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Michael Wegecsanyi
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3000 Oak Rd., Suite 400
Walnut Creek, CA 94597
michael.wegecsanyi@canadiansolar.com

August 24th, 2017

RE: OSU Sports Complex Solar Feasibility Study
Corvallis, OR
Project Number: 217195

Dear Michael,

The following is a feasibility study of five existing structures for support of roof mounted solar arrays. In this study we reviewed historical documents, visited the site where more information was needed, and analyzed roof members for support of additional vertical load. All five roofs are constructed of light framed materials. Therefore the additional load of 5 psf solar requires that the roof members be analyzed for current code vertical load combinations of snow and dead load. This requirement is stipulated in Chapter 34 of the IBC 2012 code, which states that any addition that increases vertical loads to a member by more than 5% be analyzed for current code forces and/or upgraded. Below is a summary of our findings. Appendices A to E show the analysis used in our report for each building.

1) **Gill Coliseum**
   a. **Existing Structure**: The existing structure was constructed in 1948 and is registered as a historical building. The main structure is a combination of steel and concrete with masonry walls. The roof consists of 220 foot clear spanning trusses at 20 feet on center. Purlins are steel W10x21 members at 8 feet on center. The roof deck is 2x6 tongue and groove decking with a metal standing seam overlay.
   b. **Vertical Support Recommendations:** The roof trusses and purlins are adequate for support of a solar array. Solar attachments should either be spaced at small intervals of 24" on center, perpendicular to decking, or aligned with purlins at 8 feet on center to prevent local failure of the decking.
   c. **Lateral Considerations**: Given the mass of the bleacher and wall assemblies, the expected additional weight of a solar array would not increase global lateral forces by more than 10%. Thus there are no limitations to the size of the solar array.
   d. **Architectural Considerations**: Because this building is a historically designated building, any change to the exterior, including solar panels, may require a land use review.

2) **Performance Sports Center (Basketball Practice Facility Expansion)**
   a. **Existing Structure**: We reviewed existing plans for the 2013 expansion which is the northernmost and largest building in this complex. It is a 2-story structure with an upper mezzanine. The lower levels are steel beams with metal pan deck and concrete. The roof consists of several long spanning bent steel beams,

approximately 83 feet in length spaced at 20 feet on center. Purlin beams are W10x22 members at 10 feet on center. 2" metal pan deck runs over the purlins.

b. **Vertical Support Recommendations**: The steel girder beams and purlin beams are adequate for support of solar loads. The metal deck is also adequate for support of solar attachment, provided attachment points are no more than 48" on center, perpendicular to the deck ribs. For spacing greater than 48" on center we recommend locating posts directly over the W10x22 members at 10 feet on center.

c. **Lateral Considerations**: The addition of solar over the entire roof area does not increase the overall seismic mass by more than 10%. Thus we see no restriction on the size of the array.

3) Reser Stadium

a. **Existing Structure**: Reser stadium was constructed in two phases, 2005 and 2008. The north side which includes the canopy was part of the 2005 construction. The canopy is constructed from four pairs of steel cantilevering trusses that span back to main supporting columns, and four 30 foot square concrete towers. They cantilever 95 feet off the main support columns with a 45 foot backspan to the towers. The pairs themselves are 60 feet apart, 90 feet apart, and 60 feet apart. The overall width is 330 feet. The roof is higher at the cantilevering section and steps down several feet between pairs. At the high canopy, steel beams span the 30 feet between the main trusses. At the lower canopy, secondary trusses span the 60 feet and 90 feet. The spacing of both the roof beams and trusses are 11'-8" maximum. The roof deck is 3" x 18 gauge Type N decking.

b. **Vertical Support Recommendations**: Through analysis, the steel beams and secondary trusses were found to be adequate for support of additional solar loading. A quick check was made of the main supporting truss and found that it could also carry addition solar loads. If distributed evenly the roof deck is also adequate for support of solar loads. However, for attachment purposes, and to minimize penetrations, it may be simpler for racking to span between supports 11'-8' on center.

c. **Lateral Considerations**: Globally the additional solar mass will not increase the seismic forces of the stadium by more than 10%. Therefore seismic analysis of the main structure is not required. However, locally the additional solar mass will increase seismic forces by more than 10%. This will mainly affect the bracing between cantilevered trusses and their attachments. Further study will be required to model these members. Given the robustness of the structure we anticipate that lateral elements will be found to be adequate for additional lateral forces.

4) Truax Practice Facility

a. **Existing Structure**: Truax Indoor Practice Facility was constructed in 2004. The structure consists of a single level metal building. The walls of the building are 8" grouted CMU with a clear story window system. A horizontal tube transfers out of plane wall forces into the metal building frames. Metal building frames span 200 feet at a spacing of 30 feet on center. 10 inch x 12 gauge purlins spaced at 5 feet on center span between frames. The roof consists of light gage metal roofing, gauge undetermined. Existing metal building drawings could not be retrieved. Field measurements were made of the roof structure.

b. **Vertical Support Recommendations**: The existing purlins were capable of supporting solar loads for all bays. The existing metal building frames were found to be overstressed when supporting full solar loads. We recommend strengthening the column to beam connection with a stiffener element since this was the area of maximum flexure and overstress. For attachment to the metal roofing we recommend a spacing of 24" on center or a racking system that spans 5 feet to each purlin.

   c. **Lateral Considerations**: The added solar weight increased the seismic forces on the frames by more than 10% requiring analysis. A model was run for the seismic load case. The frames were found to be adequate to resist additional seismic forces. The vertical load combination of snow and dead load still governed the frame design.

5) **Valley Sports**
   a. **Existing Structure**: The Valley Football Center was built in two phases between 1989 and 1996. The main structure is roughly 112 feet by 66 feet. The structure is three levels of hollow core plank over steel beams and CMU walls. The main roof structure consists of glu-lam beams spanning 49 feet at 6 feet on center. 3" tongue and groove decking with a plywood overlay and metal roof decking make up the roof system.
   b. **Vertical Support Recommendations**: The glu-lam beams were capable pf supporting the additional weight of solar loads. The 3' Tongue and groove decking can also support additional solar load. We recommend solar attachments directly to the standing seam roof at 24" or 48" maximum spacing.
   c. **Lateral Considerations**: Given the mass of the 2nd and 3rd floor, in addition to the grouted CMU walls, the added solar weight is not expected to increase the seismic demand on any component by more than 10%.

Please call me at 503-244-7014 if you have any questions regarding the information in this review.

This review is based solely on visual inspection, and no destructive or subsurface testing was done to verify the information provided. The limitation of liability is strictly limited to the fees charged for this review.

Sincerely,

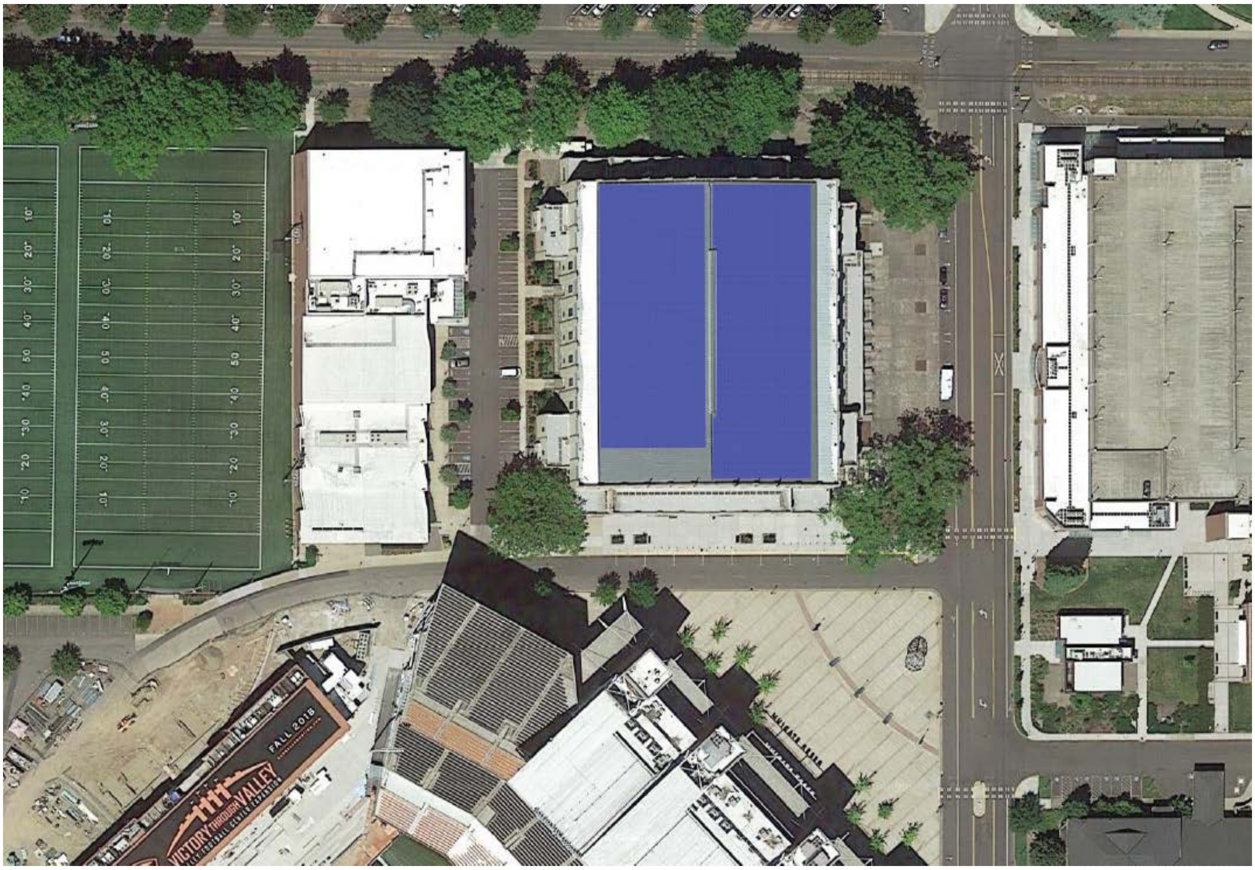
Jesse Wolfe, P.E.
Grummel Engineering, LLC

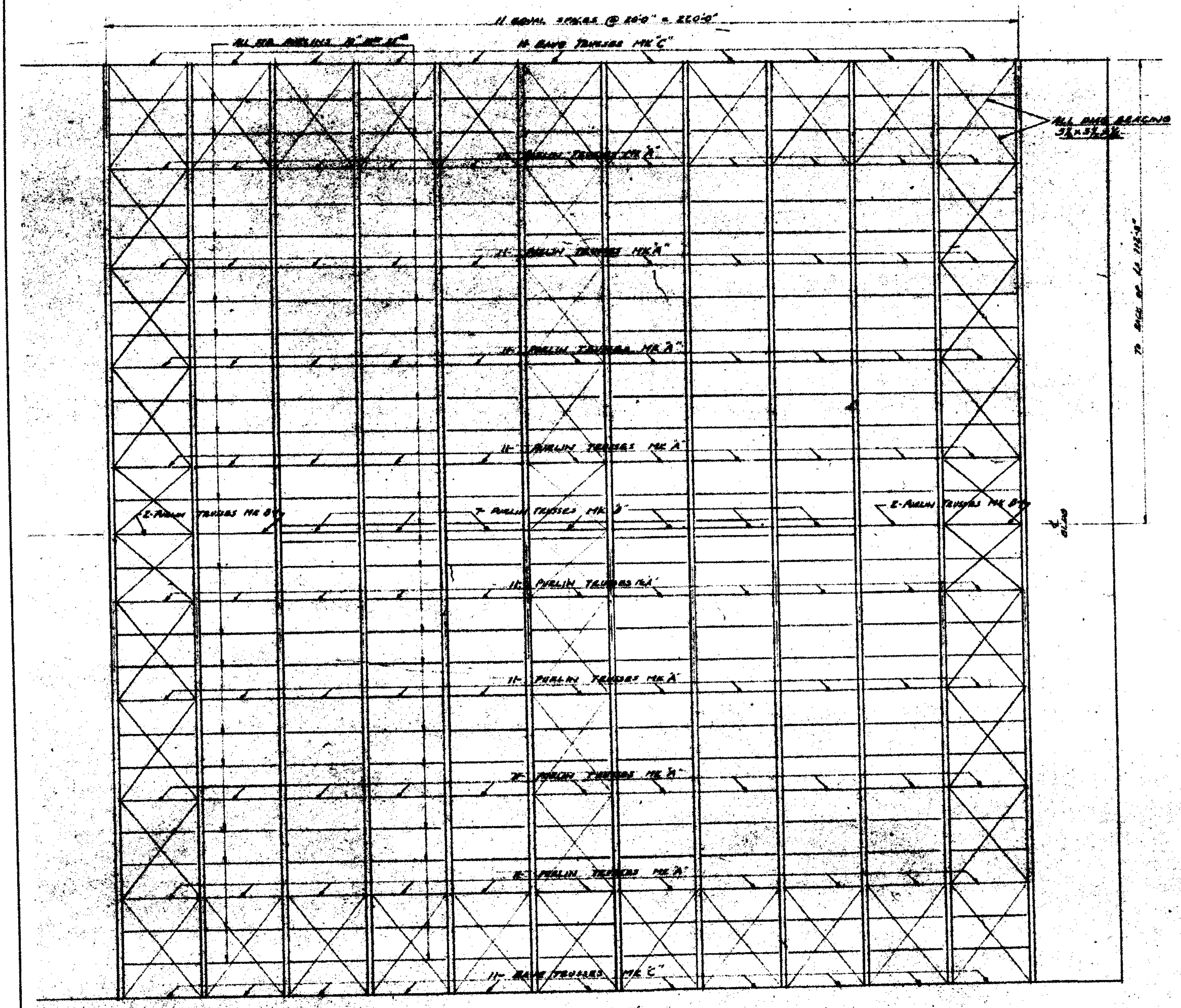
A) GILL COLLUSEUM

A2

CanadianSolar

GILL





STRUCTURAL STEEL ROOF FRAMING PLAN
SCALE: 1/16" = 1'-0"

