STRUCTURAL DESIGN CERTIFICATION

2023
NOV-23

PV-ezRACK^{R} SolarRoof Tin (Metal) & Asphalt Roof Interface Spacing Tables - Canada

STEENHOF
BUILDING SERVICES GROUP

CLENERGY

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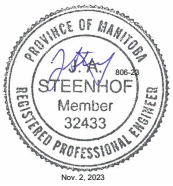
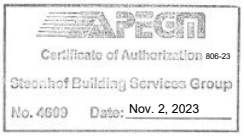
Québec Only - Refer to separate letter from Cleland Jardine Engineering Ltd for use of this certificate in the Province of Quebec.

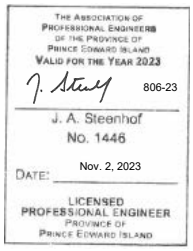
Applicable Standards:

- National Building Code of Canada 2020
- Ontario Building Code 2012 with 2022 amendments
- British Columbia Building Code 2018
- National Building Code – Alberta Edition 2019
- National Building Code 2010 with Manitoba Amendments
- CAN/CSA S157-17, "*Strength Design in Aluminum*"

Engineering Seal(s):
The Professional Engineer's seal(s) below encompass pages 1-10 of this certificate.







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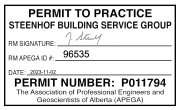


***DISCLAIMER**: From the date of publication onwards, any amendment made to any of the above-mentioned Standards will render this report outdated and a new report will be required to be released, unless the amendment has no implications on this certificate.*

PV-ezRack SolarRoof Interface Spacing Tables

Type of Rail ER-R-ECO (Refer to *Applicable Components* for other compatible rails)

Type of Interface ER-I-05 Tin/Metal Interface and Applicable Interfaces noted in "Applicable Components" (Refer to *Spacing Criteria Note #3*)

Solar Panel Dimensions 2m x 1.4m - Portrait (Refer to *Spacing Criteria Note #4*)

TABLE T1 – Roof Angle - 0° < θ ≤ 7°											
Maximum Span of ECO-Rail (mm)											
Building Height (m)	Roof Snow Load (kPa)	1:50 Reference Wind Velocity Pressure ($q_{1/50}$)									
		0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75
H ≤ 6	1.0	1500	1475	1475	1475	1475	1450	1450	1450	1450	1450
	2.0	1225	1225	1225	1225	1225	1200	1200	1200	1200	1200
	2.5	1075	1075	1075	1075	1075	1075	1075	1075	1075	1075
	3.0	975	975	975	975	975	975	975	975	975	975
6 < H ≤ 10	1.0	1500	1475	1475	1475	1450	1450	1450	1450	1400	1300
	2.0	1225	1225	1225	1225	1200	1200	1200	1200	1200	1200
	2.5	1075	1075	1075	1075	1075	1075	1075	1075	1075	1075
	3.0	975	975	975	975	975	975	975	975	975	975
10 < H ≤ 15	1.0	1475	1475	1475	1475	1450	1450	1450	1425	1400	1300
	2.0	1225	1225	1225	1225	1200	1200	1200	1200	1200	1200
	2.5	1075	1075	1075	1075	1075	1075	1075	1075	1075	1075
	3.0	975	975	975	975	975	975	975	975	975	975
15 < H ≤ 20	1.0	1475	1475	1475	1450	1450	1450	1425	1425	1400	1300
	2.0	1225	1225	1225	1200	1200	1200	1200	1200	1200	1200
	2.5	1075	1075	1075	1075	1075	1075	1075	1075	1075	1050
	3.0	975	975	975	975	975	975	975	975	975	975

