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Team Crowder College – Drury University

Project Manual

August 17, 2015

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON 2015

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Table of Contents

Summary of Changes

Significant changes to the project manual that have occurred between submissions have been outlined below. The Construction Drawings should also be reviewed for relevant revisions.

Revision 1 to Design Development Documents: November 18, 2014

The Project Manual has been updated from the previous issue. Revisions include:

- Rules Compliance Checklist
- Interconnection Application Form
- Water Budget
- Structural revised Lateral Load Analysis

Revision 2 to Construction Documents: March 26, 2015

The following Construction Drawing sheets have been revised:

- A-102 Roof Plan and Details
- A-201 Elevations
- A-202 Elevations & Fence Details
- A-203 Cladding Schedule and Details
- A-301 Building Sections and Interior Elevations
- A-302 Wall Sections
- S-101 Foundation Plan and Details
- S-401 Steel Details
- S-402 Steel Details
- E-101 Distribution Plan
- E-102 PV Wiring Diagram
- E-602 Three Line Diagram
- E-603 Service Panel Schedule

The Project Manual has been updated from the previous issue. Revisions include:

- Summary of Changes
- Rules Compliance Checklist
- Structural Analysis Calculations
- Division 26 Electrical

Revision 3 to Construction Documents: August 17, 2015

The following Construction Drawing sheets have been revised:

- G-001 Cover Page

- G-002 Sheet Index
- G-201 Ground Contact
- H-101 Spill Containment Plan and Details
- L-101 Landscape Plan and Details
- L-102 Deck
- S-101 Foundation Plan and Details
- S-401 Steel Details
- S-402 Steel Details
- A-101 Floor Plan and Reflected Ceiling Plan
- A-102 Roof Plan and Details
- A-201 Elevations
- A-202 Elevations & Cladding Details
- A-203 Cladding Schedule and Details
- A-301 Building Sections and Interior Elevations
- A-302 Wall Sections
- A-401 Fence Units and Details
- A-402 Fence Panels and Brackets
- A-403 Kitchen Cabinets
- A-404 Bathroom Details
- A-405 Cabinet Details
- E-603 Service Panel Schedule

The Project Manual has been updated from the previous issue. Revisions include:

- Summary of Changes
- Rules Compliance Checklist
- Division 05 Metals
- Division 06 Wood, Plastics and Composites
- Division 07 Thermal and Moisture Protection
- Division 08 Openings
- Division 11 Equipment
- Division 12 Furnishings
- Division 21 Fire Suppression
- Division 22 Plumbing
- Division 23 Central Heating Equipment
- Division 26 Electrical
- Division 32 Exterior Improvement

Rules Compliance Checklist

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	O-101 O-901 O-902
Rule 4-2	Construction Equipment	Specifications for heavy machinery	N/A
Rule 4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	G-201
Rule 4-4	Impact within the Solar Envelope	Drawing(s) showing the location, contact area, and bearing pressure of every component resting directly within the solar envelope	G-201 See structural Calculations
Rule 4-5	Generators	Specifications for generators (including sound rating)	N/A
Rule 4-6	Spill Containment	Drawing(s) showing the locations of all equipment, containers, and pipes that will contain liquids at any point during the event	H-101
Rule 4-6	Spill Containment	Specifications for all equipment, containers, and pipes that will contain fluids at any point during the event	21 10 00
Rule 4-7	Lot Conditions	Calculations showing that the structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	PM-Pages S- Series Drawings
Rule 4-7	Lot Conditions	Drawing(s) showing shimming methods and materials to be used if 18 in. (45.7 cm) of vertical elevation change exists on the lot	A-302
Rule 5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	L-101 A-201 A-301
Rule 5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	N/A
Rule 6-1	Structural Design Approval	List of, or marking on, all drawing and project manual sheets that will be stamped by the qualified, licensed design professional in the stamped structural submission; the stamped submission shall consist entirely of sheets that also appear in the drawings and project manual	See Structural Calculatoins S- Series Drawings
Rule 6-2	Finished Square Footage	Drawing(s) showing all information needed by the rules officials to measure the finished square footage electronically	G-101

Rule 6-2	Finished Square Footage	Drawing(s) showing all movable components that may increase the finished square footage if operated during contest week	N/A
Rule 6-3	Entrance and Exit Routes	Drawing(s) showing the accessible public tour route	G-101
Rule 7-1	Placement	Drawing(s) showing the location of all vegetation and, if applicable, the movement of vegetation designed as part of an integrated mobile system	L-101
Rule 7-2	Watering Restrictions	Drawing(s) showing the layout and operation of greywater irrigation systems	N/A
Rule 8-1	PV Technology Limitations	Specifications for photovoltaic components	Division 48
Rule 8-3	Batteries	Drawing(s) showing the location(s) and quantity of all primary and secondary batteries and stand-alone, PV-powered devices	N/A
Rule 8-3	Batteries	Specifications for all primary and secondary batteries and stand-alone, PV-powered devices	N/A
Rule 8-4	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	N/A
Rule 8-4	Desiccant Systems	Specifications for desiccant system components	N/A
Rule 8-5	Village Grid	Completed interconnection application form	PM Page 99
Rule 8-5	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-102, E-602
Rule 8-5	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	48 10 00
Rule 8-5	Village Grid	One-line electrical diagram	E-601
Rule 8-5	Village Grid	Calculation of service/feeder net computed load per NEC 220	E-603
Rule 8-5	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	G-101 L-101, E-101
Rule 8-5	Village Grid	Elevation(s) showing the meter housing, main utility disconnect, and other service equipment	E-101
Rule 9-1	Container Locations	Drawing(s) showing the location of all liquid containers relative to the finished square footage	L-101
Rule 9-1	Container Locations	Drawing(s) demonstrating that the primary supply water tank(s) is fully shaded from direct solar radiation between 9 a.m. and 5 p.m. PDT or between 8 a.m. and 4 p.m. solar time on October 1	L-101

Rule 9-2	Team-Provided Liquids	Quantity, specifications , and delivery date(s) of all team-provided liquids for irrigation, thermal mass, hydronic system pressure testing, and thermodynamic system operation	O-102 Division 21 Division 22
Rule 9-3	Greywater Reuse	Drawing(s) showing the layout and operation of greywater reuse systems	N/A
Rule 9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	N/A
Rule 9-6	Thermal Mass	Drawing(s) showing the locations of liquid-based thermal mass systems	N/A
Rule 9-6	Thermal Mass	Specifications for components of liquid-based thermal mass systems	N/A
Rule 9-7	Greywater Heat Recovery	Drawing(s) showing the layout and operation of greywater heat recovery systems	N/A
Rule 9-8	Water Delivery	Drawing(s) showing the complete sequence of water delivery and distribution events	O-102
Rule 9-8	Water Delivery	Specifications for the containers to which water will be delivered	22 12 00
Rule 9-9	Water Removal	Drawing(s) showing the complete sequence of water consolidation and removal events	O-102
Rule 9-9	Water Removal	Specifications for the containers from which water will be removed	22 12 00
Rule 11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	G-101

Structural Calculations

Structural Calculations | Team Drury
Solar Decathlon 2015 | March 24, 2015

STRUCTURAL CALCULATIONS-INTRODUCTION

Team Drury has chosen to design a three module dwelling. The outer modules will be used for sleeping quarters and kitchen and bath facilities, and the center module will be the primary gathering room.

The loads for the design of the dwelling were taken from the International Residential Code (IRC-2012), the International Building Code (IBC-2012), and the American Society of Civil Engineers Standard ASCE 7-10. The California Residential Code (CRC-2013) was also consulted to rectify any differences between the CRC and the IBC and ASCE. In addition, due to the frequent nature of tornados in and around Springfield, Missouri, Team Drury felt that analysis for tornado forces would prove beneficial for the eventual owner of the dwelling. However, tornado load analysis is not formally addressed in the building code standards. Journal articles for tornado forces on buildings were consulted to formulate a general design guide for the tornado forces. Load analysis can be found in section 1 of the calculations.

Section 2 of the calculations addresses loading on individual members, the sheathing used on the floors and walls for diaphragms, and the connections of the modules to each other. Dead Load, floor and roof Live Loads, Snow Loads, and Rain Surcharge Loads are addressed in section 2. In addition, analysis of wind and earthquake load requirements on individual members was included. Information and codes used here include the American Institute of Steel Construction (AISC) Manual of Steel Construction 13th Addition, National Design Specifications for Wood Construction (NDS 2005), and the American Plywood Association (APA) documents.

Section 3 of the calculations looks at the stability of the dwelling under lateral loads, which include wind, earthquake, and tornado loads (tornado loads to be finalized). In general, tornado loading will control the lateral load stability requirements. However, due to the seismic activity at the California-based competition location, earthquake loading requires some discussion.

For seismic loading, the lateral force resisting system consists of light-framed shear walls with wood structural panels rated for shear resistance. The seismic loads from the walls will be split between the floor and roof diaphragms, with the seismic loads from the roof and floor collected in the roof and floor diaphragms respectively. The roof diaphragms will transfer the seismic loading from the roof, through the wall diagrams and into the floor diaphragms. Because the roofs, walls, and floors are sheathed with wood sheathing inside and out, the attachment for seismic load transfer will be adequate, with the double panel systems creating more than enough shear capacity. The seismic loading will be transferred to the proprietary seismic piers designed similarly to those manufactured by Central Piers. The piers are equally spaced under the modules, so little if any load transfer through collector elements or drag struts are needed. According to Central Piers' literature, the piers used will provide California, code-required support for gravity and lateral load stability when placed on approved, wood-sheathing bearing plates. EPDM rubber matting will be used between the wood sheathing and the asphalt pavement of the exhibition site for frictional resistance to lateral movement. This will be the case for the decks and ramps.

Please see the remaining calculations for more specifics on load analysis for the dwelling.

Structural Calculations
Solar Decathlon 2015

Team Drury
March 24, 2015

STRUCTURAL CALCULATIONS

Section — Page

SECTION 1
LOAD ANALYSIS

Structural Calculations
Solar Decathlon 2015

Team Drury
February 12, 2015
1-2

LOAD ANALYSIS INTRODUCTION

The calculations in this section define the load parameters for the analysis. The following information and codes were consulted for the load analysis parameters:

- International Residential Code (IRC) 2012
- International Building Code (IBC) 2012
- California Residential Code ((CRC) 2013
- American Society of Civil Engineers Standard ASCE 7-10
- Tornado Research Papers-See References at the End of Tornado Loads Section

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Design Gravity Loads (ASCE 7-10 Table C3-1)

Roof DL (Modules)

Cover	=	2 PSF
Deck	=	2 PSF
Framing	=	6 PSF
Insulation	=	3 PSF
Ceiling	=	2 PSF
MPE	=	2 PSF
		17 PSF

Floor DL (Module)

Cover	=	4 PSF
Deck	=	2 PSF
Framing	=	6 PSF
Insulation	=	3 PSF
Ceiling	=	2 PSF
MPE	=	2 PSF
		19 PSF

Roof DL (Center)

Cover	=	2 PSF
Deck	=	3 PSF
Framing	=	8 PSF
Insulation	=	6 PSF
Ceiling	=	2 PSF
MPE	=	2 PSF
		23 PSF

Floor DL (Center)

Cover	=	4 PSF
Deck	=	2 PSF
Framing	=	6 PSF
Insulation	=	3 PSF
Bottom Cover	=	2 PSF
MPE	=	2 PSF
		19 PSF

Floor DL (Deck)

Same as above = 19 PSF

Wall DL (Typical Ext)

Ext. Cover	=	1 PSF
Sheathing	=	2 PSF
Studs	=	5 PSF
Insulation	=	1 PSF
Sheathing	=	2 PSF
Cover	=	1 PSF
MPE	=	1 PSF
		13 PSF

Wall DL (Glass Door)

Total Assume = 12 PSF

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LIVE LOADS (ASCE 7-10 TABLE 4-1)

PUBLIC ROOMS & CORRIDORS SERVING THEM = 100 PSF
DECK (CONSIDER AS PUBLIC ROOM) = 100 PSF
BEDROOM/KITCHEN = 50 PSF

SNOW LOADS (ASCE 7-10, CH. 5)

IRVINE, CA REQUIREMENTS

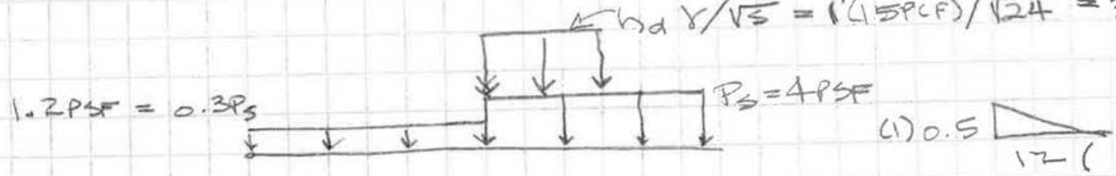
GROUND SNOW LOADS $P_g = 5$ PSF
FLAT ROOF SNOW $P_F = 0.7 C_e C_t I_s P_g$
$P_F = 0.7(1.1)(1.0)(1.0)(5 PSF)$
$C_e = 1.1$ (EXP. C, SHELTERED)
$C_t = 1.0$ (HEATED)
$P_F = 4$ PSF

MINIMUM LOW-SLOPE $P_m = I_s P_g$
$P_m = 5$ PSF
(NO DRIFT, ETC.)

SLOPED ROOF SNOW $P_S = C_S P_f = 4$ PSF
$C_s = 1.0$ (SLOPE < 1:12)

EDGE LOAD $P_{LINE} = 2 P_f$
$P_{LINE} = 8$ PSF (FOR UPSLOPE)
(NO OTHER LOAD)

UNBALANCED SNOW
$\gamma = 0.13 P_g + 14 = 15$ PCF
$h_d \gamma / \sqrt{S} = (1)(15 PCF)/\sqrt{24} = 3$ PSF



$\frac{0.5}{12} = \frac{1}{S}$
$S = 24$

DRIFTS:
$\frac{h_c}{h_b} = \frac{2'}{4 PSF / 15 PCF} = 7.5$ CONTROLS
LEEWARD $h_d = 1.0' \rightarrow P_D = 15$ PSF, $W = 4 h_d = 4'$
WINDWARD $h_d = 0.75' \rightarrow P_D = 11.25$ PSF, $w = 4 h_d^2 / h_c = 1.125$

SLIDING = $0.4 P_f W = 0.4 (4 PSF)(10')/8' = 2$ PSF MAX
RAIN = 5 PSF

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SNOW LOADS (CONT'D)

SPRINGFIELD/NEOSHO, MO

GROUND SNOW LOADS $P_g = 18\ PSF$

FLAT ROOF SNOW $P_F = 0.7 C_e C_t I_s P_g$

$P_F = 0.7(1.1)(1.0)(1.0)(18PSF)$

$C_e = 1.1$ (EXP. C, SHELTERED)

$C_t = 1.0$ (HEATED)

$P_F = 14\ PSF$

MINIMUM LOW SLOPE $P_M = I_s P_g$

$P_M = 18\ PSF$ (NO DRIFT, ETC.)

SLOPED ROOF SNOW $P_S = C_S P_F$

$P_S = 1.0(14PSF)$

$P_S = 14\ PSF$

$C_S = 1.0$ (SLOPE < 1:12)

EDGE LOAD $P_{LINE} = 2P_F$

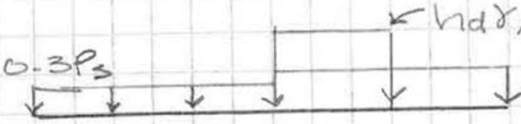
$P_{LINE} = 28\ PSF$ (FOR UP SLOPE) (NO OTHER LOADS)

UNBALANCED SNOW

$\gamma = 0.13P_g + 14 = 16.3\ PSF$

$\leftarrow h_d \gamma / \sqrt{S} = 1.2'(16.3PSF)/\sqrt{24} = 4\ PSF$

$4.2^{PSF} = 0.3P_S$



$P_S = 14\ PSF$

DRIFTS

$\frac{h_c}{h_b} = \frac{2'}{14PSF/16PCF} = 2.3$

← CONTROLS

LEEWARD $h_d = 1.2' \rightarrow P_D = 17PSF$, $w = 4h_d = 5'$

WINDWARD $h_d = 0.9' \rightarrow P_D = 15PSF$, $w = 4h_d^2/h_c = 2'$

SLIDING $= 0.4 P_f w = 0.4(14PSF)(10')/8' = 7PSF$

RAIN $= 5PSF$

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WIND LOADS

IRVINE, CA (ASCE 7-10 CH. 26, 27)

BASIC WIND SPEED	V	= 110 MPH
WIND DIRECTIONALITY FACTOR	(K_d)	= 0.85 (MWFRS & C&C)
EXPOSURE CATEGORY		= C
TOPO FACTOR	(K_{zt})	$= (1 + K_1 K_2 K_3)^2 \doteq 1.0$
GUST EFFECT FACTOR	(G)	= 0.85
ENCLOSURE CLASS		= ENCLOSED (BLDG)
		= OPEN (DECKS)
INTERNAL PRESSURE COEFF		= ±0.18 (ENCLOSED)

MWFRS DIRECTIONAL PROCEDURE USED (CH. 27, PART 2)

RISK CATEGORY (TABLE 1.5-1)		= II
WIND SPEED	V	= 110 MPH
EXPOSURE		= C
TOPO		= 1.0
GUST		= 0.85
ENCLOSED		

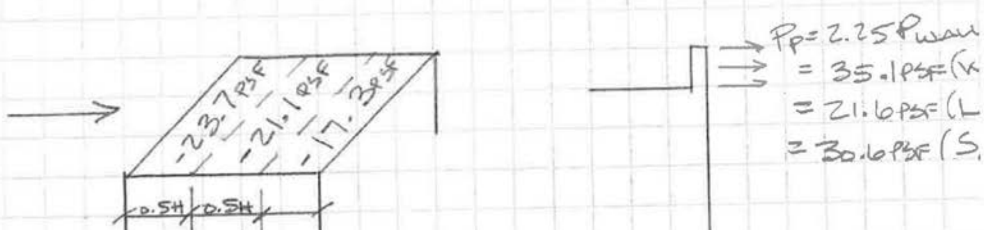
WIND LOAD WALLS (CLASS 2 BLDG)

$L/B_1 = 38/35 \doteq 1.0$

$L/B_2 = 35/38 \doteq 1.0$

WINDWARD + LEEWARD	= 25.2 PSF
SIDEWALL	= 0.54 (25.2 PSF) = 13.6 PSF
WINDWARD	= 25.2 PSF (0.62) = 15.6 PSF
LEEWARD	= 25.2 PSF (0.38) = 9.6 PSF

WIND LOAD ROOFS (FLAT SINCE θ<10°)



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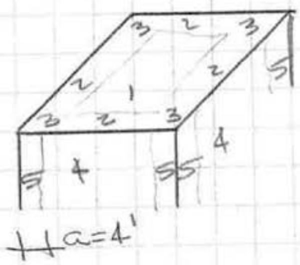
1-7

WIND LOADS (CONT'D)

IRVINE, CA (CONT'D)

COMPONENTS & CLADDING (PART 2 SIMPLIFIED)

$P_{NET} = \lambda K_{zt} P_{net30} = 1.2(1.0) P_{net30}$



1	(500 SF +)	7.0 PSF / -19.9 PSF
2	(100 SF)	7.0 PSF / -23.6 PSF
3	(16 SF)	8.5 PSF / -50 PSF
4	(20 SF)	18 PSF / -20 PSF
5	(30 SF)	20 PSF / -22 PSF

w/ λ FACTOR

1	(500 SF +)	8.4 PSF / -24 PSF
2	(100 SF)	8.4 PSF / -28 PSF
3	(16 SF)	10.2 PSF / -60 PSF
4	(20 SF)	21.6 PSF / -24 PSF
5	(30 SF)	24 PSF / -26 PSF

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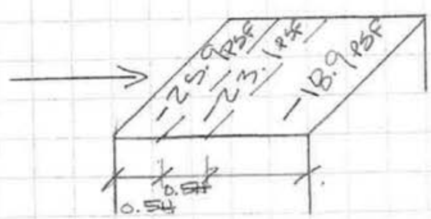
WIND LOADS

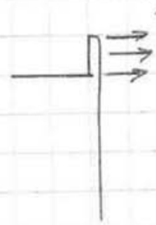
SPRINGFIELD/NEOSHO, MO (ASCE 7-10 CH. 26,27)

BASIC V = 115 MPH
K_d = 0.85
EXPOSURE = C
TOPO K_{zt} = 1.0
G = 0.85
ENCLOSED

CLASS 2 BLDG (L/B ≈ 1.0 E W)
WINDWARD + LEE = 27.6 PSF
WINDWARD = 17.1 PSF
LEEWARD = 10.5 PSF
SIDE WALLS = 14.9 PSF

ROOF WIND LOADS (θ<10°)