Project: OSU Solar

Corvallis, OR

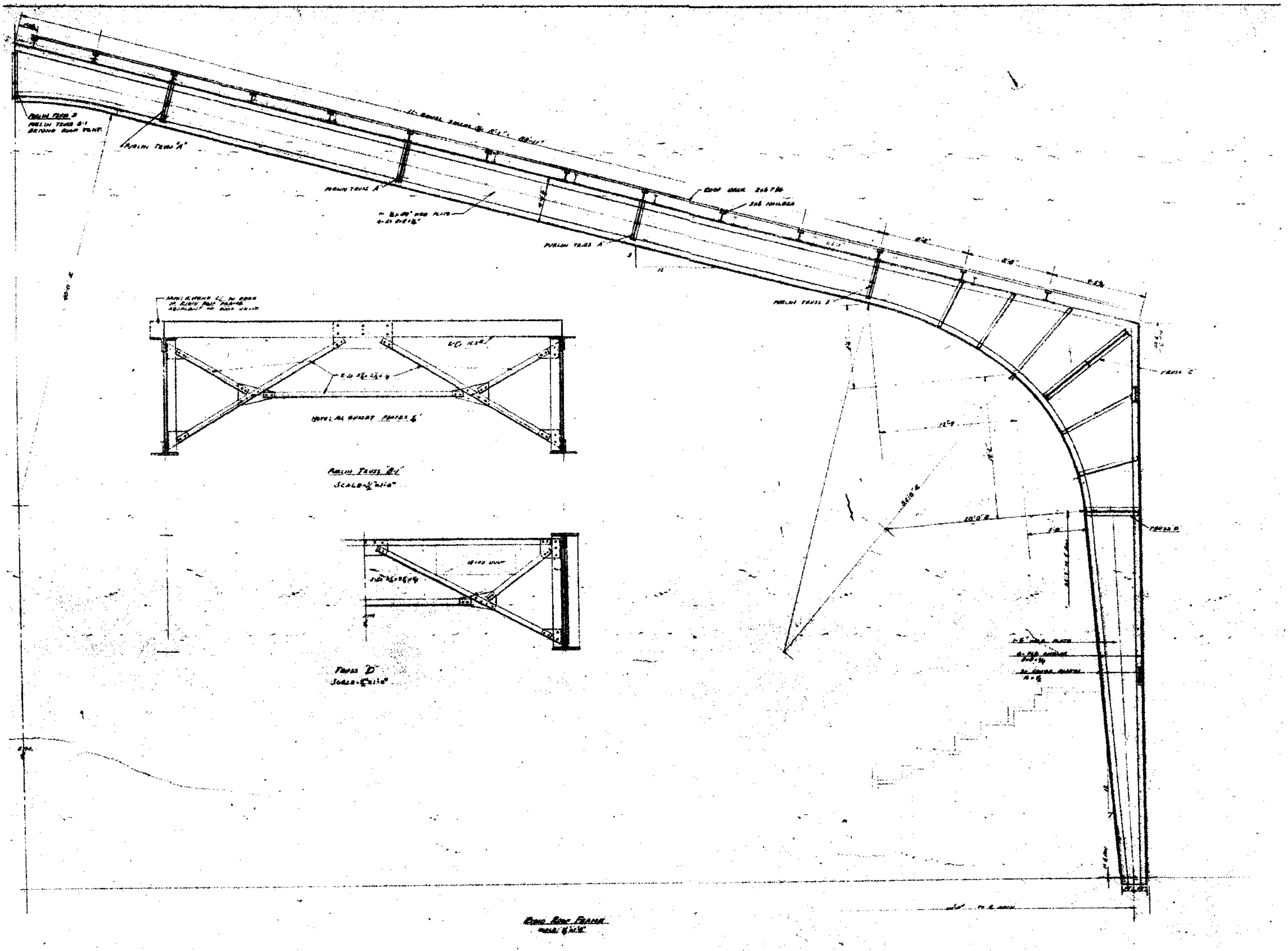
Client: **Canadian Solar**

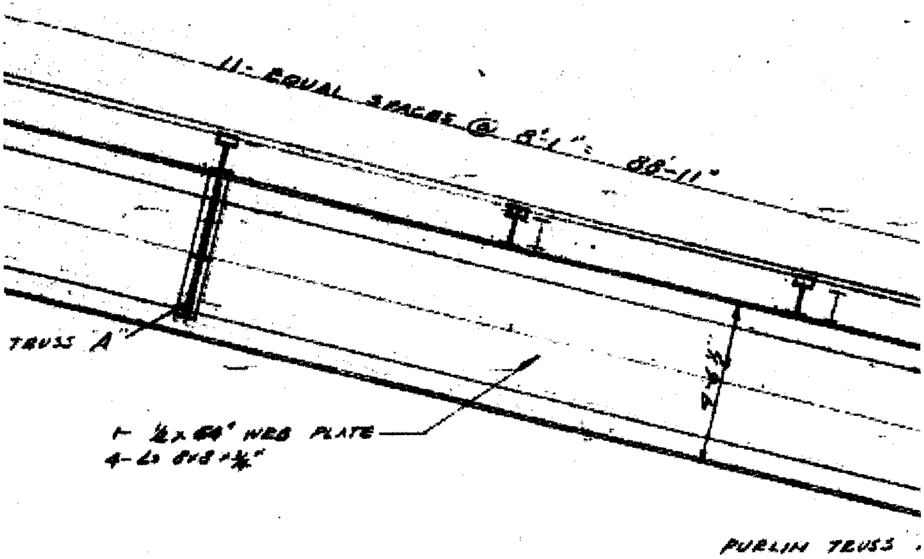
Date: 8/24/17

Page: A4

By:

Job #: 217195


Purlin Truss 'A'
Roof Deck 2x6 T&G
2x6 Nailers
Purlin Truss B
Truss 'C'
Truss 'D'
12'-9"
20'-0" R
8'-8"
Note: All gusset plates ¼"
Purlin Truss 'B-1'
Truss 'D'
Rigid Roof Frame


11- EQUAL SPACES @ 8'-1" = 88'-11"
TRUSS "A"
1- ½ x 64" WEB PLATE
4- Ls 8x8 x ¾"
7'-4½"
PURLIN TRUSS

Project: OSU Solar

Corvallis, OR
Client: **Canadian Solar**

Date: 8/24/17
Page: A7
By:
Job #: 217195

EXISTING ROOF MASS SUMMATION

ROOF DECK 2×6 T&G — 4 psf
PURLINS @ 8'0" OC. W10×21 — 2.6 psf
ROOFING — 2 psf
INSUL — 2 psf
MISC. — 2 psf

DL = 12.6 USE 13 psf

CHECK PURLINS (ASD) W10×21 →

bf = 5.75"
tf = 5/16
tw = 0.25
d = 9 7/8
$S_x = 21.5$
$I_x = 106.3$

$DL = 13\,psf + \underbrace{5\,psf}_{SOLAR} - 18\,psf$

SNOW LOAD = 25 psf

q = 43 psf

TRIB = 8 FT OC.

W = 344 PLF

SPAN = 20 FT OC.

$$M = \frac{wl^2}{8} = 17.2\ K\text{-}FT$$

$$\frac{M_n}{\Omega} = \frac{S_x F_Y}{\Omega} = \frac{21.5(36)}{1.67}\left(\frac{1}{12}\right) = 38.6\ K\text{-}FT \quad \underline{OK}$$

Project: OSU Solar

Corvallis, OR
Client: **Canadian Solar**

Date: 8/24/17
Page: A8
By:
Job #: 217195

TRUSS DESIGN

L = 222 FT SPAN

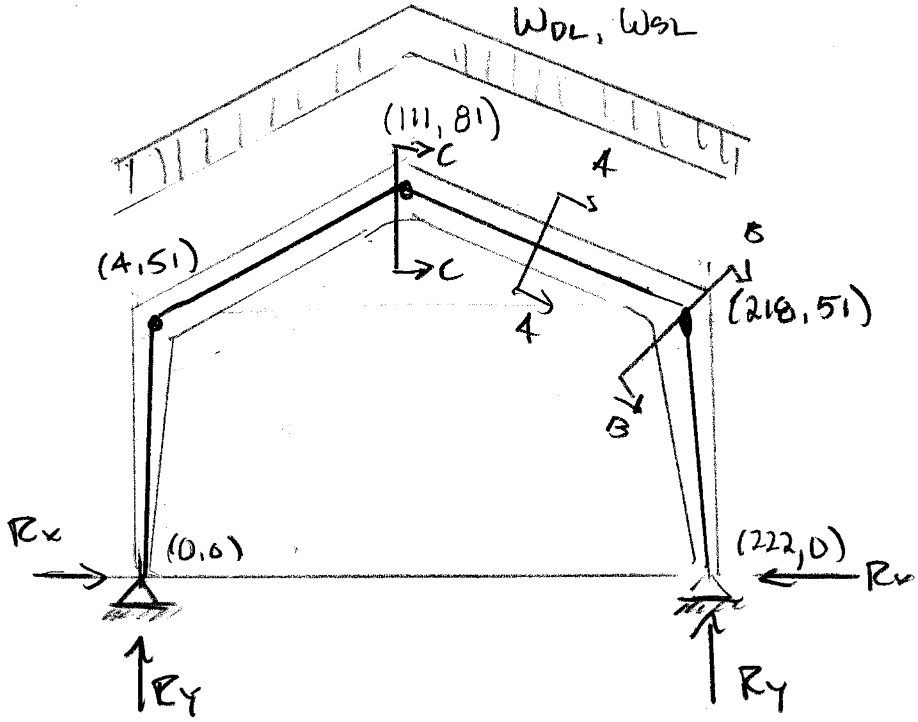
TRIB = 20 FT

DL_{ROOF} = 13 psf

SELF WT = 185 PLF

W_{DL} = 445 PLF

W_{SL} = 500 PLF



LOAD COMBINATIONS

① DL

② DL+SL

ANALYSIS (ASD)

R_x = 60.3 K

R_Y = 113 K

$M_A \approx M_C$ = 1193 K-FT (FROM RISA)

M_B = 2555 K-FT (FROM RISA)

Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

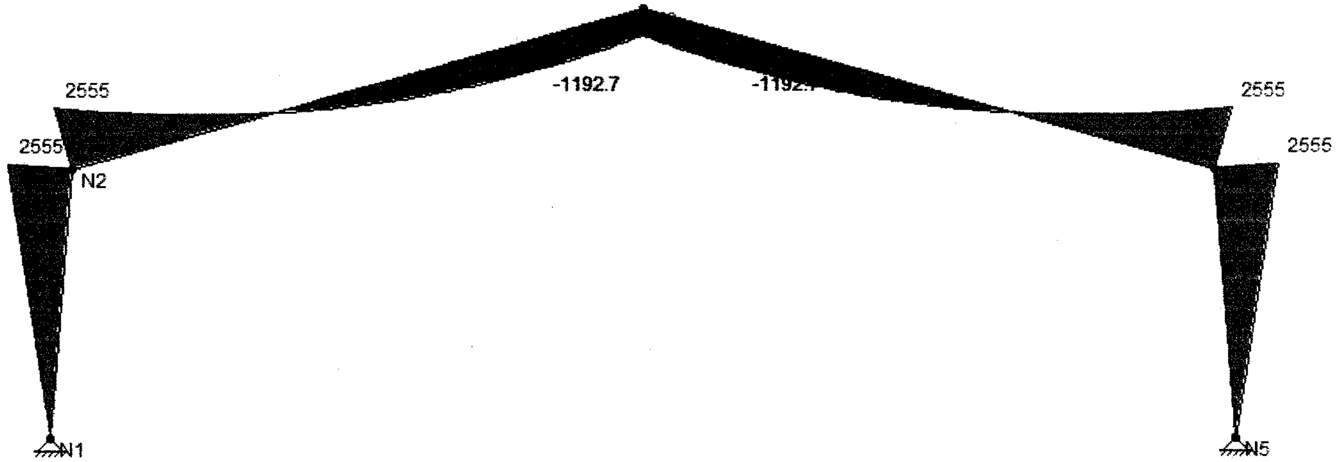
Date: 8/24/17

Page: A9

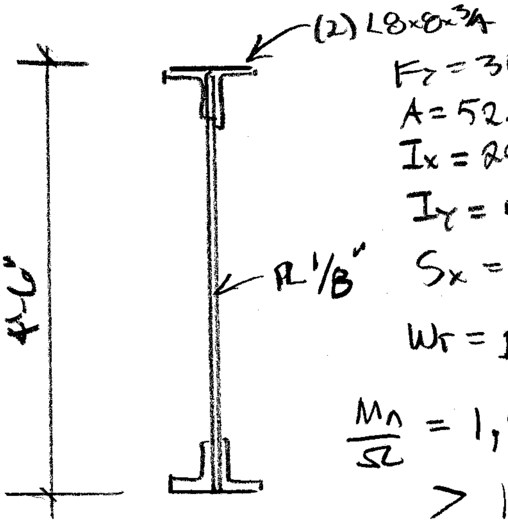
By:

Job #: 217195

Moment Diagram (k-ft)



TRUSS PROFILE "A"

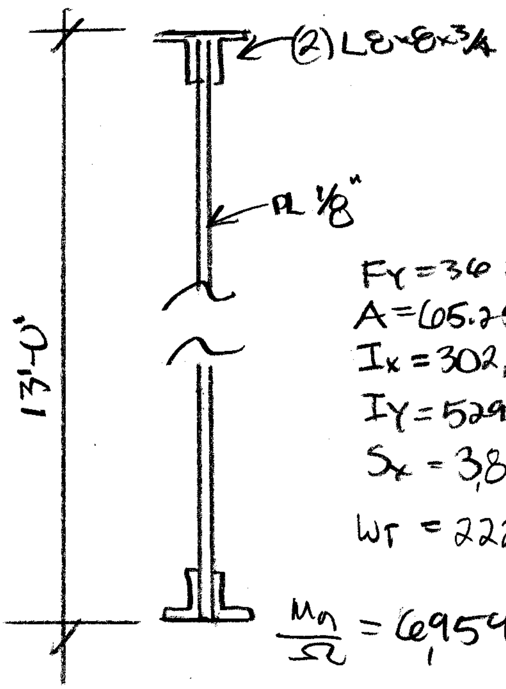


$F_y = 36$ ksi
$A = 52.5$ in^2
$I_x = 29,883$ in^4
$I_y = 529$ in^4
$S_x = 1106$ in^3
$W_T = 179$ PLF

$\frac{M_n}{\Omega} = 1,986$ K-FT
$\geq 1,193$

OK

TRUSS PROFILE "B"

