

2 KW PLAN VIEW
NTS

**LAYOUT FOR SOLAR PANELS ON ROOF ZONE 1 PER FBC 2010
(LOCATION SHALL NOT BE WITHIN ZONES 2 & 3 AS SHOWN)**

ARRANGEMENT BASED ON A 39" x 65" SOLAR PANEL DIMENSIONS
* CONFIRM FOR SITE CONDITIONS



Plan Review	App. By	Date
Building	J GOMEZ	03/13/2013
Electric	NA	03/13/2013
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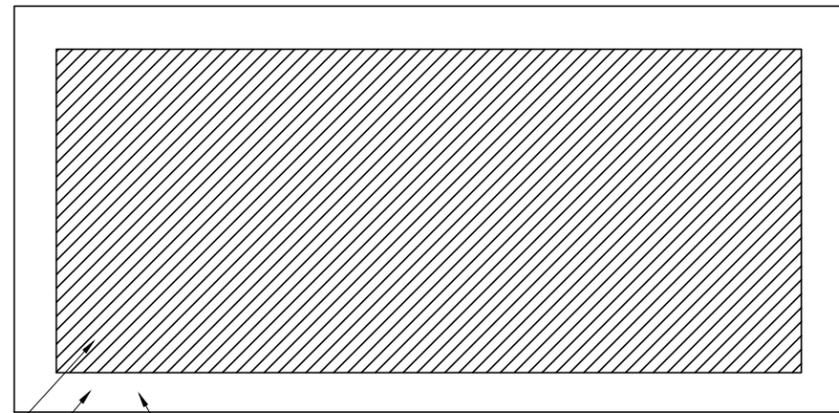


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PHOTOVOLTAIC SYSTEM PROTOTYPE DESIGN
GO SOLAR - BROWARD COUNTY
ENVIRONMENTAL PLANNING AND GROWTH MANAG. DEPT.
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- FSEC APPROVED PANELS (250 WATTS) TO COMPLY WITH U.L.1703
1. 1SOLTECH MODEL SPM-240G
 2. ASEC MODEL 250G6M6B
 3. LIGHTWAY SOLAR MODEL LW250(29)
 4. GREEN TRIPLEX MODEL PM250M00
 5. MONOX MODEL LG250S1C
- NOTE: LIST IS NOT INTENDED TO SHOW ALL CERTIFIED; EQUAL ALTERNATIVES MAY BE USED. SOLAR PANELS USERS ARE ENCOURAGED TO REVIEW MANUFACTURERS AND INSTALLERS DATA FROM FSEC LISTS.



FLAT ROOF PLAN
NTS

LEGEND:
 CAN BE INSTALLED
 CANNOT BE INSTALLED

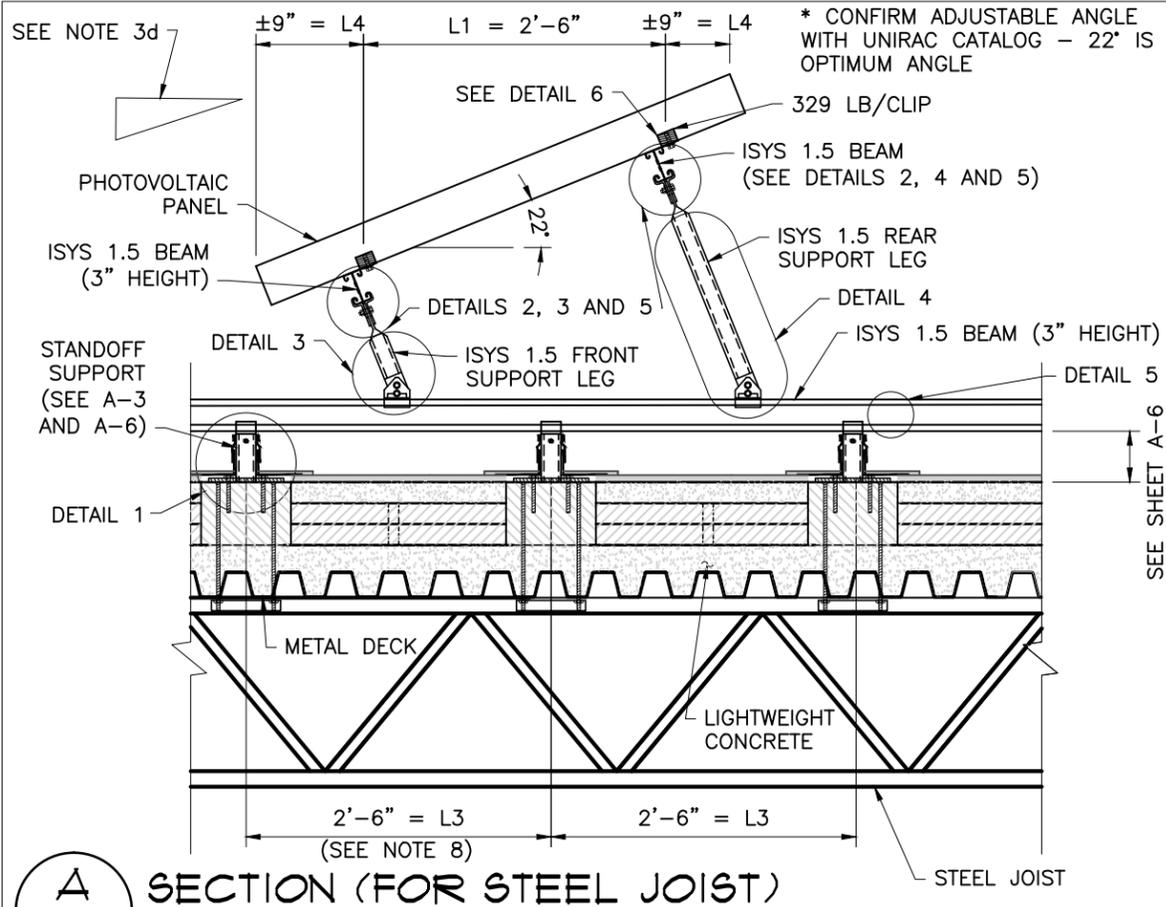
SOLAR PANEL SHALL BE SLOPED TOWARDS THE SOUTH AT 22 DEGREES. SEE NOTE C
 SOLAR PANELS CANNOT BE INSTALLED IN THIS AREA. SEE NOTE A

- NOTE:
- 10% OF LEAST HORIZONTAL DIMENSION OR 0.4h, WHICHEVER IS SMALLER, BUT NOT LESS THAN EITHER 4% OF LEAST HORIZONTAL DIMENSION OR 3'.
 - THE SYSTEM IS ONLY TO BE USED ON ROOF STRUCTURES OF STEEL JOISTS OR P.C. JOISTS. COORDINATE SHEET A-2 CONSIDERATIONS.
 - THE PANELS MUST BE INSTALLED IN THE ROOF AREA FACING SOUTH.