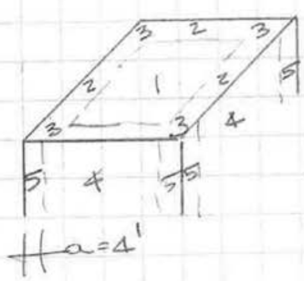


P_P = 2.25 P_{WALL}
= 38.5 PSF (W)
= 23.5 PSF (L)
= 33.5 PSF (S)

NO TORSIONAL EFFECTS REQ'D FOR 1-2 FAM RESIDENTIAL

COMPONENTS + CLADDING (PART 2 SIMPLIFIED)

$P_{NET} = \lambda K_{zt} P_{NET30} = 1.2(1.0) P_{NET30}$



1 (50SF +) 7.7PSF/-21.8PSF
2 (100SF) 7.7PSF/-25.3PSF
3 (16SF) 9.3PSF/-55PSF
4 (200SF) 19PSF/-21PSF
5 (30SF) 22PSF/-29PSF

W/ λ FACTOR

1 (50 +) 9.2PSF/-26.2PSF
2 (100SF) 9.2PSF/-31PSF
3 (16SF) 11.2PSF/-66PSF
4 (200SF) 22.8PSF/-25PSF
5 (30SF) 26.4PSF/-35PSF

1-9

EARTHQUAKE LOADS

IRVINE, CA (ASCE 7-10, USGS WEB TOOL)

FROM USGS

$S_{DS} = 1.024$
$S_{D1} = 0.544$

PER 12.14 IBC, USE SIMPLIFIED DESIGN

$a \leq d/5 \Rightarrow a = 0'\pm$
$d/5 = 38/5 \leq 7$

BASE SHEAR

$V = \frac{F S_{DS} W}{R} = \frac{1.0(1.02)}{6.5} w = 0.157 W$

$S_{DS} = 1.02$
$R = 6.5$

$W_{RF} = 17PSF(8')(31') + 17PSF(11')(34') + 23PSF(19')(25')$
$= 21.5 K$
$W_{WALL} = 13PSF(8')(22' + 62') + 13PSF(8)(16' + 68') + 12PSF(8')(19')(2)$
$= 21.1 K$
$W_{ROOF} = 19PSF(8')(31') + 19PSF(11')(34') + 19PSF(19')(25')$
$= 20.8K$

$V = 0.157(63.4^K) = 9.95^K$

ELEMENTS OF STRUCTURE

VERTICAL

$E_V = 0.2 S_{DS} D = \underline{0.20D}$

WALL

$E_H = 0.4 k_a S_{DS} W_p = 0.4(2.0)(1.02) w_p = \underline{0.82 W_p}$

OTHER

$E_H = \frac{0.4 a_p S_{DS} W_p (1 + 2 z/h)}{(R_p/I_p)}$ SUBJECT TO $E_H > 0.3 I W$, $E_H < 1.7 W$

$E_H = \frac{0.4(1.0)(1.02)(1+2(1.0))}{(2.5/1.0)} = \underline{0.50 W}$

1-10

USGS Design Maps Summary Report

User–Specified Input

Report Title Irvine, California
Thu October 9, 2014 14:32:27 UTC

Building Code Reference Document 2012 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 33.68596°N, 117.82613°W

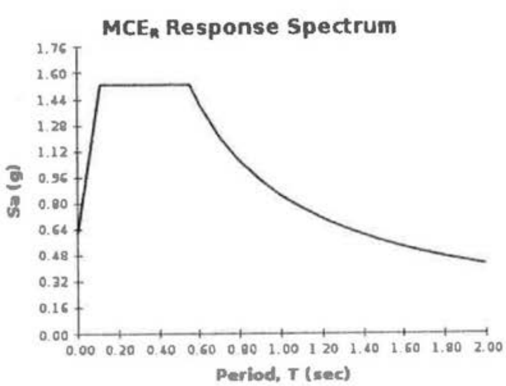
Site Soil Classification Site Class D – "Stiff Soil"

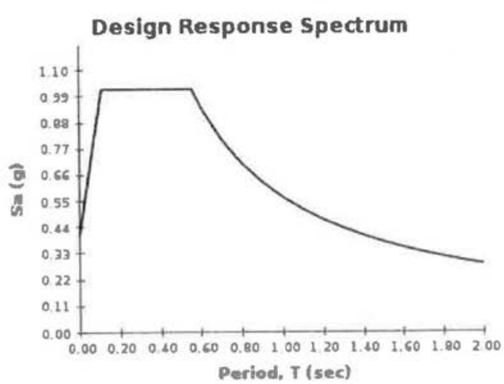
Risk Category I/II/III

USGS–Provided Output

S_S =	1.529 g	S_{MS} =	1.529 g	S_{DS} =	1.020 g
S_1 =	0.564 g	S_{M1} =	0.847 g	S_{D1} =	0.564 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





1-11

USGS Design Maps Detailed Report

2012 International Building Code (37.21546°N, 93.29631°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1] $S_S = 0.193$ g

From Figure 1613.3.1(2) [2] $S_1 = 0.104$ g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index $PI > 20$, • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_s \le 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_s

For Site Class = D and S_s = 0.193 g, F_a = 1.600

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.104 g, F_v = 2.386

Equation (16-37):	$S_{MS} = F_aS_S = 1.600 \times 0.193 = 0.309$ g
Equation (16-38):	$S_{M1} = F_vS_1 = 2.386 \times 0.104 = 0.247$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39):	$S_{DS} = ⅔\ S_{MS} = ⅔ \times 0.309 = 0.206$ g
Equation (16-40):	$S_{D1} = ⅔\ S_{M1} = ⅔ \times 0.247 = 0.165$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.206 g, Seismic Design Category = B

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.165 g, Seismic Design Category = C

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = C

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

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USGS Design Maps Summary Report

User–Specified Input

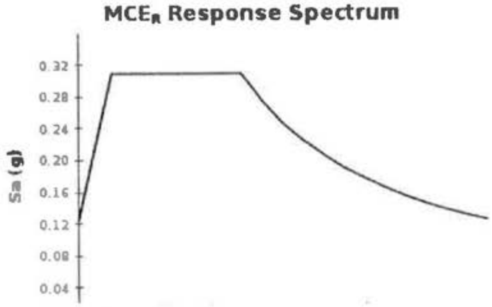
Report Title	Springfield/Neosho, MO Thu October 9, 2014 14:39:01 UTC
Building Code Reference Document	2012 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	37.21546°N, 93.29631°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

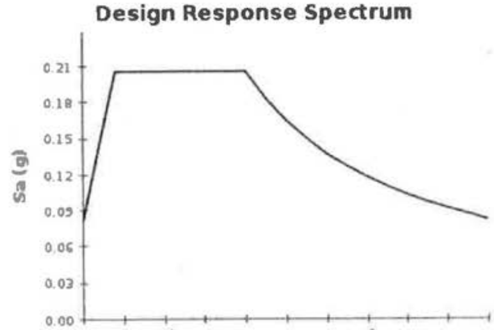
S_S =	0.193 g	S_{MS} =	0.309 g	S_{DS} =	0.206 g
S_1 =	0.104 g	S_{M1} =	0.247 g	S_{D1} =	0.165 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE_R Response Spectrum



Design Response Spectrum



http://ehp2-earthquake.wr.usgs.gov/designmaps/us/summary.php?template=minimal&latit... 10/9/2014

Design Maps Summary Report

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

USGS Design Maps Detailed Report

2012 International Building Code (33.68596°N, 117.82613°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1] S_S = 1.529 g

From Figure 1613.3.1(2) [2] S_1 = 0.564 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20, • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

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Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_S

For Site Class = D and S_s = 1.529 g, F_a = 1.000

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1-s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.564 g, F_v = 1.500

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Equation (16-37): $S_{MS} = F_aS_S = 1.000 \times 1.529 = 1.529$ g

Equation (16-38): $S_{M1} = F_vS_1 = 1.500 \times 0.564 = 0.847$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39): $S_{DS} = ⅔ S_{MS} = ⅔ \times 1.529 = 1.020$ g

Equation (16-40): $S_{D1} = ⅔ S_{M1} = ⅔ \times 0.847 = 0.564$ g

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Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.020 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.564 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = D

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

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Solar Decathlon

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LATERAL LOAD ANALYSIS-TORNADO

Introduction

Tornado load analysis is not part of code-required design analysis. However, due to the frequent nature of tornados in and around Springfield, Missouri, Team Drury felt that analysis for tornado forces would prove beneficial for the eventual owner of the dwelling. However, with no code-requirements for tornado analysis, where do we begin with such an analysis?

The study of tornados is not a recent phenomenon. Evidence is available that indicates efforts to understand tornados have been undertaken for hundreds of years. More recent efforts include observational attempts to define tornado characteristics, laboratory and semi-empirical attempts at quantifying tornado forces on structures, and tornado simulation and interaction with buildings with computational fluid dynamic (CFD). Fortunately scientific understanding of tornados has accelerated during the latter half of the 20th century and into the 21st century. The study of tornado forces in the past twenty years has led to publications that outline force coefficients for tornado forces similar to those used in straight wind code provisions such as those found in ASCE7.

Early Attempts to Define Tornado Characteristics

One of the earliest records of a tornado in the United Sates was recorded in 1812 during the War of 1812. British Troops had surrounded Washington D.C. in 1814 with the intent to burn it to the ground. The White House was torched and the planned destruction of the capitol was underway; however, a tornado reportedly tracked through the captiol on August 25, 1814. The force of the storm and the subsequent rainfall killed or wounded more British Soldiers than all the firearms of the American troops. The rainfall extinguished the fires set by the British. As a result, a tornado was credited for saving the United States Capitol (Dole 2007). Most records of tornados, though, are not as encouraging. A report of a tornado from 1851 in Middlesex County Massachusetts spoke of trees decapitated, roofs of houses taken and not found, and crops buried in the ground (Brooks et al, 1852).

Observational Attempts to Define Tornado Characteristics

Later attempts were made to scientifically document tornado wind speeds and forces associated with tornado winds. Using movies of high quality and methods of photogrammetry and perspective, Hoecker (1960) as able to measure the tangential wind speed in the Dallas, Texas tornado of April 02, 1957. The tangiential wind speed was estimated as 170 mph. The upward, vertical wind speed was estimated as 150 mph. Fujita (1971) took these observations and along with his own developed a widely used classification for tornado force intensity know as the Fujita Scale. The intensity of tornados was based on damage assessment, classifying tornado wind intensity into six major classifications to speed up the damage assessment. The Fujita Scale has been used successfully to quickly quantify damage assessment. Following after Fujita, Mehta, et. al. (1976) used building damage information and material resistance to wind speed and back-calculated the wind speeds in the tornado outbreak of April 3-4, 1974. The analysis relied on then current code design and analysis principles to determine the approximate wind speed in the tornado outbreak. The tornado outbreak was initially assigned a probable maximum wind speed of 250-275 mph. However, the engineering analysis concluded that:

- Wind speeds in the tornado outbreak were generally less than the upper bound values of 250-275 mph that were previously estimated.
- Wind, not atmospheric pressure change, was the governing cause of building failure.
- Correlation of damage to wind speed was problematic for wind speeds exceeding approximately 175 mph.
- Building connectivity was a leading indicator of building component loss.

Davis-Jones and Kessler (1974) also doubted wind speeds in excess of 300 mph that were historically assigned to large-scale tornados.

Recent advances in meteorological devices have provided a means to determine tornado characteristics. Lee et al (2004) and Karstens et al (2010) describe the characteristics of a number of tornados that have been intercepted with In-situ Hardened Pressure Probes, Video Probes, and Mobile Mesonet Intrumentation since 2002. These interceptions have enabled meteorologists to report rough estimates of tornado size, translational velocity, and rotational velocity. Whereas these estimates are by no means concrete, they do serve as a starting point for understanding tornado size and wind characteristics. Table 1-1 shows the translational and rotational velocities and comparative size of intercepted tornados with respect to some common structures sizes (ratio of tornado radius to structure diameter or length).

Table 1-1. Illustration of Tornado Velocities from Karstens et al (2010) and Lee et al (2004) and Tornado Comparison to Common Structure Sizes.

Tornado	Translate Velocity (V_t) (m/s)	Rotate Velocity (V_θ) (m/s)	Tornado Radius (m)	Power Pole (R_{tor}/D_{str})	20 m Bldg. (R_{tor}/L_{str})
Stratford, TX (05-15-2003)	15	106	400	100+	20
Manchester, SD (06-24-2003)	9.4	98	96	24+	4.8

Laboratory Simulation of Tornado Forces

The next logical step to tornado understanding was laboratory simulation. Chang was commonly credited with producing the first laboratory simulation of a tornado, a schematic of which is shown in Figure 1-1 (Millet 2003, Fouts 2003). He was able to:

- Visualize the vortex with smoke;
- Control circulation;
- Avoid buoyancy affects with a high fan location;
- Create constant vertical pressure except in the core;
- Measure velocity profiles (tangential, radial, and vertical) with varying size of tornado cores;
- Measure pressure distribution.

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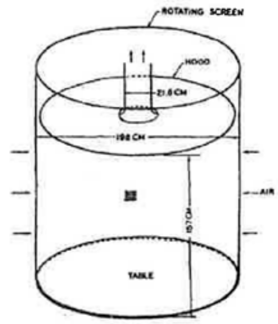

Figure 1-1: Schematic of the Chang Laboratory Simulator (Fouts 2003)

He found that static pressure and tangential velocity depended on the distance from center except in the vortex core region, where the probes in the flow skewed the results. Ward was credited with creating what is referred to as the Ward Simulator, a schematic of which is shown in Figure 1-2 (Fouts 2003). It was a chambered simulator. The lower chamber was for the convergent zone. The lower chamber was separated from the circular convection zone, or vortex chamber, by a rotating circular screen. Above the vortex chamber was a honeycomb screen. The screen separated the vortex chamber from a fan. The fan created inflow at the bottom of the simulator and updraft in the vortex chamber. The tangential velocity was controlled by the rotating screen and the radial velocity by the exhaust fan.

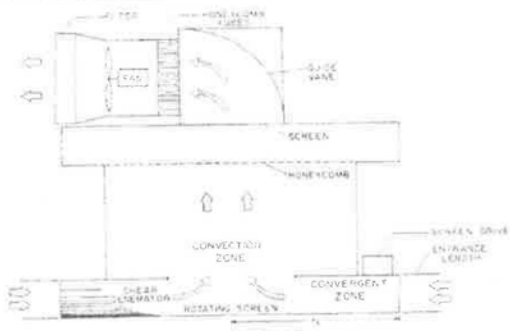

Figure 1-2: Schematic of the Ward Laboratory Simulator (Fouts 2003)

Ward's design was able to straighten the flow by separating the convergent and convection areas. It changed the top collection area design to remove tangential component vorticity variations. The simulator:

- Characterized surface pressure profiles;
- Produced bulging deformations of the vortex core;
- Produced multiple vortices in a single convergence.

Numerous other attempts at laboratory simulation have been performed, notably at Purdue University, Texas Tech University, and Oklahoma University (Fouts 2003). The work was based on the Ward Simulator. In particular, the work at Purdue University (Figure 1-3):

- Improved air inflow by using vane-created flow instead of screen-mesh inflow;
- Created multiple vortices within the chamber at the same time;

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- Realized downdraft pressure in a two-celled vortex;
- Used Laser-Doppler velocimeters to prevent skewing of results inherent in probe-type velocimeters.

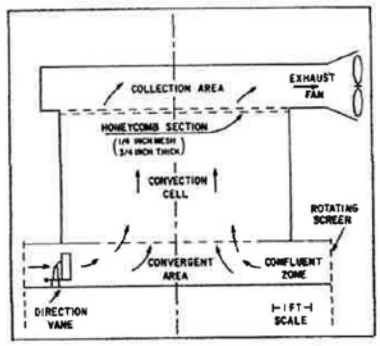

Figure 1-3: Schematic of Purdue and Other Current Laboratory Simulators (Fouts 2003)

The improvements from the Purdue work were incorporated into current laboratory simulator designs. Despite the work performed by the laboratory simulators, little simulator work was done to ascertain the forces on structures due to tornados until recently. Furthermore, tornados are a translating phenomenon, yet none of the previous attempts at laboratory simulation accounted for the translational effects of tornado wind forces. The lack of tornado-structure interaction and translation limited previous laboratory simulation attempts at characterizing tornado winds.

Sarkar et al (2005, 2006, 2008), Haans et al (2008, 2010), Sengupta et al (2008), and Zhang and Sarkar (2009) developed the first known simulator that could not only simulate tangential velocity and updraft but could also create translational velocity (Figures 1-4 and 1-5). The simulator was circular and was suspended from a crane rail system. The simulator created flow from continuous ducting around its perimeter. Airflow was drawn vertically through a honey-comb screen centered in the top of the vortex chamber by a fan suspended just above the screen. The air flow was recycled through the top of the simulator, through vanes capable of directing the airflow, and out to the outer perimeter of the simulator. The air was directed downward through the continuous perimeter ducting, where it was directed into the vortex chamber of the simulator again. The device simulated a thunderstorm by producing a strong region of updraft surrounding a spinning tube of air that descended toward the ground plane. This spinning air, which was created by adjustable turning vanes at the top of the simulator, simulated the Rear Flank Downdraft (RFD) of a tornado. The simulator used the swirl ratio to calculate the vortex tangential velocity. The simulator predicted the pressure drop through the airflow circuit. The pressure drop was used to calculate the vertical velocity. Tornado simulation was correlated to actual measured field conditions in a tornado that passed through Spencer, South Dakota in 1998 and one that passed through Mulhall, Oklahoma in 1999 (Figure 1-6).

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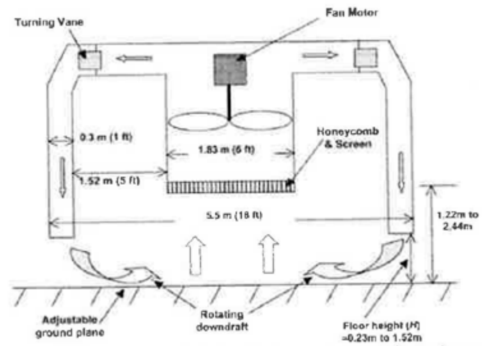

Figure 1-4: Schematic of the Iowa State Laboratory Simulator (Sarkar et al 2005)

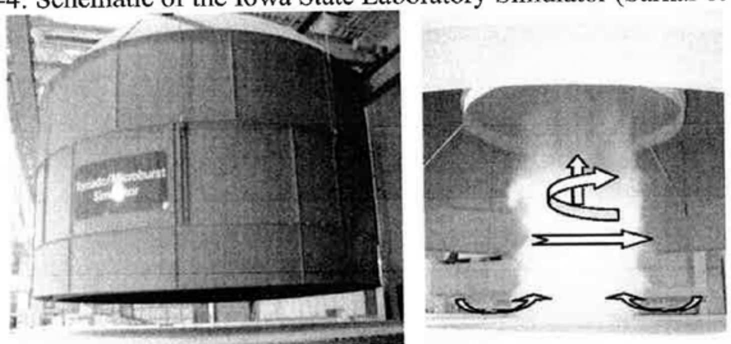

Figure 1-5: Iowa State Laboratory Simulator (Sarkar et al 2006)

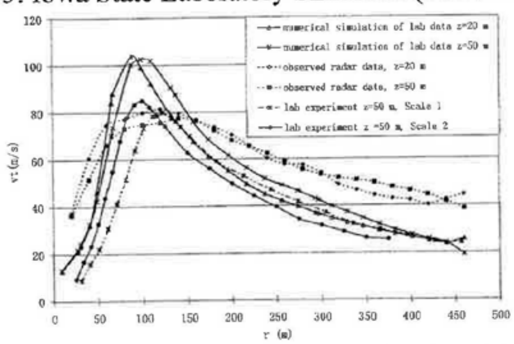

Figure 1-6: Correlation of the Iowa State Laboratory Simulator Tangential Velocity with Observed Data and Numerical Simulation (Sarkar et al 2005)

The simulator was also used to study the effect of surface roughness on tangential velocity. It was found that surface roughness decreased the tangential velocity. Furthermore, the simulator was used to measure the velocity and pressure effects on various sized buildings, including single-story, gable-roof buildings similar to typical residential dwellings. The laboratory simulation of a single-story, gable-roof building and a cube building showed that the peak lateral force coefficients in tornadoes may exceed the corresponding ASCE 7-05, main-wind-force-resisting system (MWFRS) design force coefficients for a 90 mile per hour straight line wind by a factor of 1.50 to 2.07. The peak uplift force coefficients were exceeded by a factor of between 1.46 to 1.8 to 3.2. For components and cladding, the lateral force coefficients in tornados may exceed the ASCE 7-05 coefficients by a factor of 1.3, with peak uplift force coefficients exceeded by a factor of between 1.4 and 2.4. The simulation was correlated to an F2 tornado. Tornados of F5 intensity were shown to create uplift forces that ranged from 3.7 to 5.8.