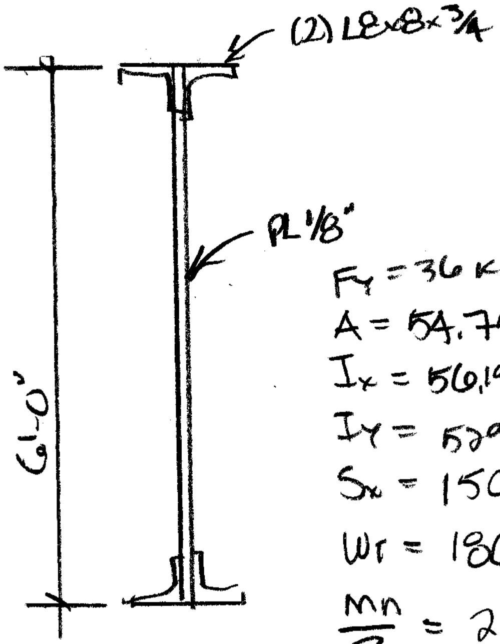


$F_y = 36$ ksi
$A = 65.25$ in^2
$I_x = 302,156$ in^4
$I_y = 529$ in^4
$S_x = 3,874$ in^3
$W_T = 222$ PLF

$\frac{M_n}{\Omega} = 6,959$ K-FT

OK

TRUSS PROFILE "C"



$F_y = 36$ ksi
$A = 54.75$ in^2
$I_x = 56,196$ in^4
$I_y = 529$ in^4
$S_x = 1561$ in^3
$W_T = 186$ PLF

OK

$\frac{M_n}{\Omega} = 2804$ K-FT ≥ 2555

B) SPORTS PERFORMANCE CENTER

B2

PERFORMANCE SPORTS CENTER

Project: OSU Solar

Corvallis, OR

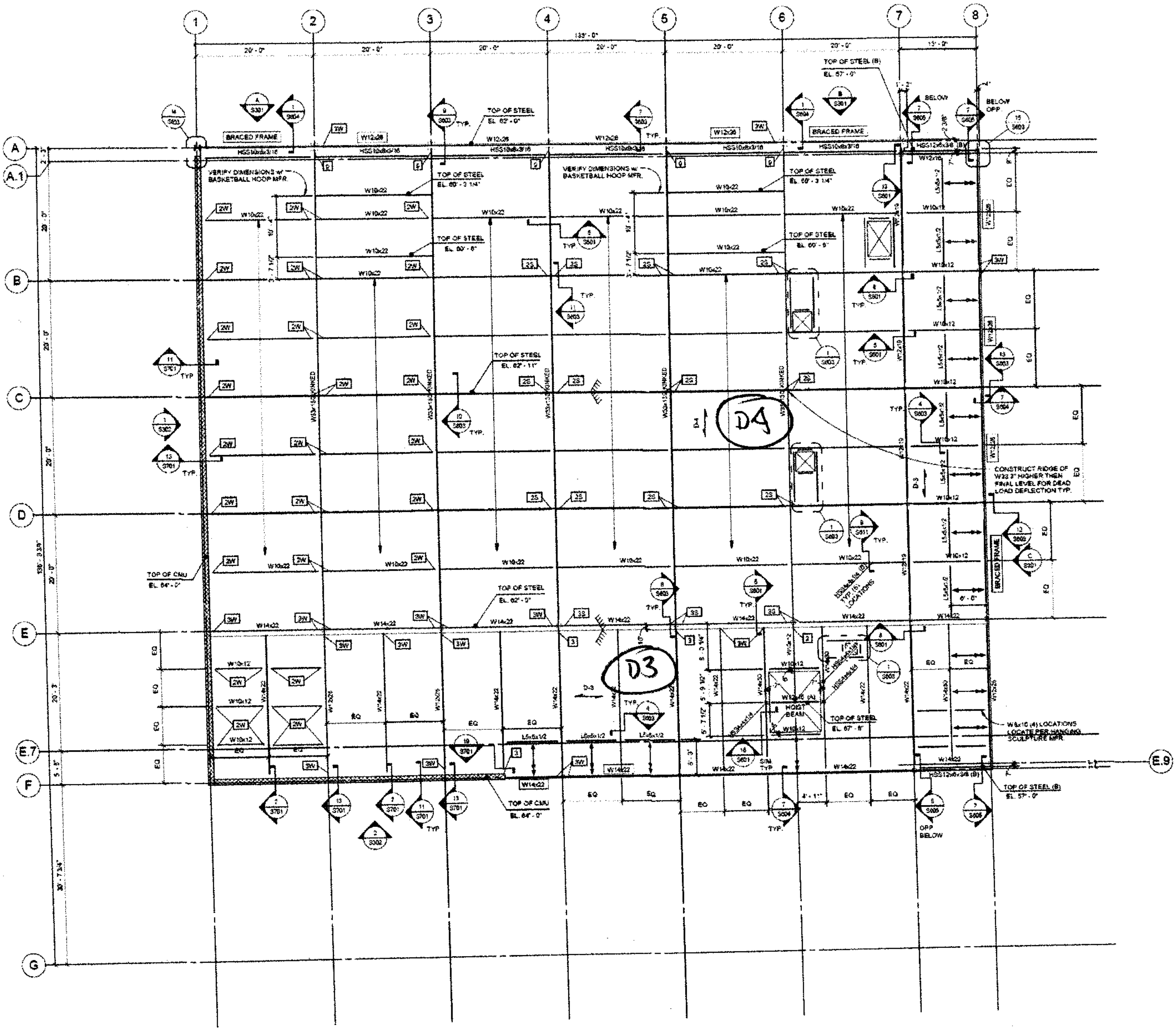
Client: **Canadian Solar**

Date: 8|24|17

Page: B3

By:

Job #: 217195



1/S604 ROOF FRAMING PLAN

1/8" = 1'-0"

Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

Date: 8/24/17
Page: B4
By:
Job #: 217195

FLOOR AND ROOF DECK SCHEDULE

DECK DESIGNATION	DECK TYPE	TOPPING THICKNESS	CONCRETE STRENGTH	REINFORCING	NOTES
D-1	3"x18 GA. TYPE W	3"	4000 PSI	6x6-W1.4xW1.4 WWF	-
D-2	3 1/2"x18 GA. VERSA-DEK LS	3"	4000 PSI	6x6-W1.4xW1.4 WWF	ACOUSTICAL DECKING w/ ADD'L. ISOLATED 3" SLAB w/ WWF
D-3	2"x18 GA. VERSA-DEK S	NONE	-	-	24.5/4 WELD PATTERN w/ 1 1/2" FILLET WELD SIDE LAP CONN. @ 24" o.c.
D-4	2"x18 GA. VERSA-DEK S	NONE	-	-	ACOUSTICAL DECKING 24.5/4 WELD PATTERN w/ 1 1/2" FILLET WELD SIDE LAP CONN. @ 24" o.c.
D-5	1 1/2"x18 GA.TYPE B	NONE	-	-	36/4 WELD PATTERN w/ 1 1/2" FILLET WELD SIDE LAP CONN. @ 24" o.c.
D-6	2"x18 GA.TYPE W	2"	4000 PSI	6x6-W.14xW1.4 WWF	PROVIDE 3/4" DIA.x3 1/2" HEADED STUDS AT COMPOSITE BEAMS

NOTES:

1. REF. GENERAL STRUCTURAL NOTES ON S002 FOR FLOOR AND ROOF DECK ATTACHMENTS.
2. REF. PLAN FOR ADD'L. REINFORCING TYP.

Metal Dek Group®
a unit of CSi®

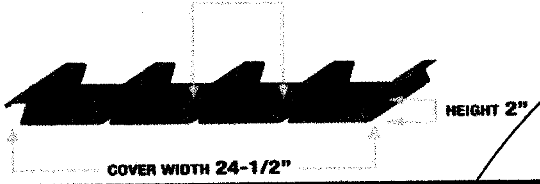
VERSA-DEK® S ROOF (ASD)

2" high x 6-1/8" pitch x 24-1/2" wide

B5

SECTION PROPERTIES fy = 40 ksi

GAGE	Wd	I_D (DEFLECTION)	Sp	Sn	Rbe			Rbi		Va
					2"	3"	4"	3"	4"	
22	2.22	0.409	0.289	0.268	712	820	910	1271	1395	2949
20	2.69	0.497	0.363	0.337	1013	1162	1287	1811	1981	3562
18	3.56	0.661	0.485	0.462	1688	1923	2121	3020	3289	4676
16	4.48	0.836	0.617	0.598	2574	2915	3204	4613	5003	5844



10'-0" SPAN OK

ASD DESIGN		MAXIMUM SUPERIMPOSED UNIFORM ASD LOADS, psf											
Span	Load Combinations	SINGLE SPAN				DOUBLE SPAN				TRIPLE SPAN			
		GAGE											
		22	20	18	16	22	20	18	16	22	20	18	16
8'-6"	D+L (Strength)	62	78	104	132	54*	67*	91*	118*	64*	80*	109*	141*
	D+L (Deflection)	41	50	67	85	54	67	91	118	64	80	109	141
	L (Deflection)	29	35	47	60	54	67	91	118	55	67	89	112
9'-0"	D+L (Strength)	55	69	92	117	49*	61*	83*	107*	58*	73*	100*	129*
	D+L (Deflection)	35	42	56	71	49	61	83	107	58	73	100	129
	L (Deflection)	25	30	40	50	49	61	83	107	46	56	75	95
9'-6"	D+L (Strength)	49	62	82	105	45*	56*	77*	98*	54*	67*	92*	118*
	D+L (Deflection)	29	35	47	60	45	56	77	98	54	67	92	116
	L (Deflection)	21	25	34	43	45	56	77	98	39	48	64	80
10'-0"	D+L (Strength)	44	55	74	94	41*	51*	70*	90*	50*	62*	85*	109*
	D+L (Deflection)	25	30	40	50	41	51	70	90	48	59	78	99
	L (Deflection)	18	22	29	37	41	51	70	88	34	41	55	69
10'-6"	D+L (Strength)	40	50	67	85	37*	46*	63*	82*	46*	57*	78*	100*
	D+L (Deflection)	21	26	34	43	37	46	63	82	41	50	67	85
	L (Deflection)	15	19	25	32	37	45	60	76	29	35	47	60
11'-0"	D+L (Strength)	36	45	61	77	33*	42*	57*	74*	42*	53*	72*	93*
	D+L (Deflection)	18	22	29	37	33	42	57	74	36	44	58	73
	L (Deflection)	13	16	22	28	32	39	52	66	25	31	41	52
11'-6"	D+L (Strength)	33	41	55	70	30*	38*	52*	68*	38*	48*	66*	85*
	D+L (Deflection)	15	19	25	32	30	38	52	68	31	38	50	64
	L (Deflection)	12	14	19	24	28	34	46	58	22	27	36	45
12'-0"	D+L (Strength)	30	38	50	64	28*	35*	48*	62*	35*	44*	60*	78*
	D+L (Deflection)	13	16	22	27	28	35	48	62	27	33	44	55
	L (Deflection)	10	13	17	21	25	30	40	51	19	24	32	40
12'-6"	D+L (Strength)	27	34	46	59	25*	32*	44*	57*	32*	40*	55*	72*
	D+L (Deflection)	12	14	19	24	25	32	44	57	24	29	38	48
	L (Deflection)	9	11	15	19	22	27	36	45	17	21	28	35
13'-0"	D+L (Strength)	25	32	42	54	23*	29*	40*	52*	29*	37*	51*	66*
	D+L (Deflection)	10	12	16	21	23	29	40	52	21	25	34	43
	L (Deflection)	8	10	13	17	20	24	32	40	15	19	25	31
13'-6"	D+L (Strength)	23	29	39	50	21*	27*	37*	48*	27*	34*	47*	61*
	D+L (Deflection)	9	11	14	18	21	27	37	48	18	22	30	38
	L (Deflection)	7	9	12	15	17	21	28	36	14	17	22	28
14'-0"	D+L (Strength)	21	27	36	46	20*	25*	34*	44*	25*	32*	43*	56*
	D+L (Deflection)	8	9	12	16	20	25	34	44	16	20	26	33
	L (Deflection)	7	8	11	13	16	19	25	32	12	15	20	25
14'-6"	D+L (Strength)	20	25	33	42	18*	23*	32*	41*	23*	29*	40*	52*
	D+L (Deflection)	7	8	11	14	18	23	31	39	14	17	23	29
	L (Deflection)	6	7	9	12	14	17	23	29	11	13	18	23
15'-0"	D+L (Strength)	18	23	31	39	17*	21*	29*	38*	22*	27*	37*	49*
	D+L (Deflection)	6	7	9	12	17	21	27	35	13	16	21	26
	L (Deflection)	5	6	9	11	13	16	21	26	10	12	16	20

8'-6"	D+L (Strength)	62	←Max. superimposed ASD dead + live load (psf) (governed by strength limitation)
	D+L (Deflection)	41	←Max. superimposed ASD dead + live load (psf) (governed by deflection limitation)
	L (Deflection)	29	←Max. superimposed ASD live load (psf) (governed by deflection limitation)

↑ Vertical load span (center to center spacing)

Wd	Weight of deck (uncoated), psf
I_D	Moment of inertia for deflection per foot of deck width (in^4)/ft
Sp	Section modulus for positive bending per foot of deck width, (in^3)/ft
Sn	Section modulus for negative bending per foot of deck width, (in^3)/ft
Va	Allowable shear value per foot of deck width, plf
Rbe	Allowable exterior web crippling value per foot of deck, plf
Rbi	Allowable interior web crippling value per foot of deck, plf
D	Uniform dead load, psf
L	Uniform live load, psf

Notes:
1. Bending strength based on allowable flexural stress of 24 ksi.
2. Loads marked with asterisk (*) are governed by moment & shear, interior reactions (web crippling) or applied moment & reactions assuming 4" of interior bearing.
3. Deflection based on maximum dead + live load deflection of L/240 or 1 in. and on maximum live load deflection of L/360 or 1 in.
4. An upper limit of 400 psf has been applied to the loads.
5. Deck length over 45'-0" require inquiry and special accommodations. Please contact the Metal-Dek Group® for further information.

The section properties table is based on 2001 AISI's North American Specification for the Design of Cold-Formed Steel Structural Members (2004 Supplement).
Acoustical profile is also available.

<< INDEX < BACK NEXT >

STEEL RAFTER BEAMS

EXISTING W10×22

DL = 3.5 psf (DECK)

2.0 psf (INSUL.)

5.0 psf (SOLAR)

2.0 psf (MISC.)

2.5 psf (RAFTERS) → W10×22 @ 10' c"

15.0 psf

SL = 25 psf

TRIB = 10'-0" OC.

