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IronRidge
1495 Zephyr Ave
Hayward, CA 94544

December 30, 2013

Attn: Mr. William Kim, Chief Executive Officer

Subject: IronRidge Standard Rail (XRS), Roof Flush Mounting System – Structural Analysis

Dear Sir:

We have analyzed the IronRidge Standard Rail for the subject solar panel support system and determined that, for the configurations and criteria described below, it is in compliance with the applicable sections of the following Reference Documents:

Codes: ASCE/SEI 7-10 Min. Design Loads for Buildings & Other Structures
International Building Code 2012 Edition
California Building Code 2013 Edition
Other: AC428, Acceptance Criteria for Modular Framing Systems Used to Support PV Modules, dated Effective November 1, 2012 by ICC-ES
Aluminum Design Manual, 2010 Edition

The IronRidge Standard Rail is an extruded aluminum section with an overall depth of 3.00 in. and a net area of 0.807 sq.in. The rails are used to support solar panels, typically, on the roof of a building. See Exhibit A – attached. The rails are clamped to aluminum angle brackets that are either attached directly to the roof framing or attached to a stand that is screwed to the roof framing. The rails are mounted across the slope with a small clearance (flush mounting) to the underlying roof structure. The installed solar panels are at the same slope as the underlying roof structure.

All loads are transferred to the roof framing through the angle brackets by simple bi-axial flexure of the rails. The maximum span of the rails is governed by either the mid-span flexural stresses or the deflection requirement that the rail not come into contact with the roof.

The effect of seismic loads (for all design categories A-F) have been determined to be less than the effect due to wind loads in all load conditions and combinations. Therefore, the maximum allowable spans for common load cases are shown in Tables 1, 2 & 3 below.

Table 1 - MAXIMUM SPANS (inches) - Roof Wind Zone 1											
Standard Rail	Wind Speed	Ground Snow Load									
Exposure	mph	0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf
Category B	100	148	128	109	94	83	75	69	64	60	57
	105	148	128	109	94	83	75	69	64	60	57
	110	148	128	109	94	83	75	69	64	60	57
	120	148	128	109	94	83	75	69	64	60	57
	130	147	128	109	94	83	75	69	64	60	57
	140	137	128	109	94	83	75	69	64	60	57
	150	129	126	108	94	83	75	69	64	60	57
	160	121	121	106	94	83	75	69	64	60	57
	170	115	115	104	93	83	75	69	64	60	57
	180	109	109	102	91	83	75	69	64	60	57
Category C	100	148	128	109	94	83	75	69	64	60	57
	105	148	128	109	94	83	75	69	64	60	57
	110	147	128	109	94	83	75	69	64	60	57
	120	136	128	109	94	83	75	69	64	60	57
	130	126	125	107	94	83	75	69	64	60	57
	140	117	117	105	93	83	75	69	64	60	57
	150	110	110	103	92	83	75	69	64	60	57
	160	104	104	100	90	82	75	69	64	60	57
	170	98	98	98	88	81	75	69	64	60	57
	180	93	93	93	87	80	74	69	64	60	57
Category D	100	148	128	109	94	83	75	69	64	60	57
	105	142	128	109	94	83	75	69	64	60	57
	110	136	128	109	94	83	75	69	64	60	57
	120	125	125	107	94	83	75	69	64	60	57
	130	116	116	104	93	83	75	69	64	60	57
	140	109	109	102	91	83	75	69	64	60	57
	150	102	102	100	89	82	75	69	64	60	57
	160	96	96	96	88	80	75	69	64	60	57
	170	90	90	90	86	79	74	69	64	60	57
	180	86	86	86	84	78	73	68	64	60	57