The simulator does not, however, predict pressure drop but back calculates the pressure drop through the airflow. Further, the simulator does not use the Reynolds Number to calculate the pressure drop. Yet the Reynolds Number admittedly controls the structure of the tornado vortices. The model tends also to break down at high swirl ratios, indicating the larger diameter tornado simulation may not accurately predict the tangential and vertical velocities for large tornados. Furthermore, smaller diameter tornados were found to produce larger peak load coefficients, contrary to the intuitive sense that larger diameter tornados produce larger peak coefficients. Also, it has been historically shown through damage assessment that larger diameter tornados have more damaging effects on structures.

Semi-Empirical Computation of Tornado Forces

Wen (1975) proposed a semi-empirical calculation methodology for tornado forces on tall buildings. He proposed that the tornado forces and resulting drag and lift force coefficients should include an inertia force component because if the center of the tornado translating toward the structure is line with the structure, omission of the inertia force would artificially reduce the drag coefficient. Dynamic magnification should also be considered, especially with tall buildings, due to the inherent swaying of tall buildings engulfed by tornado flow. Numerical equations were developed to address inertia and dynamic tornado forces. A method to determine the probabilistic risk for tornado forces on tall buildings was developed. These equations were later shown to overestimate the magnitude of tornado forces on structure, primarily by Selvam et al (2002).

Computer Simulation and Computation of Tornado Forces

For more than twenty-five years, Dr. Panneer Selvam's group as the University of Arkansas (UARK) has studied tornado-structure interaction. Two computer programs have developed, a two dimensional (2D) program that is used to study tornado forces on a cylinder and a three dimensional (3D) program that is used to study tornado forces on rectangular buildings. Both programs are non-dimensional.

In both the two and three dimensional models (2D and 3D), computational fluid dynamics (CFD) is used. The modeling software was developed by Dr. R. Panneer Selvam over the past 30 years. Computer modeling of tornado interaction with structures was well documented in Selvam et al (2002), Millet (2003), and Selvam and Millet (2003, 2005). The modeling software translates a tornado wind field across a computational domain. The tornado wind field interacts with a structure body. No deformation of the body is assumed. Figure 1-7 illustrates the tornado-structure interaction.

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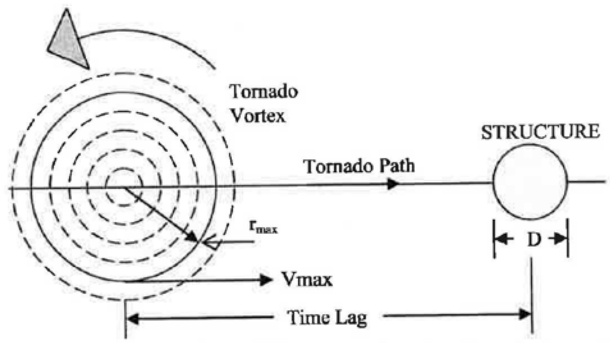

Figure 1-7: Illustration of the tornado-structure interaction.

Wind field modeling of tornado flow around structures is a complicated, fluid-dynamics phenomenon. Such modeling requires equations of velocity flow in all considered directions as well as pressure changes. Since tornado wind flow changes in time, time dependent equations are also needed. Dr. Selvam has found that the incompressible Navier-Stokes equations of fluid flow provide an adequate basis for representing wind and tornado velocity flow in a computerized, computational domain. The equations are illustrated below and are taken from Millet (2003). Principal directions for the equations are in line with the tornado path (X-direction), perpendicular to tornado path (Y-direction), and vertical (Z-direction).

Continuity Equation

$$\nabla \cdot V = 0$$

Momentum Equations

X-direction: $$\rho \frac{Du}{Dt} = -\frac{\partial p}{\partial x} + \mu \nabla^2 u + \rho f_x$$

Y-direction: $$\rho \frac{Dv}{Dt} = -\frac{\partial p}{\partial y} + \mu \nabla^2 v + \rho f_y$$

Z-direction: $$\rho \frac{Dw}{Dt} = -\frac{\partial p}{\partial z} + \mu \nabla^2 w + \rho f_z$$

Where:

μ is the viscosity of fluid (which includes the Reynolds number R_e)
ρ is the fluid density
u,v, and w are velocities in the x-,y-, and z-directions
p is pressure
f are the body forces in the three principal directions
∇ is the Eulerian operator, which stands for $\left(\frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \frac{\partial}{\partial z}\right)\Phi$
∇^2 is the Laplacian operator, which stands for $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right)\Phi$

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What these equations show is that velocity flow in multiple directions, pressure with respect to the three principal directions, and Reynolds number all vary with time and must be determined. In the two-dimensional case, only the X and Y directions are pertinent. The model employs the Rankin Combined Vortex Model (RCVM) to simulate tornado rotational velocity flow in the forced vortex region of the tornado inner core region and the free vortex region of the tornado updraft and downdraft regions. The RCVM model has been shown to reasonably represent pressure and velocity changes in tornados in Lee et al (2004) and Karstens (2010). The RCVM model is shown in Figures 1-8. In the RCVM, the tangential velocity (V_θ) increases linearly from the center of the tornado core to a maximum at the outer edge of the inner core radius r_{max} by a rotational constant (α). Tangential velocity (V_θ) varies in an exponential fashion from the outer edge of the inner core radius until it dissipates some distance from the forced vortex region.

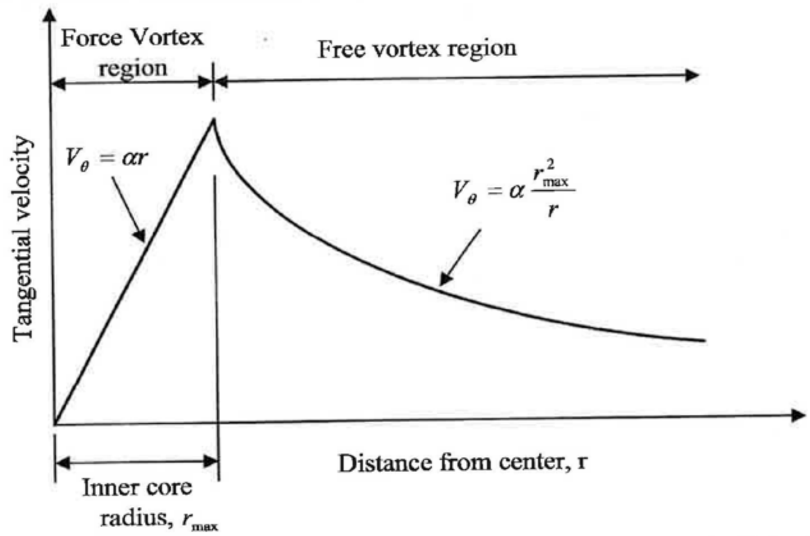

Figure 1-8. The Rankine Combined Vortex Model (RCVM) Showing Tornado Velocity Change.

Currently a maximum tornado velocity of 250 mph (110 m/s) is used.

Because of the complexity of the Navier-Stokes equations, they must be solved in an iterative process. Selvam (2002) showed that the equation variables can be solved with a finite difference, control volume procedure. Convection terms are approximated with central difference. Large-eddy simulation is used for the turbulence model. Various Reynolds numbers have been considered. Higher Reynolds numbers require three dimensions for accurate solution. Once the velocity values in the computational domain are found, forces on the surface of the cylinder are determined and converted to force coefficients. Simiu and Scanlan (1978) showed that a building is only subject to the pressure forces due to the velocity of the airflow in the tornado. Additional atmospheric forces can be neglected. The forces essentially simply to the following:

$$C_x = F_x/(0.5\rho V^2 D)$$
$$C_y = F_y/(0.5\rho V^2 D)$$
$$C_z = F_z/(0.5\rho V^2 D)$$

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Where:

F_x, F_y, and F_z are forces acting on the cylinder in the x, y, and z directions.
V is the reference velocity (V_{ref}).
D is the cylinder diameter (D_{str}), which is taken as 1.0 or the dimension of the building, currently taken as 1.0.
ρ is the density of air.

The tornado traveling across the domain is assigned a translational velocity V_t, which is the same as V_{ref}. The velocities on the surfaces of the structures are taken to be zero which is called no-slip condition. The models use non-dimensional domains to generalize the problem, a circular domain as illustrated in Figure 2-9 for the 2D model and a three-dimensional "box" in the case of the 3d model. The 2D model domain is illustrated in figure 1-9.

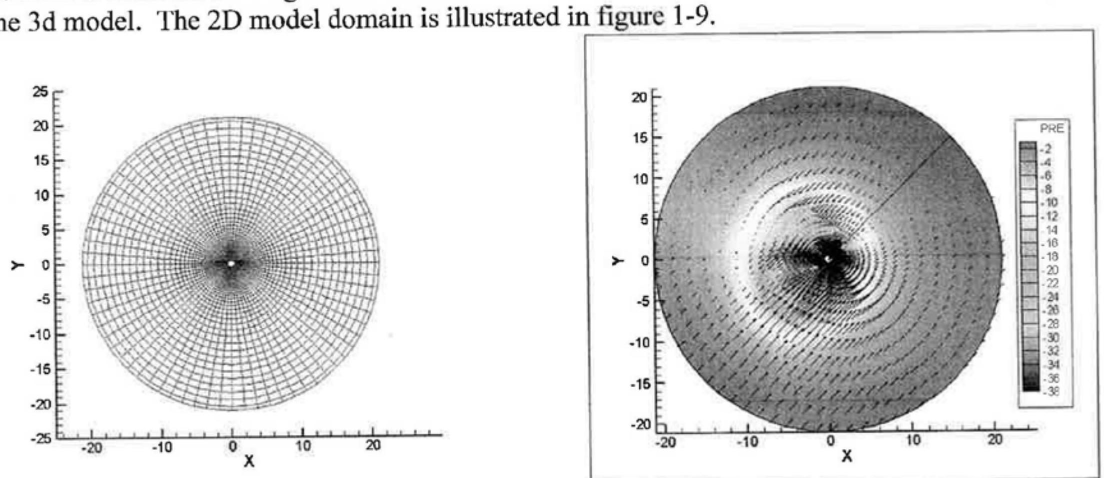

Figure 1-9. A representative example of the computational domain for the program and the velocity forces found with wind flow simulation. The tornado travels left to right and the cylinder is in the center (from Selvam and Gorecki 2012).

Further explanations of the mathematical formulations are given in Selvam (1993, 1995, 1996, 1997, 2008), Selvam and Patterson (1993), and Selvam and Qu (2001).

Using these programs, Selvam et al (2002) showed that for the ratio of tornado radius to cylindrical building diameter of 3:1, the force coefficients for tornadoes differed from those with SL winds. Selvam and Millet (2003 & 2005) showed that for the same maximum wind speed and the ratio of tornado radius to rectangular building dimension of 3:1, the force coefficients due to tornado wind were 1.5 to 2.0 times higher than SL winds. Alrasheedi and Selvam (2011) later showed that the force coefficients were closer to straight wind as the building plan size grew larger than the tornado. Alrasheedi (2012) showed that the force coefficients were increasing for thinner, rectangular structures when the ratio of tornado radius to structure dimension increased to 30:1. Grid resolution hampered their ability to capture time variation effects like vortex shedding. For instance, 32 points were used around the thin structure in Alrasheedi and Selvam (2011) but 91 points were used around a circular cylinder in Selvam et al (2002) where regular vortex shedding was demonstrated when the tornado was far away from the cylinder. Selvam and Gorecki (2012) showed for a circular cylinder that the force coefficients increased for larger tornado-radius to cylinder-diameter ratios up to 8:1 but did show an increase in force coefficients. The study of tornado interaction with varying sizes of cylindrical structures was continued in Ragan et al (2013). The study showed that tornado force coefficients converged to an upper-bound maximum value when the tornado radius to structure diameter was greater than 15:1. Numerical issues in the CFD program must still be worked out to predict forces on thin, cylindrical structures. Table 1-2 lists a partial summary of the research work at UARK. No other similar work has been found to date in this literature survey.

Table 1-2: Partial Summary of Force Coefficients for the Research Work at UARK

Building	Tornado Radius to Bldg. Dim.	Researcher	Force Coefficients (Tornado Travel on x)		
			Cx (Wall)	Cy (Wall)	Cz (Roof)
1D Cylinder	3:1	Selvam et al (2002)	Cx>SL Wind	Cy>SL Wind	
			SL=1.4		
1Wx1Lx1H Cube	3:1	Selvam and Millet (2003, 2005)	50%>SL Wind	50%>SL Wind	100%>SL Wind
			1.36	1.36	1.81
1D Cylinder	3:1	Selvam and Millet (2003, 2005)	Velocity Flow Study	Velocity Flow Study	NA
8Wx8Lx1H	0.38:1 to 3:1	Selvam and Alrasheedi (2011)	18%>SL Wind	Same as SL Wind	Coef.<SL Wind
			0.90	0.00	0.07
0.1Wx0.1Lx1H	3:1 to 30:1	Alrasheedi (2012)	50%>SL Wind	Coef.>SL Wind	75%>SL Wind
			1.55	1.40	2.48
1D Cylinder	1:1 to 8:1	Selvam and Gorecki (2012)	Coef. Trend	Coef. Trend	NA
			Increasing	Increasing	

Additional work is ongoing for other structure shapes.

Design Methodology for Tornados

ASCE7 (2011) requires an intricate design methodology for the forces on a structure from straight wind. The design methodology considers not only force due to velocity but also changes in the forces due to building importance, terrain features, and structure type. In design for tornado forces, the forces are less understood. Consideration of building importance and terrain seems premature. As a result, tornado design here will only consider the forces from the velocity flow and the type of structure. The force coefficients will be taken from state of the art research discussed above. The tornado forces will be calculated from:

$$F=C_f(0.5\rho V^2 A)$$

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F is the total force on a building surface area (A) or a tributary area (A) for a structure component.
C_f will be 1.5 for the building sides and 2.0 for the building roof.
V will be a maximum of 250 mph based on Lee et al (2004) and Karstens et al (2010) and that used at UARK.
ρ is the density of air.

Components and cladding forces will be calculated with the same force coefficients since detailed components and cladding force coefficients have not been developed.

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SECTION 2
MEMBER LOAD ANALYSIS

Structural Calculations
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MEMBER LOAD ANALYSIS INTRODUCTION

The calculations in this section check the member sizes for gravity loading conditions. The members were analyzed for:

- Dead Load
- Floor and Roof Live Loads
- Snow Loads
- Rain Surcharge Loads

An analysis of wind and earthquake load requirements on individual members was included here as well.

Information and codes used here include the following;

- American Institute of Steel Construction (AISC) Manual of Steel Construction 13th Addition
- National Design Specifications for Wood Construction (NDS 2005)
- American Plywood Association (APA)

Title : Job # 2-3
Dsgnr: Date: 12:05PM, 9 OCT 14
Description :

Scope :

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General Timber Beam

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Description Roof Framing Member-8' Long (Wind Included)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	8.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.600	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	#/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	-264.0 lbs	lbs	-264.0 lbs	lbs	lbs	lbs	lbs
...distance	2.000 ft	4.000 ft	6.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 8.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.313 : 1			
Maximum Moment	-0.4 k-ft	Maximum Shear * 1.5		0.3 k
Allowable	1.3 k-ft	Allowable		1.8 k
Max. Positive Moment	0.00 k-ft at 8.000 ft	Shear:	@ Left	0.19 k
Max. Negative Moment	-0.41 k-ft at 2.016 ft		@ Right	0.19 k
Max @ Left Support	0.00 k-ft	Camber:	@ Left	0.000 in
Max @ Right Support	0.00 k-ft		@ Center	0.090 in
			@ Right	0.000 in
Max. M allow	1.32	Reactions...		
fb 655.96 psi	fv 35.73 psi	Left DL 0.08 k	Max	-0.19 k
Fb 2,093.00 psi	Fv 216.00 psi	Right DL 0.08 k	Max	-0.19 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.060 in	0.170 in	Deflection	0.000 in	0.000 in
...Location	4.000 ft	4.000 ft	...Length/Defl	0.0	0.0
...Length/Defl	1,596.3	565.85	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.090 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

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General Timber Beam

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Description Roof Framing Member-8' Long (Wind Included)

Stress Calcs

Bending Analysis

Ck	25.646	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	188.000		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.41 k-ft	2.37 in3	2,093.00 psi
@ Left Support	0.00 k-ft	0.00 in3	2,093.00 psi
@ Right Support	0.00 k-ft	0.00 in3	2,093.00 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.29 k	0.29 k
Area Required	1.365 in2	1.365 in2
Fv: Allowable	216.00 psi	216.00 psi

Bearing @ Supports

Max. Left Reaction	-0.19 k	Bearing Length Req'd	0.295 in
Max. Right Reaction	-0.19 k	Bearing Length Req'd	0.295 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	-0.19 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

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Title :
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General Timber Beam

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Description Roof Framing Member-11' Long (Wind Included)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	11.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.600	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	#/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	-264.0 lbs	-93.0 lbs	-264.0 lbs	lbs	lbs	lbs	lbs
...distance	2.000 ft	5.500 ft	9.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 11.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.376 : 1					
Maximum Moment	-0.5 k-ft			Maximum Shear * 1.5		0.3 k
Allowable	1.3 k-ft			Allowable		1.8 k
Max. Positive Moment	0.00 k-ft	at	11.000 ft	Shear:	@ Left	0.21 k
Max. Negative Moment	-0.50 k-ft	at	5.500 ft		@ Right	0.21 k
Max @ Left Support	0.00 k-ft			Camber:	@ Left	0.000 in
Max @ Right Support	0.00 k-ft				@ Center	0.322 in
					@ Right	0.000 in
Max. M allow	1.32			Reactions...		
fb 787.64 psi	fv	38.97 psi	Left DL	0.10 k	Max	-0.21 k
Fb 2,093.00 psi	Fv	216.00 psi	Right DL	0.10 k	Max	-0.21 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.215 in	0.391 in	Deflection	0.000 in	0.000 in
...Location	5.500 ft	5.500 ft	...Length/Defl	0.0	0.0
...Length/Defl	614.1	337.47	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.322 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

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Title :
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General Timber Beam

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Description Roof Framing Member-11' Long (Wind Included)

Stress Calcs

Bending Analysis							
Ck	25.646	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	206.000		
			Max Moment		Sxx Req'd		Allowable fb
@ Center			0.50 k-ft		2.85 in3		2,093.00 psi
@ Left Support			0.00 k-ft		0.00 in3		2,093.00 psi
@ Right Support			0.00 k-ft		0.00 in3		2,093.00 psi
Shear Analysis			@ Left Support		@ Right Support		
Design Shear			0.32 k		0.32 k		
Area Required			1.489 in2		1.489 in2		
Fv: Allowable			216.00 psi		216.00 psi		
Bearing @ Supports							
Max. Left Reaction			-0.21 k		Bearing Length Req'd		0.323 in
Max. Right Reaction			-0.21 k		Bearing Length Req'd		0.323 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	-0.21 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

Z-7

Title : Job #
Dsgnr: Date: 12:05PM, 9 OCT 14
Description :

Scope :

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General Timber Beam

Page 1
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Description Roof Framing Member-19' Long (Wind Included)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x12	Center Span	19.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	11.250 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.600	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	#/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	-196.0 lbs	-196.0 lbs	-196.0 lbs	lbs	lbs	lbs	lbs
...distance	4.000 ft	9.500 ft	15.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 19.00ft, Beam Width = 1.500in x Depth = 11.25in, Ends are Pin-Pin

Max Stress Ratio	0.202 : 1				
Maximum Moment	-0.9 k-ft	Maximum Shear * 1.5			0.2 k
Allowable	4.2 k-ft	Allowable			3.6 k
Max. Positive Moment	0.00 k-ft at 19.000 ft	Shear:		@ Left	0.18 k
Max. Negative Moment	-0.86 k-ft at 9.500 ft			@ Right	0.18 k
Max @ Left Support	0.00 k-ft	Camber:		@ Left	0.000 in
Max @ Right Support	0.00 k-ft			@ Center	0.335 in
				@ Right	0.000 in
Max. M allow	4.25	Reactions...			
fb 325.26 psi	fv 11.63 psi	Left DL	0.18 k	Max	-0.11 k
Fb 1,610.00 psi	Fv 216.00 psi	Right DL	0.18 k	Max	-0.11 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.224 in	0.201 in	Deflection	0.000 in	0.000 in
...Location	9.500 ft	9.500 ft	...Length/Defl	0.0	0.0
...Length/Defl	1,019.7	1,131.59	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.335 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