W = 400 PLF

SPAN = 20 FT (L_B = 20 FT)

$$M = \frac{wl^2}{8} = 20 \text{ K-FT}$$

$$\frac{M_n}{\Omega} = 24 \text{ K-FT} \text{ (TABLE 3-10)}$$

GIRDER BEAM [EXISTING W33×130]

SPAN = 82'-3", (L_B = 10 FT)

TRIB = 20 FT

DL = 15 psf

SELF = 130 PLF

SL = 25 psf

W = 930 PLF

$$M = \frac{wl^2}{8} = 786 \text{ K-FT}$$

$$S_{REQ'D} = \frac{M \times 12}{50 \div 1.67} = 113 \text{ in}^3$$

W33×130

S_x = 406, OK ON STRENGTH

I_x = 6710

Δ_{TOT} = 4.86 – BEAM IS KINKED, OK
NO BRITTLE FINISHED

$$= \frac{L}{202}$$

Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

Date: 8\24\07

Page: C1

By: JJW

Job #: 217195

C) RESER STADIUM

C2

RESER

Project: OSU Solar

Corvallis, OR

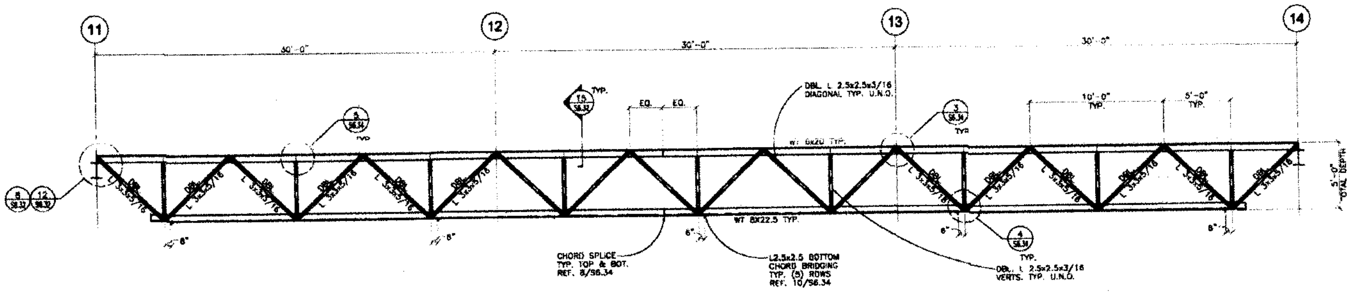
Client: **Canadian Solar**

Date: 8|24|17

Page: C3

By:

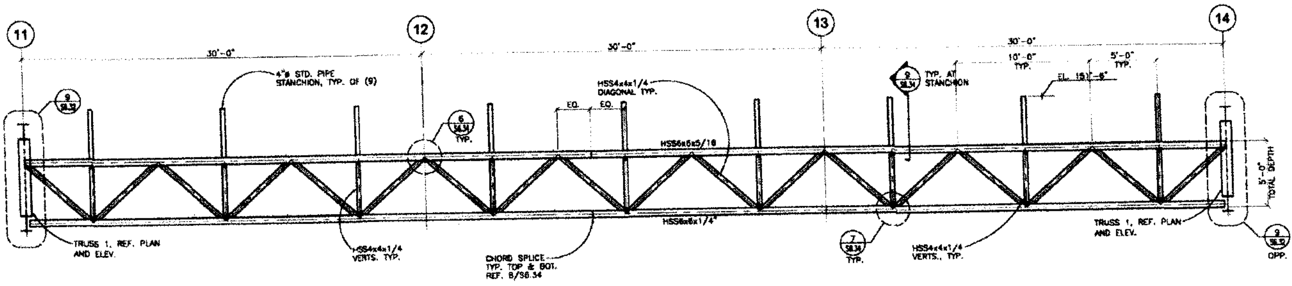
Job #: 217195



NOTE:
USE A572, GR. 50 FOR
WT TRUSS CHORD MEMBERS
AND A36 FOR DOUBLE ANGLE
TRUSS WEB MEMBERS

3 ROOF TRUSS 6 ELEVATION

1/4"=1'-0"



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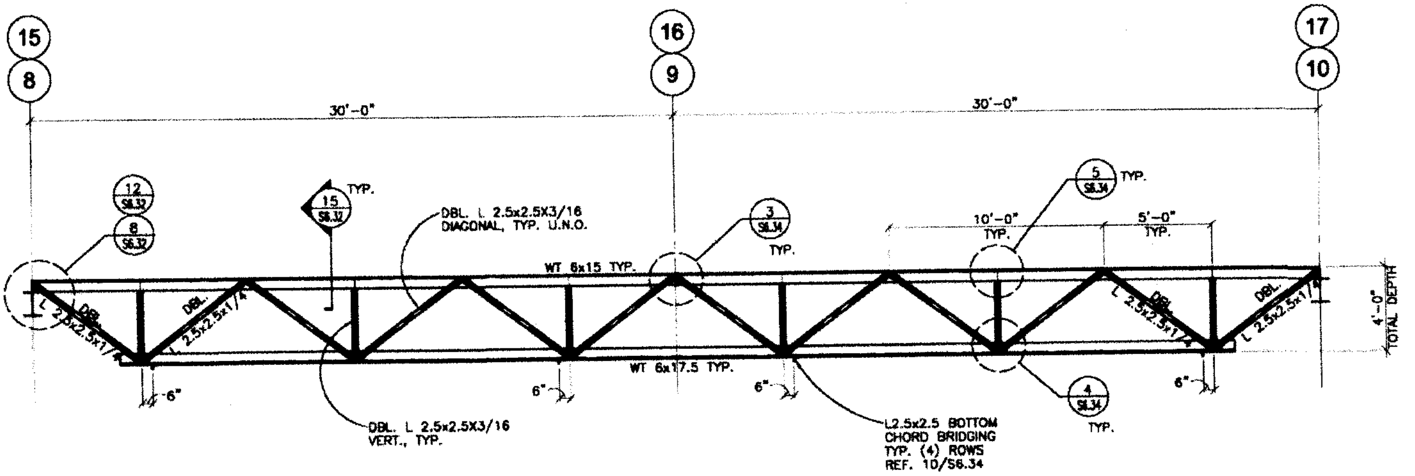
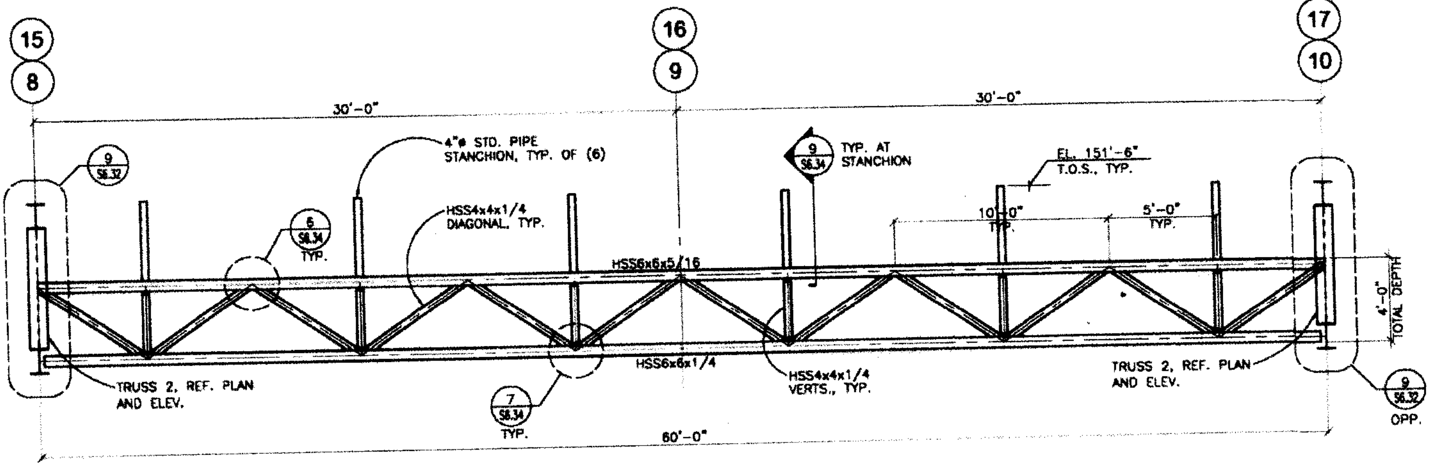
Date: 8/24/17
Page: C4
By:
Job #: 217195



NOTE:
USE A572, GR. 50 FOR
WT TRUSS CHORD MEMBERS
AND A36 FOR DOUBLE ANGLE
TRUSS WEB MEMBERS

① ROOF TRUSS 4 ELEVATION
1/4"=1'-0"



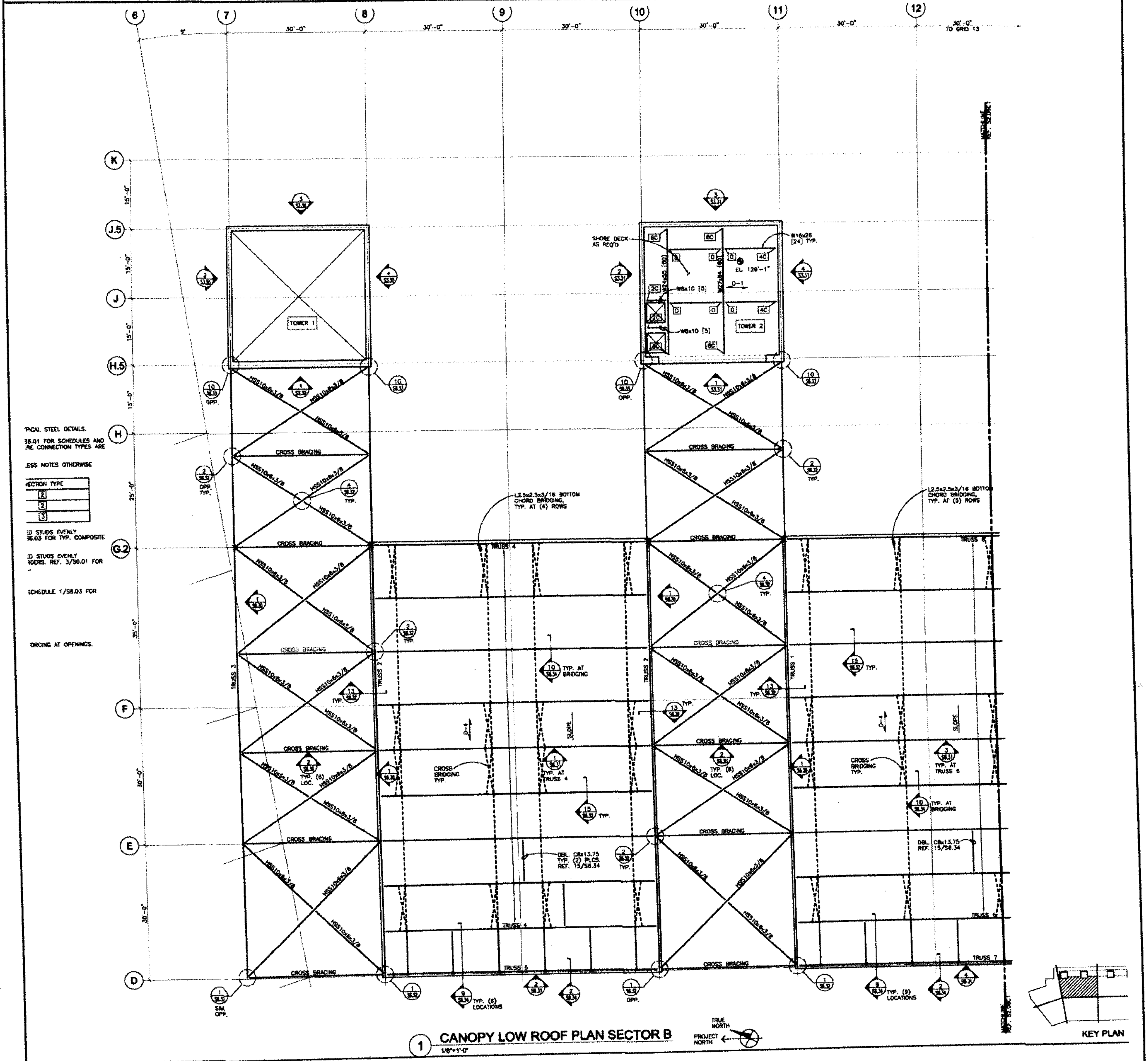
② ROOF TRUSS 5 ELEVATION
1/4"=1'-0"

Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

Date: 8/24/17
Page: C5
By:
Job #: 217195



① CANOPY LOW ROOF PLAN SECTOR B
1/8"=1'-0"

