Relationships built on trust

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Structural Design Documentation

Tilt Array Frame System Spacing Table

According to AS/NZS 1170.2-2021
with ECO Rail – Tin Roof (Pierced Fix Roof)
within New Zealand
Terrain Category 2 & 3

For: CLENERGY AUSTRALIA
1/10 Duerdin St
Clayton, VIC 3168

Job Number: 10148-2-Rev1
Date: 8 March 2022

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Job No: **10148-2-Rev1**
Client: **CLENERGY AUSTRALIA**
Project: **Tilt Array Frame System Spacing Table**
with ECO Rail – Tin Roof (Pierced Fix Roof)
Address: **within New Zealand**
Wind Terrain Category: **Terrain Category 2 & 3**

Australian/New Zealand 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 1170.3:2003 (R2016)	Structural design actions Part 3: Snow and ice actions
AS/NZS 1664.1:1997 (R2020)	Aluminium structures Part 1: Limit state design
AS/NZS 4600:2018	Cold-formed steel structures
AS 4100:2020	Steel structures

Designed: **AA**
Checked: **HS**
Date: **Mar-22**

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Tilt Array Frame System Spacing Table for Tin Roof (mm)

Type of Rail	ER-R-ECO
Type of Interface	Tilt Leg
Solar Panel Dimension	2mx1m
Terrain category	**2**

Tilt angle to roof surface (α), α ≤ 15°

Wind Region	Building Height – h (m)															
	h≤5				5<h≤10				10<h≤15				15<h≤20			
	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal
NZ1&NZ2	545	830	1125	1605	445	680	920	1420	--	615	830	1280	--	580	780	1205
NZ1&NZ2 with M_{lee}	--	440	595	910	--	--	490	750	--	--	445	675	--	--	--	635
NZ3	--	610	820	1265	--	500	675	1035	--	450	605	930	--	--	575	875
NZ4	435	660	895	1380	--	540	730	1125	--	490	660	1015	--	465	625	955

Tilt angle to roof surface (α), 15° < α ≤ 25°

Wind Region	Building Height – h (m)															
	h≤5				5<h≤10				10<h≤15				15<h≤20			
	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal
NZ1&NZ2	--	585	790	1215	--	480	645	990	--	435	585	895	--	--	550	840
NZ1&NZ2 with Mlee	--	--	--	640	--	--	--	525	--	--	--	475	--	--	--	450
NZ3	--	430	580	885	--	--	475	725	--	--	430	655	--	--	--	615
NZ4	--	465	630	960	--	--	515	790	--	--	465	710	--	--	440	670

Tilt angle to roof surface (α), 25° < α ≤ 60°

Wind Region	Building Height – h (m)															
	h≤5				5<h≤10				10<h≤15				15<h≤20			
	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal
NZ1&NZ2	--	430	580	885	--	--	475	725	--	--	430	655	--	--	--	620
NZ1&NZ2 with Mlee	--	--	--	470	--	--	--	--	--	--	--	--	--	--	--	--
NZ3	--	--	--	650	--	--	--	535	--	--	--	480	--	--	--	455
NZ4	--	--	460	705	--	--	--	580	--	--	--	520	--	--	--	495

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Tilt Array Frame System Spacing Table for Tin Roof (mm)

Type of Rail	ER-R-ECO
Type of Interface	Tilt Leg
Solar Panel Dimension	2mx1m
Terrain category	**3**

Tilt angle to roof surface (α), α ≤ 15°

Wind Region	Building Height – h (m)															
	h≤5				5<h≤10				10<h≤15				15<h≤20			
	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal
NZ1&NZ2	655	1010	1375	1725	655	1010	1375	1725	565	865	1175	1630	505	770	1045	1565
NZ1&NZ2 with M_{lee}	--	535	725	1110	--	535	725	1110	--	465	625	955	--	--	560	855
NZ3	485	735	1000	1515	485	735	1000	1515	--	635	860	1330	--	570	770	1185
NZ4	525	800	1085	1540	525	800	1085	1540	455	690	935	1450	--	615	835	1285

Tilt angle to roof surface (α), 15° < α ≤ 25°

Wind Region	Building Height – h (m)															
	h≤5				5<h≤10				10<h≤15				15<h≤20			
	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal
NZ1&NZ2	465	705	960	1485	465	705	960	1485	--	610	825	1270	--	545	735	1130
NZ1&NZ2 with Mlee	--	--	510	780	--	--	510	780	--	--	440	670	--	--	--	600
NZ3	--	520	700	1075	--	520	700	1075	--	450	605	925	--	--	540	825
NZ4	--	565	760	1170	--	565	760	1170	--	490	660	1010	--	435	585	895