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Title :
Dsgnr:
Description :

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General Timber Beam

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Description Roof Framing Member-19' Long (Wind Included)

Stress Calcs

Bending Analysis

Ck	25.646	Le	0.000 ft	Sxx	31.641 in3	Area	16.875 in2
Cf	1.000	Rb	0.000	Cl	113.500		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.86 k-ft	6.39 in3	1,610.00 psi
@ Left Support	0.00 k-ft	0.00 in3	1,610.00 psi
@ Right Support	0.00 k-ft	0.00 in3	1,610.00 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.20 k	0.20 k
Area Required	0.909 in2	0.909 in2
Fv: Allowable	216.00 psi	216.00 psi

Bearing @ Supports			
Max. Left Reaction	-0.11 k	Bearing Length Req'd	0.178 in
Max. Right Reaction	-0.11 k	Bearing Length Req'd	0.178 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	-0.11 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

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Title : Job #
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Description :

Scope :

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General Timber Beam

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Description Roof Framing Member-8' Long (Earthquake Included)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	8.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.250	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	20.00 #/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	9.0 lbs	9.0 lbs	9.0 lbs	lbs	lbs	lbs	lbs
...distance	2.000 ft	4.000 ft	6.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 8.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.338 : 1					
Maximum Moment	0.3 k-ft		Maximum Shear * 1.5			0.2 k
Allowable	1.0 k-ft		Allowable			1.4 k
Max. Positive Moment	0.35 k-ft	at 4.000 ft	Shear:	@ Left		0.17 k
Max. Negative Moment	0.00 k-ft	at 0.000 ft		@ Right		0.17 k
Max @ Left Support	0.00 k-ft		Camber:	@ Left		0.000 in
Max @ Right Support	0.00 k-ft			@ Center		0.090 in
				@ Right		0.000 in
Max. M allow	1.03		Reactions...			
fb 552.20 psi	fv	27.64 psi	Left DL	0.08 k	Max	0.17 k
Fb 1,635.16 psi	Fv	168.75 psi	Right DL	0.08 k	Max	0.17 k

Deflections

Center Span...	Dead Load	Total Load	**Left Cantilever...**	Dead Load	Total Load
Deflection	-0.060 in	-0.137 in	Deflection	0.000 in	0.000 in
...Location	4.000 ft	4.000 ft	...Length/Defl	0.0	0.0
...Length/Defl	1,596.3	700.86	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.090 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

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Title :
Dsgnr:
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General Timber Beam

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Description Roof Framing Member-8' Long (Earthquake Included)

Stress Calcs

Bending Analysis

Ck	29.015	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	169.500		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.35 k-ft	2.55 in3	1,635.16 psi
@ Left Support	0.00 k-ft	0.00 in3	1,635.16 psi
@ Right Support	0.00 k-ft	0.00 in3	1,635.16 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.23 k	0.23 k
Area Required	1.351 in2	1.351 in2
Fv: Allowable	168.75 psi	168.75 psi

Bearing @ Supports

Max. Left Reaction	0.17 k	Bearing Length Req'd	0.266 in
Max. Right Reaction	0.17 k	Bearing Length Req'd	0.266 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.17 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

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Title :
Dsgnr:
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General Timber Beam

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Description Roof Framing Member-11' Long (Earthquake Included)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	11.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.250	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	20.00 #/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	12.5 lbs	12.5 lbs	12.5 lbs	lbs	lbs	lbs	lbs
...distance	3.000 ft	5.500 ft	8.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 11.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.642 : 1					
Maximum Moment	0.7 k-ft			Maximum Shear * 1.5		0.3 k
Allowable	1.0 k-ft			Allowable		1.4 k
Max. Positive Moment	0.66 k-ft	at	5.500 ft	Shear:	@ Left	0.23 k
Max. Negative Moment	0.00 k-ft	at	11.000 ft		@ Right	0.23 k
Max @ Left Support	0.00 k-ft			Camber:	@ Left	0.000 in
Max @ Right Support	0.00 k-ft				@ Center	0.322 in
					@ Right	0.000 in
Max. M allow	1.03			Reactions...		
fb 1,050.05 psi	fv	39.29 psi		Left DL 0.10 k	Max	0.23 k
Fb 1,635.16 psi	Fv	168.75 psi		Right DL 0.10 k	Max	0.23 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.215 in	-0.492 in	Deflection	0.000 in	0.000 in
...Location	5.500 ft	5.500 ft	...Length/Defl	0.0	0.0
...Length/Defl	614.1	268.22	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.322 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

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Title :
Dsgnr:
Description :

Scope :

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General Timber Beam

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Description Roof Framing Member-11' Long (Earthquake Included)

Stress Calcs

Bending Analysis

Ck	29.015	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	233.250		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.66 k-ft	4.86 in3	1,635.16 psi
@ Left Support	0.00 k-ft	0.00 in3	1,635.16 psi
@ Right Support	0.00 k-ft	0.00 in3	1,635.16 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.32 k	0.32 k
Area Required	1.921 in2	1.921 in2
Fv: Allowable	168.75 psi	168.75 psi

Bearing @ Supports

Max. Left Reaction	0.23 k	Bearing Length Req'd	0.366 in
Max. Right Reaction	0.23 k	Bearing Length Req'd	0.366 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.23 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

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Title :
Dsgnr:
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General Timber Beam

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Description Roof Framing Member-19' Long (Earthquake Included)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x12	Center Span	19.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	11.250 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.250	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	23.00 #/ft	LL	20.00 #/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	13.0 lbs	13.0 lbs	13.0 lbs	13.0 lbs	13.0 lbs	lbs	lbs
...distance	3.000 ft	6.000 ft	9.500 ft	13.000 ft	16.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 19.00ft, Beam Width = 1.500in x Depth = 11.25in, Ends are Pin-Pin

Max Stress Ratio	0.639 : 1					
Maximum Moment	2.1 k-ft			Maximum Shear * 1.5		0.6 k
Allowable	3.3 k-ft			Allowable		2.8 k
Max. Positive Moment	2.12 k-ft	at	9.500 ft	Shear:	@ Left	0.44 k
Max. Negative Moment	0.00 k-ft	at	19.000 ft		@ Right	0.44 k
Max @ Left Support	0.00 k-ft			Camber:	@ Left	0.000 in
Max @ Right Support	0.00 k-ft				@ Center	0.406 in
					@ Right	0.000 in
Max. M allow	3.32			Reactions...		
fb 803.70 psi	fv	35.71 psi		Left DL 0.22 k	Max	0.44 k
Fb 1,257.81 psi	Fv	168.75 psi		Right DL 0.22 k	Max	0.44 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.271 in	-0.552 in	Deflection	0.000 in	0.000 in
...Location	9.500 ft	9.500 ft	...Length/Defl	0.0	0.0
...Length/Defl	842.4	413.15	Right Cantilever...		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.406 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

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Title :
Dsgnr:
Description :

Scope :

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General Timber Beam

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Description Roof Framing Member-19' Long (Earthquake Included)

Stress Calcs

Bending Analysis

Ck	29.015	Le	0.000 ft	Sxx	31.641 in3	Area	16.875 in2
Cf	1.000	Rb	0.000	Cl	441.000		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	2.12 k-ft	20.22 in3	1,257.81 psi
@ Left Support	0.00 k-ft	0.00 in3	1,257.81 psi
@ Right Support	0.00 k-ft	0.00 in3	1,257.81 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.60 k	0.60 k
Area Required	3.571 in2	3.571 in2
Fv: Allowable	168.75 psi	168.75 psi

Bearing @ Supports

Max. Left Reaction	0.44 k	Bearing Length Req'd	0.692 in
Max. Right Reaction	0.44 k	Bearing Length Req'd	0.692 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.44 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

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Title :
Dsgnr:
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General Timber Beam

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Description Floor Framing Member-8' Long (Earthquake Included)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	8.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.250	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	100.00 #/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

SHOULD BE 50PSF

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	9.0 lbs	9.0 lbs	9.0 lbs	lbs	lbs	lbs	lbs
...distance	2.000 ft	4.000 ft	6.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 8.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.959 : 1					
Maximum Moment	1.0 k-ft			Maximum Shear * 1.5		0.7 k
Allowable	1.0 k-ft			Allowable		1.4 k
Max. Positive Moment	0.99 k-ft	at	4.000 ft	Shear:	@ Left	0.49 k
Max. Negative Moment	0.00 k-ft	at	8.000 ft		@ Right	0.49 k
Max @ Left Support	0.00 k-ft			Camber:	@ Left	0.000 in
Max @ Right Support	0.00 k-ft				@ Center	0.090 in
					@ Right	0.000 in
Max. M allow	1.03			Reactions...		
fb 1,567.73 psi	fv	79.31 psi		Left DL 0.08 k	Max	0.49 k
Fb 1,635.16 psi	Fv	168.75 psi		Right DL 0.08 k	Max	0.49 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.060 in	-0.390 in	Deflection	0.000 in	0.000 in
...Location	4.000 ft	4.000 ft	...Length/Defl	0.0	0.0
...Length/Defl	1,596.3	246.03	Right Cantilever...		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.090 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

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Title :
Dsgnr:
Description :
Scope :

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General Timber Beam

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Description Floor Framing Member-8' Long (Earthquake Included)

Stress Calcs

Bending Analysis

Ck	29.015	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	489.500		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.99 k-ft	7.25 in3	1,635.16 psi
@ Left Support	0.00 k-ft	0.00 in3	1,635.16 psi
@ Right Support	0.00 k-ft	0.00 in3	1,635.16 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.65 k	0.65 k
Area Required	3.877 in2	3.877 in2
Fv: Allowable	168.75 psi	168.75 psi

Bearing @ Supports

Max. Left Reaction	0.49 k	Bearing Length Req'd	0.768 in
Max. Right Reaction	0.49 k	Bearing Length Req'd	0.768 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.49 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

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Title :
Dsgnr:
Description :

Scope :

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General Timber Beam

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Description Floor Framing Member-11' Long (Support @ 6') (EQ Incl.)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	6.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.250	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	100.00 #/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

SHOULD BE 80PSF

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	12.5 lbs	12.5 lbs	12.5 lbs	lbs	lbs	lbs	lbs
...distance	3.000 ft	5.500 ft	6.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 6.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.541 : 1					
Maximum Moment	0.6 k-ft		Maximum Shear * 1.5			0.5 k
Allowable	1.0 k-ft		Allowable			1.4 k
Max. Positive Moment	0.56 k-ft	at 3.000 ft	Shear:		@ Left	0.36 k
Max. Negative Moment	0.00 k-ft	at 0.000 ft			@ Right	0.37 k
Max @ Left Support	0.00 k-ft		Camber:		@ Left	0.000 in
Max @ Right Support	0.00 k-ft				@ Center	0.029 in
					@ Right	0.000 in
Max. M allow	1.03		Reactions...			
fb 884.43 psi	fv	58.26 psi	Left DL	0.06 k	Max	0.36 k
Fb 1,635.16 psi	Fv	168.75 psi	Right DL	0.06 k	Max	0.39 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.019 in	-0.123 in	Deflection	0.000 in	0.000 in
...Location	3.000 ft	3.000 ft	...Length/Defl	0.0	0.0
...Length/Defl	3,783.8	583.74	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.029 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

Z-18

Title :
Dsgnr:
Description :
Scope :

Job #
Date: 12:05PM, 9 OCT 14

Rev: 580004
User: KW-0606622, Ver 5.8.0, 1-Dec-2003
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General Timber Beam

Page 2
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Description Floor Framing Member-11' Long (Support @ 6') (EQ Incl.)

Stress Calcs

Bending Analysis

Ck	29.015	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	364.292		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.56 k-ft	4.09 in3	1,635.16 psi
@ Left Support	0.00 k-ft	0.00 in3	1,635.16 psi
@ Right Support	0.00 k-ft	0.00 in3	1,635.16 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.47 k	0.48 k
Area Required	2.756 in2	2.848 in2
Fv: Allowable	168.75 psi	168.75 psi

Bearing @ Supports

Max. Left Reaction	0.36 k	Bearing Length Req'd	0.571 in
Max. Right Reaction	0.39 k	Bearing Length Req'd	0.607 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.36 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

2-19

Title : Job #
Dsgnr: Date: 12:05PM, 9 OCT 14
Description :

Scope :

Rev: 580004
User: KW-0606622, Ver 5.8.0, 1-Dec-2003
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General Timber Beam

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Description Floor Framing Member-19' Long (Support @ 6') (EQ Incl.)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	**2x6**	Center Span	6.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.250	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		**Repetitive Member**
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	19.00 #/ft	LL	100.00 #/ft
Left Cantilever	DL	#/ft	LL	#/ft
Right Cantilever	DL	#/ft	LL	#/ft

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	12.5 lbs	12.5 lbs	12.5 lbs	lbs	lbs	lbs	lbs
...distance	3.000 ft	5.500 ft	6.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 6.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.541 : 1					
Maximum Moment	0.6 k-ft			Maximum Shear * 1.5		0.5 k
Allowable	1.0 k-ft			Allowable		1.4 k
Max. Positive Moment	0.56 k-ft	at	3.000 ft	Shear:	@ Left	0.36 k
Max. Negative Moment	0.00 k-ft	at	0.000 ft		@ Right	0.37 k
Max @ Left Support	0.00 k-ft			Camber:	@ Left	0.000 in
Max @ Right Support	0.00 k-ft				@ Center	0.029 in
					@ Right	0.000 in
Max. M allow	1.03			Reactions...		
fb 884.43 psi	fv	58.26 psi		Left DL 0.06 k	Max	0.36 k
Fb 1,635.16 psi	Fv	168.75 psi		Right DL 0.06 k	Max	0.39 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	-0.019 in	-0.123 in	Deflection	0.000 in	0.000 in
...Location	3.000 ft	3.000 ft	...Length/Defl	0.0	0.0
...Length/Defl	3,783.8	583.74	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.029 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

Z-20

Title :
Dsgnr:
Description :

Scope :

Job #

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General Timber Beam

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Description Floor Framing Member-19' Long (Support @ 6') (EQ Incl.)

Stress Calcs

Bending Analysis

Ck	29.015	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	364.292		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.56 k-ft	4.09 in3	1,635.16 psi
@ Left Support	0.00 k-ft	0.00 in3	1,635.16 psi
@ Right Support	0.00 k-ft	0.00 in3	1,635.16 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.47 k	0.48 k
Area Required	2.756 in2	2.848 in2
Fv: Allowable	168.75 psi	168.75 psi

Bearing @ Supports

Max. Left Reaction	0.36 k	Bearing Length Req'd	0.571 in
Max. Right Reaction	0.39 k	Bearing Length Req'd	0.607 in

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.36 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

2-21

Title : Job #
Dsgnr: Date: 12:05PM, 9 OCT 14
Description :

Scope :

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General Timber Beam

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Description Wall Framing Member-8' Long (Wind)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	8.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.600	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Full Length Uniform Loads

Center	DL	#/ft	LL	26.00	#/ft
Left Cantilever	DL	#/ft	LL		#/ft
Right Cantilever	DL	#/ft	LL		#/ft

Summary

Beam Design OK

Span= 8.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.158 : 1		
Maximum Moment	0.2 k-ft	Maximum Shear * 1.5	0.1 k
Allowable	1.3 k-ft	Allowable	1.8 k

Max. Positive Moment	0.21 k-ft	at 4.000 ft	Shear:	@ Left	0.10 k	
Max. Negative Moment	0.00 k-ft	at 0.000 ft		@ Right	0.10 k	
Max @ Left Support	0.00 k-ft		Camber:	@ Left	0.000 in	
Max @ Right Support	0.00 k-ft			@ Center	0.000 in	
				@ Right	0.000 in	
Max. M allow	1.32		Reactions...			
fb 330.05 psi	fv	16.79 psi	Left DL	0.00 k	Max	0.10 k
Fb 2,093.00 psi	Fv	216.00 psi	Right DL	0.00 k	Max	0.10 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	0.000 in	-0.082 in	Deflection	0.000 in	0.000 in
...Location	8.000 ft	4.000 ft	...Length/Defl	0.0	0.0
...Length/Defl	0.0	1,166.52	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.000 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

Stress Calcs

Bending Analysis

Ck	25.646	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	104.000		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.21 k-ft	1.19 in3	2,093.00 psi
@ Left Support	0.00 k-ft	0.00 in3	2,093.00 psi
@ Right Support	0.00 k-ft	0.00 in3	2,093.00 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.14 k	0.14 k
Area Required	0.641 in2	0.641 in2
Fv: Allowable	216.00 psi	216.00 psi

Bearing @ Supports

Max. Left Reaction	0.10 k	Bearing Length Req'd	0.163 in
Max. Right Reaction	0.10 k	Bearing Length Req'd	0.163 in

2-22

Title :
Dsgnr:
Description :

Scope :

Job #
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General Timber Beam

Page 2
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Description Wall Framing Member-8' Long (Wind)

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.10 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

2-23

Title :
Dsgnr:
Description :
Scope :

Job #
Date: 12:05PM, 9 OCT 14

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General Timber Beam

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Description Wall Framing Member-8' Long (Earthquake)

General Information

Code Ref: 1997/2001 NDS, 2000/2003 IBC, 2003 NFPA 5000. Base allowables are user defined

Section Name	2x6	Center Span	8.00 ft	.....Lu	0.00 ft
Beam Width	1.500 in	Left Cantilever	ft	.....Lu	0.00 ft
Beam Depth	5.500 in	Right Cantilever	ft	.....Lu	0.00 ft
Member Type	Sawn	Spruce - Pine - Fir, No. 1/No. 2			
		Fb Base Allow	875.0 psi		
Load Dur. Factor	1.600	Fv Allow	135.0 psi		
Beam End Fixity	Pin-Pin	Fc Allow	425.0 psi		Repetitive Member
		E	1,400.0 ksi		

Point Loads

Dead Load	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Live Load	28.5 lbs	28.5 lbs	28.5 lbs	lbs	lbs	lbs	lbs
...distance	2.000 ft	4.000 ft	6.000 ft	0.000 ft	0.000 ft	0.000 ft	0.000 ft

Summary

Beam Design OK

Span= 8.00ft, Beam Width = 1.500in x Depth = 5.5in, Ends are Pin-Pin

Max Stress Ratio	0.086 : 1					
Maximum Moment	0.1 k-ft		Maximum Shear * 1.5			0.1 k
Allowable	1.3 k-ft		Allowable			1.8 k
Max. Positive Moment	0.11 k-ft	at 4.000 ft	Shear:	@ Left		0.04 k
Max. Negative Moment	0.00 k-ft	at 8.000 ft		@ Right		0.04 k
Max @ Left Support	0.00 k-ft		Camber:	@ Left		0.000 in
Max @ Right Support	0.00 k-ft			@ Center		0.000 in
				@ Right		0.000 in
Max. M allow	1.32		Reactions...			
fb 180.89 psi	fv	7.77 psi	Left DL	0.00 k	Max	0.04 k
Fb 2,093.00 psi	Fv	216.00 psi	Right DL	0.00 k	Max	0.04 k

Deflections

Center Span...	Dead Load	Total Load	Left Cantilever...	Dead Load	Total Load
Deflection	0.000 in	-0.043 in	Deflection	0.000 in	0.000 in
...Location	8.000 ft	4.000 ft	...Length/Defl	0.0	0.0
...Length/Defl	0.0	2,240.41	**Right Cantilever...**		
Camber (using 1.5 * D.L. Defl) ...			Deflection	0.000 in	0.000 in
@ Center	0.000 in		...Length/Defl	0.0	0.0
@ Left	0.000 in				
@ Right	0.000 in				

Stress Calcs

Bending Analysis

Ck	25.646	Le	0.000 ft	Sxx	7.563 in3	Area	8.250 in2
Cf	1.300	Rb	0.000	Cl	42.750		

	Max Moment	Sxx Req'd	Allowable fb
@ Center	0.11 k-ft	0.65 in3	2,093.00 psi
@ Left Support	0.00 k-ft	0.00 in3	2,093.00 psi
@ Right Support	0.00 k-ft	0.00 in3	2,093.00 psi

Shear Analysis	@ Left Support	@ Right Support
Design Shear	0.06 k	0.06 k
Area Required	0.297 in2	0.297 in2
Fv: Allowable	216.00 psi	216.00 psi

Bearing @ Supports

Max. Left Reaction	0.04 k	Bearing Length Req'd	0.067 in
Max. Right Reaction	0.04 k	Bearing Length Req'd	0.067 in

2-24

Title :
Dsgnr:
Description :

Scope :

Job #
Date: 12:05PM, 9 OCT 14

Rev: 580004
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General Timber Beam

Page 2
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Description Wall Framing Member-8' Long (Earthquake)

Query Values

M, V, & D @ Specified Locations		Moment	Shear	Deflection
@ Center Span Location =	0.00 ft	0.00 k-ft	0.04 k	0.0000 in
@ Right Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in
@ Left Cant. Location =	0.00 ft	0.00 k-ft	0.00 k	0.0000 in

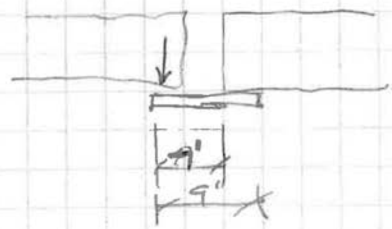
2-25

MISCELLANEOUS CALCULATIONS

CONNECTION OF CENTER FLOOR SECTIONS

1/2" PL x 12" x 9.5"

P = 119 PSF (4')(4') = 1904#



$M = 1904^{\#}(6") = 11.42^{KIN}$

$f_b = \frac{11.42^{KIN}}{(12")(0.5")^2/6} = 22.8^{KSI}$ OK

$F_b \approx 0.66(36^{KSI}) = 23.8^{KSI}$

$I = \frac{12"(0.25")^3}{12} = 0.42 IN^4$

$\Delta = \frac{1.9^K(6")^3}{3(29000KSI)(0.42IN^4)} = 0.01"$

(L/534)

OK

1/2 L ... BOLTS INTO WOOD GOOD FOR

DOUGL BRG = 2300#
SHEAR ∥ TO GRAIN = 480#
SHEAR ⊥ TO GRAIN = 290#

8 - 1/2" Φ BOLTS
@ ANGLES TO PANELS

SPACING EDGE 2"
END 2" OK
SPACING 2" OK

MISCELLANEOUS

1/2 BOLTS FLOOR TO CHANNEL @ BOXES (LOWER FLR LL)

SHEAR ∥ TO GRAIN = 720# - 770#
SHEAR ⊥ TO GRAIN = 340 - 430# ←
FLR LD = 19PSF + 50PSF = 69 PSF (5.5')(1') = 380#
OK

9' HEADER

DL = 17 PSF (5.5') + 23 PSF (9.5') + 12 PSF (4') = 360 PLF
LL = 20 PSF (5.5) + 20 PSF (9.5) = 300 PLF
M = 6.8 KFT
V = 2.9K

MC 7x19.1 $f_b = 6.8(12)/12.3 = 6.6KSI$ OK
$\Delta = 0.1" = L/1080$ OK

Z-26

TORNADO LOADS

FRAMING MEMBERS

$q = 0.00256\,(250\,\text{MPH})^2 = 160\,\text{PSF}$

$P_{ROOF} = 160\,\text{PSF}\,(2.0) = 320\,\text{PSF}$

$P_{WALL} = 160\,\text{PSF}\,(1.5) = 240\,\text{PSF}$

WALL (2x6 @ 12" O.C.)