Project: OSU Solar

Corvallis, OR

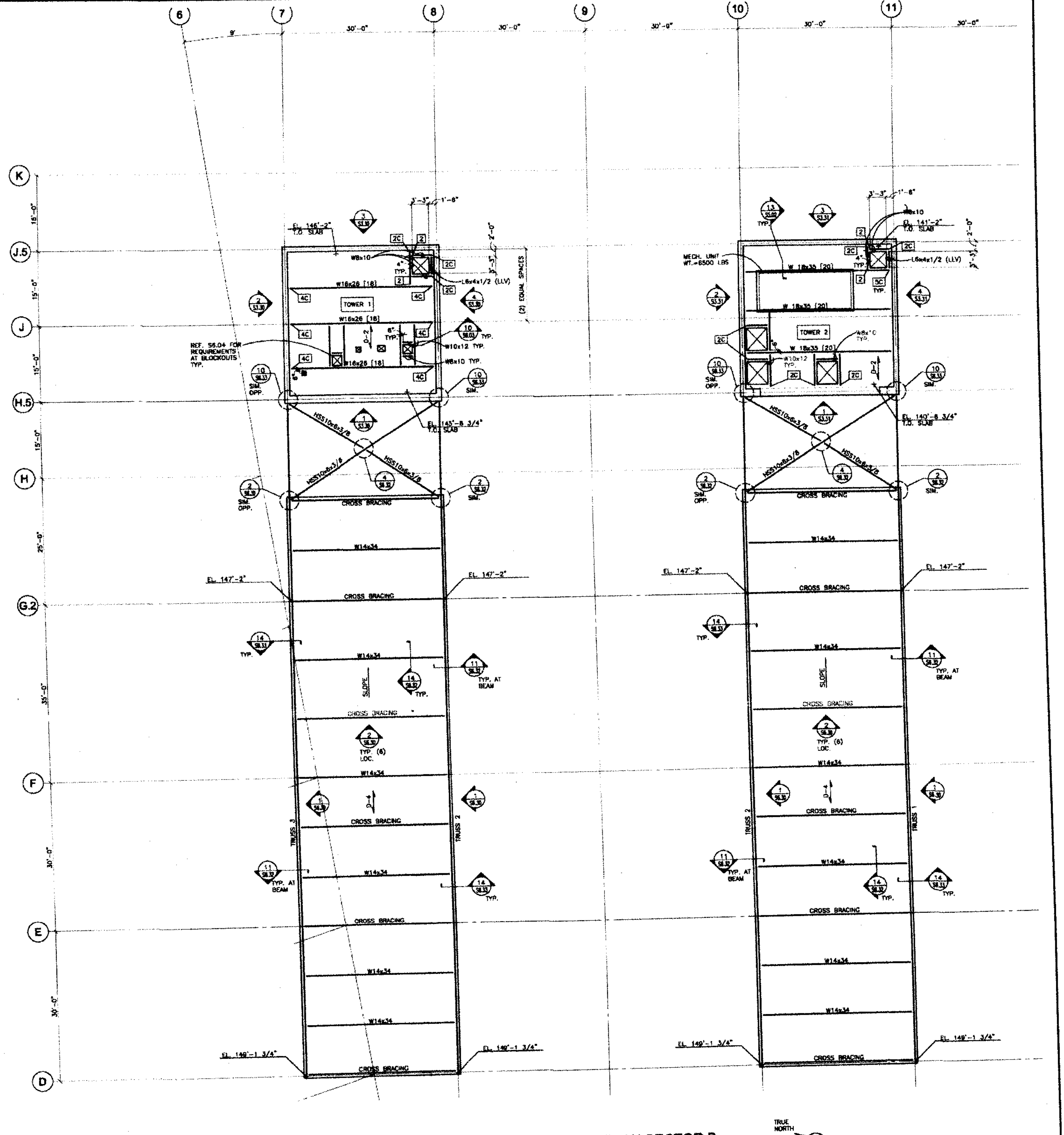
Client: **Canadian Solar**

Date: 8/24/17

Page: C6

By:

Job #: 217195



1 CANOPY HIGH ROOF PLAN SECTOR B

1/8"=1'-0"

Project: OSU Solar

Corvallis, OR

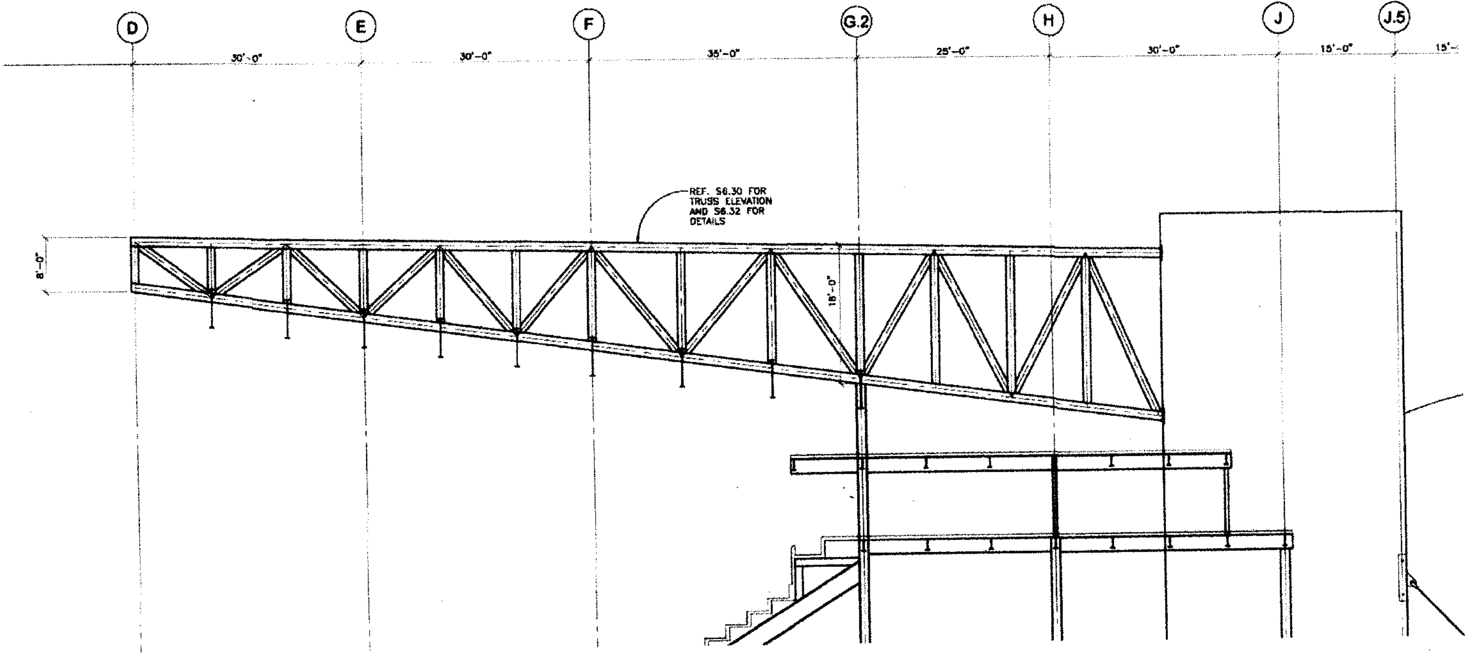
Client: **Canadian Solar**

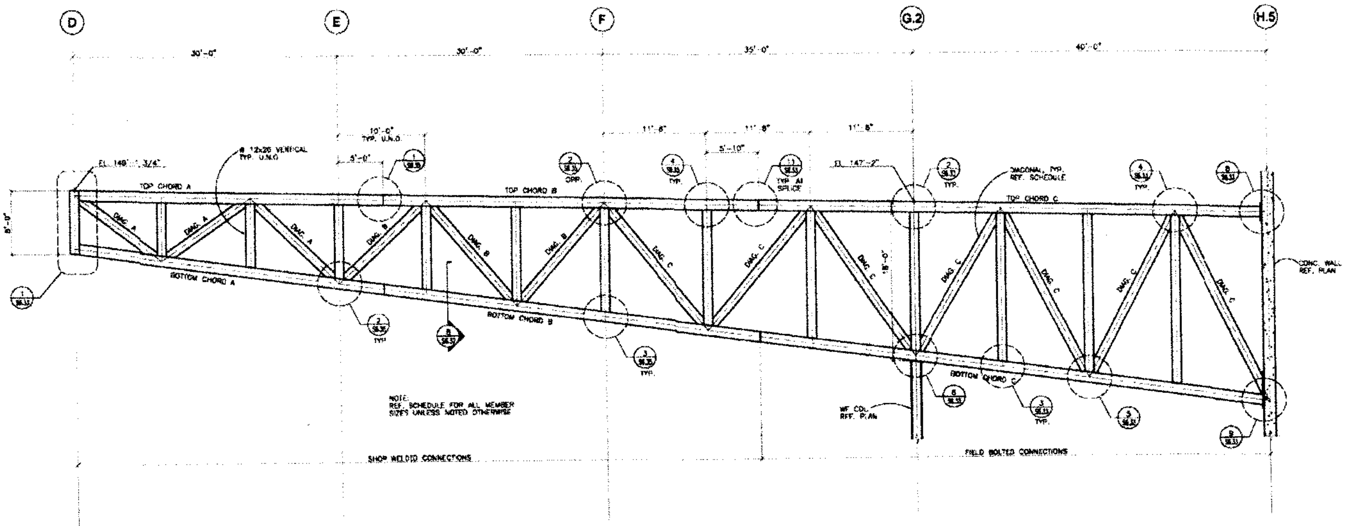
Date: 8/24/17

Page: C7

By:

Job #: 217195





		TOP CHORD			BOT. CHORD			DIAGONAL		
TRUSS	GRIDS	A	B	C	A	B	C	A	B	C
1	11, 14	W14x43	W14x82	W14x132	W14x61	W14x120	W14x145	W12x32	W12x40	W12x58
2	8, 10, 15, 17	W14x43	W14x68	W14x99	W14x61	W14x90	W14x109	W12x26	W12x40	W12x58
3	7, 18	W14x30	W14x30	W14x43	W14x30	W14x53	W14x61	W12x26	W12x26	W12x45

① ROOF TRUSSES 1, 2 AND 3 ELEVATION
3/16"=1'-0"

		TOP CHORD			BOT. CHORD			DIAGONAL		
TRUSS	GRIDS	A	B	C	A	B	C	A	B	C
1	11, 14	W14x43	W14x82	W14x132	W14x61	W14x120	W14x145	W12x30	W12x40	W12x58
2	8, 10, 15, 17	W14x43	W14x68	W14x99	W14x61	W14x90	W14x109	W12x26	W12x40	W12x58
3	7, 18	W14x30	W14x30	W14x43	W14x30	W14x53	W14x61	W12x26	W12x26	W12x45

Project: OSU Solar

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Date: 8|24|17
Page: C10
By:
Job # 217195

FLOOR AND ROOF DECK SCHEDULE

DECK DESIGNATION	DECK TYPE	TOPPING THICKNESS	CONCRETE STRENGTH	REINFORCING	NOTES
D-1	3" x 18 GA. TYPE W	3 1/2"	4000 psi	#4 ● 16" o.c. EA. WAY	TOPPING THICKNESS VARIES AT SIM. REF. PLANS
D-2	3" x 20 GA. TYPE W	2 1/2"	4000 psi	6x6-W1.4xW1.4 WWF	REF. PLANS FOR ADD'L. REINF.
D-3	1 1/2" x 18 GA. TYPE B	2 1/2"	4000 psi	6x6-W2.5xW2.5 WWF	REF. PLANS FOR ADD'L. REINF.
D-4	3" x 18 GA. TYPE N	NONE	–	–	
D-5	1 1/2" x 18 GA. TYPE B	NONE	–	–	

NOTES:

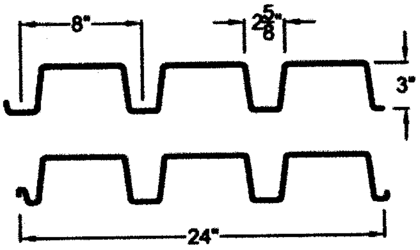
1. REF. GENERAL STRUCTURAL NOTES ON S0.1 FOR FLOOR DECK ATTACHMENTS.
2. PROVIDE VENTED DECK FOR D-1 WHERE WATERPROOFING MEMBRANE IS BEING USED ON TOP OF CONCRETE. REF ARCH.
3. TYPE B DECK FOR D-3 TO BE COMPOSITE FLOOR DECK.
4. ATTACH ROOF DECK TO SUPPORTS WITH HILTI ENP2 POWDER ACTUATED FASTENERS WITH (7) PINS PER 36" SHEET FOR 1 1/2" DECK AND (4) PINS PER 24" SHEET FOR 3" DECK. FASTEN TO SUPPORTS WITH PINS ● 18" o.c. AT PERIMETER SUPPORTS PARALLEL TO FLUTES. FASTEN SIDE LAPS WITH BUTTON PUNCH ● 8" o.c.
5. PROVIDE G90 GALVANIZED COATING WHERE SPACE BELOW DECK IS NOT AN ENCLOSED SPACE.

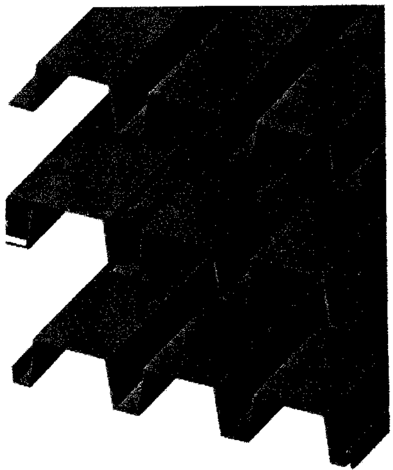
① FLOOR AND ROOF DECK SCHEDULE

C1

3 N, NI, NA, NIA

Maximum Sheet Length 42'-0
Extra Charge for Lengths Under 6'-0
ICC ER-3415
FM Global Approved[2]





Interlocking side lap is not drawn to show actual detail.

SECTION PROPERTIES

Deck type	Design thickness in.	W psf	Section Properties I_p in⁴/ft	S_p in³/ft	I_n in⁴/ft	S_n in³/ft	V_a lbs/ft	F_y ksi
N22	0.0295	2.26	0.659	0.382	0.884	0.433	2232	33
N20	0.0358	2.71	0.848	0.501	1.079	0.552	3287	33
N19	0.0418	3.15	1.045	0.597	1.260	0.659	4217	33
N18	0.0474	3.56	1.238	0.688	1.430	0.749	4771	33
N16	0.0598	4.46	1.683	0.893	1.807	0.944	5988	33

ACOUSTICAL INFORMATION

Deck Type	Absorption Coefficient 125	250	500	1000	2000	4000	Noise Reduction Coefficient[1]
3NA, 3NIA	.18	.39	.88	.93	.58	.39	0.70

[1] Source: Riverbank Acoustical Laboratories.
Test was conducted with 1.50 pcf fiberglass batts and 2 inch polyisocyanurate foam insulation for the SDI.

Acoustical deck (Type 3 NA, NIA) is particularly suitable in structures such as auditoriums, schools and theaters where sound control is desirable. Acoustic perforations are located in the vertical webs where the load carrying properties are negligibly affected (less than 5%).

Inert, non-organic glass fiber sound absorbing batts are placed in the rib openings to absorb up to 70% of the sound striking the deck.