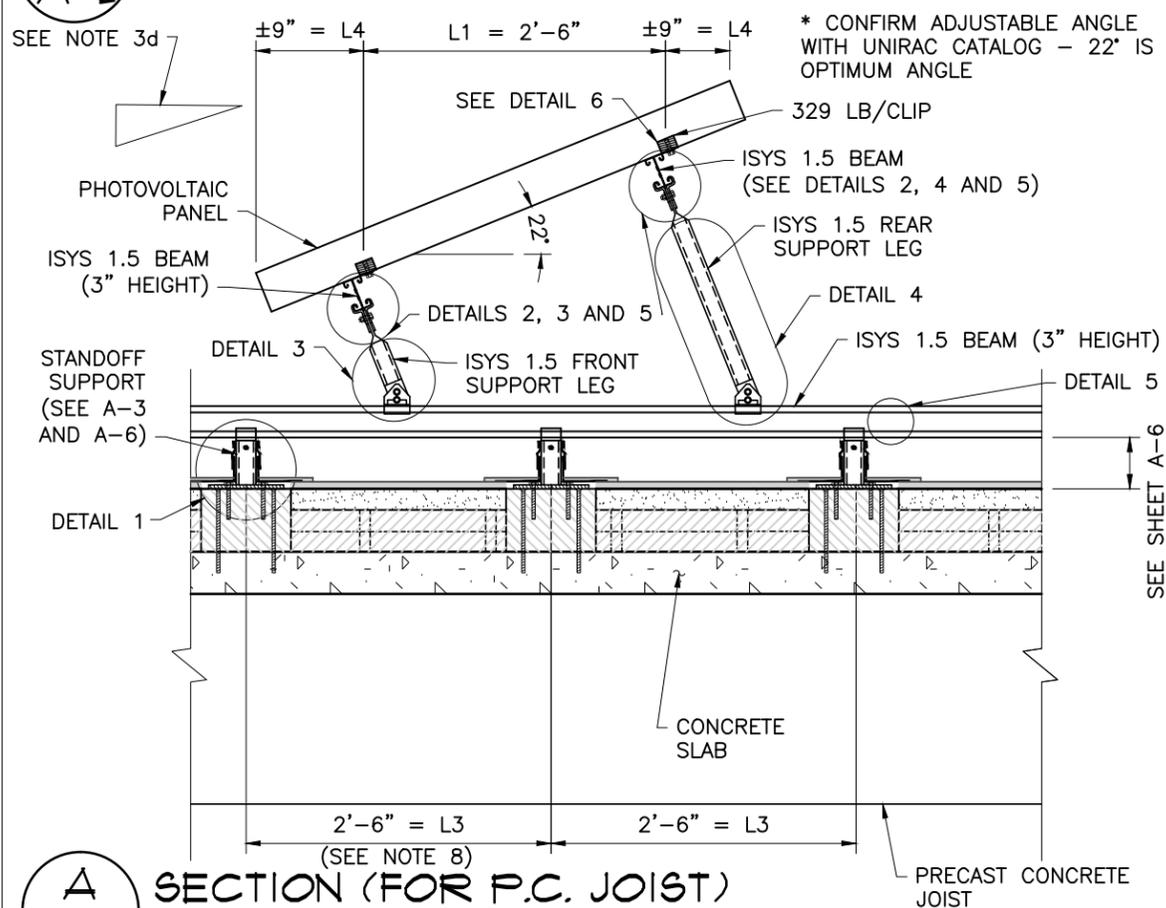
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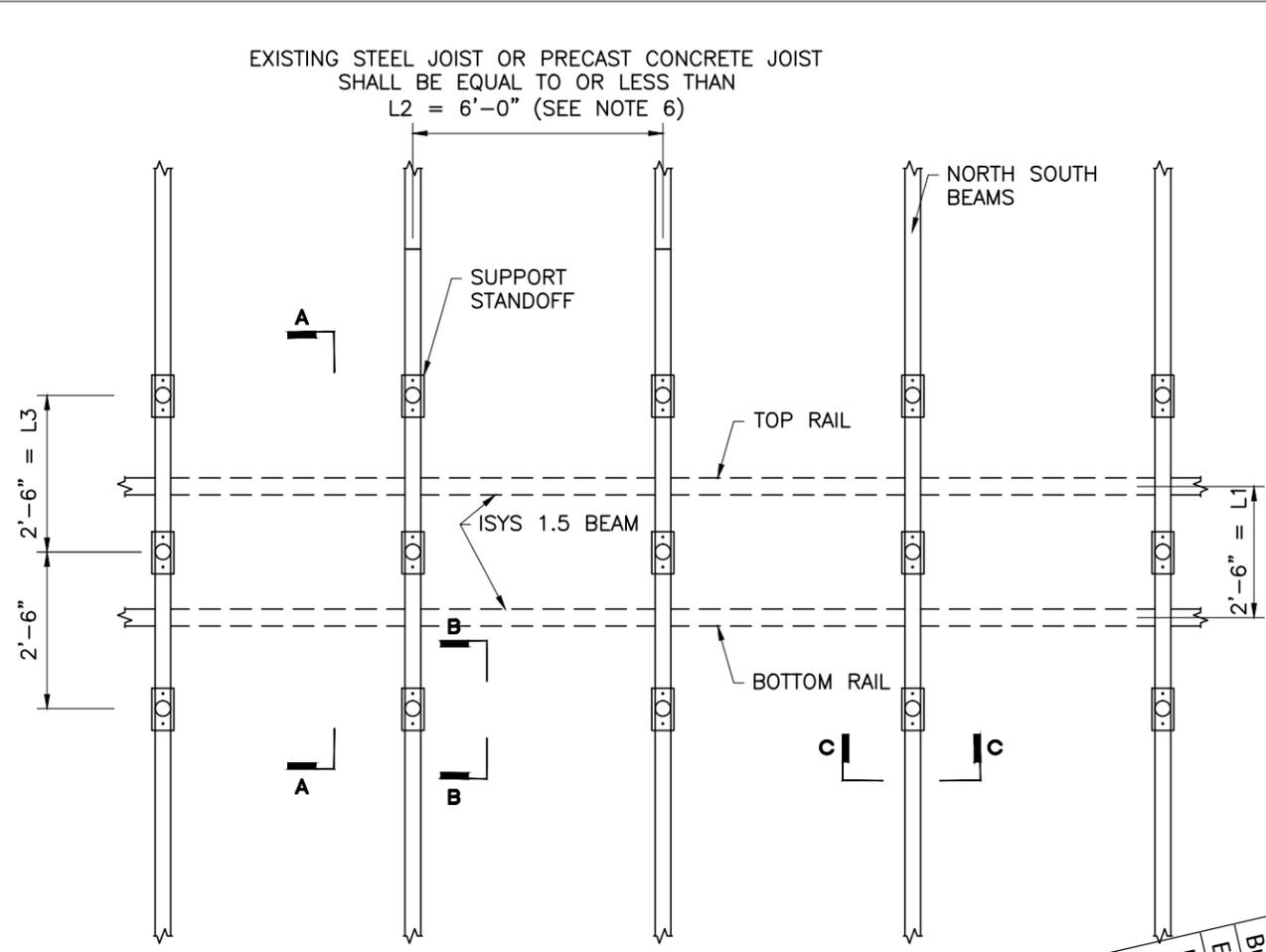
2KW PLAN VIEW
 DATE: 03-13-2013
 DRAWN BY: JTB
 CHECKED BY: JJ
 1286
 A-1
 1 9 7