$w = 240\,\text{PSF}\,(1') = 240\,\text{PLF}$

$M = 240\,\text{PLF}\,(8')^2/8 = 1920\,\#\text{FT}$

2x6 w/ 5/8" - 3/4" PLY BOTH SIDES (ADHERED & SCREWS)

$I = I + Ad^2 = 20.80\,\text{IN}^4 + 0.625"(12")(5.5"/2 + 5/8"/2)^2(2)$

$I = 161\,\text{IN}^4$

$f_b = \dfrac{Mc}{I} = \dfrac{1920\,\#\text{FT}\,(12"/1)(5.5/2 + 0.625")}{161\,\text{IN}^4}$

$f_b = 483\,\text{PSI}$

FOR SPRUCE PINE FIR

$F_b = 875\,\text{PSI}\,C_d C_F = 875\,\text{PSI}(1.9)(1.15) = 1912\,\text{PSI}$ OK

$V = 240\,\text{PLF}\,(4') = 960\,\#$

$f_v = 3/2\; V/A = 3/2\,(960\#)/(1.5")(5.5")$

$f_v = 175\,\text{PSI}$ WOOD ONLY

$F_v = 135\,\text{PSI}\,C_d = 135\,\text{PSI}\,(1.9) = 256\,\text{PSI}$ OK

$\Delta = \dfrac{5(240\,\text{PLF})(8')^4(12"/1')^3}{384(1400\,000\,\text{PSI})(161\,\text{IN}^4)} = 0.10" = L/978$ OK

2x6 @ 16" O.C. OK TOO

Z-27

TORNADO LOADS (CONT'D)

FRAMING MEMBERS (CONT'D)

ROOF (8'–11') @ 12" O.C.

$w = 320\,PSF(1') = 320\,PLF \quad w_T = 19\,PLF$

$M = (320-19)(11')^2/8 = 4553\#FT$

2×6 w/PLY LIKE WALL

$I = 161\,IN^4$

$f_b = 4553\#FT(12"/')\dfrac{(5.5"/2 + 0.625")}{161\,IN^4} = 1145\,PSI$

$F_b = 1912\,PSI$ OK

$V = (320-19)(5.5') = 1655\#$

$f_v = 1655\#(3/2)/(1.5)(5.5) = 301\,PSI$

$F_{v2\times6} = 256\,PSI$
$F_{vPLY} = 63\,\#/IN$ PANEL $(12") = 756\#/$

$V \leq 256\,PSI(1.5")(5.5") + 756\# = 2868\#$ OK w/ PLYWOOD

$\Delta = \dfrac{5(320-19)(11)^4(12"/')^3}{384(1400000\,PSI)(161\,IN^4)} = 0.44" = L/300$ OK

SHEAR FLOW

$q = \dfrac{VQ}{I} = \dfrac{1655\#(12")(0.625")(5.5/2+0.625/2)}{161\,IN^4} = 236\#/IN$

SCREWS @ 3" O.C.
$V = 100\#(1.9) = 190\#/SCREW$
GLUE MORE THAN WOOD, SO GLUE + NAIL OK
WOOD + PLY TAKES SHEAR, SO OK.

Z-28

TORNADO LOADS (CONT'D)

FRAMING MEMBERS (CONT'D)

ROOF (19') @ 12" O.C.

$M = (320-23)(19')^2/8 = 13402$ #FT

2 X 12 W/ PLY EACH SIDE

$I = 178 IN^4 + 0.625''(12'')(11.25''/2 + 0.625''/2)^2(2) = 707 IN^4$

$f_b = \frac{13402^{\#FT}(12''/1)(11.25''/2 + 0.625'')}{707 IN^4} = 1422 PSI$

$F_b = 875 PSI \; C_d C_r = 875 PSI (1.9)(1.15) = 1912 PSI$ OK

$V = (320-23)(19'/2) = 2822\#$

$f_v = 3/2 V/A = 3/2 (2822\#)/(1.5)(11.25'') = 251 PSI$

$F_v = 135 PSI (1.9) = 256 PSI$ OK FOR WOOD ONLY

$\Delta = \frac{5(320-23)(19)^4(12)^3}{384(1400000)(707)} = 0.90'' = L/259$ OK

SHEAR FLOW

$q = \frac{VQ}{I} = \frac{2822^{\#}(0.625''(12'')(11.25''/2 + 0.625''/2))}{707 IN^4} = 178 \#/IN$

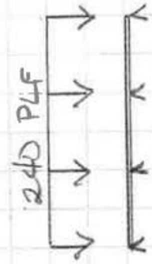
NEED SCREWS + GLUE (GLUE MORE THAN WOOD & WOOD OK W/ SHEAR)

2-29

TORNADO LOADS (CONT'D)

PLYWOOD SHEATHING

PRESSURE/SUCTION (3 SPAN CONDITION)



FOR 12" SPAN 5/8" PLY

BENDING

$w = \frac{120 M C_D}{L^2} = \frac{120(625 \text{ lb-in/ft})(1.9)}{(12")^2}$

w = 989 PSF PLENTY OK

SHEAR

$w = 20 V_s / L_s = 20\,(246 \text{ lb-in/ft})(1.9)/12" = 820$ PSF

DEFLECTION

$\Delta = \frac{wL^4}{1743EI} \Rightarrow w = \frac{1743 EI\Delta}{L^4} = \frac{1743(247{,}500 \text{ \#-in}^2/\text{ft})(12"/240)}{12^4}$

USE $\Delta = L/240$

w = 1040 PSF OK

NOTE: ROOF @ 320 PSF WOULD BE OK ALSO

ATTACHMENT

USE SCREWS

$w = 2850\ G^2 D$

FROM NDS 2005 FOR SPF (S.G = 0.40)

w = 63 (#6)
w = 69 (#7)
w = 75 (#8)
w = 81 (#9)
w = 86 (#10)

PENETRATION:

320 PSF / 86 #/in = 3.7" SCREWS @ 12" O.C.

320 PSF / 86 #/in/2 = 1.86" SCREWS @ 6" O.C.

320 PSF / 86 #/in/3 = 1.24" SCREWS @ 4" O.C.

#10 @ 4" PLENTY TO ATTACH

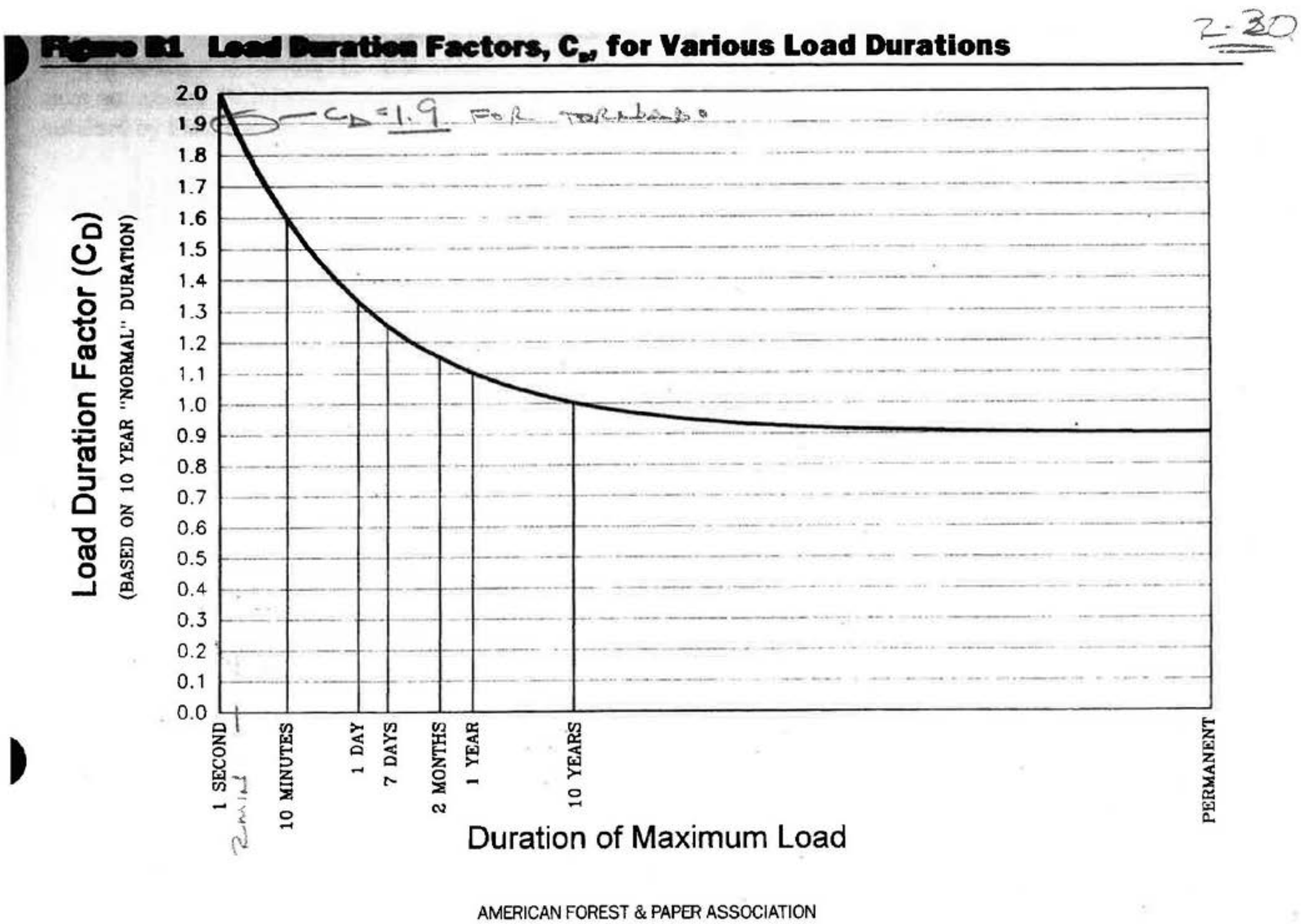


Figure B1 Load Duration Factors, C_D, for Various Load Durations
2-30
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Load Duration Factor (C_D)
(BASED ON 10 YEAR "NORMAL" DURATION)
1 SECOND
10 MINUTES
1 DAY
7 DAYS
2 MONTHS
1 YEAR
10 YEARS
PERMANENT
Duration of Maximum Load
AMERICAN FOREST & PAPER ASSOCIATION

Z-31

MISCELLANEOUS CALCULATIONS

UPLIFT OF CENTER ROOF

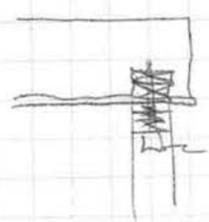
P_{UP} = 2822# (TORNADO)
WIND IS REDUCED BY NOT TO BE INSIGNIFICANT

SIMPSON HL33
910#(1.9/1.6) = 1081#
OK FOR WIND, TOO SMALL FOR TORNADO

HD3B OK (ALLOWABLE)
P_{ULT} = 3000##

IF LOOK @ ULTIMATE LOAD, S.F. ≈ 3+, INDICATING ULTIMATE LOAD WOULD WORK FOR TORNADOS

LAG FROM STUBWALL UP TO CENTER ROOF

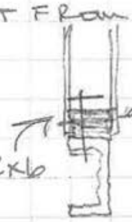


SPF 1/2" Φ BOLT (3" WOOD)
271# (3.5) = 949#
C_D = 1.9
P = 949#(1.9) = 1802#

& 5" WOOD
271#(5") = 1355
C_D = 1.9
P = 2600# CLOSE
SPACE @ 12" O.C.

FOR TORNADO
FOR ULTIMATE LOADS - THIS WOULD WORK FOR 3" & 4.5"
(2-2x & 3 2x)

BOLT FROM BOX TO STUB WALL



PLYWOOD SHEAR 2822#/2 = 1422#
SCREW ≥ 100/SCREW (1.9) = 190#/SCREW
1422#/190 = 8 SCREWS
(2 ROWS / 3" O.C.)

10D PENETRATION = 0.19"(10) = 1.9"

2-32

WIND FORCES ON FENCING

TORNADO WINDS WILL CONTROL

P_{WALL} = 240 PSF

FENCING SUPPORT @ 2' O.C.

P = 240 PSF (2'X2') = 960 #/4 = 240#/SCREW (4 – 1/4" LAG BOLTS FOR S.G. = .50) (OK FOR S.P. F.D.F.)

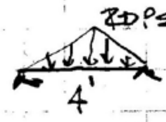
FENCING SUPPORT @ 4' O.C.

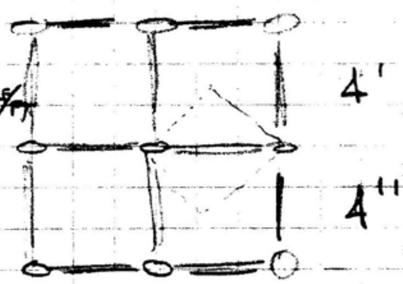
P = 240 PSF (4')(4') = 3840 #/4 = 960#/SCREW (NOT PRACTICAL FOR 2X6)

STANDARD WIND (P ≤ 20 PSF, 4-1/4" OK @ 4'X4' SPACING)

BENDING OF TUBES

20 PSF(4') = 80 #/FT





$M = \frac{4}{3} w = \frac{4}{3}(80(4)\frac{1}{2})$

$M = 160^{\#}(4/3) = 213^{\#FT}$

$S \geq 0.213^{KFT}(12''/') / 46 KSI$ (TUBE) $= 0.06 IN^3$ (HSS 1 1/2 x 1 1/2 x 1/8 OK FOR 90 MPH WIND)

$I \geq \frac{WL^3}{60E\Delta} = \frac{213^{\#}(4')^3(12''/')^3}{60(29000KSI)(4'/240)} = 0.07 IN^4$

GRAVITY LOAD – 20 PSF

SECTION 3
LATERAL LOAD ANALYSIS

LATERAL LOAD ANALYSIS INTRODUCTION

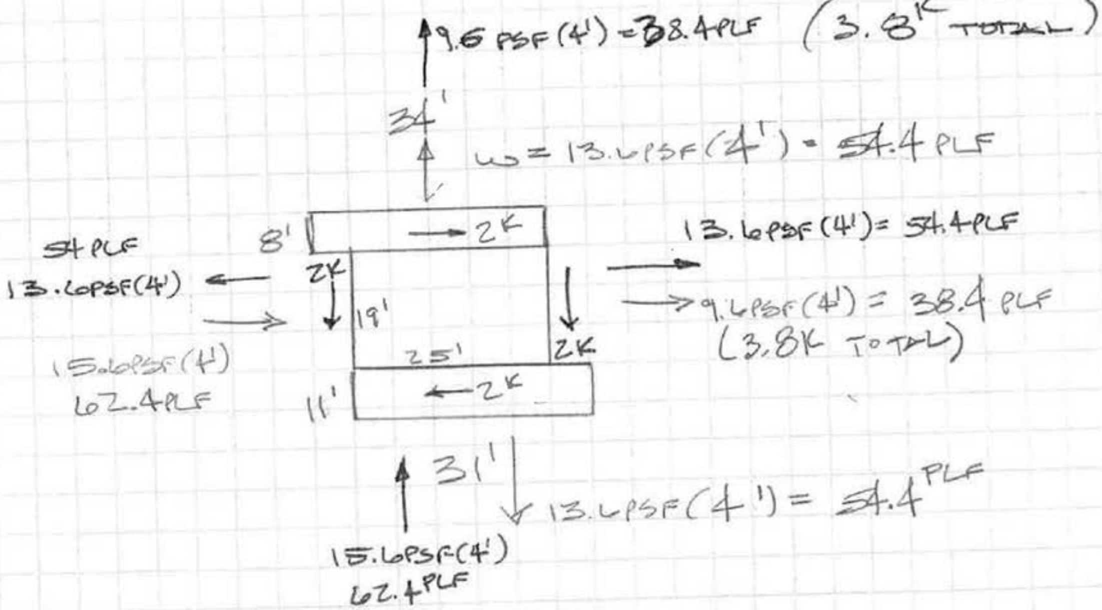
The calculations in this section check the overall stability of the structure due to wind and earthquake loads. The members were analyzed for:

- Wind Load (Springfield/Neosho MO wind loading controlled)
- Earthquake Load (Irvine, California earthquake loading controlled)
- Tornado Wind Load (Experimentally Based Analysis)

3-3

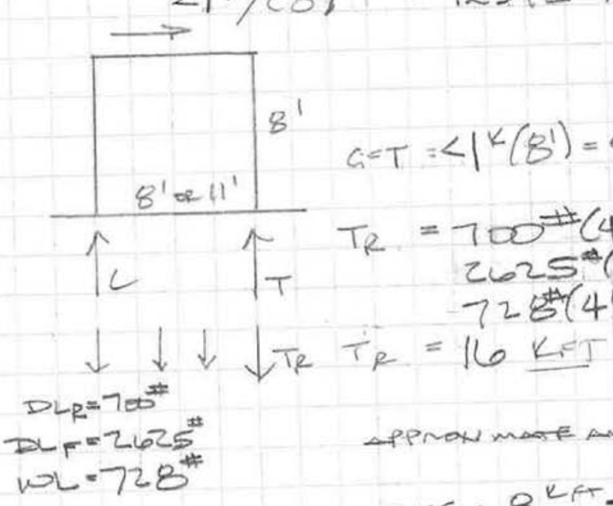
LATERAL FORCE DISTRIBUTION

WIND (SPRINGFIELD CONTROLLED)



SHEAR WALL LOAD (WORST CASE)

<1K/(8') = 125 PLF MINIMAL REQUIRED



C = T = <1K(8') = 8 KFT / 8' = 1.0K

TR = 700#(4')
2625#(4')
728#(4')

