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Gamcorp (Melbourne) Pty Ltd
A.C.N 141 076 904 A.B.N 73 015 060 240
www.gamcorp.com.au solar@gamcorp.com.au
Tel: +61 3 9543 2211

Structural Design Documentation

Flush Array Frame System Spacing Table

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

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

Job Number: 10148-1-Rev1
Date: 8 March 2022

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A.C.N 141 076 904 A.B.N 73 015 060 240
www.gamcorp.com.au solar@gamcorp.com.au
Tel: +61 3 9543 2211

Job No: **10148-1-Rev1**
Client: **CLENERGY AUSTRALIA**
Project: **Flush Array Frame System Spacing Table**
with ECO Rail - Tin & Tile 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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Address: **within New Zealand**

Job: **10148-1-Rev1**
Date: **Mar-22**
Designed: **AA**
Checked: **HS**

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

Type of Rail	ER-R-ECO
Type of Interface	ER-I-05/ER-I-25
Solar Panel Dimension	2mx1m
Terrain category	**2**

h/d ≤ 0.5 *

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	665	1030	1415	1880	545	840	1145	1765	490	755	1030	1610	465	710	970	1515
NZ1&NZ2 with M_{lee}	355	540	735	1135	--	445	600	925	--	400	540	835	--	380	510	785
NZ3	490	750	1020	1595	400	610	830	1290	360	550	745	1160	340	520	705	1090
NZ4	530	815	1110	1695	435	665	905	1410	395	600	815	1265	370	565	770	1190

h/d ≥ 1.0 *

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	455	695	945	1475	370	565	770	1195	335	510	695	1070	--	485	655	1010
NZ1&NZ2 with Mlee	--	370	495	765	--	--	410	625	--	--	370	565	--	--	350	530
NZ3	--	510	685	1060	--	415	565	865	--	375	505	780	--	355	480	735
NZ4	360	550	745	1155	--	455	610	945	--	410	550	845	--	385	520	800

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

Type of Rail	ER-R-ECO
Type of Interface	ER-I-05/ER-I-25
Solar Panel Dimension	2mx1m
Terrain category	**3**

h/d ≤ 0.5 *

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	810	1260	1740	1995	810	1260	1740	1995	695	1075	1480	1910	620	955	1310	1840
NZ1&NZ2 with Mlee	430	660	895	1395	430	660	895	1395	370	565	770	1190	--	505	685	1060
NZ3	590	910	1250	1795	590	910	1250	1795	510	785	1070	1680	455	700	950	1485
NZ4	640	990	1360	1820	640	990	1360	1820	555	855	1165	1725	495	760	1035	1620

h/d ≥ 1.0 *

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	550	845	1150	1765	550	845	1150	1765	475	725	985	1540	420	645	875	1365
NZ1&NZ2 with Mlee	--	445	605	930	--	445	605	930	--	385	520	800	--	345	465	715
NZ3	405	615	835	1300	405	615	835	1300	350	530	720	1115	--	475	640	990
NZ4	435	670	910	1420	435	670	910	1420	380	580	785	1215	340	515	695	1075

*** For intermediate values of h/d ratios, linear interpolation shall be used. Refer Note 27 for defination h and d.**

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Gamcorp (Melbourne) Pty Ltd
A.C.N 141 076 904 A.B.N 73 015 060 240
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Address: **within New Zealand**

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

Flush Array Frame System Spacing Table for Tile Roof (mm)

Type of Rail	ER-R-ECO
Type of Interface	ER-I-01 (see Note 23 for other Tile interfaces)
Solar Panel Dimension	2mx1m
Terrain category	**2**

h/d ≤ 0.5 *

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	405	635	885	1455	330	515	710	1150	--	460	635	1015	--	435	600	955
NZ1&NZ2 with M_{lee}	--	325	450	710	--	--	365	570	--	--	325	515	--	--	--	480
NZ3	--	440	605	965	--	360	490	775	--	--	440	695	--	--	415	650
NZ4	--	460	635	1015	--	375	515	815	--	340	465	730	--	--	435	685

h/d ≥ 1.0 *

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	--	425	580	925	--	345	470	745	--	--	425	665	--	--	400	625
NZ1&NZ2 with Mlee	--	--	--	470	--	--	--	380	--	--	--	345	--	--	--	--
NZ3	--	--	405	630	--	--	325	515	--	--	--	460	--	--	--	435
NZ4	--	--	425	665	--	--	345	540	--	--	--	480	--	--	--	455