A
A-2
SECTION (FOR STEEL JOIST)
SCALE: 1-1/2" = 1'-0"



A
A-2
SECTION (FOR P.C. JOIST)
SCALE: 1-1/2" = 1'-0"



**LOWER PARTIAL PLAN VIEW
SOLAR PANEL ATTACHMENT**

GENERAL NOTES:

1. DESIGN LOAD CRITERIA

- a. FLORIDA BUILDING CODE 2010
- b. ASCE 7-10, HURRICANE PRONE REGION
- c. BASIC SPEED - 170 mph
- d. EXPOSURE CATEGORY : C
- e. RISK CATEGORY : II
- f. DESIGN LOADS:

WIND LOADS
+56 PSF POSITIVE PRESSURE
-68 PSF UPLIFT

DEAD LOAD PANEL ASSUMED
5 PSF

THE WEIGHT OF SOLAR PANELS AND SUPPORT STRUCTURE TOGETHER IS 5 LB/FT². WE ASSUMED THAT THE LIVE LOAD ROOF IS 30 LB/FT² WHICH IS MORE THAN THE DEAD LOAD OF 5 LB/FT², WHICH IS A CONSERVATIVE CONDITION.

2. ALL STRUCTURAL SUPPORT SYSTEMS MANUFACTURED BY UNIRAC ISYS 1.5 IN COMPLIANCE WITH AAMA 911-92.

3. LIMITATIONS; THESE NOTES SET OUT THE PARAMETERS UNDER WHICH THE SOLAR PANELS MUST BE INSTALLED.

- a. BROWARD COUNTY
- b. ROOF COMMERCIAL SYSTEM
- c. 30' MAXIMUM HEIGHTS IN BUILDING ROOF
- d. ROOF MUST BE FLAT (SLOPE < 7°) AND THE SOLAR PANEL SHALL BE SLOPED TOWARDS THE SOUTH AT 22°.
- e. SOLAR PANEL MUST WITHSTAND THE FOLLOWING WIND LOADS:
 - DOWNWARD DIRECTION: +56 PSF
 - UPWARD DIRECTION: -68 PSF
- 4. CONTRACTOR IS RESPONSIBLE TO VERIFY THAT EXISTING ROOF AND STRUCTURAL CONDITIONS MATCH THE STRUCTURE SHOWN IN THESE DRAWINGS PRIOR TO INSTALLATION.
- 5. CONTRACTOR SHALL VERIFY THAT THE EXISTING ROOF STRUCTURAL SYSTEM IS IN GOOD CONDITION.
- 6. MAXIMUM SPACING BETWEEN STEEL AND CONCRETE JOIST IS 6'-0".
- 7. THE UNIRAC ISYS 1.5 INTERFACE SHALL BE DIRECTLY ABOVE A STEEL OR CONCRETE JOIST.
- 8. CONFIRM WITH MANUFACTURER OF SELECTED PANEL FROM LIST SHOWN ON A-1.
- 9. FOLLOW ALL UNIRAC MANUALS THAT APPLY.

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N

must be on job before any inspection will be made.

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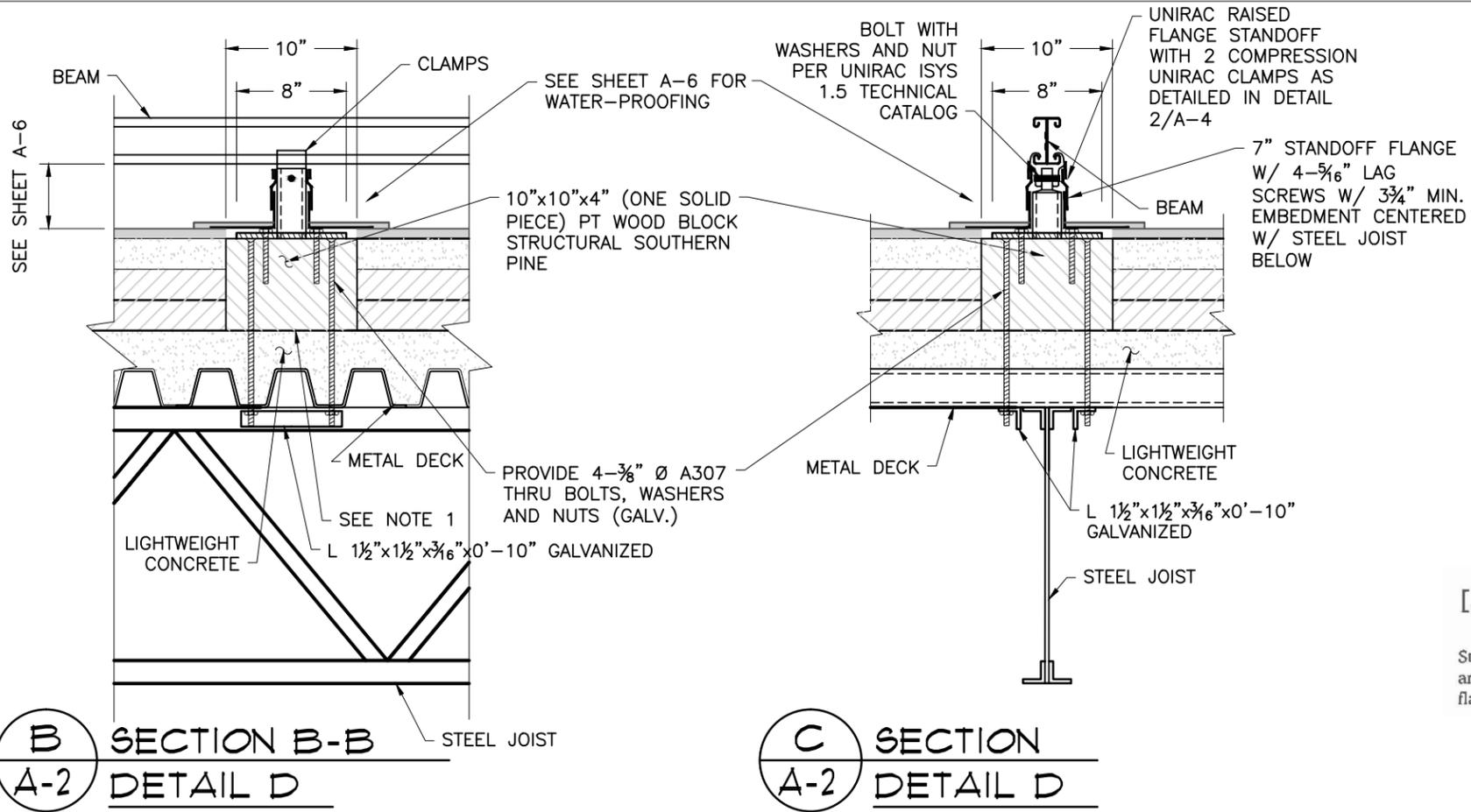
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2KW SECTIONS