Notes – see page 5

Table 2 - MAXIMUM SPANS (inches) - Roof Wind Zone 2											
Standard Rail	Wind Speed	Ground Snow Load									
Exposure	mph	0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf
Category B	100	140	128	109	94	83	75	69	64	60	57
	105	134	128	109	94	83	75	69	64	60	57
	110	128	128	109	94	83	75	69	64	60	57
	120	118	118	109	94	83	75	69	64	60	57
	130	109	109	109	94	83	75	69	64	60	57
	140	102	102	102	94	83	75	69	64	60	57
	150	96	96	96	94	83	75	69	64	60	57
	160	90	90	90	90	83	75	69	64	60	57
	170	85	85	85	85	83	75	69	64	60	57
	180	80	80	80	80	80	75	69	64	60	57
Category C	100	120	120	109	94	83	75	69	64	60	57
	105	114	114	109	94	83	75	69	64	60	57
	110	109	109	109	94	83	75	69	64	60	57
	120	101	101	101	94	83	75	69	64	60	57
	130	93	93	93	93	83	75	69	64	60	57
	140	87	87	87	87	83	75	69	64	60	57
	150	81	81	81	81	81	75	69	64	60	57
	160	77	77	77	77	77	75	69	64	60	57
	170	72	72	72	72	72	72	69	64	60	57
	180	68	68	68	68	68	68	68	64	60	57
Category D	100	110	110	109	94	83	75	69	64	60	57
	105	105	105	105	94	83	75	69	64	60	57
	110	101	101	101	94	83	75	69	64	60	57
	120	93	93	93	93	83	75	69	64	60	57
	130	86	86	86	86	83	75	69	64	60	57
	140	80	80	80	80	80	75	69	64	60	57
	150	75	75	75	75	75	75	69	64	60	57
	160	71	71	71	71	71	71	69	64	60	57
	170	67	67	67	67	67	67	67	64	60	57
	180	63	63	63	63	63	63	63	63	60	57

Notes – see page 5

Table 3 - MAXIMUM SPANS (inches) - Roof Wind Zone 3											
Standard Rail	Wind Speed	Ground Snow Load									
Exposure	mph	0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf
Category B	100	115	115	109	94	83	75	69	64	60	57
	105	110	110	109	94	83	75	69	64	60	57
	110	105	105	105	94	83	75	69	64	60	57
	120	97	97	97	94	83	75	69	64	60	57
	130	90	90	90	90	83	75	69	64	60	57
	140	83	83	83	83	83	75	69	64	60	57
	150	78	78	78	78	78	75	69	64	60	57
	160	73	73	73	73	73	73	69	64	60	57
	170	69	69	69	69	69	69	69	64	60	57
	180	66	66	66	66	66	66	66	64	60	57
Category C	100	98	98	98	94	83	75	69	64	60	57
	105	93	93	93	93	83	75	69	64	60	57
	110	89	89	89	89	83	75	69	64	60	57
	120	82	82	82	82	82	75	69	64	60	57
	130	76	76	76	76	76	75	69	64	60	57
	140	71	71	71	71	71	71	69	64	60	57
	150	66	66	66	66	66	66	66	64	60	57
	160	62	62	62	62	62	62	62	62	60	57
	170	59	59	59	59	59	59	59	59	59	57
	180	56	56	56	56	56	56	56	56	56	56
Category D	100	90	90	90	90	83	75	69	64	60	57
	105	86	86	86	86	83	75	69	64	60	57
	110	82	82	82	82	82	75	69	64	60	57
	120	76	76	76	76	76	75	69	64	60	57
	130	70	70	70	70	70	70	69	64	60	57
	140	65	65	65	65	65	65	65	64	60	57
	150	61	61	61	61	61	61	61	61	60	57
	160	57	57	57	57	57	57	57	57	57	57
	170	54	54	54	54	54	54	54	54	54	54
	180	51	51	51	51	51	51	51	51	51	51

Notes – see page 5

Notes – Tabulated values are based on the following criteria:

1. Building mean roof height = 30 ft
2. Risk Category I
3. Roof slope = 7 to 27 deg.
4. Solar panel long dimension = 67.5 in
5. Provide 2 in. clear between roof and rail
6. End cantilever span (max) = 0.40 x maximum span from above tables
7. No rail splices in end spans
8. No rail splices in middle 1/3 of interior spans
9. Single simple span(s). Tabulated values may be increased for multiple continuous spans. Contact IronRidge.