Tilt angle to roof surface (α), 25° < α ≤ 60°

Wind Region	Building Height – h (m)															
	h≤5				5<h≤10				10<h≤15				15<h≤20			
	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal	Corner	Edge	Intermediate	Internal
NZ1&NZ2	--	520	700	1080	--	520	700	1080	--	450	605	925	--	--	540	825
NZ1&NZ2 with Mlee	--	--	--	570	--	--	--	570	--	--	--	495	--	--	--	440
NZ3	--	--	515	790	--	--	515	790	--	--	445	680	--	--	--	605
NZ4	--	--	560	855	--	--	560	855	--	--	485	740	--	--	430	660

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Project: **Tilt Array Frame System Spacing Table with ECO Rail – Tin Roof (Pierced Fix Roof)** Date: **Mar-22**
Address: **within New Zealand** Designed: **AA**
Checked: **HS**

General Notes

Note 1 Following components are satisfied to use according to AS/NZS 1170.2:2021

Components	Part Number	Description
ECO Rail	ER-R-ECO, ER-R-ECO/BA	As per drawing or test report provided by client
ECO Rail Splice	ER-SP-ECO, ER-SP-ECO/BA	
Standard Inter Clamp	ER-IC-ST, ER-IC-ST/BA	
Standard End Clamp	ER-EC-ST, ER-EC-ST/BA	
Universal Clamp	C-U/30/46, C-U/30/46/BA	
Universal Clamp with Grounding Clip	C-U/30/46-G, C-U/30/46-G/BA	
Adjustable Tilt Leg	ER-TL-10/15, ER-TL-15/30, ER-TL-30/60	
Adjustable Tilt Leg, pre-assembled	ER-TL-10/15/PS, ER-TL-15/30/PS	
Adjustable Tilt Leg with L-feet, pre-assembled	TL-10/15/L/PS, TL-15/30/L/PS	
Fixed Tilt Leg, pre-assembled	ER-TL-5/PS, ER-TL-10/PS	

Note 2 Tin roof interface spacing calculated based on 1.5mm steel purlin G450 or 35mm screw embedment into F7 (Pine) timber (JD4 seasoned timber). (2 screws per each interface)

Recommended screws

Metal Purlins/Battens	Fasteners to use
0.42mm to 0.75mm (G550)	14g-10 TPI Teks screws or approved equivalent
1.2mm to 2.4mm (G450)	14g-10 TPI Teks screws or approved equivalent
Timber Purlins/Battens/Rafters	**Fasteners to use**
Softwood F7 (Pine) (JD4 seasoned timber)	14g-10 TPI T17 screws or approved equivalent
Hardwood F17 (JD3 seasoned timber)	14g-10 TPI T17 screws or approved equivalent

Note 3 Maximum uplift wind pressure is limited to 5kPa.

Note 4 Deflection is limited to Minimum of L/120 and 15mm.

Note 5 Tilt angle is measured from roof surface.

Note 6 "--" states NOT SUITABLE FOR INSTALLATION.

Note 7 Terrain category definition according to section 4.2.1 of AS/NZS 1170.2:2021 as follows:
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).
Terrain Category 3 (TC3) - Terrain with numerous closely spaced obstructions having heights generally from 3 m to 10 m. The minimum density of obstructions shall be at least the equivalent of 10 house-size obstructions per hectare (e.g. suburban housing, light industrial estates or dense forests).

Note 8 Wind regions are shown in Figure 3.1(B) of AS/NZS 1170.2:2021.