Flush Array Frame System Spacing Table for Tile Roof (mm)

Type of Rail	ER-R-ECO
Type of Interface	ER-I-01 (see Note 23 for other Tile interfaces)
Solar Panel Dimension	2mx1m
Terrain category	**3**

h/d ≤ 0.5 *

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	495	785	1100	1850	495	785	1100	1850	425	670	935	1545	380	590	820	1335
NZ1&NZ2 with Mlee	--	400	550	875	--	400	550	875	--	345	470	740	--	--	420	655
NZ3	345	540	745	1210	345	540	745	1210	--	465	640	1025	--	410	565	900
NZ4	365	565	785	1275	365	565	785	1275	--	485	670	1075	--	430	595	945

h/d ≥ 1.0 *

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	335	515	715	1155	335	515	715	1155	--	445	610	975	--	395	540	855
NZ1&NZ2 with Mlee	--	--	370	575	--	--	370	575	--	--	--	490	--	--	--	435
NZ3	--	360	495	780	--	360	495	780	--	--	425	665	--	--	380	590
NZ4	--	380	520	820	--	380	520	820	--	325	445	700	--	--	395	620

*** For intermediate values of h/d ratios, linear interpolation shall be used. Refer Note 27 for defination h and d.**

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Address: **within New Zealand**

Job: **10148-1-Rev1**
Date: **Mar-22**
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	
Tin Interface	ER-I-05, ER-I-05/BA, ER-I-05/CM, ER-I-25, ER-I-25/BA	
Tin Interface A with ezClick	ER-I-05A/EZC/ECO	
Corrugated Roof adapter	EZ-AD-C43, EZ-AD-C43/BA	
Tile interface	ER-I-01, ER-I-02, ER-I-04, ER-I-23, ER-I-26, ER-I-51	

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).
Tile roof interface spacing calculated based on 25mm screw embedment (2 screws) into F7 (Pine) timber (JD4 seasoned timber).

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 Panels to be installed parallel to the 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.

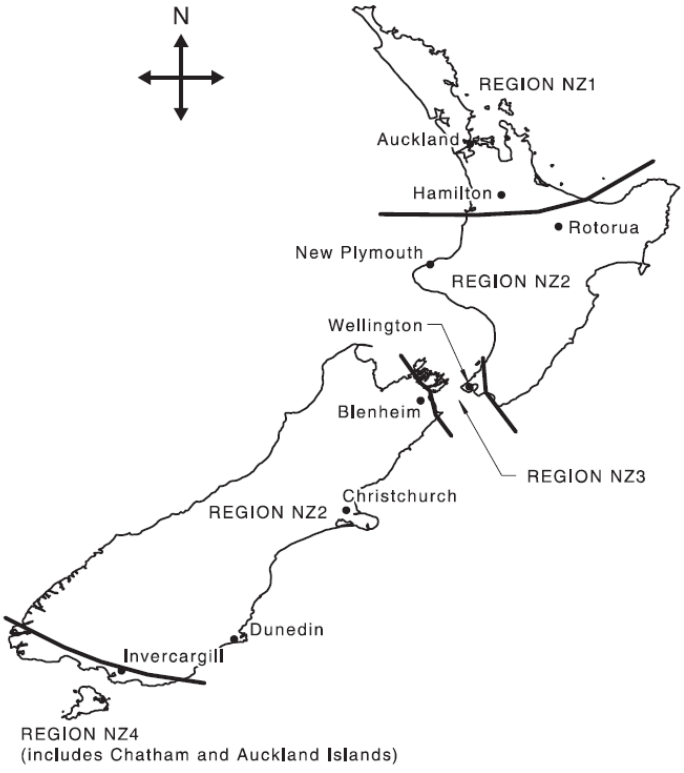

Figure 3.1(B) — Wind regions — New Zealand

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)

Gamcorp (Melbourne) Pty Ltd
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with ECO Rail - Tin & Tile Roof (Pierced Fix Roof) Designed: **AA**
Address: **within New Zealand** Checked: **HS**