Our analysis assumes that the rails, including the connections and associated hardware, are installed in a workmanlike manner in accordance with the "IronRidge Standard Rail Installation Manual" by IronRidge and generally accepted standards of construction practice. Additional information is available at the IronRidge web site, IronRidge.com. Verification of PV Module capacity to support the loads associated with the given array shall be the responsibility of the Contractor or Owner and not IronRidge or Starling Madison Lofquist.

The adequacy of the supporting roof framing is to be determined by others.

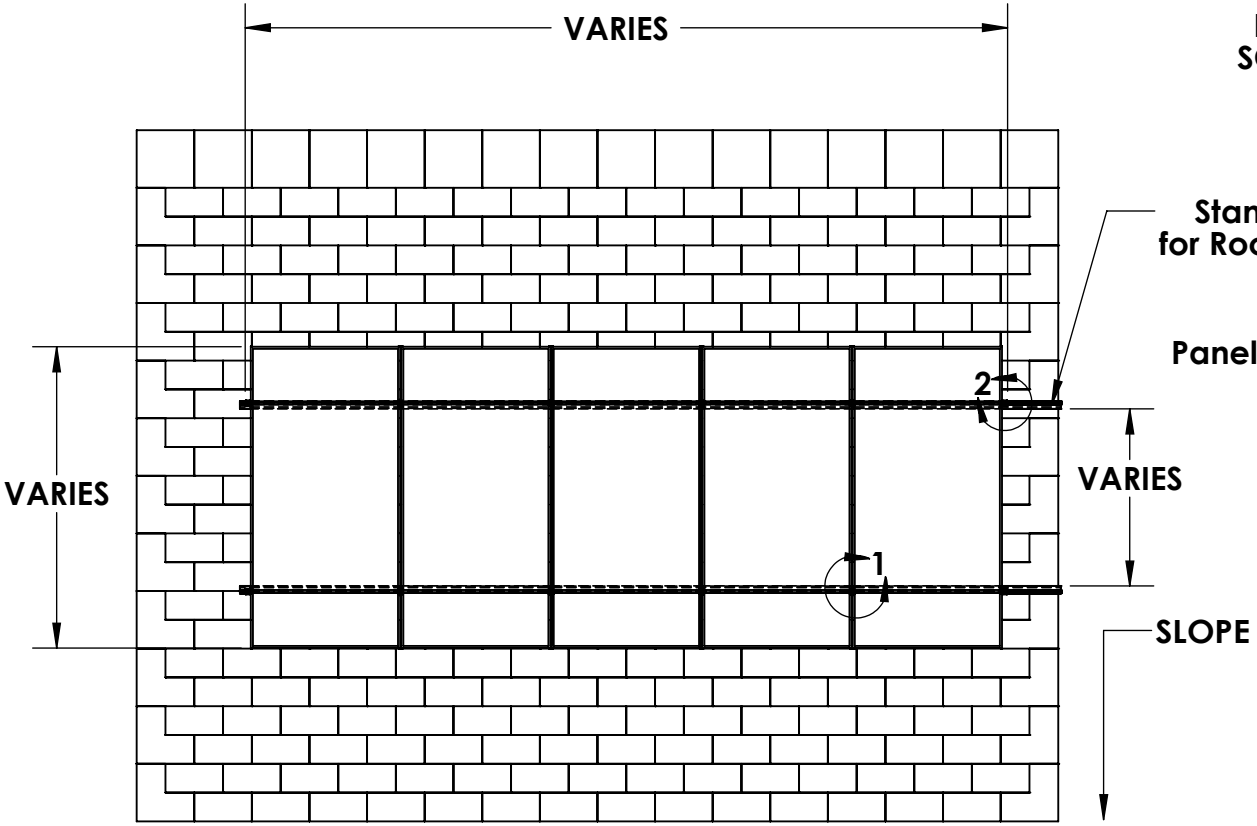
Please feel free to contact me at your convenience if you have any questions.