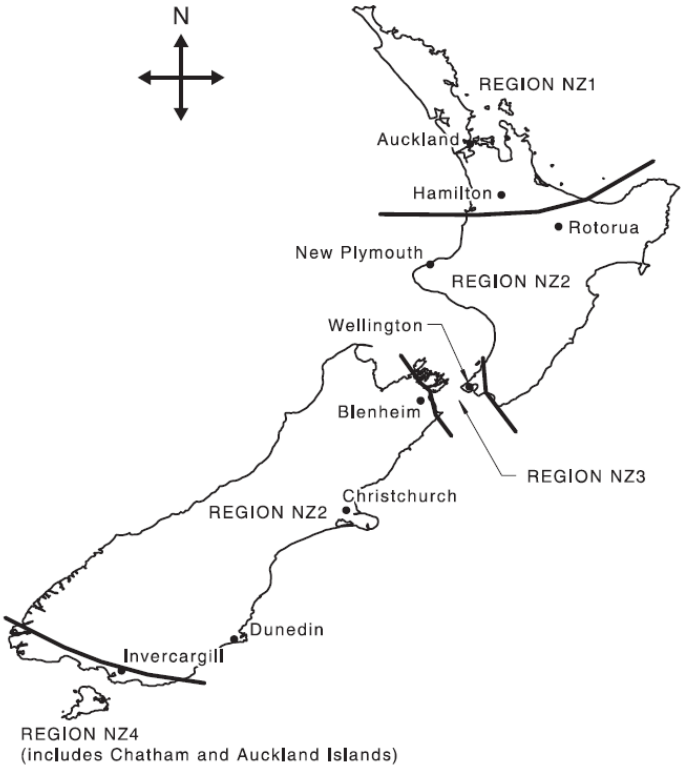

Figure 3.1(B) — Wind regions — New Zealand

Note 9 Base interface spacing to be multiplied by all applicable reduction/increase factors. Factored spacing less than one third of the panel width are not satisfied. (NOT SUITABLE FOR INSTALLATION)

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Note 10 Wind direction multiplier (Md), Shielding multiplier (Ms) and Hill shape multiplier (Mh) are taken as 1.0.

Note 11 Refer section 4.4 of AS/NZS 1170.2:2021 for Lee multiplier (Mlee) and topographic multiplier (Mt).

Note 12 Lee multiplier (Mlee) is taken as 1.0 except for WR NZ1&NZ2 with Mlee which is taken as 1.35. Refer section 4.4.1 of AS/NZS 1170.2:2021 for topographic multiplier (Mt). See Note 25 for Lee zones map.

Note 13 No consideration has been taken on the effect of earthquake loads.

Note 14 No consideration has been taken on the effect of snow loads within the alpine regions.

Note 15 Refer section 2.3 and Figure 2.2 of AS/NZS 1170.3:2003 (R2016) for sub-alpine regions. Probability factor (kp) and Exposure reduction coefficient (Ce) are taken as 1.0 and Shape coefficient (μi) is taken as 0.7. See Note 26 for sub-alpine regions map.

Note 16 Maximum panel weight is limited to 15kg/m^2.

Note 17 Maximum panel width is limited to 1200mm.

Note 18 Maximum rail and panel width overhang is limited to the 40% of the allowable interface spacing.

Note 19 PV panels clamping zone to be according to the manufacturer's specifications.

Note 20 This certificate is applicable for the corrosion zones C1, C2 and C3. Correspondent roof interface must be used for each zone. For corrosion zones C4 and C5 a site specific certificate is required. Refer SNZ TS 3404:2018 for corrosion zones definitions.

Note 21 This assessment is based on the capacity of the fixings of array frame to the structure and the array frame itself but not PV panel nor roof structures. Other building structures are deemed to be satisfactory. It is the responsibility of the installer to adopt the most critical spacing.

Note 22 Following reduction/increase factors to be applied to the base spacing for different type of tophat, purlin or batten or if timber screw embedment is reduced by fixing to smaller timber depth.

Purlin/Batten Material	Fixing Type		Purlin thickness (mm)	Min. Embedment (mm)	Spacing Reduction / Increase			
	Interface	No. of screws			WR NZ1&NZ2	WR NZ1&NZ2 with M_{lee}	WR NZ3	WR NZ4
Timber F7 (Pine)	Tin	1	-	25	-22%	-22%	-22%	-22%
Timber F7 (Pine)	Tin	2	-	25	0%	0%	0%	0%
Timber F7 (Pine)	Tin	1	-	30	-6%	-6%	-6%	-6%
Timber F7 (Pine)	Tin	2	-	30	0%	0%	0%	0%
Timber F7 (Pine)	Tin	1 or 2	-	35	0%	0%	0%	0%
Timber F17 (HW)	Tin	1 or 2	-	25	0%	0%	0%	0%
Timber F17 (HW)	Tin	1 or 2	-	30	0%	0%	0%	0%
Timber F17 (HW)	Tin	1 or 2	-	35	0%	0%	0%	0%
Metal (G550)	Tin	2	0.42	-	-60%	-60%	-60%	-60%
Metal (G550)	Tin	2	0.48	-	-54%	-54%	-54%	-54%
Metal (G550)	Tin	2	0.55	-	-48%	-48%	-48%	-48%
Metal (G550)	Tin	2	0.75	-	-29%	-29%	-29%	-29%
Metal (G450)	Tin	1	1.2	-	-38%	-38%	-38%	-38%
Metal (G450)	Tin	2	1.2	-	0%	0%	0%	0%
Metal (G450)	Tin	1	1.5	-	-22%	-22%	-22%	-22%
Metal (G450)	Tin	2	1.5	-	0%	0%	0%	0%
Metal (G450)	Tin	1 or 2	1.9	-	0%	0%	0%	0%
Metal (G450)	Tin	1 or 2	2.4	-	0%	0%	0%	0%