TABLE T2 - Roof Angle – 7° < θ ≤ 27°											
Maximum Span of ECO-Rail (mm)											
Building Height (m)	Roof Snow Load (kPa)	1:50 Reference Wind Velocity Pressure ($q_{1/50}$)									
		0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75
H ≤ 6	1.0	1350	1350	1350	1350	1350	1350	1325	1225	1125	1050
	2.0	1125	1125	1125	1100	1100	1100	1100	1100	1100	1050
	2.5	975	975	975	975	975	950	950	950	950	950
	3.0	850	850	850	850	850	850	850	825	825	825
6 < H ≤ 10	1.0	1350	1350	1350	1350	1350	1325	1200	1100	1025	950
	2.0	1125	1125	1100	1100	1100	1100	1100	1100	1025	950
	2.5	975	975	975	975	950	950	950	950	950	950
	3.0	850	850	850	850	850	850	825	825	825	825
10 < H ≤ 15	1.0	1350	1350	1350	1350	1325	1325	1200	1100	1025	950
	2.0	1125	1100	1100	1100	1100	1100	1100	1100	1025	950
	2.5	975	975	975	950	950	950	950	950	950	950
	3.0	850	850	850	850	850	825	825	825	825	825
15 < H ≤ 20	1.0	1350	1350	1350	1325	1325	1325	1200	1100	1025	950
	2.0	1125	1100	1100	1100	1100	1100	1100	1100	1025	950
	2.5	975	975	975	950	950	950	950	950	950	950
	3.0	850	850	850	850	825	825	825	825	825	825

TABLE T3 - Roof Angle – 27° < θ ≤ 45°											
Maximum Span of ECO-Rail (mm)											
Building Height (m)	Roof Snow Load (kPa)	1:50 Reference Wind Velocity Pressure ($q_{1/50}$)									
		0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75
H ≤ 6	1.0	1250	1250	1225	1225	1225	1225	1225	1200	1200	1200
	2.0	1025	1025	1025	1025	1025	1000	1000	1000	1000	1000
	2.5	900	900	900	900	900	900	900	900	900	900
	3.0	800	775	775	775	775	775	775	775	775	775
6 < H ≤ 10	1.0	1250	1225	1225	1225	1225	1200	1200	1200	1200	1175
	2.0	1025	1025	1025	1025	1000	1000	1000	1000	1000	1000
	2.5	900	900	900	900	900	900	900	900	900	900
	3.0	775	775	775	775	775	775	775	775	775	775
10 < H ≤ 15	1.0	1250	1225	1225	1225	1225	1200	1200	1200	1175	1175
	2.0	1025	1025	1025	1000	1000	1000	1000	1000	1000	1000
	2.5	900	900	900	900	900	900	900	900	900	875
	3.0	775	775	775	775	775	775	775	775	775	775
15 < H ≤ 20	1.0	1225	1225	1225	1225	1200	1200	1200	1175	1175	1175
	2.0	1025	1025	1025	1000	1000	1000	1000	1000	1000	1000
	2.5	900	900	900	900	900	900	900	900	875	875
	3.0	775	775	775	775	775	775	775	775	775	775

GENERAL LOADS:

1. Design tables only cover the assessment of the Clenergy PV Mounting system including the components listed in "Applicable Components". Assessment of the roof structure, PV panels and other fixings are to be checked by the installer/contractor.

2. The components from Clenergy shall be installed according to manufacturer's specification and the instructions shown in the relevant installation manual. Where third-party interfaces are utilized, the installation of the interface shall conform the manufacturer's methods.

3. Component capacities have been verified against testing data provided by Clenergy Australia

4. This document was designed to cater to the most common installation scenarios however, it does not cater to all scenarios. Contact Clenergy if you are unable to comply with any of the installation specifications listed on this document.

5. Tables are applicable for Hip and Gable Roofs only. Table values are not permitted for use with multi-Span gabled (folded) Roofs or Sawtooth Roofs.

6. Rails shall not be located within 1200mm (48") of the roof perimeter. Where such conditions exist, the Interface spacing within this area shall be adjusted. Refer to Spacing Criteria Note #5.

7. Tables are not permitted to be used with high importance or post-disaster structures as defined by NBC 2020 Table 4.1.2.1.B. *Importance Category for Buildings.*

8. Where spacing of interface does not land on structural framing members such as rafters or truss chords, the installer shall ensure solid blocking is installed to permit the installation of the interface.

9. Where the ECO-Rail is required to be spliced, the splice shall occur at the third span between interior interface modules. A tolerance of 200mm (8") either side of third span is permitted.