Respectfully yours,

Tres Warner, P.E.
Design Division Manager

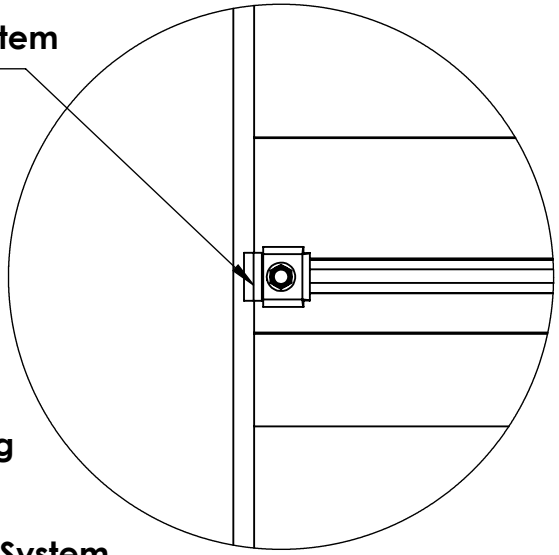
MATERIAL	FINISH	DIMENSIONS ARE IN INCHES. TOLERANCES: .XX: +/- .125" ANGLES: +/- 1.5°	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF IRONRIDGE INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF 2WO SEAS INC IS PROHIBITED.

ZONE	REV.	REVISIONS DESCRIPTION	DATE	APPROVED
	01	Initial Release	09-14-09	HV
	02	Updated L-Foot	3-14-12	SM



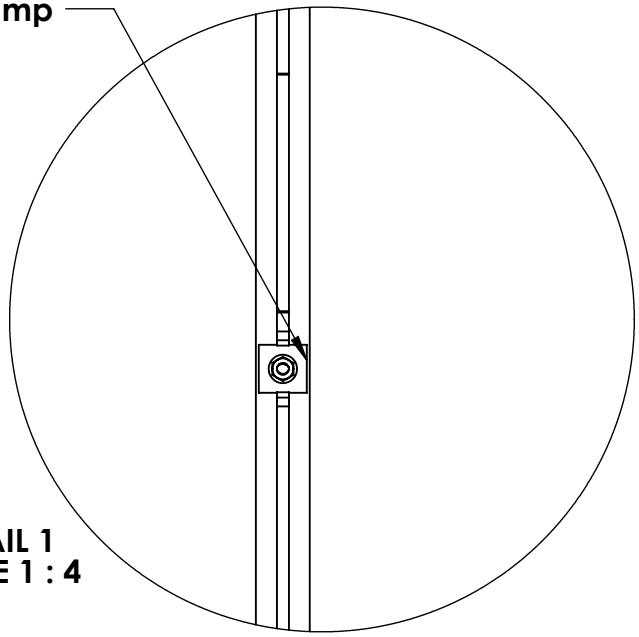
PLAN VIEW
SCALE 1:40

Panel Mounting System
End Clamp



DETAIL 2
SCALE 1 : 4

Panel Mounting System
Mid Clamp



DETAIL 1
SCALE 1 : 4

DRAWN	HV	08-06-08
CHECKED	SM	3-14-12
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

DO NOT
SCALE DRAWING

IRONRIDGE

Standard Rail Roof Mounting

SIZE	DWG. NO.	REV.
A		02

SCALE:1:40	WEIGHT:	SHEET 1 OF 3

EXHIBIT A - page 1 of 3

MATERIAL	FINISH	DIMENSIONS ARE IN INCHES. TOLERANCES: .XX: +/- .125° ANGLES: +/- 1.5°	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF IRONRIDGE INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF 2WO SEAS INC IS PROHIBITED.