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 using EZ-AD-C43 adaptor or 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	0%	0%	0%	0%
Timber F7 (Pine)	Tin	1	-	30	0%	+15%	0%	0%
Timber F7 (Pine)	Tin	1	-	35	0%	+15%	0%	0%
Timber F17 (HW)	Tin	1	-	25	0%	+15%	0%	0%
Timber F17 (HW)	Tin	1	-	30	0%	+15%	0%	0%
Timber F17 (HW)	Tin	1	-	35	0%	+15%	0%	0%
Metal (G550)	Tin	1	0.42	-	-75%	-75%	-75%	-75%
Metal (G550)	Tin	1	0.48	-	-71%	-71%	-71%	-71%
Metal (G550)	Tin	1	0.55	-	-67%	-67%	-67%	-67%
Metal (G550)	Tin	1	0.75	-	-55%	-55%	-55%	-55%
Metal (G450)	Tin	1	1.2	-	-20%	-20%	-20%	-20%
Metal (G450)	Tin	1	1.5	-	0%	0%	0%	0%
Metal (G450)	Tin	1	1.9	-	0%	+15%	0%	0%
Metal (G450)	Tin	1	2.4	-	0%	+15%	0%	0%

Note 23 Tile roof interface spacing to be reduced as follows:

Interface	Spacing Reduction
ER-I-01	0%
ER-I-02	-52%
ER-I-04	-44%
ER-I-23	0%
ER-I-26	0%
ER-I-51	-74%

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

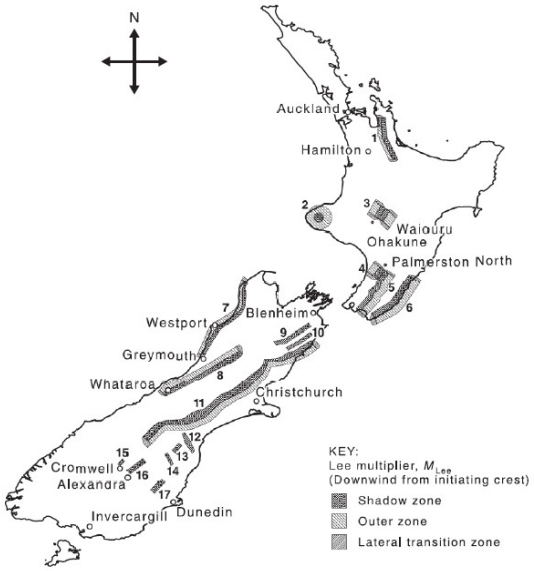
Panel Length (mm)	No. of Rails	Spacing Reduction / Increase			
		WR NZ1&NZ2	WR NZ1&NZ2 with M_{lee}	WR NZ3	WR NZ4
1700	2	+4%	+17%	+4%	+4%
	3	+15%	+37%	+15%	+15%
	4	+24%	+47%	+24%	+24%
1800	2	+3%	+11%	+3%	+3%
	3	+14%	+35%	+14%	+14%
	4	+22%	+45%	+22%	+22%
1900	2	+1%	+4%	+1%	+1%
	3	+12%	+33%	+12%	+12%
	4	+20%	+43%	+20%	+20%
2000	2	0%	0%	0%	0%
	3	+11%	+32%	+11%	+11%
	4	+19%	+41%	+19%	+19%
2100	2	-5%	-5%	-5%	-5%
	3	+9%	+30%	+9%	+9%
	4	+18%	+39%	+18%	+18%
2200	2	-10%	-10%	-10%	-10%
	3	+8%	+28%	+8%	+8%
	4	+16%	+38%	+16%	+16%
2300	2	-14%	-14%	-14%	-14%
	3	+7%	+26%	+7%	+7%
	4	+15%	+36%	+15%	+15%
2400	2	-18%	-18%	-18%	-18%
	3	+6%	+24%	+6%	+6%
	4	+14%	+35%	+14%	+14%

Client: **CLENERGY AUSTRALIA** Job: **10148-1-Rev1**
Project: **Flush Array Frame System Spacing Table** Date: **Mar-22**
with ECO Rail - Tin & Tile Roof (Pierced Fix Roof) Designed: **AA**
Address: **within New Zealand** Checked: **HS**

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 & Tile roof interface spacing in sub-alpine regions to be limited to follows for all roof zones (Tile roof interface capacity in compression must be checked separately before using these limitations).