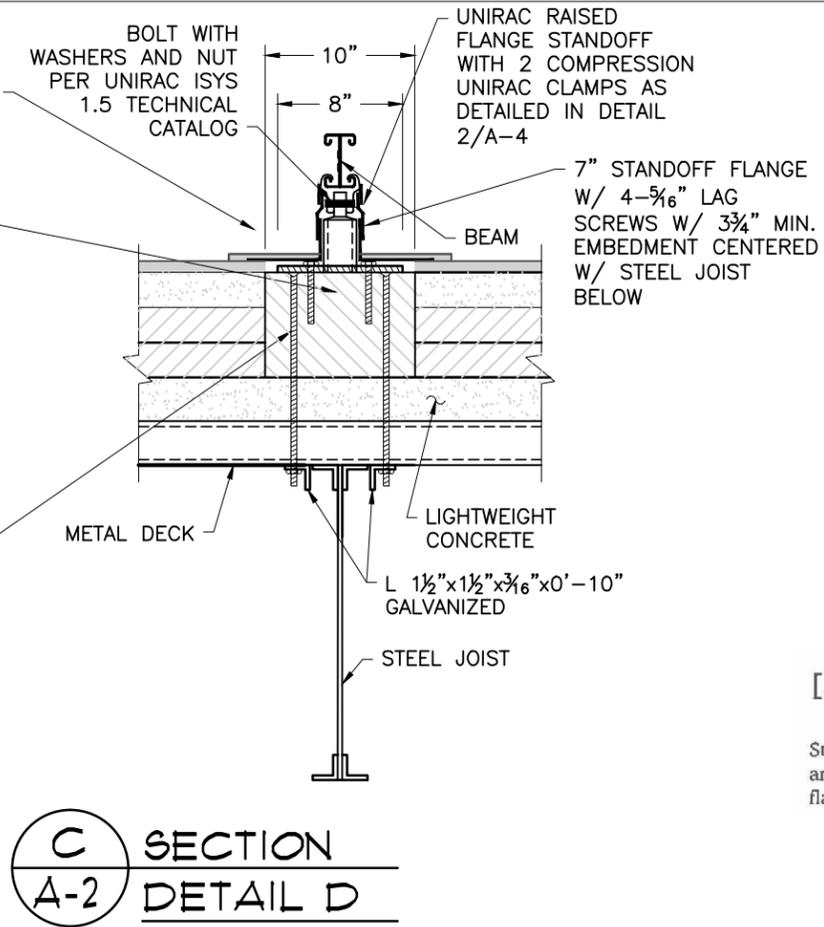
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DRAWN BY: JTB
CHECKED BY: JJ

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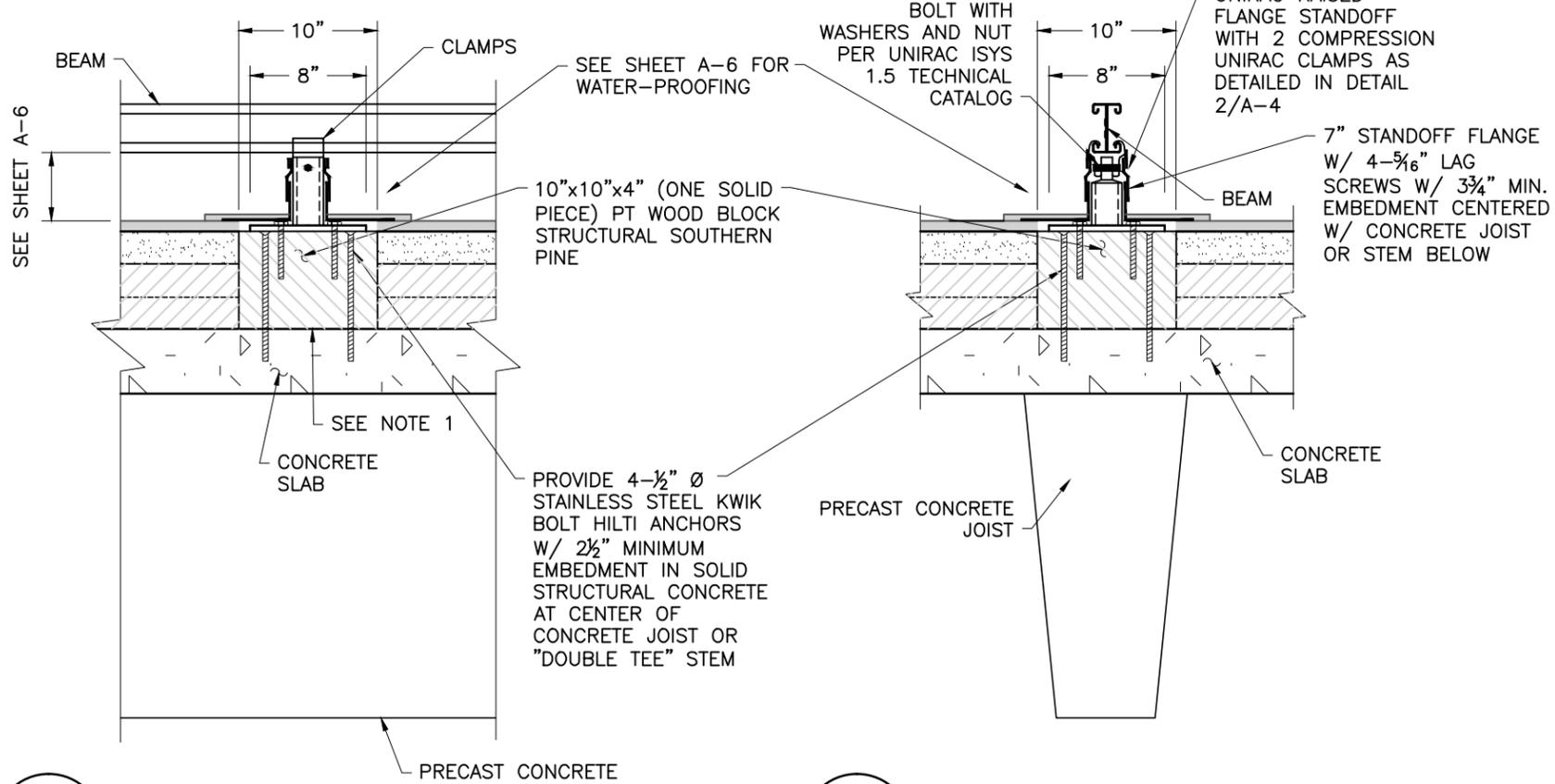
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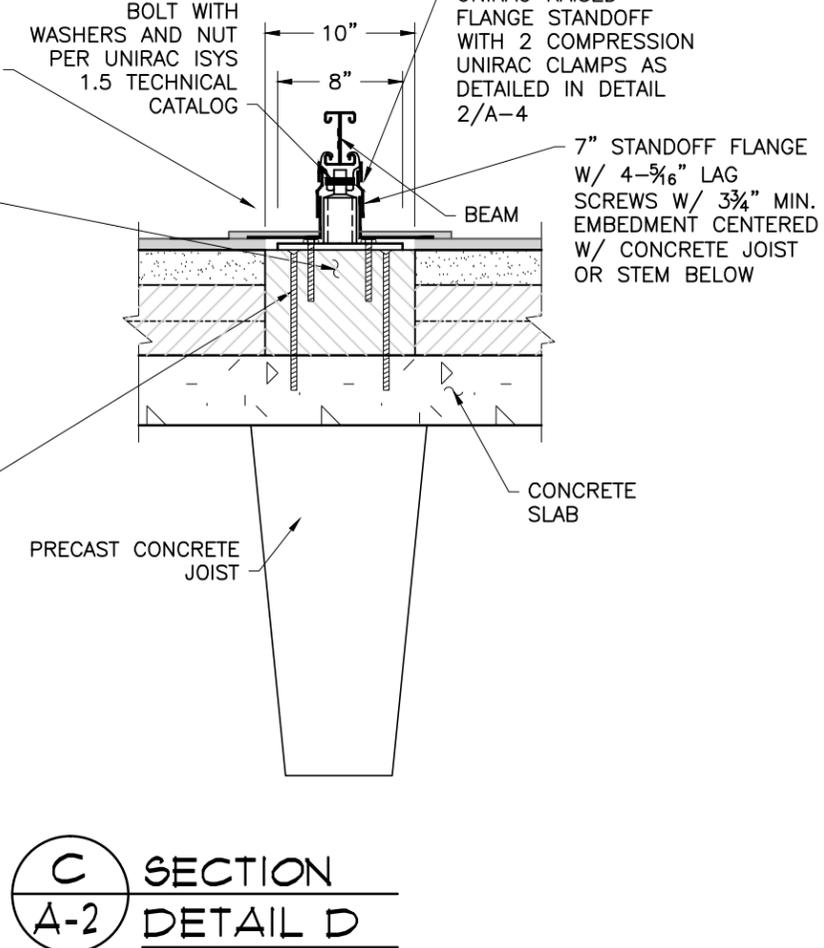
B SECTION B-B
A-2 DETAIL D