10. At no time shall components project past the fascia line of the roof structure. Interface modules shall not be installed on roof overhangs and shall be a minimum of 200mm (8") from valleys, hips and ridges.

11. Clamping zone of the PV panels shall be completed in accordance with the manufacturer's specifications.

12. Roof Slope is presented in degrees. The following table presents common Rise:Run conversions to degree slope.

ROOF SLOPE CONVERSIONS												
Rise:Run	1:12	2:12	3:12	4:12	5:12	6:12	7:12	8:12	9:12	10:12	11:12	12:12
Degrees	4.8	9.5	14	18.4	22.6	26.6	30.3	33.7	36.7	39.8	42.5	45

CLIMATIC LOADS:

1. Reference Velocity Pressures ($q_{1/50}$) provided are based on the annual probable exceedance of 1:50. Refer to the climatic data provided in the National Building Code or governing Provincial Code for the applicable $q_{1/50}$ values.

2. Climatic data may be obtained by the following means indicated below. Please note that reliability and accuracy of the information presented through the following means is the responsibility of the installer.

    a. National Building Code or Governing Provincial Building Code using methods outlined in Part 4 or Part 9
    b. Local Building Department (Recommended approach for Solar Installers not familiar with Building Code Requirements)
    c. Snow Load (S): https://www.jabacus.com/engineering/load2015/snow.php
        Refer to sample calculation at end of this report
    d. Wind Load (q_{50}): https://www.jabacus.com/engineering/load2015/wind.php
        Refer to sample calculation at end of this report

3. For structures where snow drifting may occur (Primarily structures outside the scope of NBC Part 9), refer to base building structural drawings for snow drift information and magnitude (Typically available from the Local Building Department or structure owner).

4. Wind Exposure factor C_e is based on the height of the structure and Open Terrain.

5. Gust Effect Factor, C_g, and External Pressure Coefficient, C_p, have been combined and determined in accordance with Figures 4.1.7.6.C and 4.1.7.6.E of the NBC.

6. Topographic Factor, Ct, has been taken as 1.0. Where the structure is located on a hill or Escarpment in which $H_h/(2L_h) > 0.1$, contact Clenergy for guidance.
    H_h = Height of the Hill or Escarpment
    L_h = Length of the Hill or Escarpment taken as the horizontal distance from the base of the Hill or Escarpment to the peak of the Hill or Escarpment.

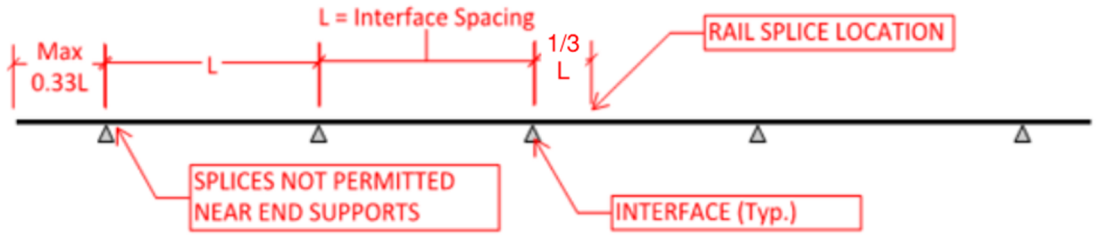
7. Roof Snow load is to be determined in accordance with NBC Part 9 for structures meeting NBC Part 9 criteria, and NBC Part 4 for all other structures.