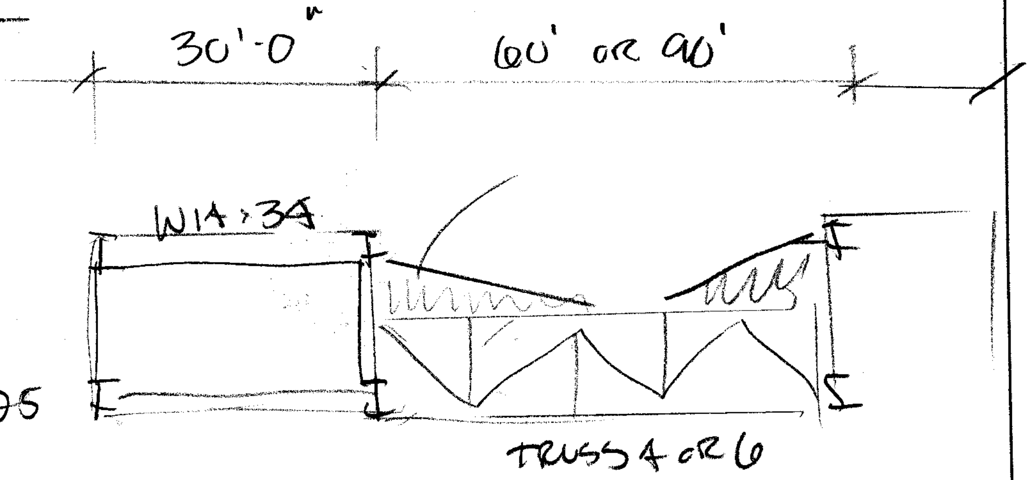
Batts are field installed and may require separation.

VERTICAL LOADS FOR TYPE 3N

No. of Spans	Deck Type	Max. SDI Const. Span	Allowable Total (PSF) / Load Causing Deflection of L/240 or 1 inch (PSF) Span (ft.-in.) ctr to ctr of supports 10-0	10-6	11-0	11-6	12-0	12-6	13-0	13-6	14-0	14-6	15-0
1	N22	11'-7	50 / 43	46 / 37	42 / 32	38 / 28	35 / 25	32 / 22	30 / 20	28 / 18	26 / 16	24 / 14	22 / 13
	N20	13'-2	66 / 56	60 / 48	55 / 42	50 / 37	46 / 32	42 / 28	39 / 25	36 / 23	34 / 20	31 / 18	29 / 16
	N19	14'-7	79 / 69	71 / 59	65 / 51	59 / 45	55 / 40	50 / 35	47 / 31	43 / 28	40 / 25	37 / 22	35 / 20
	N18	15'-11	91 / 81	82 / 70	75 / 61	69 / 53	63 / 47	58 / 42	54 / 37	50 / 33	46 / 30	43 / 27	40 / 24
	N16	18'-6	118 / 110	107 / 95	97 / 83	89 / 73	82 / 64	75 / 56	70 / 50	65 / 45	60 / 40	56 / 36	52 / 33
2	N22	13'-8	56 / 122	51 / 105	47 / 92	43 / 80	39 / 71	36 / 62	34 / 55	31 / 50	29 / 44	27 / 40	25 / 36
	N20	15'-6	72 / 152	65 / 131	60 / 114	55 / 100	50 / 88	46 / 78	43 / 69	40 / 62	37 / 55	34 / 50	32 / 45
	N19	16'-11	86 / 182	78 / 157	71 / 137	65 / 120	60 / 105	55 / 93	51 / 83	47 / 74	44 / 66	41 / 60	38 / 54
	N18	18'-1	98 / 211	89 / 182	81 / 158	74 / 139	68 / 122	63 / 108	58 / 96	54 / 86	50 / 77	47 / 69	44 / 62
	N16	20'-4	123 / 276	112 / 238	102 / 207	93 / 181	86 / 159	79 / 141	73 / 125	68 / 112	63 / 100	59 / 90	55 / 82
3	N22	13'-8	69 / 95	64 / 82	58 / 72	53 / 63	49 / 55	45 / 49	42 / 43	39 / 39	36 / 35		
	N20	15'-6	90 / 119	81 / 103	74 / 90	68 / 78	63 / 69	58 / 61	53 / 54	50 / 48	46 / 43		
	N19	16'-11	107 / 143	97 / 123	89 / 107	81 / 94	75 / 83	69 / 73	64 / 65	59 / 58	55 / 52		
	N18	18'-1	122 / 165	111 / 143	101 / 124	92 / 109	85 / 96	78 / 84	72 / 75	67 / 67	63 / 60		
	N16	20'-4	154 / 216	139 / 186	127 / 162	116 / 142	107 / 125	99 / 111	91 / 98	85 / 88	79 / 79		

Notes: 1. Minimum exterior bearing length required is 1.50 inches. Minimum interior bearing length required is 3.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. FM Global approved numbers and spans available on page 21.

TRUSS DRIFTING SNOW



$l_u = 30$ FT

$P_g = 25$ psf

$h_d = 2$ FT

$\gamma = 0.13 p_g + 14 = 17.25$

$W = 4 h_d = 8$ FT

$$\text{TOTAL DRIFT WEIGHT} = (2\ \text{DRIFTS})\left(\frac{34.5 \times 8}{2}\right) = 276\ \text{LB}$$

$$q_{\text{DRIFT } 60'} = \frac{276}{60} = 4.6\ \text{psf}$$

$$q_{\text{DRIFT } 90'} = \frac{276}{90} = 3.0\ \text{psf}$$

UPPER CANOPY RAFTERS

EXISTING W14×34 @ 11'-8 o.c.

DL = 3.5 psf (DECK)
2.0 psf (MISC.)
5.0 psf (SOLAR)
3.0 psf (SELF)
13.5 psf

SL = 25 psf

W = 449

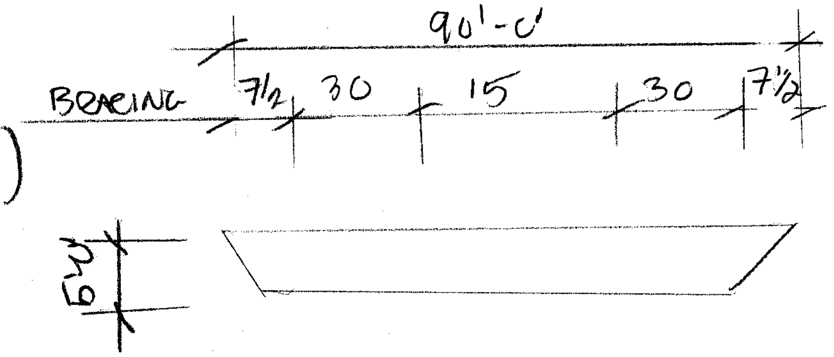
SPAN = 30'0" (LB = 30'0")

$M = \frac{wl^2}{8} = 50.5$ K-FT

PROVIDE CROSS BRACING (LB = 15'0")

$\frac{M_n}{\Omega} = 88$ K-FT

LOW CANOPY TRUSS "G"



DL = 15 psf (INCLUDES SELF + SOLAR)

SL = 25 psf

$SL_{DRIFT} = 3$ psf

TRIB = 11.66 FT

W = 501 PLF

$M = \frac{w\ell^2}{8} = 507.7$ K-FT

$T = C = \frac{M}{5} = 101$ KIPS

TENSION MEMBER

WT8×22.5

$\frac{T_n}{\Omega} = \frac{6.63 \times 50ksi}{2.0} = 165K$ ✓

CHECK COMPRESSION ( )

~~K = 0.65 (CONTINUOUS)~~

~~$L_{B_{YY}} = 30$ FT~~

~~$KL_{YY} = 19.5$ FT~~

~~WT6×20~~

~~$\frac{P_n}{\Omega} = 56.5$~~

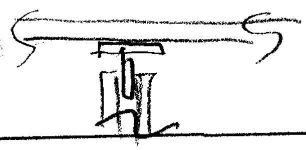
K = 0.65

$L_{B_{xx}} = 5$ FT

$KL_{xx} = 3.25$

$\frac{P_n}{\Omega} = 140K$ ✓

DECK PROVIDES
CROSS BRACING



Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

Date: 8/24/17

Page: C15

By:

Job #: 217195

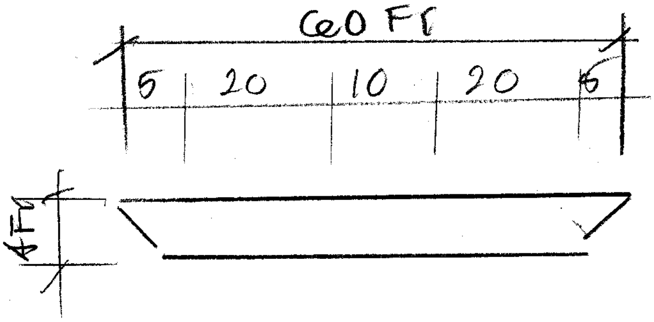
CANOPY TRUSS "4"

DL = 15 psf

SL = 25 psf

SL_{DRIFT} = 5 psf

TRIB = 11.66



W = 501 PLF

$$M = \frac{wl^2}{8} = 225.4 \text{ K-FT}$$

T = C = 56.4 K

COMPRESSION MEMBER

L_{Bxx} = 4 FT

K = 0.65

WT6x15

$$\frac{P_n}{\Omega} = 78.1 \text{K}$$ ✓

TENSION MEMBER

WT6x17.5

$$\frac{T_n}{\Omega} = \frac{5.17 \times 50}{2.0} = 129 \text{K}$$ ✓

MAIN TRUSS

CHECK SECTION "C" - (END)
- GRID 8, 10, 15, 17 -

$TRIB = \frac{90 FT}{2} = 45 FT$

DL ≈ 15 psf

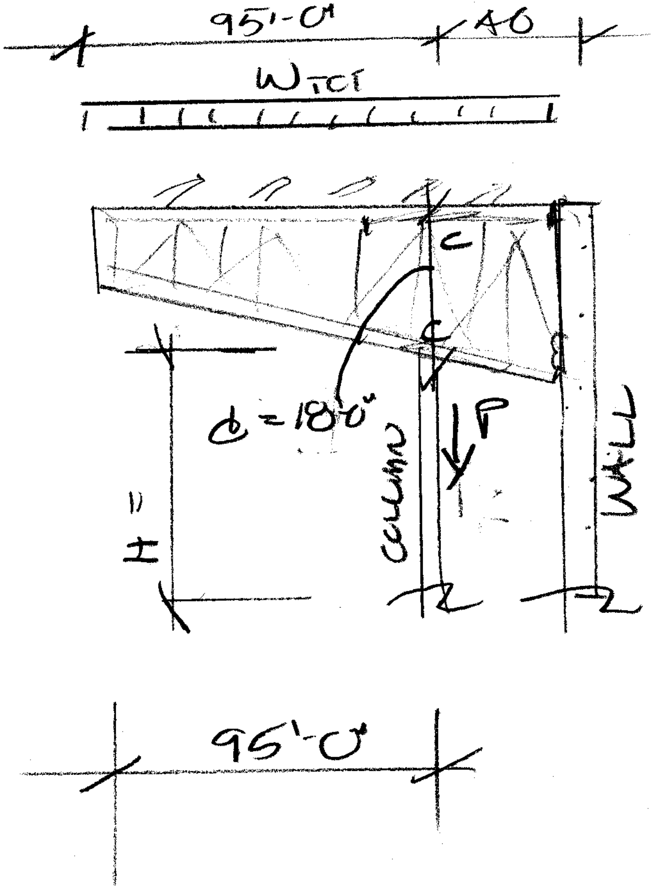
SL = 25 psf

SL_{DRIFT} = 3psf (AVERAGE

$W_{ROOF} = 1350$ PLF

$W_{SELF} \approx 300$ PLF

$W_{TOT} = 1650$ PLF



ANALYSIS

$M = \frac{wl^2}{2}$ (CANT.)

M = 7,445 K-FT

$T = C = \frac{M}{d} = 413 K$

TOP CHORD W14x99 ($A = 29.1 in^2$)

$L_B = 11.66 FT$

$\frac{T_n}{\Omega} = \frac{F_Y A}{2.0} = 727 K \geq 413$

BTM CHORD W14x109

$L_B = 11.66$

$\frac{P_n}{\Omega} = 860 K \geq 413$

CHECK COLUMN

$P = w\left(95 + \frac{40}{2}\right) + \frac{w(95)^2}{2}\left(\frac{1}{40}\right)$

P = 376 KIPS

$L_B = 10'-0"$

W14x193

$\frac{P_n}{\Omega} = 1590$ OK

D) TRUAX PRACTICE FACILITY

Note; Existing plans were not available for metal building constructed in 2004. All member sizes are from field measurements.

D2

TRUAX

PRIVILEGED & CONFIDENTIAL

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Corvallis, OR

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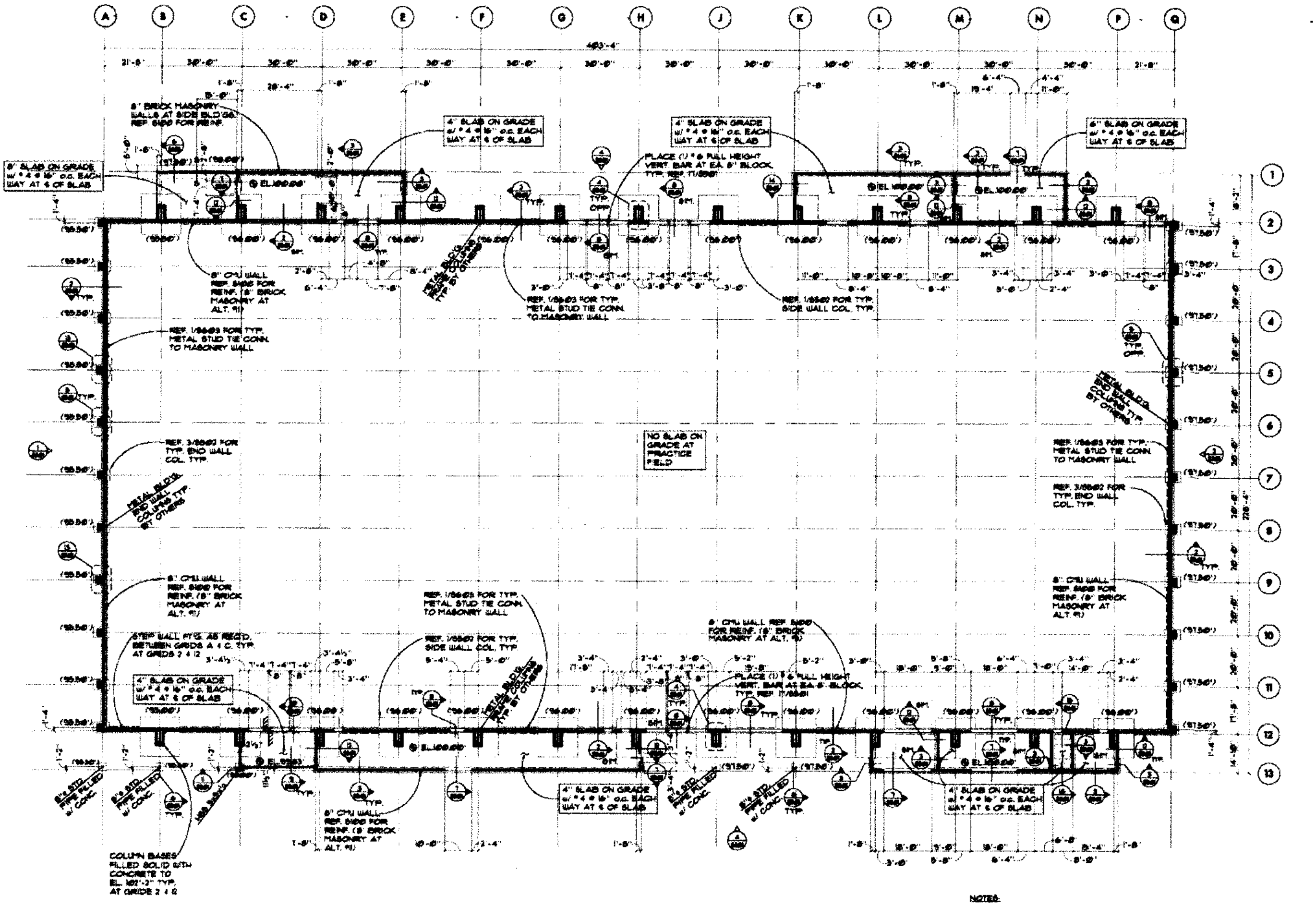
Date: 8/24/17
Page: D3
By:
Job #: 217195