C SECTION
A-2 DETAIL D



B SECTION B-B
A-2 DETAIL D



C SECTION
A-2 DETAIL D

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[3.2.3] Laying out standoffs

Standoffs (Figure 10) are used to increase the height of the array above the surface of the roof. Pair each standoff with a flashing to seal the lag bolt penetrations to the roof.



7" Raised flange standoff

DETAIL 1

NOTE:
EXISTING CONDITIONS APPLICABLE TO THESE DRAWINGS SHALL BE VERIFIED PRIOR TO INSTALLATION.

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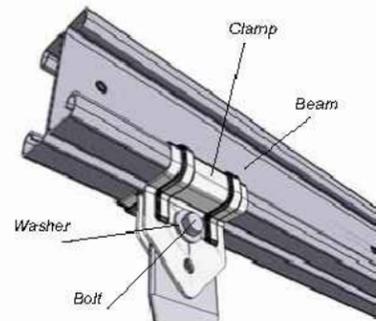
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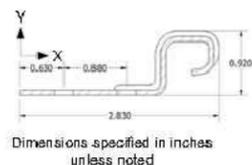
2KW SECTIONS AND DETAILS
DATE: 06-12-2013
DRAWN BY: JTB
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1286
A-3

ISYS Compression Clamp
Drawing No. A62008



- **Clamp Material:** ASTM A653 Grade 50 Galvanized (Min. G90)
Min. Tensile Strength: 60 ksi; Min. Yield Strength: 50 ksi
- **Compression Clamp Weight:** 0.18 lbs (81 g)
- Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents.
- Clamps are compatible with ISYS Small Series I-Beams
- Use two clamps per beam connection
- For east/west beams: assemble each set of two clamps with one 1/4-20 x 3/4 SAE Grade 8 hex head bolt, one 1/4 ANSI, B, N flat washer, and one 1/4-20 SAE Grade 8 serrated flange nut. The bolt must be assembled in the top most hole of the clamp
- For north/south beams: assemble each set of two clamps with two bolts, two washers, and two nuts
- Tighten to 10 ft-lbs of torque
- Resistance factors are determined according to **FBC 2222.2 standards**
- Safety factors are determined according to AISI S100 section F1.2

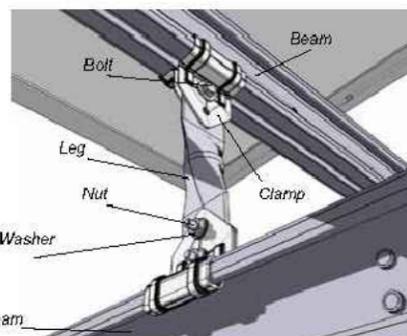


Dimensions specified in inches unless noted

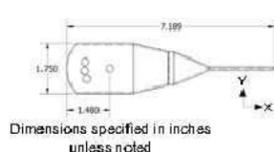
Applied Load Direction	Average Ultimate lbs (N)	Allowable Load (ASD) lbs (N)	Safety Factor, Ω	Design Load (LRFD US) lbs (N)	Resistance Factor, ϕ
Tension, X+	2013 (8954)	803 (3572)	2.51	1167 (5191)	0.579
Compression, X-	3173 (14114)	1132 (5035)	2.80	1379 (6134)	0.430
Transverse, Y±	59 (262)	23 (102)	2.55	35 (156)	0.584
Sliding, Z±	200 (890)	81 (360)	2.44	120 (534)	0.600
Moment, M _L	97 ft-lbs (132 Nm)	49 ft-lbs (66 Nm)	2.00	78 ft-lbs (106 Nm)	0.800

Conversion factor LRFD US to LSD Canada = 0.75

ISYS Front Support Leg
Drawing No. A62000, A620001



- DETAIL 2**
- **Front Support Leg Material:** 1" Galvanized electrical metallic tubing
Ultimate tensile: 75 ksi; Yield: 30 ksi
 - **Front Support Leg Weight:** 0.38 lbs (172 g)
 - Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents
 - Front support legs are compatible with Compression Clamps
 - Resistance factors are determined according to AISI S100 section F1.1
 - Safety factors are determined according to AISI S100 section F1.2



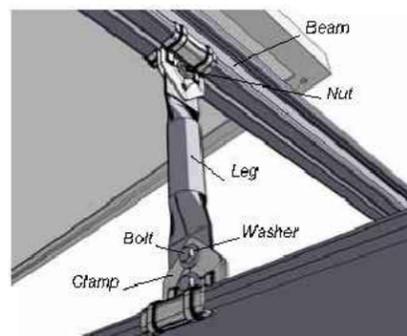
Dimensions specified in inches unless noted

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load (ASD) lbs (N)	Safety Factor, Ω	Design Load (LRFD US) lbs (N)	Resistance Factor, ϕ
Tension, X+	2013 (8954)	803 (3572)	2.51	1282 (5703)	0.637
Compression, X-	2646 (11770)	1016 (4519)	2.60	1628 (7242)	0.615

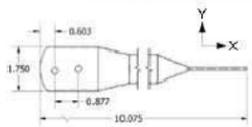
Conversion factor LRFD US to LSD Canada = 0.75

DETAIL 3

ISYS Rear Support Leg
Drawing No. A62002, A62003, A62004, A62005, A62006, A62007



- **Rear Support Leg Material:** 1" Galvanized electrical metallic tubing
Ultimate tensile: 75 ksi; Yield: 30 ksi
- **Rear Support Leg Weight:** varies from 0.51 to 1.38 lb (231 to 617 g)
- Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents
- Rear support legs are compatible with Compression Clamps
- Resistance factors are determined according to AISI S100 section F1.1
- Safety factors are determined according to AISI S100 section F1.2
- Compression loads apply to the leg only; check clamp capacities



