*
	Corner Zone	100*	65*	53*	83*	54*	44*	75*	49*	40*	71*	46*	38*

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. Panel tilt angle is given in reference to roof surface
5. The spacing table is based on the fixing condition specified in General Note 6.

EBULEN CONSULT

General Notes

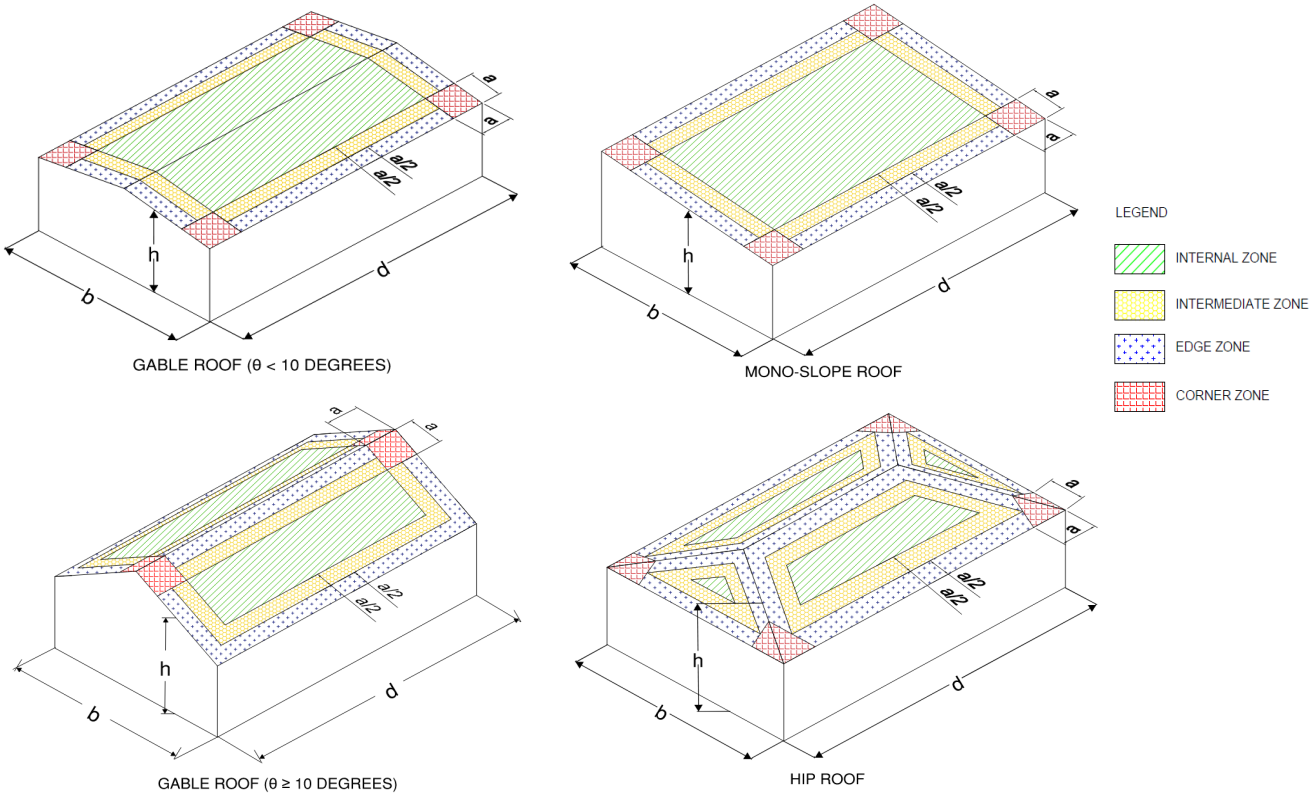
Note 1 Terrain Category 3 (TC 3) denotes terrain with numerous closely spaced obstructions having heights generally from 3m to 10m. The minimum density of obstructions shall be at least the equivalent of 10 house-size obstructions per hectare.

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.