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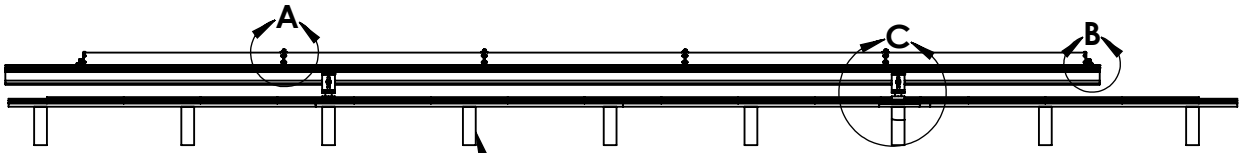
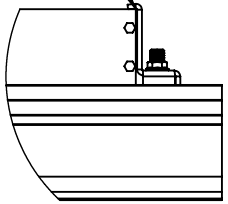
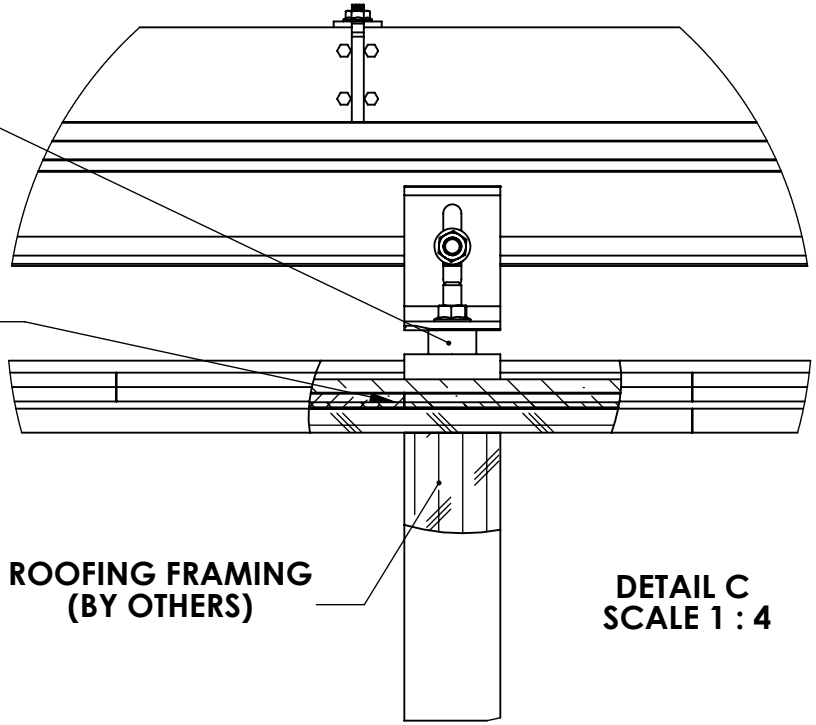


EXISTING ROOF STRUCTURE

PANEL MOUNTING SYSTEM
END CLAMP

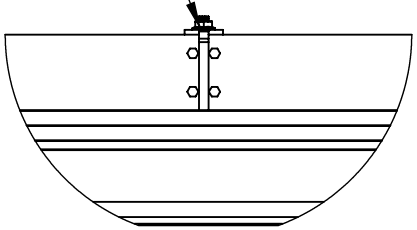


DETAIL B
SCALE 1 : 5



DETAIL C
SCALE 1 : 4

PANEL MOUNTING SYSTEM
MID CLAMP



DETAIL A
SCALE 1 : 5

DRAWN	HV	08-06-08
CHECKED	SM	3-14-12
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

DO NOT
SCALE DRAWING

IRONRIDGE

Standard Rail Roof Mounting

SIZE	DWG. NO.	REV.
A		02

SCALE:1:30	WEIGHT:	SHEET 2 OF 3

	MATERIAL	FINISH	DIMENSIONS ARE IN INCHES. TOLERANCES: .XX: +/- .125" ANGLES: +/- 1.5°	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF IRONRIDGE INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF 2WO SEAS INC IS PROHIBITED.