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
	3	1970	1720	1415	1610
	4	2120	1870	1560	1775
500 ≤ E < 700	2	1490	1320	1160	1285
	3	1705	1510	1330	1470
	4	1860	1660	1460	1620
700 ≤ E < 900	2	1340	1200	1100	1195
	3	1535	1375	1260	1370
	4	1690	1515	1385	1510
900 ≤ E < 1200	2	1195	N/A	N/A	N/A
	3	1370			
	4	1510			

2.3 NEW ZEALAND

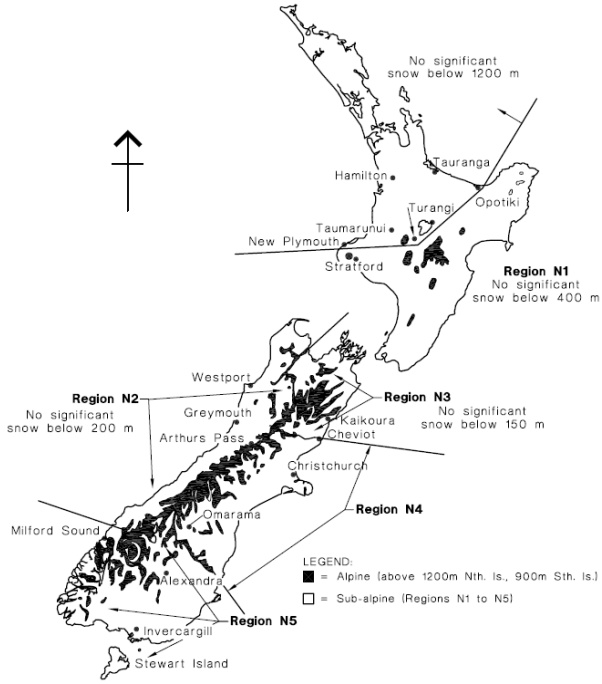
Alpine and sub-alpine regions are defined as follows:

(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

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Job: **10148-1-Rev1**
Date: **Mar-22**
Designed: **AA**
Checked: **HS**

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

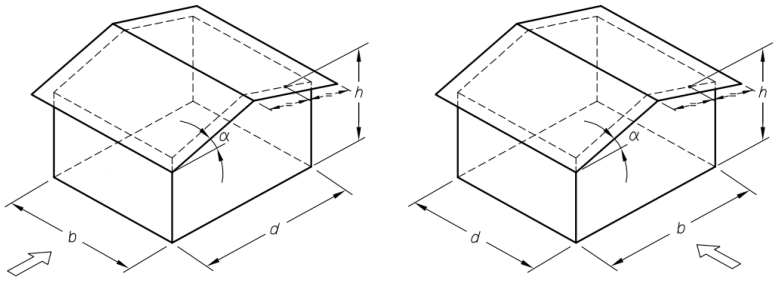
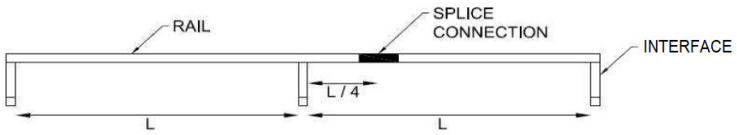


Figure 1 – h, d and b definition

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.