Note 23 This certificate can be used for the installation of tilt legs on uncracked concrete roofs using one Chemset per tilt leg/bracket. The minimum pull-out tensile capacity of the fixing anchor must be higher than 5kN with drilled hole depth of 80mm. Concrete slab thickness to be minimum 150mm because of anchor cover requirement. Adopt Metal (G450), 2.4mm purlin thickness for increasing ratio.

Note 24 Following reduction/increase factors to be applied to the base spacing for different panel length.

Panel Length (mm)	No. of Rails	Spacing Reduction / Increase			
		WR NZ1&NZ2	WR NZ1&NZ2 with M_{lee}	WR NZ3	WR NZ4
1700	2	+5%	+17%	+5%	+5%
1800	2	+3%	+11%	+3%	+3%
1900	2	+2%	+4%	+2%	+2%
2000	2	0%	0%	0%	0%
2100	2	-6%	-6%	-6%	-6%
2200	2	-10%	-10%	-10%	-10%
2300	2	-14%	-14%	-14%	-14%
2400	2	-17%	-17%	-17%	-17%

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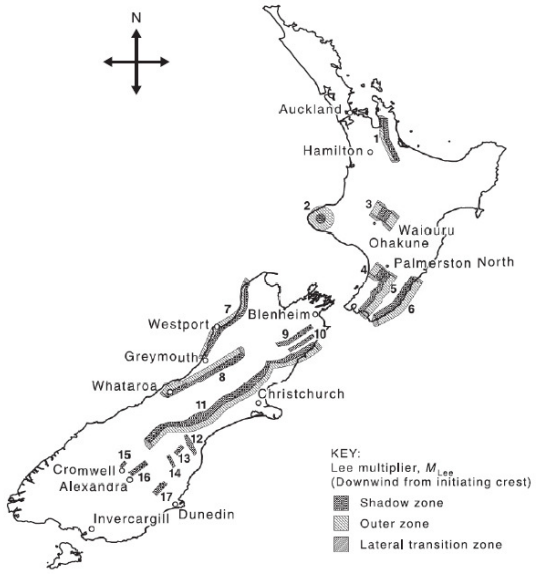
Note 25 Interface spacing to be reduced as follows for sites in wind regions NZ1 & NZ2 with Mlee over 500m above sea level:

Site Elevation, E (m)	Spacing Reduction
E < 500	0%
500 ≤ E < 700	-19%
700 ≤ E < 900	-23%
900 ≤ E < 1200	-30%
E ≥ 1200	N/A

North Island	
1	Kaimai
2	Taranaki
3	Ruapehu
4	Tararua
5	Tararua and Orongorongo
6	Coastal Wairarapa
South Island	
7	West Coast North
8	West Coast Alps
9	Awatere
10	Inland Kaikoura
11	Southern Alps
12	Hunter
13	Hakataramea
14	St Mary's
15	Pisa
16	Dunstan
17	Rock and Pillar



NOTE 1 Some outer and lateral transition zones are not shown.

NOTE 2 For numbers shown, see the first column of Table 4.4.

Figure 4.6 — Locations of New Zealand lee zones

Note 26 Maximum Tin roof interface spacing in sub-alpine regions to be limited to follows for all roof zones. Lateral loading on array frame (due to accumulation snow under PV panels or exerted by drifts) has not been considered.