8. Effects of Seismic Loads have not been considered.

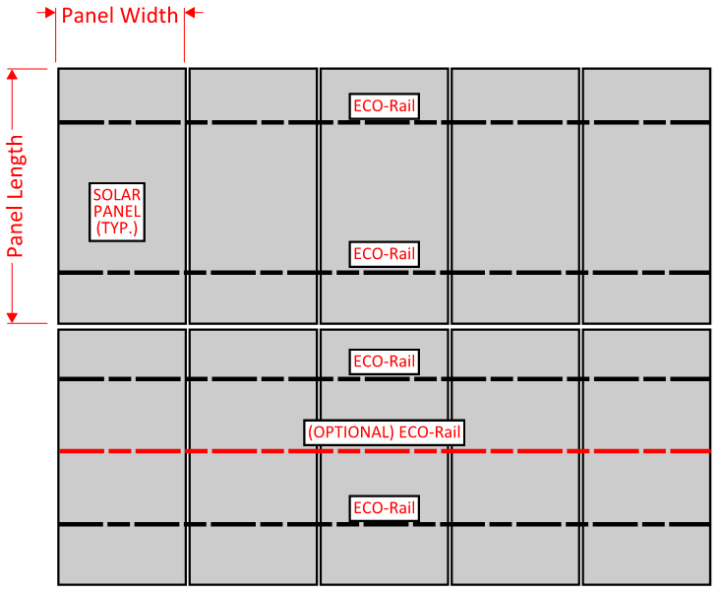
SPACING CRITERIA:

1. Tables T1 thru T3 are based on strength of the rail, deflection of the rail (L/200), and Clenergy's ER-I-05 Tin Interface when used in combination with Buildex 14-11 x 70 Hex Head Zips with 16mm Aluminum Bonded Washer having a minimum penetration of 30mm (1 ¼") into SPF No1/No.2. Wood Members.

2. Graphical representation of Interface spacing is provided in the image below. Splices, if required, shall occur at the third point of the interface spacing provided the third point is not one which is closest to an end interface.



3. Tables are based on a 2m x 1.4m Panel in portrait or landscape orientation supported by two (2) ECO-Rails [Image below]. A spacing adjustment multiplier is permitted to be applied on all interface spacing as shown in the following table. Factors less than 1.0 (red) are required to be applied to the interface spacing. **Adjustment factors assume of a minimum clamping zone located 300mm (12") from panel edge and Maximum of 400mm (16") from the panel edge.**



Panel Length	Rail Qty.	Spacing Multiplier
≤ 1700mm	2	1.03
	3	1.15
	4	1.30
≤ 1800mm	2	1.00
	3	1.13
	4	1.25
≤ 2000mm	2	1.00
	3	1.10
	4	1.20
≤ 2100mm	2	0.96
	3	1.06
	4	1.17
≤ 2200mm	2	0.93
	3	1.05
	4	1.15
≤ 2400mm	2	0.90
	3	1.00
	4	1.13

4. Where a third-party interface is used, the installer shall verify allowable spacings of the interface and compare against Tables 1 thru 3. **The more stringent spacing shall govern.**

5. For rails located within 1200mm (48”) of the roof perimeter, the interface spacing shall be multiplied by the following factors:

Roof Slope	Spacing Adjustment Multiplier	
	$q_{1/50} \leq 0.5$ kPa	0.5 kPa < $q_{1/50} \leq 0.75$
0° < θ ≤ 7°	0.57	0.37
7° < θ ≤ 27°	0.58	0.41
27° < θ ≤ 45°	No Reduction Required	

6. Spacing tables are based on portrait orientation in which rails are not shared between adjacent panels.

7. A minimum of 4 interface modules per rail is required.

APPLICABLE COMPONENTS:

Component	Part No.	Description
ECO-Rail	ER-R-ECO/XXXX	ECO-Rail
Splice	ER-SP-ECO	PV-ezRack Splice for ECO Rail
Australian Made Mill Finish ECO Rail	R-ECO/XXXX/AUMF	PC-ezRack Australian Made Mill Finish ECO Rail
ST-Rail	ER-R-STXXXX	Standard Rail
Splice	ER-SP-ST	PV-ezRack Splice for Standard Rail 200mm
ECO Rail Black	ER-R-ECO/XXXX/BA	ECO-Rail Black
Black Splice ECO Rail	ER-SP-ECO/BA	Splice for ECO Rail Black
Inter Clamp	ER-IC-STXX	Clamp + Z-Module + Bolt
End Clamp	ER-EC-STXX	Clamp + Z-Module + Bolt
Clamp	C-U/30/46-G	Universal Clamp for Frame Height 30-46mm with Grounding Clip
Clamp	C-U/30/46	Universal Clamp for Frame Height 30-46mm
End Clamp	ER-EC-DU35/40	End Clamp dual 35 or 40mm
End Clamp	ER-EC-DU40/46	End Clamp dual 40 or 46mm
Inter Security Clamp	ER-IC-STXX/S	Clamp + Z-Module + Security Bolt
End Security Clamp	ER-EC-STXX/S	Clamp + Z-Module + Security Bolt
Interface	ER-I-O5	Tin Interface
Black Interface	ER-I-05/BA	Black Tin Interface
Interface	ER-I-05/CM	Tin Interface with Click Module
Interface	ER-I-05A/EZC/ECO	ezClick Connection for ECO-Rail
Interface	ER-I-25	Tin Interface with curved base for corrugated roof
Black Interface	ER-I-25/BA	Black Tin Interface with curved base for corrugated roof
Interface	I-05-8/28/TH	Tin Interface with M8x28 Bolt and for threaded holes
Interface	ER-I-05A/EZC/ECO/TH	Tin Interface 'A' with ezClick Connection and for threaded holes
Interface	13-120150-213	Tin Interface with Double Fastener & ezClick connection
Interface	ER-I-O1/EZC/ECO	Tile Interface with ezClick connection for ECO-Rail
Interface	ER-I-61/EZC/ECO	Adjustable Tile Interface with ezClick connection, 170mm horizontal arm
Connector Clamp	CRC-R/ECO-ZBW	Cross Connector Clamp for ECO-Rail
Hanger Bolt	ER-HB-8/150	PV-ezRack, Hanger Bolt wood rafter M8*150
Hanger Bolt	ER-HB-MP/8/150EP	PV-ezRack Hanger Bolt for metal purlin M8*150mm
Mid Clamp XX Black	ER-EC-STXXB	Inter Clamp XX Black
End Clamp XX Black	ER-EC-STXXB	End Clamp XX Black
Black Universal Clamp	C-U/30/46-BA	Black Universal Clamp
Black Universal Clamp	C-U/30/40-G-BA	Black Universal Clamp with grounding clip
ECO Rail Cap	CAP-ECO/PA	Cap for ECO Rail
Black ECO Rail CAP	CAP-ECO/PA-BA	Black Cap for ECO Rail
Z-Module Fastener	EZ-Z-STBW	Z-Module Nut & Bolt with Washer
Rail Cable Clip	CC-R/ECO/6	Rail Cable Clip for 6 Cables
Panel Clip	EZ-CC-PV/2	Panel Cable Clip for 2 Cables

SAMPLE CALCULATION OF ROOF SNOW LOAD FOR HOUSES

jabacus Roof Snow Load (NBC 2015)

version 1.0.1
August 18, 2022

Project: CLENERGY SAMPLE CALCULATION

Designer:

Climatic Data

Location

Province: Ontario

Location: Orillia

Importance factor

I_s: Normal

Factors

C_b: 0.55 — 0.55 for Houses & Small Buildings conforming to NBC PART 9

If Cb left blank, provide the dimensions in the roof geometry to compute C_b

C_w: 1.0

C_a: 1.0

Roof Geometry

Pitch: 0 /12

Slippery: No

Roof Plan dimensions

Dimensions used to calculated C_b if C_b left empty.

Longer dimension, l: m

Shorter dimension, w: m

ITEMS IN RED ARE ITEMS REQUIRING ADJUSTMENT IN JABACUS.

ITEMS IN GREEN ARE THE RESULTS TO BE USED WITH THE SPACING TABLES

ITEMS IN BLUE SHALL NOT BE ADJUSTED.