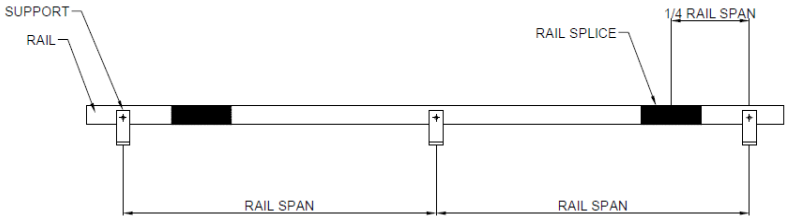


Refer to AS/NZS 1170.2:2021 – Chapter 5.4.4 for more accurate Roof Zone notion and cases.

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 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 4 Number of panel clamps required per panel for installation when the tilting angle is **less than 15 degrees**:

		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	6	6	6	6	6
	Corner	6	6	6	6	8	8	8	8	8
Region B1&B2	Internal	4	4	4	4	4	4	4	4	4
	Intermediate	4	4	6	6	6	6	6	6	6
	Edge	6	6	6	8	8	8	8	8	8
	Corner	8	8	10	10	NA	NA	10	NA	NA
Region C	Internal	4	6	6	6	6	6	6	8	8
	Intermediate	6	8	8	8	8	10	10	10	10
	Edge	8	10	10	10	NA	NA	NA	NA	NA
	Corner	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region D	Internal	6	8	8	8	8	8	10	10	10
	Intermediate	10	NA	NA	NA	NA	NA	NA	NA	NA
	Edge	NA	NA	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.

Number of panel clamps required per panel for installation with tilting angle **up to 45 degrees**:

		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	6	6	6	6
	Intermediate	6	6	6	6	6	8	8	8	8
	Edge	6	8	8	8	8	10	10	10	10
	Corner	10	NA	NA	NA	NA	NA	NA	NA	NA
Region B1&B2	Internal	6	6	6	6	8	8	8	8	10
	Intermediate	8	10	10	10	10	NA	NA	NA	NA
	Edge	10	NA	NA	NA	NA	NA	NA	NA	NA
	Corner	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C	Internal	8	10	10	10	10	NA	NA	NA	NA
	Intermediate	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Edge	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Corner	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region D	Internal	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Intermediate	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Edge	NA	NA	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 5 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	120%
2300x1200	4 rails	160%
2100x1100	2 rails	109%
2100x1100	3 rails	131%
2100x1100	4 rails	175%
2000x1100	2 rails	115%
2000x1100	3 rails	138%
2000x1100	4 rails	176%
1700x1100	2 rails	128%
1700x1100	3 rails	162%
1700x1100	4 rails	214%

Note: The maximum allowable fixing spacing shall not exceed 1800mm after applying the adjustment factors.

Note 6 Fixing spacing in the above tables are based on 1 x 14 gauge penetrative screw fixing pull-out capacity into 1.9BMT steel and 35mm embeded into JD4 seasoned timber. The fixing spacing must be adjusted if the roof structure being fixed into a different substructure The recommended typical penetrative fixings to be adopted are as following:

Steel purlin/batten - 14g-10TPI Self-drilling Tek Metal Screw (Buildex recommended)
Timber purlin/batten - 14g-10TPI Self-drilling T17s Timber Screw (Buildex recommended)

Larger diameter new screws (14 gauge typical) shall be used for solar installation to replace the old roof screws (12 gauge typical). All self-drilling penetrative fixing must be in compliance with AS3566-2002 (R2015).

For fixing into steel roof structure with different thicknesses, refer below for adjustment factors based on the given spacing tables.

1) 1.2mm BMT: 62%
2) 1.5mm BMT: 77%
3) 2.4mm BMT: 100% for region A, B, C and D.

When installing on concrete roof, adopt concrete chemical or mecahnical anchor as per the anchor manufacturer's specifications. The recommended concrete fixing anchors are as below:

Chemical anchor - M8/M10 G5.8 galvanised anchor stud with Chemset Reo502 PLUS or approved equivalent; Minimum embedment depth 70mm

Mechanical anchor - M8/M10 DynaBolt PLUS DP08065SS or DP10075GH or approved equivalent; Minimum embedment depth 35mm/45mm

For fixing into concrete roofs, refer below for adjustment factors based on the given spacing tables. 100% for Region A, B, C and D;

Note 7 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 example, when installing the racking frame with 2300mm x 1200mm panels and 3 rails fixed to 1.5mm BMT purlins in Region C, it is incorrect that spacing = original spacing x 120% x 77%. For multiple installation conditions change, please seek for the engineer's advice.