Site Elevation, E (m)	No. of Rails	Maximum Interface Spacing (mm)			
		Snow Region N1	Snow Region N2&N3	Snow Region N4	Snow Region N5
E < 500	2	1775	1500	1240	1410
500 ≤ E < 700	2	1490	1320	1160	1285
700 ≤ E < 900	2	1340	1200	1100	1195
900 ≤ E < 1200	2	1195	N/A	N/A	N/A

2.3 NEW ZEALAND

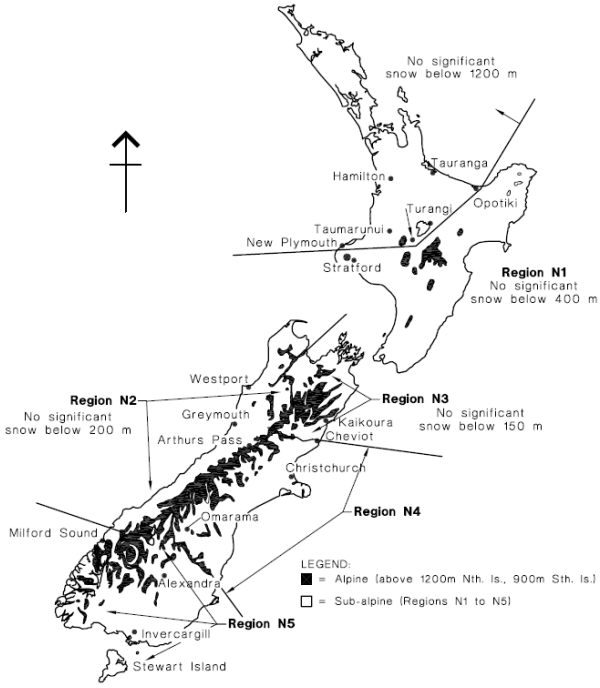
Alpine and sub-alpine regions are defined as follows:

(a) N1 (southern portion of North Island of New Zealand, see Figure 2.2):
  (i) Sub-alpine between 400 m and 1200 m.
  (ii) Alpine ≥1200 m.

(b) N2 (South Island of New Zealand):
  (i) Sub-alpine between 200 m and 900 m.
  (ii) Alpine ≥900 m.

(c) N3 (South Island of New Zealand):
  (i) Sub-alpine between 150 m and 900 m.
  (ii) Alpine ≥900 m.

(d) N4 and N5 (South Island of New Zealand):
  (i) Sub-alpine <900 m.
  (ii) Alpine ≥900 m.



NOTE: This map is approximate only and altitude above mean sea level shall be used to determine snow region. For sub-alpine regions in the South Island (N2, N3, N4 and N5) the regions coincide with the 1988 county boundaries. Where an alpine region exists between sub-alpine regions, the alpine region separates the 2 sub-alpine regions (which extend downwards from 1200 m altitude).

FIGURE 2.2 NEW ZEALAND—APPROXIMATE LOCATIONS OF ALPINE AND SUB-ALPINE REGIONS

Note 27 Building height is average roof height of structure above ground. Refer Figure 1 for definition of h, d and b.

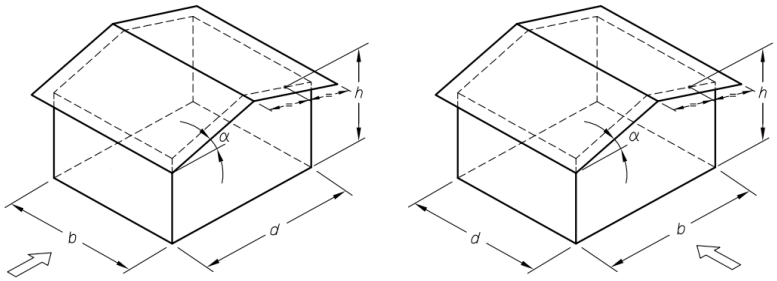
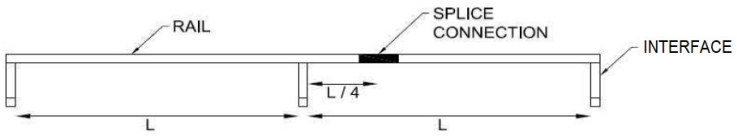


Figure 1 – h, d and b definition

Note 28 Rail splice connection must be placed a quarter length of the spacing of interface. No Splice connection should be placed at the centre of spacing or over the interface.



Note 29 Refer Figure 2 for definition of roof zones. The smallest spacing to be used for panels fall between two (or more) roof zones.