Specified Snow Load

$S = I_s[S_s(C_bC_wC_sC_a)+S_r]$ *[4.1.6.2]*

Factors

Location: Orillia, Ontario
Ss = 2.4 kPa / Sr = 0.4 kPa
Importance Factor, ULS: I_s = 1.0 / SLS: I_s = 0.9
C_w = 1
C_b = 0.55
C_b is based on input value. Not computed from roof dimensions
Roof slope = 0 degrees
Slope Factor
For non-slippery roof:
Slope <= 30 degrees.
C_s = 1

ROOF SNOW LOAD VALUES TO BE USED WITH TABLES

ULS:

S = 1.0[2.4(0.55*1.0*1*1.0)+0.4] = 1.72kPa

S = 1.72 kPa

S = 35.9 psf

SLS:

S = 0.9[2.4(0.55*1.0*1*1.0)+0.4] = 1.55kPa

S = 1.55 kPa

S = 32.3 psf

SAMPLE CALCULATION OF REFERENCE WIND VELOCITY PRESSURE ($q_{1/50}$)

jabacus Specified Wind Load Figure 4.1.7.6.-A (NBC 2015)

version 1.0.1
August 18, 2022

Project: CLENERGY SAMPLE CALCULATION

Designer:

Climatic Data

Location

Province: Ontario

Location: Orillia

Return Period: 50 year

Factors

Importance factor

I_w: Normal

Terrain: Open terrain

Reference height in meters above grade for C_e

Height, h: 1.0 m

Reference height in meters above grade for C_{ei}

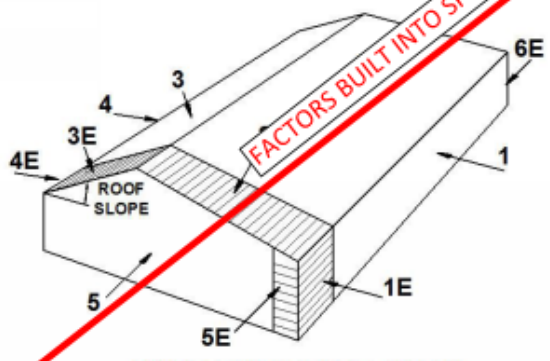
Height, h_i: 1.0 m

Roof Pitch: 0 /12

C_t: 1.0 * optional

Internal pressure Category, C_{pi}:

Category 1: Cpi = -0.15 to 0



WIND PRESSURE SIDES

FACTORS BUILT INTO SPACING TABLES - NOT APPLICABLE

Factors

Location: Orillia, Ontario

q_{50}: 0.36kPa REFERENCE WIND VELOCITY PRESSURE TO BE USED WITH TABLES

Importance Factor, ULS: I_w = 1.0 / SLS: I_w = 0.75

Roof slope = 0 degrees

$C_e = (h/10)^{0.2}$ = 0.9

$C_{ei} = (h/10)^{0.2}$ = 0.9

C_t = 1

External Wind Pressure

$p = I_w * q * C_e * C_t * C_g * C_p$

Load Case A: Winds generally perpendicular to ridge

Load Case B: Winds generally parallel to ridge

Side	Load Case A			Load Case B		
	C_pC_g	ULS p (kPa)	SLS p (kPa)	C_pC_e	ULS p (kPa)	SLS p (kPa)
1	0.7[illegible]	**0.24**	0.18	-0.85	**-0.28**	-0.21
1E	[illegible]	**0.37**	0.28	-0.9	**-0.29**	-0.22
[illegible]	[illegible].3	**-0.42**	-0.32	-1.3	**-0.42**	-0.32
2E	-2	**-0.65**	-0.49	-2.0	**-0.65**	-0.49
3	-0.7	**-0.23**	-0.17	-0.7	**-0.23**	-0.17
3E	-1	**-0.32**	-0.24	-1.0	**-0.32**	-0.24
[illegible]	-0.55	**-0.18**	-0.13	-0.85	**-0.28**	-0.21
4E	[illegible].8	**-0.26**	-0.19	-0.9	**-0.29**	-0.22
5	n/a	**n/a**	n/a	0.75	**0.24**	0.18
5E	n/a	**n/a**	n/a	1.15	**0.37**	0.28
6	n/a	**n/a**	n/a	-0.55	**-0.18**	-0.13
6E	n/a	**n/a**	n/a	[illegible].8	**-0.26**	-0.19

Internal Wind Pressure

C_{gi} = 2 C_{pi} = -0.15 to 0

$p_i = I_w * q * C_{ei} * C_t * C_{gi} * C_{pi}$

ULS: p_i = -0.1kPa to 0kPa

SLS: p_i = -0.07kPa to 0kPa