Applied Load Direction	Average Ultimate lbs (N)	Allowable Load (ASD) lbs (N)	Safety Factor, Ω	Design Load (LRFD US) lbs (N)	Resistance Factor, ϕ
Tension, X+	2013 (8954)	803 (3572)	2.51	1282 (5703)	0.637
Compression, X-	2746 (12215)	1289 (5734)	2.13	1976 (8790)	0.720

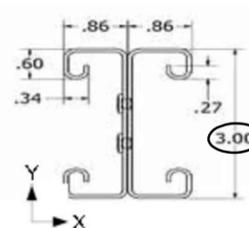
DETAIL 4

ISYS Small Series I-Beam

MATERIAL: 16 GA STEEL, ASTM A653 Grade 50; Min. Tensile Strength: 60 ksi; Min. Yield Strength: 50 ksi

Properties	Units	Beam Height (in)		
		3.0	4.20	5.25
Approximate Weight (kips per linear ft)	k/ft	0.002403	0.002860	0.003260
Total Cross Sectional Area	in ²	0.707	0.840	0.959
Effective Area	in ²	0.635	0.654	0.663
Section Modulus (X-Axis)	in ³	0.569	0.941	1.316
Section Modulus (Y-Axis)	in ³	0.180	0.179	0.179
Moment of Inertia (X-Axis)	in ⁴	0.854	1.976	3.455
Moment of Inertia (Y-Axis)	in ⁴	0.155	0.154	0.154
Radius of Gyration (X-Axis)	in	1.099	1.534	1.898
Radius of Gyration (Y-Axis)	in	0.467	0.428	0.400
Single Member Weak Axis Centroid	in	0.333	0.283	0.252
Single Member Moment of Inertia (Y-Axis)	in ⁴	0.038	0.043	0.046
For Reference Only:				
Nominal Moment Capacity (X Axis)	kip-ft	2.37	3.92	5.40
Nominal Moment Capacity (Y Axis)	kip-ft	0.75	0.75	0.75
Nominal Tension Capacity	kips	35.34	41.99	47.93
Nominal Compression Capacity	kips	31.77	32.68	47.94
Nominal Shear Capacity (along X Axis)	kips	3.87	3.68	3.68
Nominal Shear Capacity (along Y Axis)	kips	11.05	12.30	11.65

DETAIL 5



Plan Review
Building
Electric

App. By
J GOMEZ
NA

Date
03/13/2013
03/13/2013

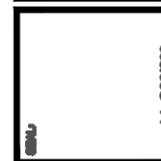
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2KW DETAILS

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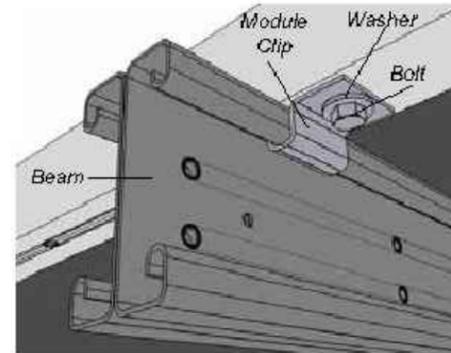


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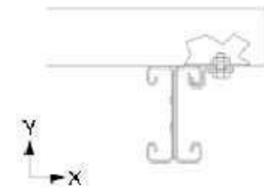
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AA 000888

ISYS Module Clip Without Dimples
Drawing No. A62142



- **Module Clip Material:** ASTM A653 Grade 50 Galvanized (Min. G90)
Min. Tensile Strength: 60 ksi; Min. Yield Strength: 50 ksi
- **Module Clip weight:** 0.06 lbs (26g)
- Allowable and design loads are valid when components are assembled according to authorized Unirac documents.
- Clips are compatible with ISYS small series I-beams.
- Assemble with 1/4-20 x 3/4" SAE Grade 8 hex head bolt, 1/4" ANSI B, N flat washer, and 1/4-20 SAE Grade 8 serrated flange nut.
- Tighten to 10 ft-lbs of torque.
- Resistance factors are determined according to AISI S100 section F1.1.
- Safety factors are determined according to AISI S100 section



Dimensions specified in inches unless noted

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load (ASD) lbs (N)	Safety Factor, Ω	Design Load (LRFD US) lbs (N)	Resistance Factor, Φ
Tension, Y+	717 (3189)	329 (1463)	2.18	505 (2246)	0.70
Transverse, X±	1263 (5618)	481 (2140)	2.62	738 (3283)	0.58
Sliding, Z±	121 (538)	34 (151)	3.58	52 (231)	0.43