TR = 16 KFT

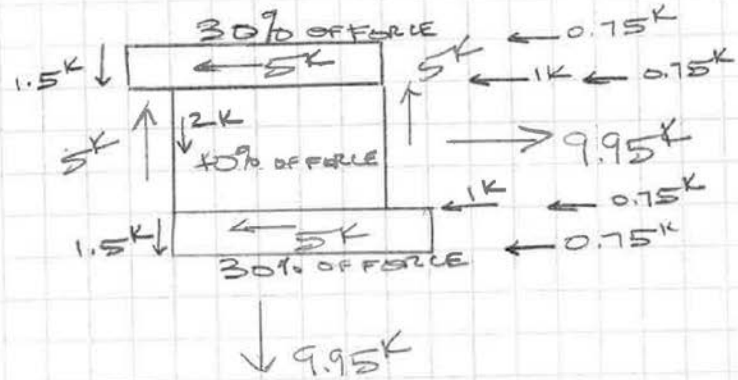
APPROXIMATE ANCHORAGE

$$T = C = \frac{8^{KFT} - 16^{KFT}(\frac{2}{2})}{8'} \leq 1.0^{K}$$

3-4

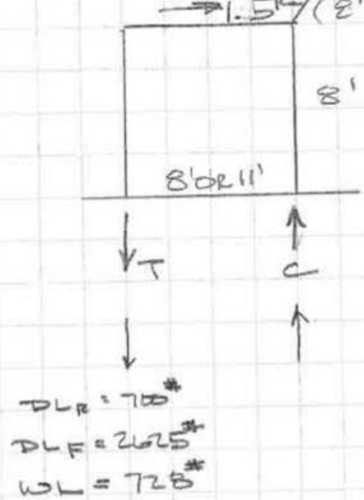
LATERAL FORCE DISTRIBUTION (CONT'D)

SEISMIC (IRVINE CONTROLLED)



SHEAR WALL LOAD (WORST CASE)

$1.5^K/(8') = 188$ PLF (LOOK @ NAILS)



$M_O = 1.5^K(8') = 12^{KFT}$

$M_R = 16^{KFT}$ (LOOK @ STRAPS & FOUNDATION)

APPROXIMATE ANCHORAGE

$$T = C = \frac{12^{KFT} - 2/3(16^{KFT})}{8'} \leq 1$$

CONTROLS BY INSPECTION

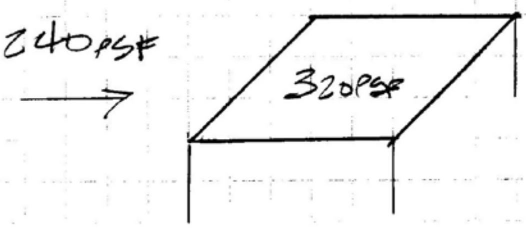
TORNADO WIND LOADS

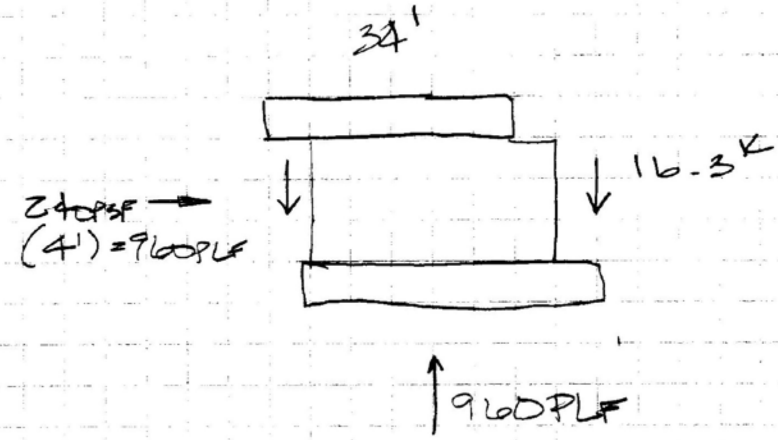
3-5

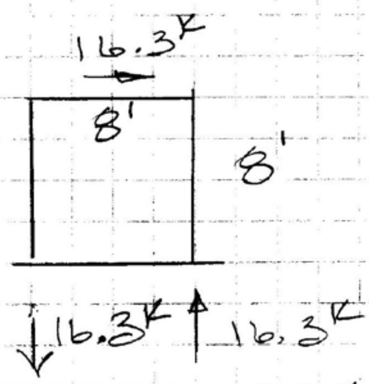
$q = 0.00256(250MPH)^2 = 160PSF$

$C_p = 2.0$ ROOF, 1.5 WALL

P = 320PSF ROOF / 240PSF WALL







PLYWOOD 16.3K/8' = 2038 PLF
w/2 LAYERS OF PLY & SCREWS 3" O.C. w/2-2X@JTS.

UPLIFT BY ANCHORAGE EACH LAYER 1000PLF THROUGH BLDG. OK

SECTION 4 FOUNDATION ANALYSIS

FOUNDATION ANALYSIS INTRODUCTION

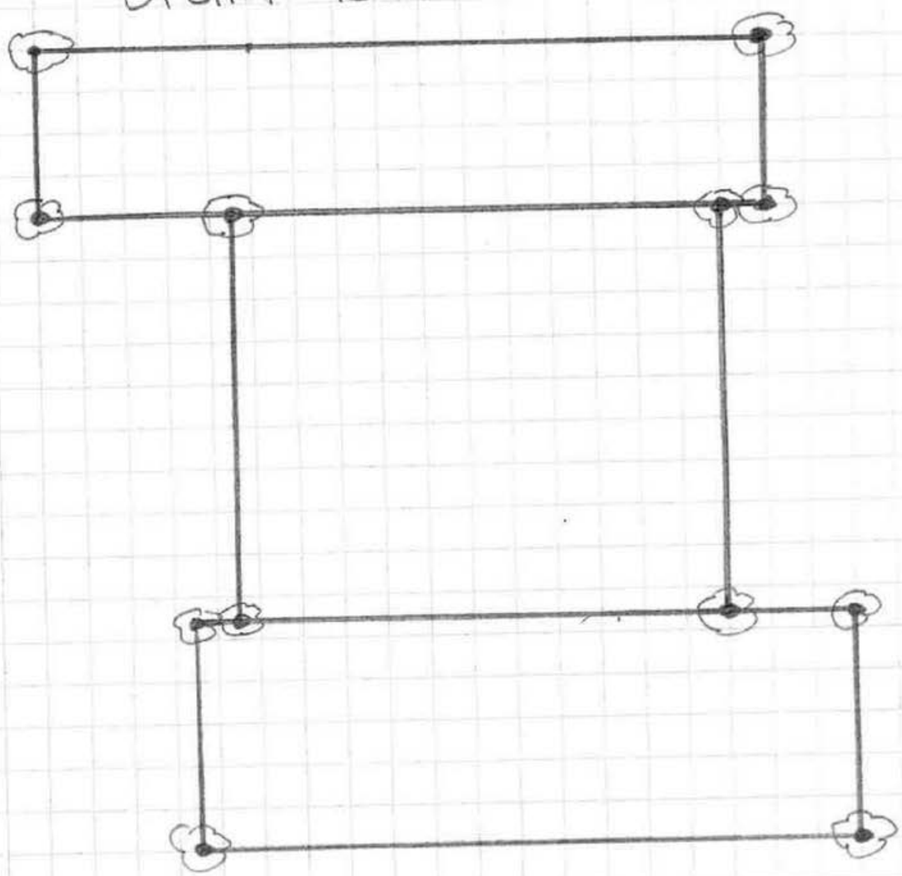
The calculations in this section check the foundation capacity and overall stability due to the applied loads. Additional information about the seismic foundation supports for the Irvine, CA location are also included.

4-3

ULTIMATE CAPACITY REQUIREMENTS, EACH PIER (SEISMIC)

LATERAL = 2.00 K

UPLIFT = 2.00 K



GRAVITY LOAD REQUIREMENTS @ ALL PIERS

P = 7.4 K EACH PIER

4-4

PIERS - 35 SF FLOOR (APPROXIMATE)

ROOF DL = (17 PSF/2 + 23 PSF/2)(35 SF) = 700 #
ROOF LL = 19 PSF (35 SF) = 665 #
FLR DL = 19 PSF (35 SF) = 665 # TL = 5383 #
FLR LL = (50 PSF/2 + 100 PSF/2)(35 SF) = 2625 #
WALL = 13 PSF (8')(7' MAX) = 728 # (1.65' SQ PAD

PIERS - 50 SF FLOOR (APPROXIMATE)

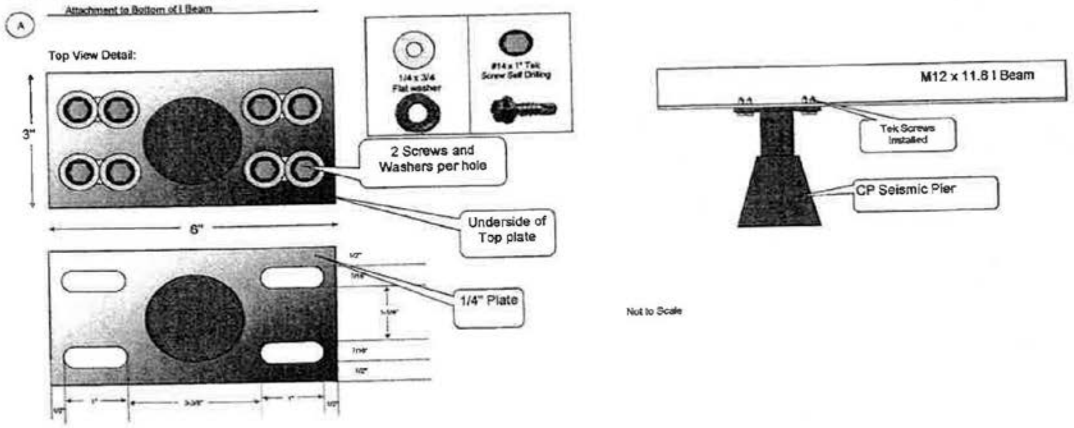
ROOF DL = (17 PSF/2 + 23 PSF/2)(50 PSF) = 1000 #
ROOF LL = 19 PSF (50 PSF) = 950 #
FLOOR DL = 19 PSF (50 PSF) = 950 # TL = 7378 #
FLOOR LL = (50 PSF/2 + 100 PSF/2)(50 PSF) = 3750 #
WALL = 13 PSF (8')(7' MAX) = 728 # (1.92' SQ PAD

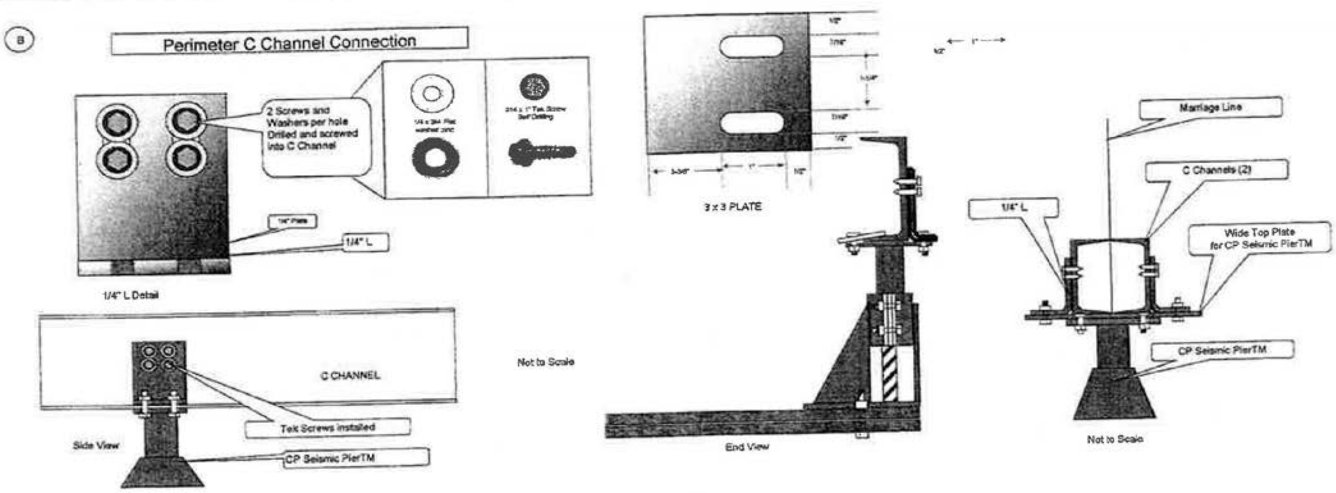
4.5

Central Piers Inc. 559-268-0828

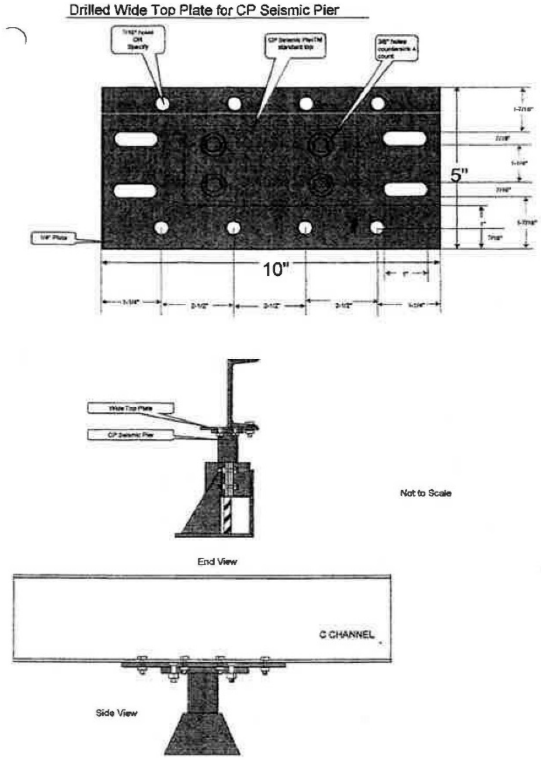
tional Alternate Connections for CP Seismic PierTM and CP Anchor Pier TM

CP Seismic Pier :

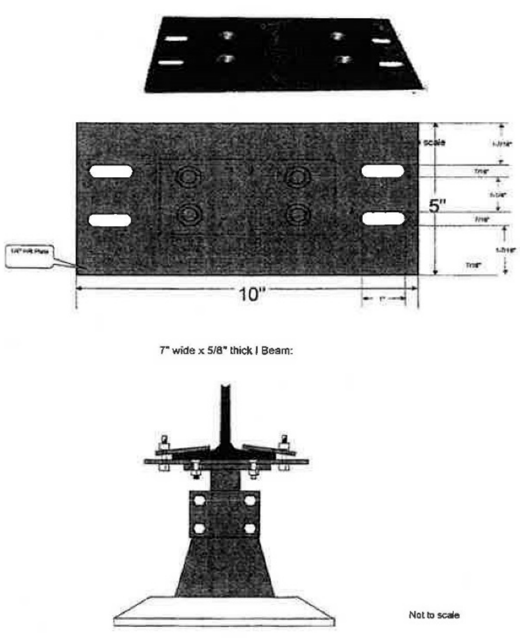




Drilled Wide Top Plate for CP Seismic Pier

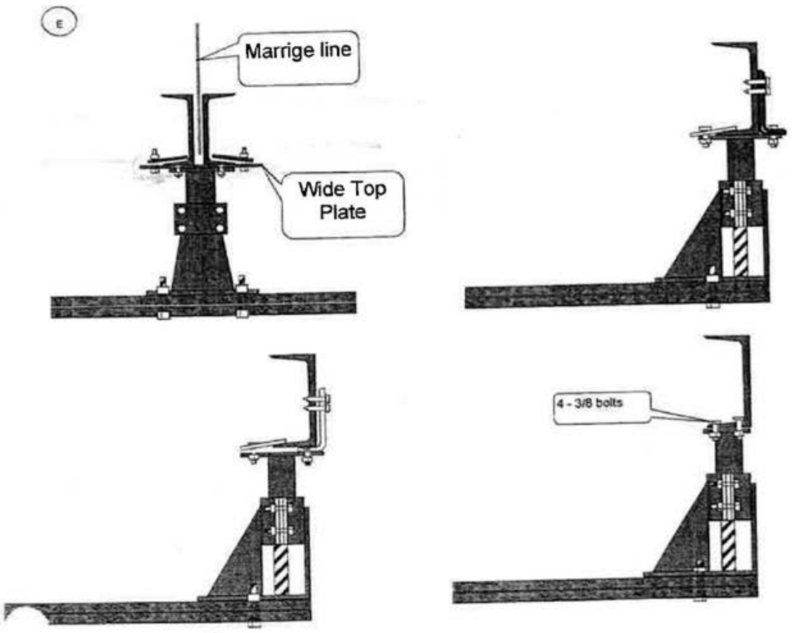


(D) Standard Wide Top Plate for CP Seismic Pier

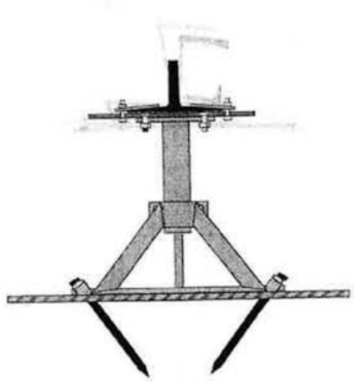


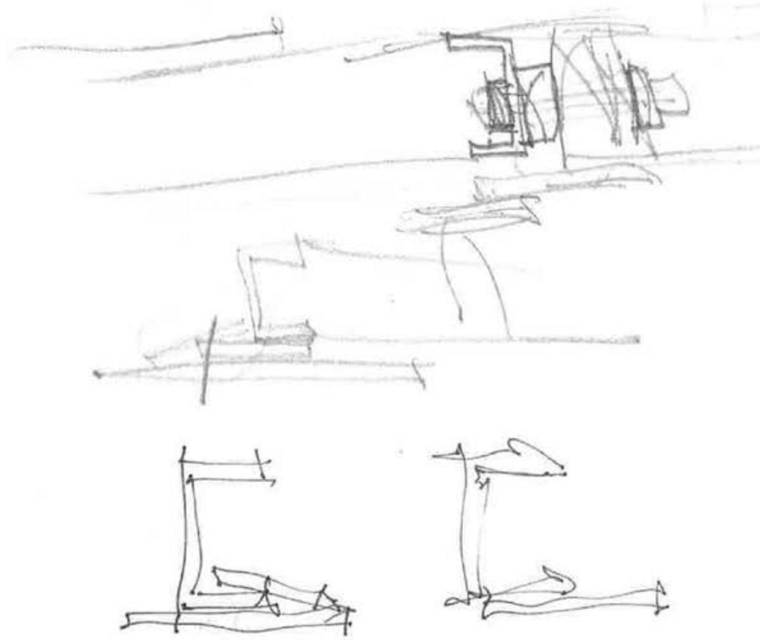
4-6

Other Options for C Channel



F Wide Top Plate for CP Anchor Pier





ENGINEERED FOUNDATION PLAN
C.P. SEISMIC PIER
SPA 30–5F

FOR: CENTRAL PIERS, INC.
284 N. THORNE AVE.
FRESNO, CA 93706
559–268–0828

BY: ROCK SOLID ENGINEERING, INC.
1100 MAIN STREET, SUITE A
WATSONVILLE, CA 95076
831–724–5868

REGISTERED PROFESSIONAL ENGINEER
YVETTE M. WILSON
No. 60245
Exp.
CIVIL
STATE OF CALIFORNIA

Signed 6/17/14

STATE APPROVAL

MANUFACTURED HOME/MOBILE HOME
FOUNDATION SYSTEM
HEALTH AND SAFETY CODE, SECTION 18551
APPROVED

SUBJECT TO CORRECTIONS NOTED

APPROVAL DOES NOT AUTHORIZE OR APPROVE ANY OMISSIONS OR DEVIATION FROM REQUIREMENTS OF APPLICABLE STATE LAWS AND REGULATIONS
State of California
Department of Housing and Community Development
DIVISION OF CODES AND STANDARDS

BY R. [signature] (signature) DATE 7/14/14
SPA NO. 30-5F FHZ-NO
This Plan Approval Expires 10/26/14

REV.	DATE	BY	COMMENTS
△			
△			
△1	06/17/14	YW	ADD 130 MPH WIND LOAD
△0	02/14/14	YW	UPDATE TO 2013 CBC/CRC

ROCK SOLID ENGINEERING, INC.

ENGINEERED FOUNDATION PLAN
CENTRAL PIERS – SPA 30–5F

SHEET F1 OF 6

4.7

GENERAL NOTES:

REFERENCE: CALIFORNIA CODE OF REGULATIONS, TITLE 25 AND 2013 C.R.C./C.B.C. THESE PLANS MEET THE INTENT OF 2013 C.R.C. 301.1.3.