(1) FOUNDATION PLAN
1/16" = 1'-0"

NOTES:

1. (XXX.XX') INDICATES BOTTOM OF FOOTING ELEVATION.
2. ⊕ EL. XXX.XX' INDICATES TOP OF SLAB ELEVATION. REF. 1/S501 FOR FOR SLAB DETAILS. FINISH FLOOR ELEV. 100.00' EQUALS DATUM ELEV. 235.00' (REF. CIVIL/LANDSCAPE).
3. INDICATES STEP IN ELEVATION.
4. REF. SHEET S501 FOR TYPICAL CONCRETE DETAILS.
5. ▬ INDICATES 8" SOLID GROUTED REINFORCED BRICK MASONRY WALL. REF. S100 FOR REINF. (U.N.O.)
6. ▨ INDICATES 8" SOLID GROUTED REINFORCED CMU WALL REF. S100 FOR REINF. (U.N.O.) FOR ALTERNATE #1 ALL CMU WALLS SHALL BE BRICK MASONRY WALLS. REF. ARCH.
7. REF. ARCH FOR ALL FLOOR DRAINS IN SLABS. SLOPE SLABS AS REQ'D.
8. REF. 16/4/5/S501 FOR TYP. MASONRY WALL CORNERS AND CONTROL JOINT DETAILS.

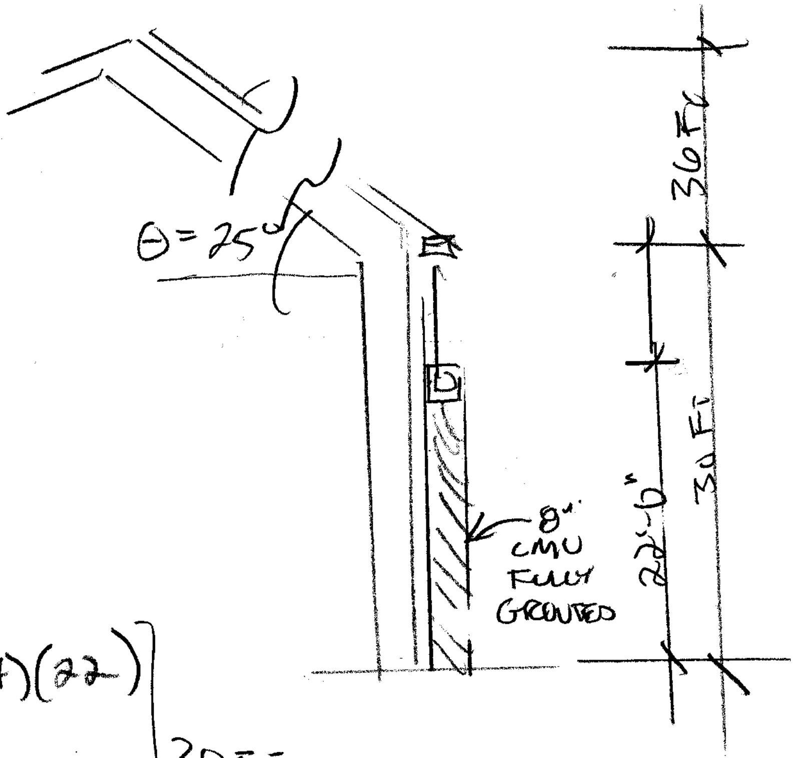
TRUAX SEISMIC MASS

ANALYZE 1-BAY

TRIB = 30 FT

$$\text{ROOF WT} = \frac{(200\text{ FT})(5\text{psf})}{\cos 25^\circ}(30) = 33.1\text{ K}$$

$$\text{SOLAR WT} = \frac{(200)(5)(30)}{\cos 25^\circ} = 33.1\text{ K}$$



$$\text{WALL WT} = \left[\left(\frac{11}{30}\right)\underbrace{(2\text{ EA.})(55\text{ psf})(22)}^{\text{CMU}} + \left(\frac{26}{30}\right)(2\text{EA.})\underbrace{(10\text{psf})}_{\text{CLEARSTORY}}(8)\right]30\text{ FT} =$$

WALL WT = 30.8 K

EXISTING WT = [33.1 + 30.8] = 63.9 K

SOLAR WT = 33.1 K

$$\Delta = \frac{33.1}{63.9} = 52\% \therefore \text{MUST CHECK}$$

Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

Date: 8/21/17

Page: iD5

By:

Job #: 217195

SEISMIC FRAME FORCES

$R = 3.25$

$I = 1.0$

$Q_E = C_S W$

$$C_S = \frac{S_{DS}}{(R/I)} = \frac{0.71}{3.25} = 0.22$$

$W = 97$ KIPS/BAY [INCLUDES SOLAR WT.]

$Q_E = 21.4$ K

ASD COMBINATION ($\rho = 1.3$)

$1.1 DL + 0.7 \rho Q_E$

$F_{QE} = 19.5$ K

WIND FORCES

120 MPH, EXP. "B"

ASCE 7-10 CHAPTER 28 MFRS

$q_{WALL} = 20.7$ psf ($\theta = 25°$)

$q_{ROOF} = 4.7$ psf

ASD FORCES

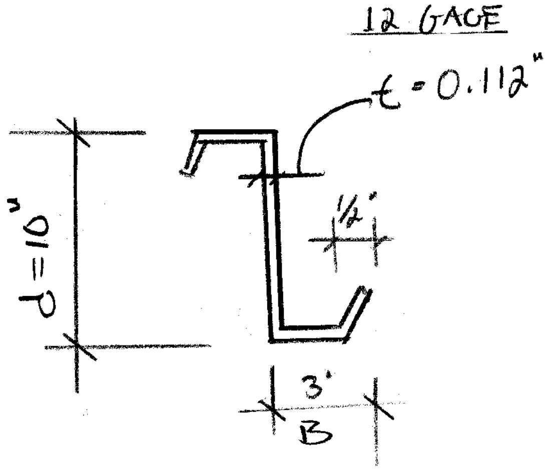
$$F_w = \left[20.7\left(\frac{30}{2}\right) + 4.7(36)\right]\overset{ASD}{0.6} \times 30 \text{ FT}$$

$F_W = 8.6$ K ≤ 19.5

SEISMIC GOVERNS
MUST ANALYZE
FRAME

TRUAX PURLINS

MEASURED GAGE = 0.112
USE 7/64 → 12 GA. = 0.1094



PROPERTIES

WT = 5.6 PLF

$I_x = 27.46 \text{ in}^4$

$S_x = 5.49 \text{ in}^3$

$F_Y = 50$ ksi (ASSUMED)

CAPACITY

$$\frac{M_n}{\Omega} = \frac{F_Y S_x}{1.67} = 164 \text{ k-in}$$
$$= 13.7 \text{ K-FT}$$

ANALYSIS (TRIB = 5'-0" O.C.)

ROOF DL = [1.1 psf – Z-PURLIN
1.5 psf – STANDING SEAM
1.5 psf – INSULATION
+0.9 psf – MISC.] = 5 psf

SOLAR = 5 psf
SNOW = 25 psf

q = 35 psf
w = 175 plf

L = 30 FT

$M = \frac{wl^2}{12}$ [CONTINUOUS] @ MID BAYS

$M = 13.1$ K-FT ≤ 13.7 OK

END BAYS OVERSTRESSED

Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

Date: 8/24/17
Page: D7
By:
Job #: 217195

TRUAX TRUSS DESIGN

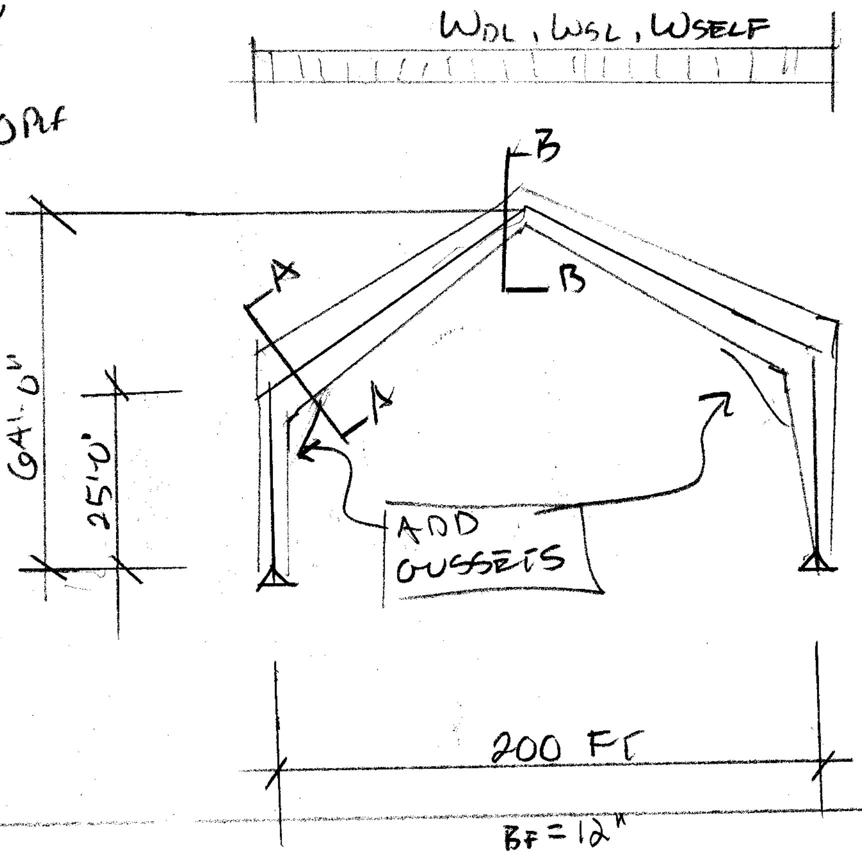
TRIB = 30 FT O.C.