Conversion factor LRFD US to LSD Canada = 0.75

DETAIL 6

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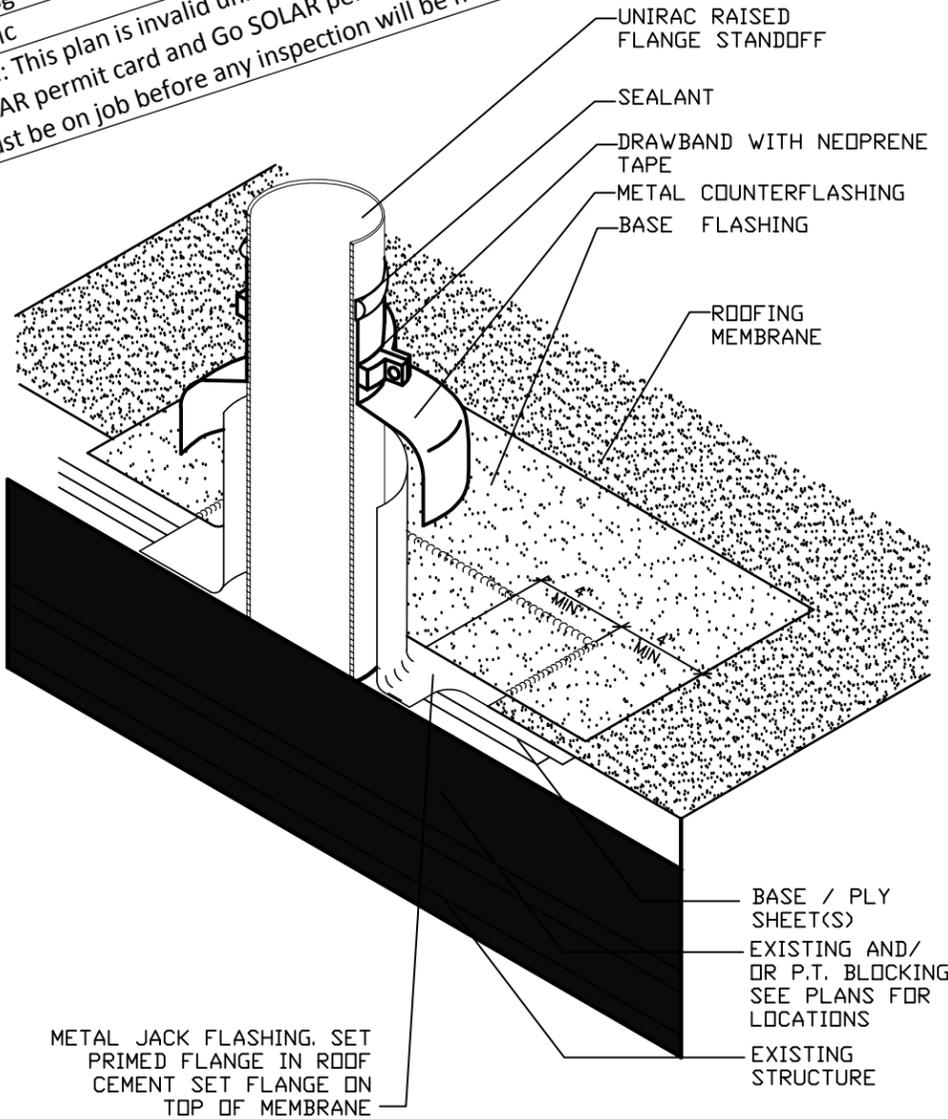
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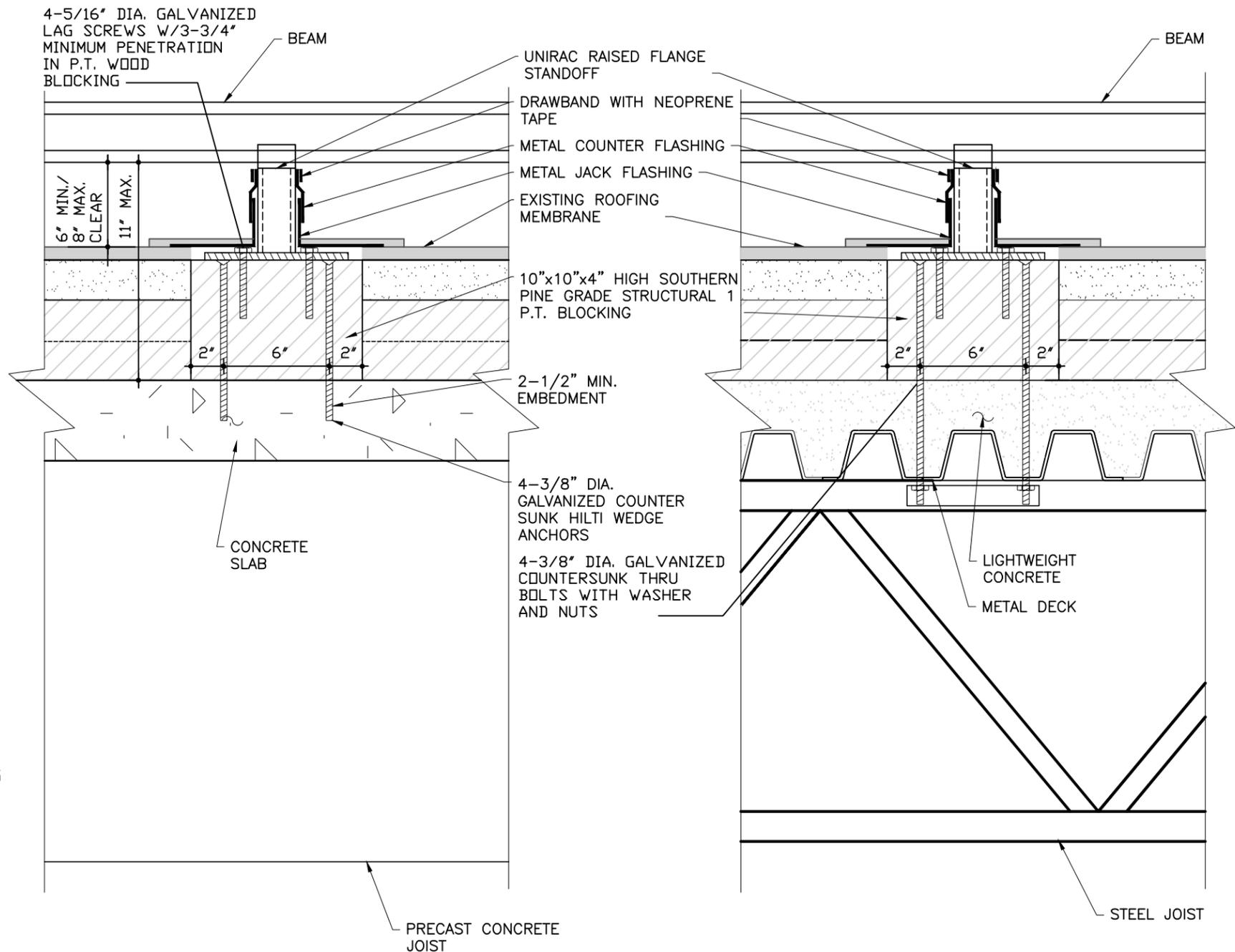
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ROOFING PENETRATION FLASHING DETAIL



CONCRETE SLAB OVER PRECAST CONCRETE JOIST WATERPROOFING DETAIL

METAL DECK OVER STEEL JOIST WATERPROOFING DETAIL

- NOTES:
1. PROVIDE NEOPRENE WASHERS AT ALL ROOFING PENETRATION (TYP.)
 2. NEW ROOFING MEMBRANE TO MATCH EXISTING MEMBRANE
 3. INFILL WITH FOAM OR RIGID INSULATION ABOVE STRUCTURAL P.T. BLOCKING WHERE REQUIRED.
 4. P.T. BLOCKING SHALL BE FIRE RETARDANT WOOD AT TYPE I AND TYPE II CONSTRUCTION.
 5. CUT ROOFING AND INSULATION AS REQUIRED TO INSTALL P.T. BLOCKING DIRECTLY ABOVE STRUCTURAL CONCRETE.

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AA COURSES

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2KW WATERPROOFING DETAIL
 DATE: 06-12-2013
 DRAWN BY: JTB
 CHECKED BY: JJ
 1236

A-6

WIND LOAD PRESSURE

Using Rooftop Structures and Equipments (29.5.1 Sheet 308) Broward County Residential: II risk category. (Table 1.5.1/ Sheet 2)

V= 170 Mph

$K_d = 0.85$ (Table 26.6-1/ Sheet 250)

$K_{zt} = 1.0$

Z = 15' → $K_z = 0.85$ (Table 29.3-1/ Sheet 310)

Z = 20' → $K_z = 0.90$

Z = 25' → $K_z = 0.94$

Z = 30' → $K_z = 0.98$

$Q = 0.00256 K_z \times K_{zt} \times K_d \times V^2$

$q_{15'} = 53.4 \text{ lb/ft}^2$

$q_{20'} = 56.6 \text{ lb/ft}^2$

$q_{25'} = 59.1 \text{ lb/ft}^2$

$q_{30'} = 61.6 \text{ lb/ft}^2$

Note:

- We use zone 1 for the calculation of wind load, assuming that the panels may be installed in zone 1
- We consider that the panels are not part of the roof and $G_{CP1} = \pm 0$

$\theta \leq 7^\circ$ h = 30'

$p_1 = 61.6[-1.1-(+0)] = -68 \text{ lb/ft}^2$ (Upward Pressure)

$27^\circ < \theta \leq 45^\circ$ (Monoslope roof) Fig 30.4-5A/ Sheet 341

$G_{CP123} = +0.3$

$G_{CP1} = -1.1$ (This coefficient value is the most critical for the upward load)

CONCRETE SLAB OVER PCI OR METAL DECK OVER STEEL JOIST

PROCEDURE FOR SELECTING LOAD OVER SYSTEM ELEMENTS UNIRAC ISYS 1.5

Data:

DL = 5 PSF (weight of system) (assumed)

WL = +56 PSF (downward pressure / DP)

WL = -68 PSF (upward pressure / UP)

Load Combination

- DL + WL (DP) = 5 + 56 x cos 22° = +57 PSF
- DL + 0.75WL (DP) = 5 + 0.75 x 56 x cos 22° = -44 PSF
- 0.6DL + WL (UP) = 0.6 x 5 - 68 x cos 22° = -60 PSF

Dimensions assumed / data:

$L_1 = 2'-6"$: spacing between leg support

$L_2 = 6'-0"$: spacing between steel joist or PC joist

$L_3 = 2'-6"$: spacing between roof support

$L_4 = 0.75'$: cantilever on both sides of the panel

Solar panel beam

Use load combination (1)

$q = 57 \text{ PSF } (L_1/2 + L_4) = 57 (2.5'/2 + 0.75') = 114 \text{ lb/ft} = 0.114^k/\text{ft}$

$M = \frac{1}{8} q L_2^2 = 1/8 \times 0.114 \times 6^2 = 0.52 \text{ k-ft} < 2.37 \text{ k-ft}$

Use: beam height = 3"

Beam support for the legs

$P = 57 \text{ PSF } (L_1/2 + L_4) (L_2) = 57 (2.5'/2 + 0.75') (6') = 684 \text{ lb} = 0.68^k$

Assume the inclined leg in the center of the beam

$M = \frac{1}{4} \times P \times L_3 = \frac{1}{4} \times 0.68 \times 6' = 1.03 \text{ k-ft} < 2.37 \text{ k-ft}$

Use: beam height = 3"

Front support leg / rear support leg

Tension: use load combination (3)

$T = 60 \text{ PSF } (L_1/2 + L_4) (L_2) = 60 (2.5'/2 + 0.75') (6') = 720 \text{ lb} < 803 \text{ lb}$ OK

Compression: use load combination (1)

$C = 57 \text{ PSF } (L_1/2 + L_4) (L_2) = 57 (2.5'/2 + 0.75') (6') = 684 \text{ lb} < 1016 \text{ lb}$ OK

Beam connection hardware

From support leg:

$T = 720 \text{ lb} < 803 \text{ lb}$ OK

$C = 684 \text{ lb} < 1132 \text{ lb}$ OK

Module clip capacity = 329 lb

Panel area = 39" x 65"/144 = 17.6 SF

$T = 60 \times 17.6/4 = 264 \text{ lb/connection}$

264 lb < 329 lb OK

Expansion bolts connection

2.5' = horizontal distance between the center of the support

2.15' = vertical distance between the center of the support

8" = distance between anchor bolts

$F_y = -60 \text{ PSF} \times \cos 22^\circ (L_1 + 2 L_4) (L_2)$

$F_y = -60 \times 0.927 (2.5' + 2' \times 0.75') (6')$

$F_y = 1335 \text{ lb} \uparrow / 4$ adjustable roof interface

$F_y = 333 \text{ lb} \uparrow / \text{ARI}$

$F_x = -60 \text{ PSF} \times \sin 22^\circ (1.62') (L_2)$

$F_x = -60 \times 0.375 \times 1.62' (6')$

$F_x = 218 \text{ lb} / 4$ adjustable roof interface

$F_x = 55 \text{ lb} / \text{ARI}$

Moment (M) at base of connection

$M = F_y (L_3) + F_x (2.15')$

$M = 333 \text{ lb} \times 5' \times 12'' + 55 \text{ lb} \times 2.15' \times 12''$

$M = 21399 \text{ lb-in}$

$M = 2 \text{ bolts } (8'') \times f_1$

$f_1 = M / (2 \times 8'') = 21399 / (2 \times 8'') = 1337 \text{ lb} / \text{bolt}$

$f_2 = F_y / 4 \text{ bolts} = 333 \text{ lb} / 4 = 83 \text{ lb} / \text{bolt}$

$N_d = f_1 + f_2 = 1337 \text{ lb} / \text{bolt} + 83 \text{ lb} / \text{bolt}$

$N_d = 1416 \text{ lb}$ (tension)

$V_d = F_x = 55 / 4 \text{ bolts} = 14 \text{ lb} / \text{bolt}$

$V_d = 14 \text{ lb} / \text{bolt}$ (shear)

Use: $\frac{1}{2}'' \varnothing$ expansion bolt by Hilti

Allowable load for: $f'_c = 3000 \text{ lb} / \text{in}^2$

$2\frac{1}{2}'' = \text{min. emb.}$

$N = 1726 \text{ lb} / \text{bolt}$ (f.c. = 3000 PSI)

$V = 3194 \text{ lb} / \text{bolt}$

$(N_d/N)^{5/3} + (V_d/V)^{5/3}$

$(1416 / 1726)^{5/3} + (14 / 3194)^{5/3} = 0.73 < 1.0$ OK

Thru bolt connection

ASD / combined tension and shear

$N_d = 1416 \text{ lb} / \text{bolt}$ (tension)

$V_d = 14 \text{ lb} / \text{bolt}$ (shear) (neglecting the shear)

Use: $\frac{3}{8}'' \varnothing$ thru bolts (A307)

Lag screw check per FBC 1620.6

1) Direct uplift

$A = 2.5 \times 6 = 15 \text{ SF}$

$U = 1.5 \times 15 \times 61.6 = 1386 \text{ lb}$

1386 / 4 screws = 346.5 lb

2) Horizontal force

$H = 3.1 (2+3) / 12 \times 6 \times 61.6 = 479 \text{ lb}$

479 / 8 screws = 60 lb

$M = 479 \times 8 / 2 \text{ supports} = 1916 \text{ lb-inch}$

$T/C = 1916 / (2.75'' \times 2) = 348 \text{ lb}$

Total withdrawal = 346 + 348 = 694.4 lb

Shear = 60 lb

$R = \sqrt{60^2 + 694.4^2} = 697 \text{ lb}$

$\alpha = \tan^{-1} 694.4/60 = 85^\circ$

$z' = 100 \text{ lb}$ for 5/16" screws southern pine

$z' \alpha = (\omega' p) z' / ((\omega' p) \cos^2 \alpha + z' \sin^2 \alpha)$ $p = 3.75''$

$= (307 \times 3.75) 100 / ((307 \times 3.75) 0.01 + 100 \times 0.99) = 1041 \text{ lb}$

$0.7 \times 1041 = 729 \text{ lb} > 697 \text{ lb}$

$0.7 \rightarrow$ wet use factor

Plan Review
Building
Electric
App. By
J GOMEZ
Date
03/13/2013
Note: This plan is invalid unless accompanied by a Go SOLAR permit card and Go SOLAR permit document. Plans must be on job before any inspection will be made.

JUAN E. LAPICA, P.E.
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PHOTOVOLTAIC SYSTEM PROTOTYPE DESIGN
GO SOLAR - BROWARD COUNTY
ENVIRONMENTAL PLANNING AND GROWTH MANAG. DEPT.

2KW CALCULATIONS
DATE: 03-13-2013
DRAWING NO: YB
CREATED BY: JJ
JOB NO: 1286

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