1. DESIGN LOADS SHALL BE CONSISTENT WITH LOCAL REQUIREMENTS WHERE INSTALLED. THE FOLLOWING DESIGN LOADS ARE INCORPORATED HEREIN:
   FLOOR LIVE LOAD: 40 PSF ROOF LIVE LOAD: 30PSF – 100 PSF
   BASIC WIND SPEED & EXPOSURE: 110-(130) MPH AS LISTED IN TABLE
   SEISMIC DESIGN CATEGORY: E
   SITE CLASS D Ss=1.5 Sds=1.4 Fa=1.4 V=0.215W (SIMPLIFIED METHOD, ASCE 7-10 SECTION 12.14)
   THIS DESIGN IS NOT INTENDED FOR USE IN FLOOD HAZARD AREAS.
2. FOOTINGS ARE TO BE SUPPORTED BY EITHER FIRM, UNSATURATED, UNDISTURBED SOIL OR COMPACTED FILL, ASPHALT OR CONCRETE. FOOTINGS ARE DESIGNED FOR 1500 PSF BEARING CAPACITY AND SHALL BE COMPATIBLE WITH LOCAL SOIL CONDITIONS. ALL FOOTINGS SHALL BE FOUNDED IN ACCORDANCE WITH H.C.D. GUIDLINES AND TITLE 25 OR PREPARE SUBGRADE PER SOIL REPORT, WHEN AVAILABLE.
3. STRUCTURAL STEEL:
   a. SHALL CONFORM TO ASTM A36 Fy = 36 KSI MINIMUM.
   b. SHALL BE FABRICATED ACCORDING TO AISC SPECIFICATIONS.
   c. SHALL BE WELDED ACCORDING TO AWS SPECIFICATIONS:
      i. ELECTRODES: E70
      ii. PLATES: ASTM A36
      iii. BOLTS: STANDARD ASTM A307
      iv. THREADED ROD: COLD DRAWN LOW CARBON WELDABLE
   d. ALL METAL COMPONENTS INCLUDING NAILS & SCREWS ETC. ARE TO BE PROTECTIVE COATED.
4. THE C.P. SEISMIC PIER SHALL BE LISTED & LABELED BY BSK ASSOCIATES FOR THESE ULTIMATE LOADS:
   7" THRU 18 INCH PIERS: 3203 LBS. (STRONG DIR), 2273 (WEAK DIR), 16,000 VERTICAL
5. THIS FOUNDATION SYSTEM IS FOR PLACING MANUFACTURED HOMES CONSTRUCTED WITH LONGITUDINAL OR CROSS JOISTS.
6. THIS FOUNDATION SYSTEM IS DESIGNED TO BE CONSTRUCTED ON A FAIRLY LEVEL SITE WITH NO EXISTING SOIL PROBLEMS. SEE NOTE 2 AND TITLE 25, SECTION 1334(b).
7. THE SIZE, TYPE & LOCATION OF STANDARD VERTICAL SUPPORT PIERS & FOOTINGS MUST BE INSTALLED PER THE HOME MANUFACTURER'S INSTALLATION MANUAL. WITHOUT MANUAL, SPACING OF STANDARD PIERS TO BE DETERMINED BY TITLE 25, SECTION 1335.5.

FOUNDATION PAD NOTES:

1. TWO FOUNDATION PADS ARE AVAILABLE FOR USE WITH THIS SYSTEM. THE CUSTOMER MAY CHOOSE ONE OF THE PADS FOR THEIR HOME. SEE SHEET F6, FOUNDATION PADS.
2. FOUNDATION PADS SHALL BE PLACED ON FIRM, LEVEL UNDISTURBED SOIL (SEE GEN. NOTE 2)
3. THE FOUNDATION PADS SHALL BE ORIENTED AS SHOWN ON THE PLAN VIEW DRAWING WITH THE BOLT HOLES PERPENDICULAR TO THE CHASSIS BEAM. SEE PLAN VIEWS, SHEETS F3 AND F4.

4. CONCRETE FOUNDATION PADS
   2500 PSI AT 28 DAYS AS TESTED AND MANUFACTURED BY STARLITE WEIGHT CONCRETE.
5. PRESSURE TREATED FOUNDATION PAD
   3/4 INCH A.P.A. 48/24 EXTERIOR P.S.I.–83 CC. PLUGGED, NER–QA397,PRP–108.
6. ATTACHMENT TO EXISTING CONCRETE SLAB
   THE C.P. SEISMIC PIER MAY BE ATTACHED TO AN EXISTING COMPETENT CONCRETE SLAB OR CONCRETE FOOTING ACCORDING TO THE FOLLOWING CRITERIA:
   1. ATTACH WITH TWO 5/8" DIAM. REDHEAD WEDGE ANCHORS
   2. MINIMUM EMBEDMENT = 2.5"
   3. MINIMUM CONCRETE THICKNESS = 3¾"
   4. MINIMUM EDGE DISTANCE = 2"

COACH SIZE NOTES:

1. UNLESS APPROVED BY ROCK SOLID ENGINEERING, INC., THE ROOF PITCH SHOULD NOT EXCEED:
   A. SINGLE WIDES: 4:12
   B. DOUBLE AND TRIPLE WIDES: 3:12 or 4:12 AS LISTED IN TABLE
2. FOR ANY HOME SIZE OTHER THAN AS SHOWN ON THIS PLAN OR REFERENCED IN THE TABLE, THE LAYOUT SHALL BE REVIEWED & APPROVED BY ROCK SOLID ENGINEERING, INC.

INSPECTION REQUIREMENTS:

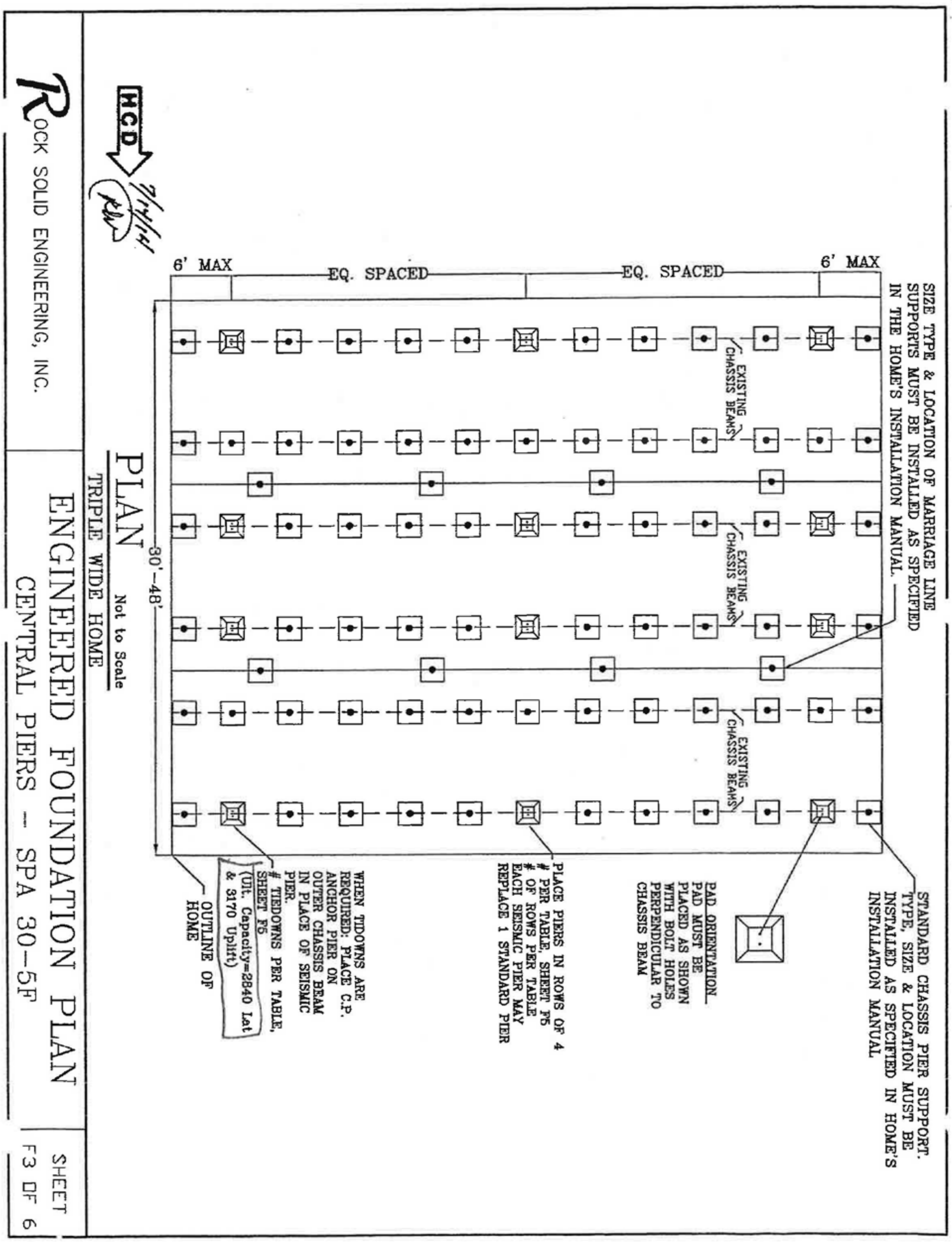
1. THE DESIGN OF THIS SYSTEM IS BASED ON STANDARD MANUFACTURED HOMES AS BUILT BY THE MANUFACTURER. SITE BUILT ADDITIONS SUCH AS GARAGES AND SECONDARY ROOFS HAVE NOT BEEN INCLUDED IN THIS DESIGN.
2. ALL DIMENSIONS INCLUDED ON THIS PLAN, INCLUDING COACH SIZE, ROOF HEIGHT AND PIER HEIGHT, SHOULD BE FIELD VERIFIED BY THE LOCAL BUILDING OFFICIAL. ANY DISCREPENCIES SHOULD BE IMMEDIATELY BROUGHT TO THE ENGINEER'S ATTENTION.
3. THE BUILDING PAD SHOULD BE INSPECTED TO ENSURE THAT PROPER SOIL CONDITIONS AND DRAINAGE PATTERNS HAVE BEEN ESTABLISHED IN ACCORDANCE WITH TITLE 25 & THE HOME INSTALLATION MANUAL.

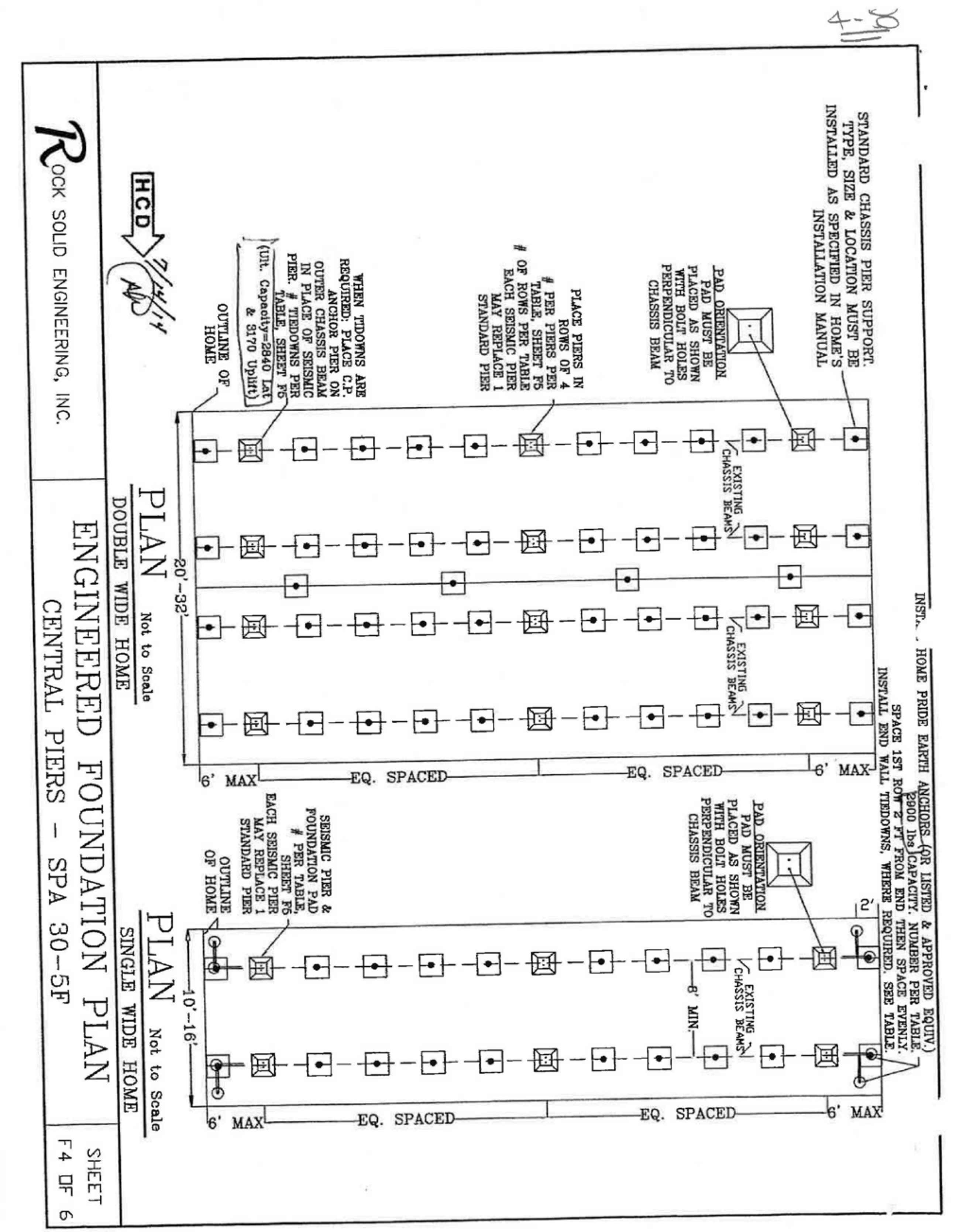
HCD 7/14/14

ROCK SOLID ENGINEERING, INC.

ENGINEERED FOUNDATION PLAN
CENTRAL PIERS – SPA 30–5F

SHEET F2 OF 6


ROCK SOLID ENGINEERING, INC.
HCD
PLAN Not to Scale
TRIPLE WIDE HOME
ENGINEERED FOUNDATION PLAN
CENTRAL PIERS – SPA 30–5F
SHEET F3 OF 6
6' MAX
EQ. SPACED
EQ. SPACED
6' MAX
30'-48'
SIZE TYPE & LOCATION OF MARRIAGE LINE SUPPORTS MUST BE INSTALLED AS SPECIFIED IN THE HOME'S INSTALLATION MANUAL.
EXISTING CHASSIS BEAMS
EXISTING CHASSIS BEAMS
EXISTING CHASSIS BEAMS
STANDARD CHASSIS PIER SUPPORT. TYPE, SIZE & LOCATION MUST BE INSTALLED AS SPECIFIED IN HOME'S INSTALLATION MANUAL
PAD ORIENTATION
PAD MUST BE PLACED AS SHOWN WITH BOLT HOLES PERPENDICULAR TO CHASSIS BEAM
PLACE PIERS IN ROWS OF 4 # PER TABLE, SHEET F5 # OF ROWS PER TABLE EACH SEISMIC PIER MAY REPLACE 1 STANDARD PIER
WHEN TIDOWNS ARE REQUIRED: PLACE C.P. ANCHOR PIER ON OUTER CHASSIS BEAM IN PLACE OF SEISMIC PIER.
TIEDOWNS PER TABLE, SHEET F5
(Ult. Capacity=2840 Lat & 3170 Uplift)
OUTLINE OF HOME


4-8
STANDARD CHASSIS PIER SUPPORT. TYPE, SIZE & LOCATION MUST BE INSTALLED AS SPECIFIED IN HOME'S INSTALLATION MANUAL
PAD ORIENTATION PAD MUST BE PLACED AS SHOWN WITH BOLT HOLES PERPENDICULAR TO CHASSIS BEAM
PLACE PIERS IN ROWS OF 4 # PER PIERS PER TABLE, SHEET F5 # OF ROWS PER TABLE EACH SEISMIC PIER MAY REPLACE 1 STANDARD PIER
WHEN TIEDOWNS ARE REQUIRED: PLACE C.P. ANCHOR PIER ON OUTER CHASSIS BEAM IN PLACE OF SEISMIC PIER. # TIEDOWNS PER TABLE, SHEET F5
(Ult. Capacity=2840 Lat & 3170 Uplift)
OUTLINE OF HOME
HCD
7/14/14
EXISTING CHASSIS BEAMS
20'-32'
PLAN Not to Scale
DOUBLE WIDE HOME
6' MAX
EQ. SPACED
EQ. SPACED
6' MAX
INSTALL HOME PRIDE EARTH ANCHORS (OR LISTED & APPROVED EQUIV.) 2900 lbs CAPACITY. NUMBER PER TABLE. SPACE 1ST ROW 2 FT FROM END THEN SPACE EVENLY. INSTALL END WALL TIEDOWNS, WHERE REQUIRED. SEE TABLE.
2'
PAD ORIENTATION PAD MUST BE PLACED AS SHOWN WITH BOLT HOLES PERPENDICULAR TO CHASSIS BEAM
SEISMIC PIER & FOUNDATION PAD # PER TABLE, SHEET F5 EACH SEISMIC PIER MAY REPLACE 1 STANDARD PIER
OUTLINE OF HOME
8' MIN.
10'-16'
PLAN Not to Scale
SINGLE WIDE HOME
6' MAX
EQ. SPACED
EQ. SPACED
6' MAX
ROCK SOLID ENGINEERING, INC.
ENGINEERED FOUNDATION PLAN
CENTRAL PIERS - SPA 30-5F
SHEET F4 OF 6

HOME SIZE			MAX. ROOF LIVE LOAD (PSF)	30 PSF			40 PSF			40 PSF			100 PSF			100 PSF		
			MAX. WIND LOAD(MPH,EXP)	110B & 110C			110C			120B			120C			130C		
	ROOF PITCH	WIDTH	LENGTH	# OF SEISMIC PIERS	# OF ROWS	# OF TIE DOWNS	# OF SEISMIC PIERS	# OF ROWS	# OF TIE DOWNS	# OF SEISMIC PIERS	# OF ROWS	# OF TIE DOWNS	# OF SEISMIC PIERS	# OF ROWS	# OF TIE DOWNS	# OF SEISMIC PIERS	# OF ROWS	# OF TIE DOWNS
SINGLES	4:12	10'-16'	UP TO 48'	4	2 ROWS	4	4	2 ROWS	4/4*	4	2 ROWS	4/4*	4	2 ROWS	4/4*	4	2 ROWS	4/4*
			48.5'-60'	6	3 ROWS	4	6	3 ROWS	4	6	3 ROWS	4	6	3 ROWS	6/4*	6	3 ROWS	6/4*
			60.5'-78'	8	4 ROWS	4	8	4 ROWS	4	8	4 ROWS	4	8	4 ROWS	8/4*	8	4 ROWS	8/4*
DOUBLE WIDES	3:12	20'-28'	UP TO 56'	8	2 ROWS	0	4	2 ROWS	4	4	2 ROWS	4	8	3 ROWS	4	6	3 ROWS	6
			56.5'-66'	8	2 ROWS	0	4	2 ROWS	4	8	3 ROWS	4	8	3 ROWS	4	6	3 ROWS	6
			66.5'-78'	12	3 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	12	4 ROWS	4	8	4 ROWS	8
		28.5'-32'	UP TO 56'	8	2 ROWS	0	4	2 ROWS	4	4	2 ROWS	4	8	3 ROWS	4	6	3 ROWS	6
			56.5'-68'	8	2 ROWS	0	12	3 ROWS	0	12	3 ROWS	0	12	4 ROWS	4	8	4 ROWS	8
			68.5'-78'	12	3 ROWS	0	12	3 ROWS	0	12	3 ROWS	0	12	4 ROWS	4	8	4 ROWS	8
	4:12	20'-30'	UP TO 60'	8	2 ROWS	0	12	3 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	6	3 ROWS	6
			60.5'-66'	8	2 ROWS	0	12	3 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	6	3 ROWS	6
			66.5'-78'	12	3 ROWS	0	12	3 ROWS	0	8	3 ROWS	4	12	4 ROWS	4	8	4 ROWS	8
		30.5'-32'	UP TO 58'	8	2 ROWS	0	12	3 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	6	3 ROWS	6
			58.5'-66'	8	2 ROWS	0	12	3 ROWS	0	8	3 ROWS	4	12	4 ROWS	4	8	4 ROWS	8
			66.5'-78'	12	3 ROWS	0	12	3 ROWS	0	8	3 ROWS	4	12	4 ROWS	4	8	4 ROWS	8
TRIPLES WIDES	4:12	30'-43'	UP TO 48'	8	2 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	8	3 ROWS	4	6	3 ROWS	6
			48.5'-60'	12	3 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	12	4 ROWS	4	8	4 ROWS	8
			60.5'-66'	12	3 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	16	5 ROWS	4	8	5 ROWS	8
			66.5'-78'	16	4 ROWS	0	12	4 ROWS	4	12	4 ROWS	4	14	5 ROWS	6	10	5 ROWS	10
		43.5'-48'	UP TO 48'	12	3 ROWS	0	8	3 ROWS	4	8	3 ROWS	4	12	4 ROWS	4	8	4 ROWS	8
			48.5'-56'	12	3 ROWS	0	8	4 ROWS	4	8	3 ROWS	4	12	4 ROWS	4	8	4 ROWS	8
			56.5'-68'	12	3 ROWS	0	8	5 ROWS	4	12	4 ROWS	4	14	5 ROWS	6	10	5 ROWS	10
			68.5'-78'	16	4 ROWS	0	12	4 ROWS	4	12	4 ROWS	4	14	5 ROWS	6	10	5 ROWS	10

TABLE NOTES

TO USE TABLE, FIND HOME SIZE (SINGLE, DOUBLE OR TRIPLE), THEN FIND ROOF PITCH, WIDTH AND LENGTH. FOLLOW ROW ACROSS TO DESIGN SNOW LOAD THEN DESIGN WIND LOAD. READ TOTAL NUMBER OF C.P. SEISMIC PIERS, # OF ROWS & TIDOWNS REQUIRED. SEE PLAN, SHEETS F3 & F4, FOR PLACEMENT OF C.P. SEISMIC PIERS AND TIEDOWN SPECIFICATIONS.