$W_{DL} = [\underbrace{5psf}_{ROOF} + \underbrace{5psf}_{SOLAR}]30 = 300PLF$

$W_{SL} = (25)(30) = 750PLF$

$W_{SELF} \approx 140$ PLF

$W_{TOT} = 1190$ PLF



ANALYSIS

$\frac{M_n}{\Omega} = \frac{770 \times 50}{12 \times 1.67} = 1921$ K-FT

$M = 2213$

∴ OVERSTRESSED

$A = 43.59 in^2$

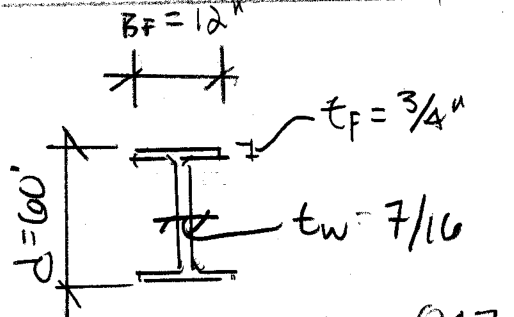
$I_x = 23097 in^4$

$I_y = 210 in^4$

$S_x = 770 in^3$

$S_y = 43 in^3$

$W_{SELF} = 148$ PLF



A-A

$Z_x = 847$

$\frac{M_n}{\Omega} = \frac{501 \times 50}{12 \times 1.67} = 1250$

$M > 665$ K-FT

$A = 35.34 in^2$

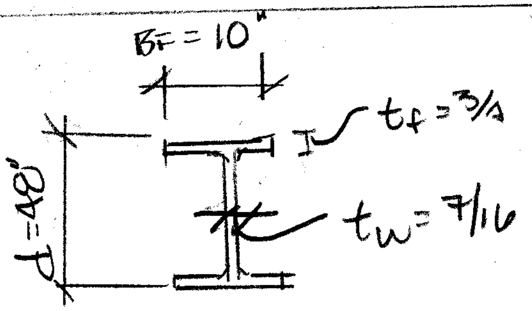
$I_x = 12038 in^4$

$I_y = 125 in^4$

$S_x = 501 in^3$

$S_y = 25 in^3$

$W_{SELF} = 120$ PLF



B-B

$Z_x = 551$

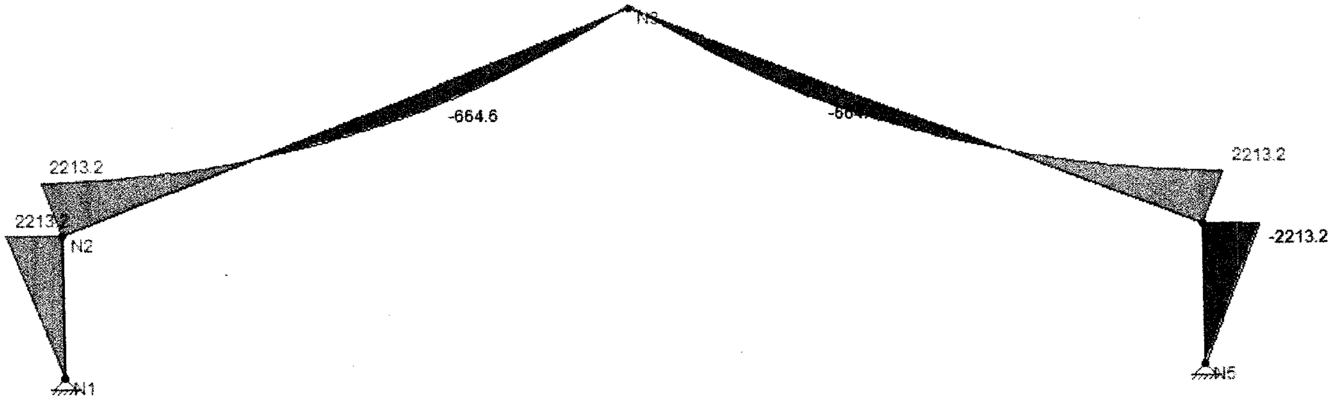
Project: OSU Solar

Corvallis, OR

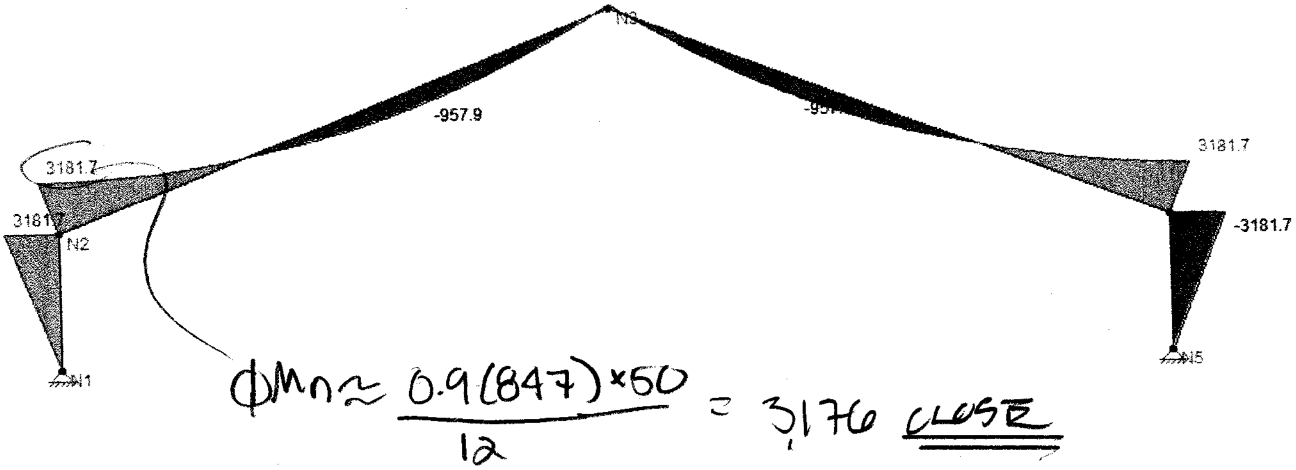
Client: **Canadian Solar**

Date: 8/24/17
Page: D8
By:
Job #: 217195

Moment Diagram (k-ft) - ASD



Moment Diagram (k-ft) - LRFD



$\phi M_n \approx \frac{0.9(847)\times 50}{12} = 3{,}176$ CLOSE

Project: OSU Solar

Corvallis, OR
Client: **Canadian Solar**

Date: 8/24/17
Page: D9
By:
Job #: 217195

CALCULATE % SOLAR TO PREVENT OVERSTRESS

$M_{100\%} = 2213$ K-FT

$\frac{M_n}{\Omega} = 1921$ K-FT

TOTAL LOAD = 40 psf [100% SOLAR + FRAME WT]

$q_{DESIRED} = \frac{1921}{2213}[40] = 34$ psf

% SOLAR = 0% ← UPGRADE FRAME

E) VALLEY SPORTS CENTER (FOOTBALL)

E2

VALLEY SPORTS

Project: OSU Solar

Corvallis, OR

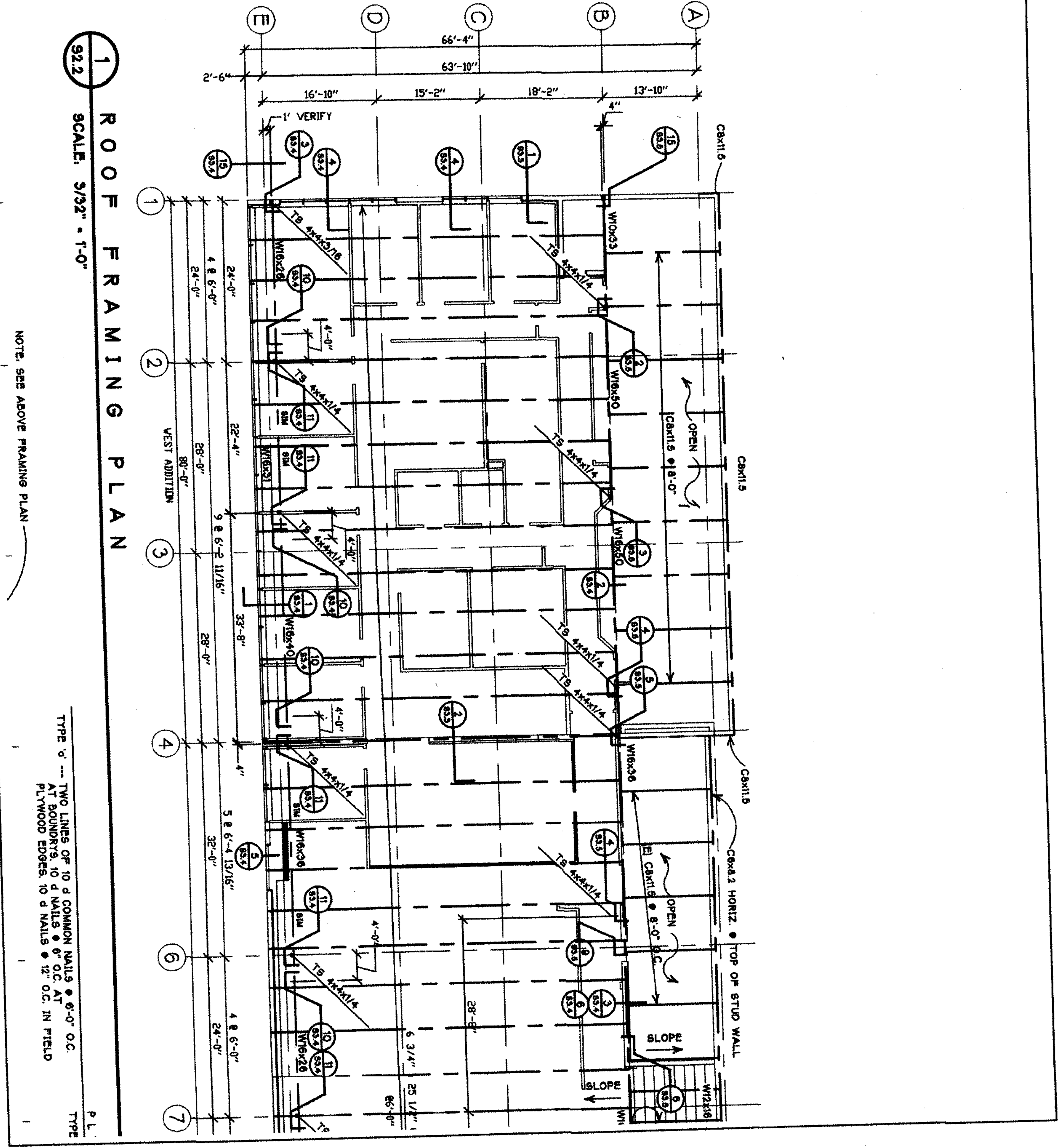
Client: **Canadian Solar**

Date: 8/24/17

Page: E3

By:

Job #: 217195



Project: OSU Solar

Corvallis, OR

Client: **Canadian Solar**

Date: 8/24/17
Page: EA
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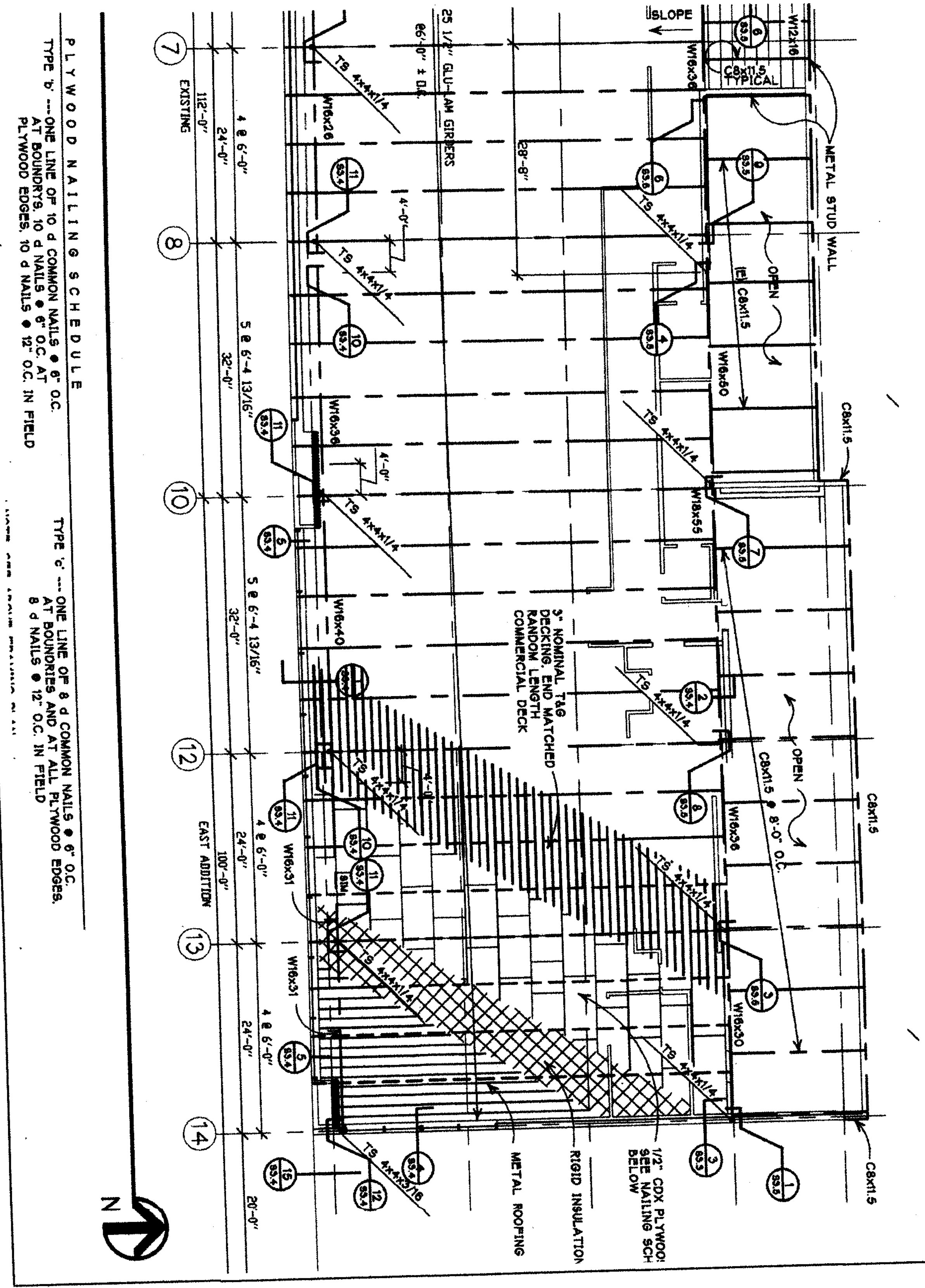

3" T&G DECKING (NOMINAL)

SPAN = 6 FT

MASS SUMMATION

3" T&G = 6.5 psf
1/2" PLYWOOD = 1.25
METAL ROOF = 1 psf
RIGID INSULATION = 2 psf
MISC. = 2 psf

$W_{DL} = 12.75 \rightarrow$ USE 13 psf

SOLAR = 5 psf

SNOW = 25 psf

$$q = (5+13+25) = 43 \text{ psf}$$

$$M = \frac{wl^2}{10} \text{ (2-SPAN)}$$

$$M = 155 \text{ lB-FT}$$

$$S_{REQ'D} = \frac{M \times 12}{1200\underbrace{(1.15)}_{\text{REP.}}\underbrace{(1.15)}_{\text{LOAD DURATION}}} = 1.17 \text{ in}^3$$

$$S_{ACTUAL} = \frac{12" \times 2.5^2}{6} = 12.5 \text{ in}^3 \quad \therefore \text{T\&G } \underline{\text{OK}}$$

GLU-LAM BEAMS (6¾ × 25½) – 1.8E

TRIB = 6'-0" OC.

DL = 13

SOLAR = 5

SELF WT = $\frac{36 \text{ PLF}}{6 \text{ FT OC.}}$ = 6 PSF

q_{DL} = 24 psf

W_{DL} = 144 plf

SL = 25 psf

W_{SL} = 150 PLF

W_{TOT} = 294 PLF

SPAN = 49 FT

$$M = \frac{wl^2}{8} = 88.2 \text{ K-FT}$$

$$M_{ALL} = F_b C_V C_L S_x \tfrac{1}{12}$$

$$S_x = \frac{6.75 \times 25.5^2}{6} = 731 \text{ in}^3$$

C_L = 1.15 (SNOW)

$$C_V = (21/49)^{\frac{1}{10}}(12/25.5)^{1/10}(5.125/6.75)^{1/10} = 0.83$$

F_b = 2400 psi

M_{ALL} = 139.6 K-FT ≥ 88.2 OK

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Page: E7
By:
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STEEL BEAMS SUPPORTING RAFTERS

NORTH SIDE (W18×55)

L = 28'-0", LB = 6FT OC

TRIB = $\frac{64}{2}$ = 32 FT

DL = 24 psf (INCLUDES SOLAR)

SL = 25

$W = 32(24+25) + 55$
$W = 1623$

$M = \frac{wl^2}{8} = 159$ K-FT

$\frac{Mn}{\Omega} = \frac{98.3 \times 50}{1.67 \times 12} = 245$ K-FT

✓

SOUTH SIDE (W16×40)

L = 28'-0", LB = 6FT OC.

TRIB = $\frac{49}{2} + 3.5 = 28$ FT

DL = 24

SL - 25

$W = 28(24+25) + 40$
$W = 1412$

$M = \frac{wl^2}{8} = 138$ K-FT

$\frac{Mn}{\Omega} = \frac{64.7 \times 50}{1.67 \times 12} = 161$ K-FT

✓