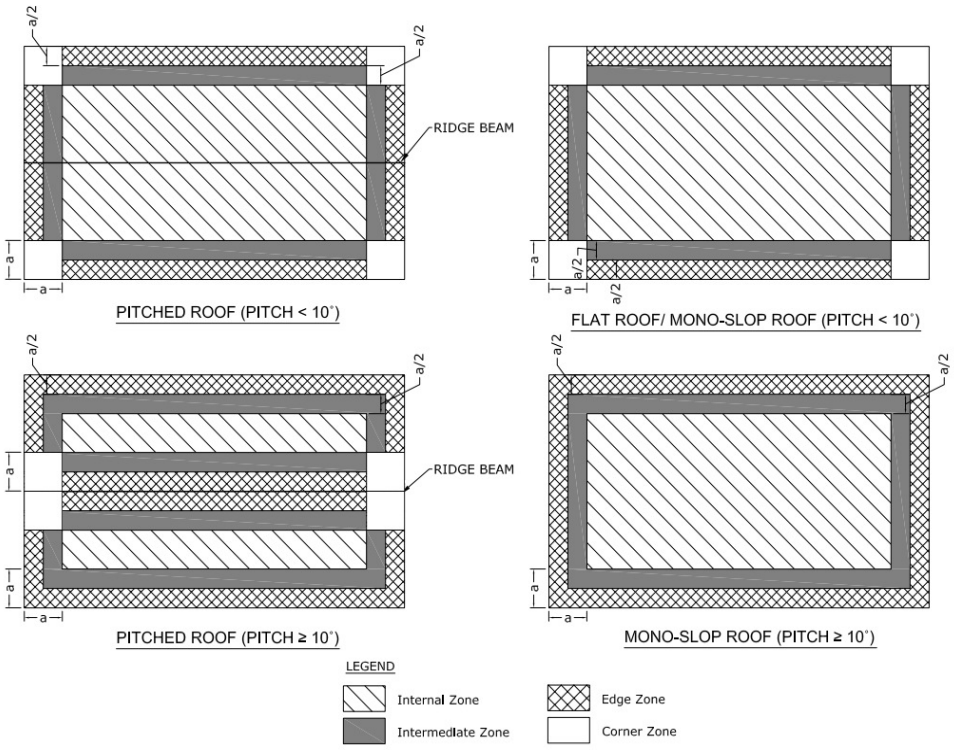


Figure2- Roof Zones Definition

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 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.

Gamcorp (Melbourne) Pty Ltd
A.C.N 141 076 904 A.B.N 73 015 060 240
www.gamcorp.com.au solar@gamcorp.com.au
Tel: +61 3 9543 2211

Client: **CLENERGY AUSTRALIA**
Project: **Flush Array Frame System Spacing Table with ECO Rail - Tin & Tile Roof (Pierced Fix Roof)**
Address: **within New Zealand**

Job: **10148-1-Rev1**
Date: **Mar-22**
Designed: **AA**
Checked: **HS**

Examples

Example 1

Tin Roof		factor
Wind Region	NZ1	-
Terrain Category	2	-
Building Height	4m	-
h/d	0.75	-
Interface	ER-I-05	-
Panel Dimension	2m x 1m	1
No. of Rails	2	
Purlin Thickness	1.5mm	1

S_z Fixing spacing for h/d=z
$= S_{0.5} - [(S_{0.5} - S_{1.0}) / (1.0 - 0.5) \times (z - 0.5)]$
$S_{0.5}$ Fixing spacing for h/d=0.5
$S_{1.0}$ Fixing spacing for h/d=1.0

Roof Zone	Spacing, h/d=0.5
Internal Zone	1880mm
Intermediate Zone	1415mm
Edge Zone	1030mm
Corner Zone	665mm

Roof Zone	Spacing, h/d=1
Internal Zone	1475mm
Intermediate Zone	945mm
Edge Zone	695mm
Corner Zone	455mm

Fixing spacing for h/d=0.75, $S_{0.75} = S_{0.5} - [(S_{0.5} - S_{1.0}) / (1.0 - 0.5) \times (0.75 - 0.5)]$

Final factor	1

Roof Zone	Spacing, h/d=0.75
Internal Zone	1675mm
Intermediate Zone	1180mm
Edge Zone	860mm
Corner Zone	560mm

Roof Zone	Final Spacing
Internal Zone	1675mm
Intermediate Zone	1180mm
Edge Zone	860mm
Corner Zone	560mm

Example 2

Tin Roof		factor
Wind Region	NZ2, with Mlee	-
Terrain Category	3	-
Building Height	12m	-
h/d	1.2	-
Interface	ER-I-05	-
Panel Dimension	1.75m x 1m	1.35
No. of Rails	3	
Purlin Thickness	1.9mm	1.15
Site Elevation	600m	0.81
Sub-alpine Region	N2 (E=750m)	-

Final factor	1.26

Roof Zone	Final Spacing
Internal Zone	1005mm
Intermediate Zone	655mm
Edge Zone	485mm
Corner Zone	--

Example 3

Tin Roof		factor
Wind Region	NZ3	-
Terrain Category	3	-
Building Height	5m	-
h/d	0.5	-
Interface	ER-I-25	-
Panel Dimension	2.1m x 1.1m	0.95
No. of Rails	2	
Purlin Thickness	2.4mm	1
Sub-alpine Region	N1 (E=500m))	-

Final factor	0.95

Roof Zone	Final Spacing
Internal Zone	1490mm
Intermediate Zone	1185mm
Edge Zone	865mm
Corner Zone	560mm

Example 4

Tile Roof		factor
Wind Region	NZ4	-
Terrain Category	3	-
Building Height	5m	-
h/d	0.5	-
Interface	ER-I-04	0.56
Panel Dimension	1.65m x 1.1m	1.04
No. of Rails	2	
Embedment F17	35mm	-
Sub-alpine Region	N5 (E=200m)	-

Final factor	0.58

Roof Zone	Final Spacing
Internal Zone	740mm
Intermediate Zone	455mm
Edge Zone	--
Corner Zone	--