ZONE	REV.	REVISIONS DESCRIPTION	DATE	APPROVED
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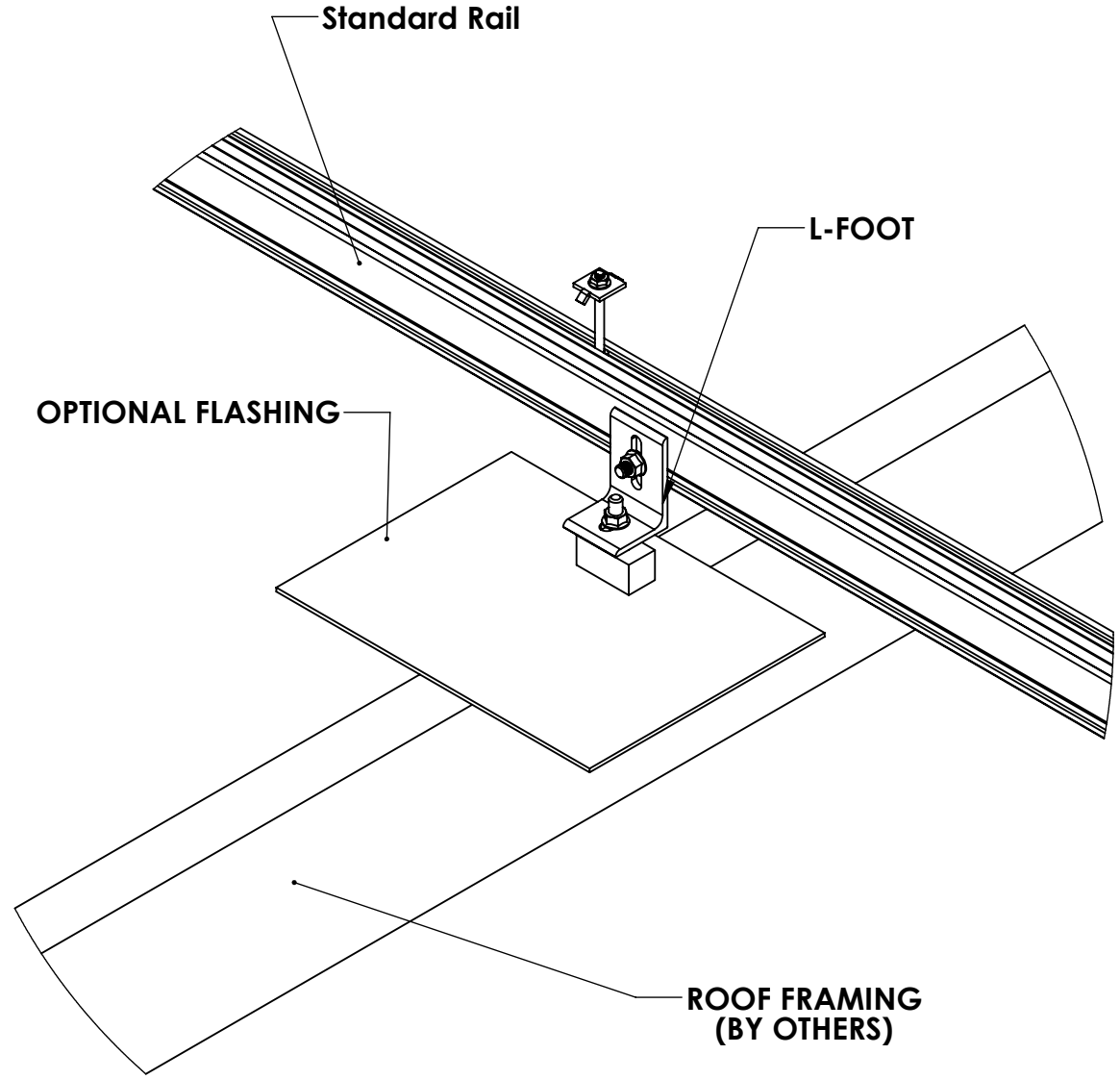
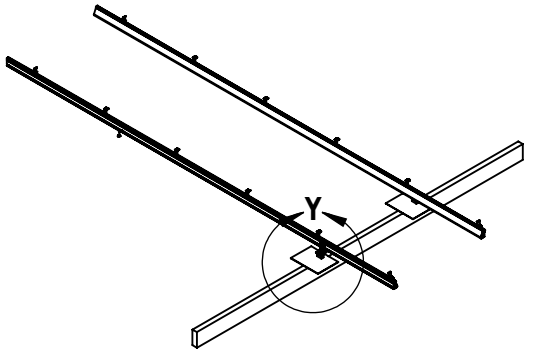
	02	Updated L-Foot	3-14-12	SM





DETAIL Y
SCALE 1 : 5

DRAWN	HV	08-06-08
CHECKED	SM	3-14-12
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

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IRONRIDGE

Standard Rail Roof Mounting

SIZE	DWG. NO.	REV.
A		02

SCALE:1:30 | WEIGHT: | SHEET 3 OF 3

EXHIBIT A - page 3 of 3