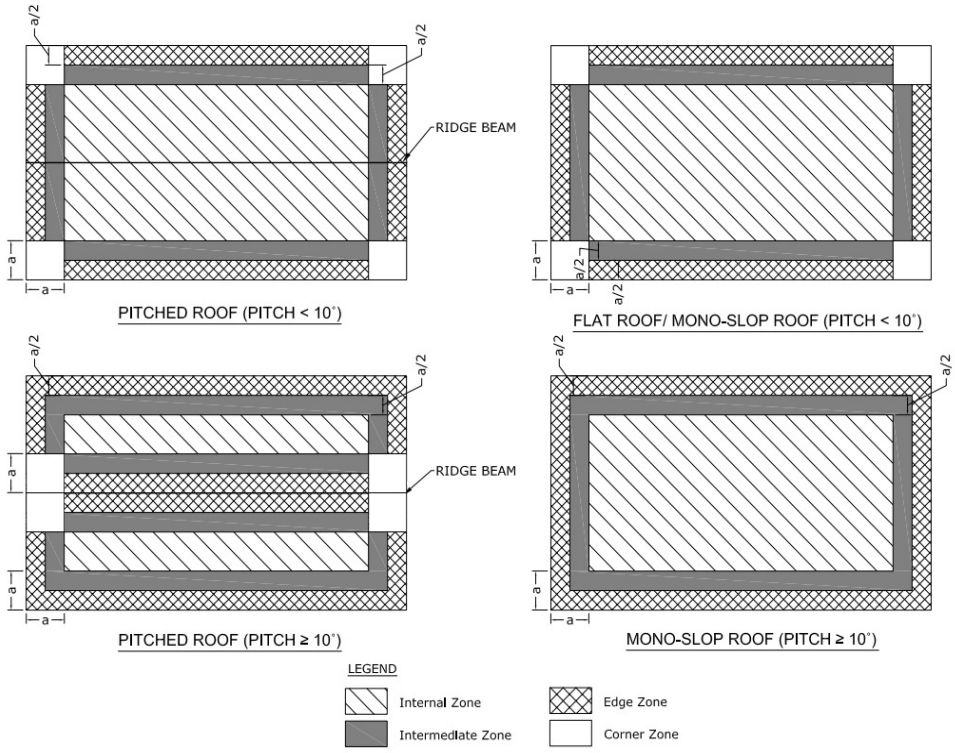


Figure2- Roof Zones Definition

In Figure 2, the value of dimension "a" is the minimum of 0.2b or 0.2d, if (h/b) or (h/d) ≥ 0.2; or 2h if both (h/b) and (h/d) < 0.2
(b & d are building dimensions and h is average roof height, see Figure 1)

Note 30 Perpendicular installation (rails to purlins) for roofs with roof pitch greater than 10 degrees is not covered by this certification.

Note 31 Installation of solar array to be done in accordance with the relevant Clenergy PV installation manual. Contact Clenergy if you are unable to comply with any of the above installation specifications.

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Examples

Example 1

		factor
Tin Roof		
Wind Region	NZ1	-
Terrain Category	2	-
Building Height	4m	-
Tilt angle	20°	-
Panel Dimension	2m x 1m	1
Purlin Thickness	1.5mm	1
No. of screws	2	

Final factor	1

Roof Zone	Final Spacing
Internal Zone	990mm
Intermediate Zone	645mm
Edge Zone	480mm
Corner Zone	--

Example 2

		factor
Tin Roof		
Wind Region	NZ2, with Mlee	-
Terrain Category	3	-
Building Height	12m	-
Tilt angle	15°	-
Panel Dimension	1.75m x 1m	1.11
Purlin Thickness	1.9mm	1
No. of screws	2	
Site Elevation	600m	0.81
Sub-alpine Region	N2 (E=750m)	-

Final factor	0.9

Roof Zone	Final Spacing
Internal Zone	600mm
Intermediate Zone	395mm
Edge Zone	--
Corner Zone	--

Example 3

		factor
Tin Roof		
Wind Region	NZ3	-
Terrain Category	3	-
Building Height	5m	-
Tilt angle	10°	-
Panel Dimension	2m x 1.1m	1
Purlin Thickness	2.4mm	1
No. of screws	1	
Sub-alpine Region	N1 (E=500m))	-

Final factor	0.95

Roof Zone	Final Spacing
Internal Zone	1490mm
Intermediate Zone	1000mm
Edge Zone	735mm
Corner Zone	485mm

Example 4

		factor
Tile Roof		
Wind Region	NZ4	-
Terrain Category	2	-
Building Height	5m	-
Tilt angle	25°	
Panel Dimension	1.65m x 1.1m	1.05
Embedment F17	30mm	1
No. of screws	2	
Sub-alpine Region	N5 (E=200m)	-

Final factor	1.05

Roof Zone	Final Spacing
Internal Zone	1005mm
Intermediate Zone	660mm
Edge Zone	485mm
Corner Zone	--