FOR EXAMPLE, FOR A 24'x70' HOME WITH A 3:12 ROOF PITCH, DESIGN SNOW LOAD OF 30 PSF & 110 MPH, EXPOSURE C WIND LOAD, READ 12 C.P. SEISMIC PIERS, PLACED IN 3 ROWS, WITH 0 C.P. ANCHOR PIER TIEDOWNS. LAYOUT SHOWN IN DOUBLE WIDE PLAN VIEW, SHEET F4

*FOR SINGLE WIDES, WHERE TIEDOWN COLUMN IS SPLIT AS SHOWN, INSTALL 2 EARTH ANCHOR TIEDOWNS AT EACH ENDWALL , TOTAL # OF ENDWALL TIEDOWS PER HOME IS INDICATED IN TABLE BY *. 4/4* — TOTAL # OF SIDEWALL TIEDOWNS; — TOTAL # OF ENDWALL TIEDOWNS

HOME SIZES REFER TO NOMINAL SIZES THAT ARE COMMONLY MANUFACTURED. IF THE EXACT SIZE OF THE HOME IS NOT LISTED, CHECK THE NEXT HIGHER OR LOWER SIZE AND USE THE ONE THAT REQUIRED MORE PIERS.

THE TIEDOWNS SHALL BE LISTED & INSTALLATION INSTRUCTIONS SHALL BE ON SITE AT TIME OF INSPECTION.

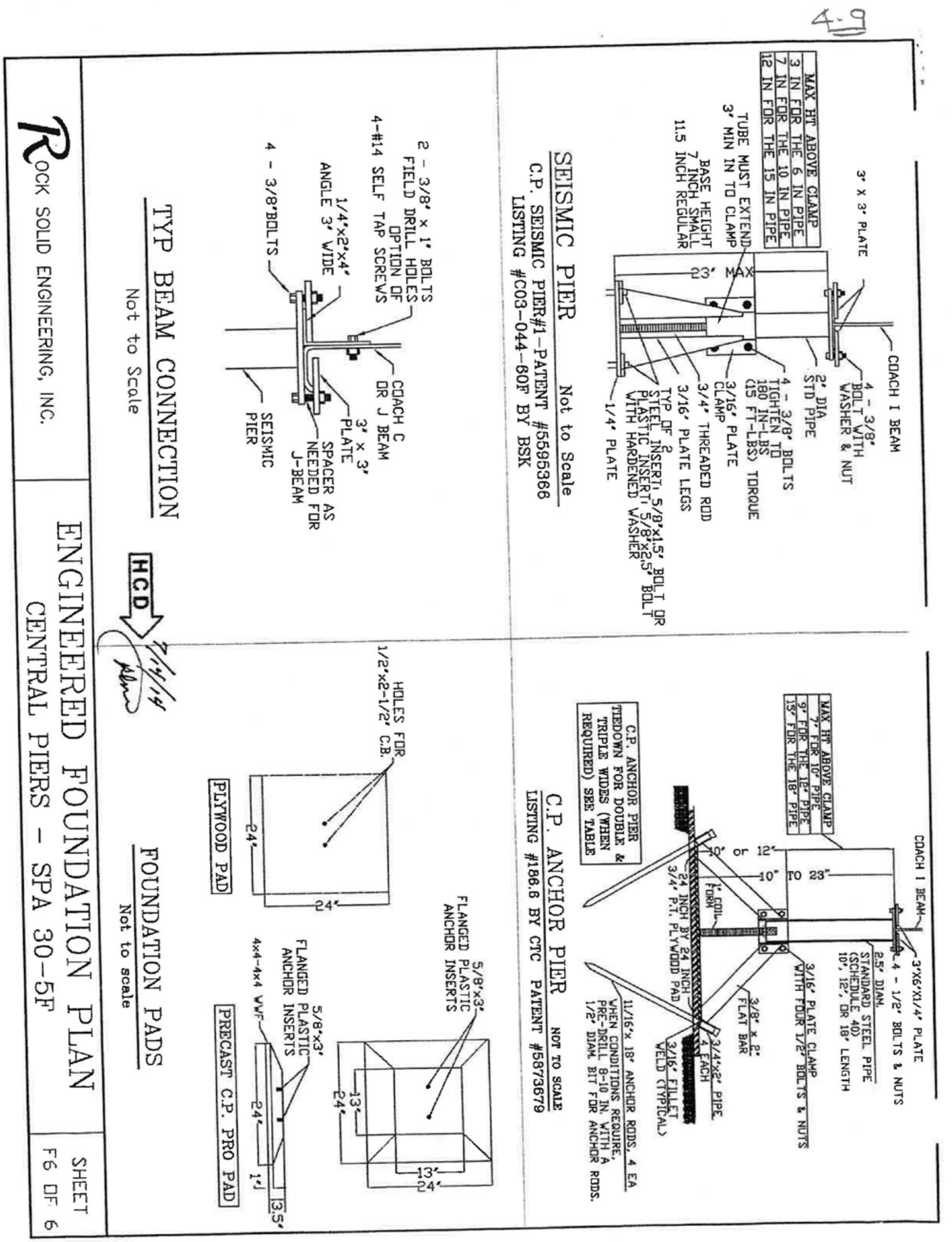
HCD 7/14/14

THIS PLAN MAY BE USED WITH C.P. SEISMIC PIERS UP TO THE 18 INCH PIER SIZE. THE MAXIMUM HEIGHT OF THE C.P. SEISMIC AND C.P. ANCHOR PIERS IS 23" MEASURED FROM THE BASE PLATE TO THE TOP PLATE.

ROCK SOLID ENGINEERING, INC.

ENGINEERED FOUNDATION PLAN
CENTRAL PIERS – SPA 30-5F

SHEET F5 OF 6


4-9
MAX HT ABOVE CLAMP
3 IN FOR THE 6 IN PIPE
7 IN FOR THE 10 IN PIPE
12 IN FOR THE 15 IN PIPE
3" X 3" PLATE
TUBE MUST EXTEND 3" MIN IN TO CLAMP
BASE HEIGHT
7 INCH SMALL
11.5 INCH REGULAR
23" MAX
COACH I BEAM
4 - 3/8" BOLT WITH WASHER & NUT
2" DIA STD PIPE
4 - 3/8" BOLTS TIGHTEN TO 180 IN-LBS (15 FT-LBS) TORQUE
3/16" PLATE CLAMP
3/4" THREADED ROD
3/16" PLATE LEGS
TYP OF 2
STEEL INSERT, 5/8"x1.5" BOLT OR PLASTIC INSERT, 5/8"x2.5" BOLT WITH HARDENED WASHER
1/4" PLATE
SEISMIC PIER Not to Scale
C.P. SEISMIC PIER#1-PATENT #5595366
LISTING #C03-044-60F BY BSK
2 - 3/8" x 1" BOLTS
FIELD DRILL HOLES OPTION OF
4-#14 SELF TAP SCREWS
1/4"x2"x4" ANGLE 3" WIDE
4 - 3/8"BOLTS
COACH C OR J BEAM
3" x 3" PLATE
SPACER AS NEEDED FOR J-BEAM
SEISMIC PIER
TYP BEAM CONNECTION
Not to Scale
HCD
7/14/14
MAX HT ABOVE CLAMP
7" FOR 10" PIPE
9" FOR THE 12" PIPE
15" FOR THE 18" PIPE
COACH I BEAM
3"X6"X1/4" PLATE
4 - 1/2" BOLTS & NUTS
2.5" DIAM. STANDARD STEEL PIPE (SCHEDULE 40) 10", 12", OR 18" LENGTH
3/16" PLATE CLAMP WITH FOUR 1/2" BOLTS & NUTS
10" or 12"
10" TO 23"
1" COIL FORM
24 INCH BY 24 INCH 3/4" P.T. PLYWOOD PAD
3/8" x 2" FLAT BAR
3/4"x2" PIPE 4 EACH
3/16" FILLET WELD (TYPICAL)
11/16"x 18" ANCHOR RODS, 4 EA WHEN CONDITIONS REQUIRE. PRE-DRILL 8-10 IN. WITH A 1/2" DIAM. BIT FOR ANCHOR RODS.
C.P. ANCHOR PIER TIEDOWN FOR DOUBLE & TRIPLE WIDES (WHEN REQUIRED) SEE TABLE
C.P. ANCHOR PIER NOT TO SCALE
LISTING #186.6 BY CTC PATENT #5873679
HOLES FOR 1/2"x2-1/2" C.B.
24"
24"
PLYWOOD PAD
5/8"x3" FLANGED PLASTIC ANCHOR INSERTS
13"
24"
13"
24"
5/8"x3" FLANGED PLASTIC ANCHOR INSERTS
4x4-4x4 WWF
24"
1"
3.5"
PRECAST C.P. PRO PAD
FOUNDATION PADS
Not to scale
ROCK SOLID ENGINEERING, INC.
ENGINEERED FOUNDATION PLAN
CENTRAL PIERS - SPA 30-5F
SHEET
F6 OF 6

Detailed Water Budget

Crowder/Drury Water Budget					
Operation/Task	**Water (gallons)**	**Liters**	**Gallons per Draw**	**Draws**	**Notes**
Hot Water	240	908.50	15	16	Calculated 15 gallons of water per draw
Cooking	4.2	15.9	0.70	6	Calculated 0.7 gallons of water per draw
Dishwasher	11.1	42.02	2.2	5	Calculated 2.2 gallons of water per cycle
Clothes Washer	120	454.25	15	8	Assumes 15 gallons of water per load
Fire Supression	230	1135.60			Uponor recommended amount
Vegetation	0	0	0	0	Water for vegetation will be brought by the team
Total	605.3	2556.27			
Safety Factor	10%	10%			10% Contingency
Total	**665.83**	**2811.893**			

Summary of Unlisted Electrical Components

Not Applicable

Summary of Reconfigurable Features

Not Applicable

Interconnection Application Form

Interconnection Application Form - Crowder Drury 2015 Solar Decathlon Team				
Photovoltaic System				
String	Module Manufacturer	Module Model	Module Watt Rating	Modules in Series
A1	Sunpower	X21	335 Watts	7
A2	Sunpower	X21	335 Watts	7
B1	Sunpower	X21	335 Watts	7
B2	Sunpower	X21	335 Watts	7
C1	Sunpower	X21	335 Watts	7
C2	Sunpower	X21	335 Watts	7

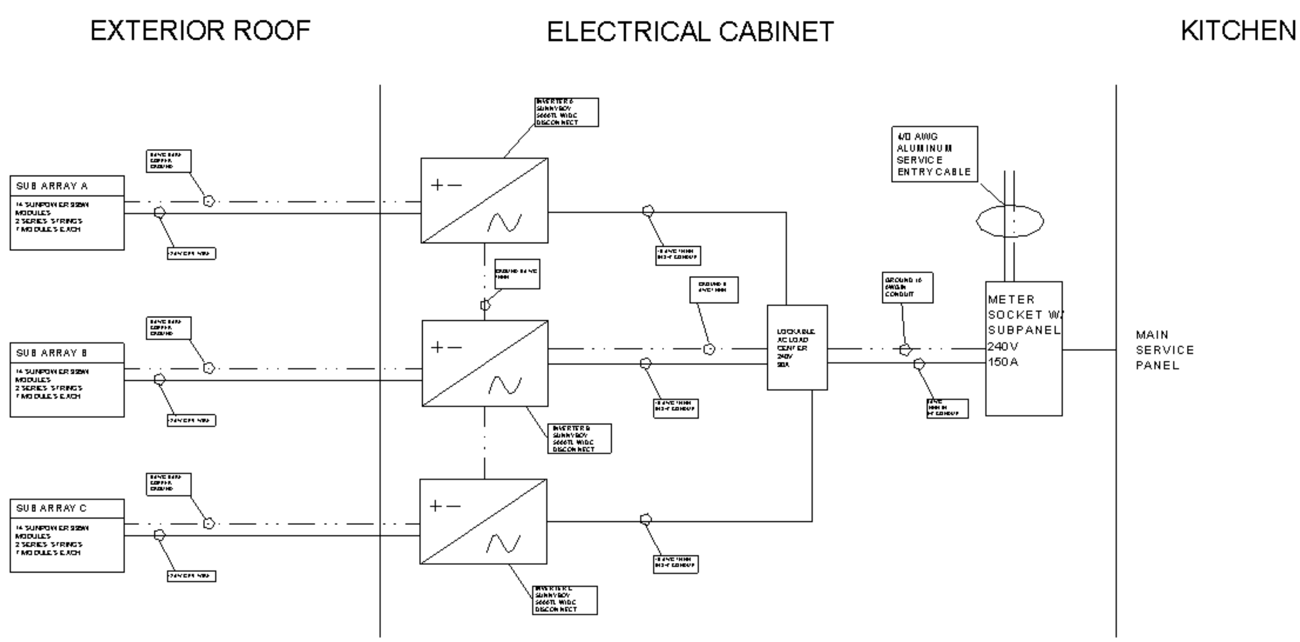
Combiner Boxes						
Box Name	Box Manufacturer	Box Model	Max VDC	Max Amps	Max Number of Strings	OCPD
A	Midnite Solar Inc.	MNPV3 (HV)	600	30	2	FUSE
B	Midnite Solar Inc.	MNPV3 (HV)	600	30	2	FUSE
C	Midnite Solar Inc.	MNPV3 (HV)	600	30	2	FUSE

Inverters				
Inverter Name	Inverter Manufacurer	Inverter Model	Inverter VA Rating	Voltage
A	SunnyBoy	5000TL	5kW	240
B	SunnyBoy	5000TL	5kW	240
C	SunnyBoy	5000TL	5kW	240

Total Power of PV System is 14.07kW

Solar Array Specs						
	Module	**String**	**Sub Array A**	**Sub Array B**	**Sub Array C**	**Array**
Pnom	335 W	2345 W	4690 W	4690 W	4690 W	14.07 kW DC
Vmp	57.3	401.1	401.1	401.1	401.1	
Imp	5.85	5.85	11.7	11.7	11.7	
Voc	67.9	475.3	475.3	475.3	475.3	
Isc	6.23	6.23	12.46	12.46	12.46	
Max Voltage	600VDC					
Power Temp Coef	-.30%/C	-.30%/C	-.30%/C	-.30%/C	-.30%/C	-.30%/C
Voltage Temp Coef	-167.4 mV/C	-167.4 mV/C	-167.4 mV/C	-167.4 mV/C	-167.4 mV/C	-167.4 mV/C
Current Temp Coef	3.5 mA/C	3.5 mA/C	3.5 mA/C	3.5 mA/C	3.5 mA/C	3.5 mA/C

One Line Diagram



Load Calculation

Service Feeder Calculations

General Lighting Load					
Square Footage of the dwelling	1000	x 3	3000		
Kitchen small appliance circuits	2	x 1500	3000		
Laundry branch circuit	1	x 1500	1500		
Subtotal of gen. lighting loads per NEC Section 220.52			7500		
Subtract 1st 3000VA per NEC 220.42			3000	X 100%	3000
Remaining VA X 35% per NEC 220.42			4500	x 35%	1575
		Total demand for general lighting loads =			4575
Fixed Appliance Loads (nameplate per NEC Section 220.14)					
Appliance	**Voltage**	**Amperage**	**VA**		
Dishwasher	120	12	1440		
Range Hood	120	6	720		
Water Heater	240	75	18000		
Disposal 1/2 HP	120	9.8	1176		
Subtotal of Fixed Appliances			21336		
NEC 220.53 — 3 or less Fixed Appliances			x 100%		
4 or more Fixed Appliances			x 75%	16002	
Cooking					
Electric Range	240	35	8400		
Stove	240	30	7200		
Subtotal of Cooking Loads			15600		
NEC 220.55			x 65%	10140	
Heating & Cooling					
HVAC			2120		
Other Loads					
EVSE	240	30	7200		
1/2 HP Water Supply Pump			373		
	Total VA Demand		40410		
VA divided by 240 volts		**Amps**	168.4		
Service Panel Size		**Amps**	200		
Neutral Conductor					
General Lighting Load NEC 220.61(a)		x 100%	4575		
Fixed Appliance Loads NEC 220.61(a)		x 100%	16002		
Cooking Loads NEC 220.61(b)		x 70%	7098		
Other Loads NEC 220.61(a)		x 100%	7573		
	Total VA Demand		35248		
VA divided by 240 volts		**Amps**	147		

Quantity Takeoff of Competition Prototype

Assembly Number	Description	Quantity	Unit
01 Site Work			
01	Reynobond Fencing	1.00	Ea.
011000	Landscaping & Plants	138.00	Ea.
0120000	1 1/2 " tubular steel for fencing	964.00	L.F.
02 Foundation			
02	CP seismic piers & Standard Piers	28.00	Ea.
03 Framing			
03	1/2" Threaded Steel Rods	544.00	L.F.
03	MC 7x19.1 C Channel including fabrication	1.00	Ea.
0308042	Exterior wall framing systems, 2" x 6", 16" OC	1,494.00	S.F.
0332042	Shed/flat roof framing systems, 2" x 8", 16" OC, 4/12 pitch	1,000.00	S.F.
04 Exterior Walls			
0400000	Lexan	1.00	Ea.
0410000	Zip wall sheathing system and tape	52.00	Ea.
0411000	Swiss Pearl Siding	1,494.00	Ea.
0414000	Kawneer windows, doors and fence material	1.00	Ea.
05 Roofing			
0511000	Flat Rubber Membrane Roof with 11" batt insulation and 2" rigid; Slope 1/4=1'	409.50	Ea.
0511000	Roof membrane and insulation on bedroom and kitchen modules	591.00	S.F.
06 Interiors			
06	Resilient Modular Carpet Tile	772.00	Ea.
06	Resilient Tile Flooring	228.00	S.F.
06	Hollow Core Interior Door	3.00	Ea.
06	Built in Entertainment Center	9.00	L.F.
06	1x4 Base Board	16.00	L.F.

Assembly Number	Description	Quantity	Unit
0604026	Wall system, 1/2" drywall, taped & finished	1,488.00	S.F.
0608026	1/2" gypsum wallboard, taped & finished ceilings	559.00	S.F.
0609000	MDF Panel Ceiling	414.00	Ea.
07 Specialties			
07	Big Ass Fans	1.00	Ea.
07	Bosch Dishwasher	1.00	Ea.
07	Water Storage Tanks	3.00	Ea.
07	Sun Power X21 335 watt panels; including inverters and structure	57.00	Ea.
07	Wood ramps, 4X4 post foundation	48.00	L.F.
07	Frididaire Refrigerator/Freezer Model#FFHT10F2L	1.00	Ea.
07	Bosch Tronic 5000 Tankless Electric Water Heater	3.00	Ea.
07	LG WM3997HWA Washer/ Dryer	1.00	Ea.
07	Daikin Mini Split HVAC System	2.00	Ea.
07	Fridgaire 30" Induction Range	1.00	Ea.
07	Ramp Decking	380.00	S.F.
07	Pressure Treated Wood Deck, 24" OC	677.00	S.F.
0708046	Laminate Countertops	16.00	Ea.
0708046	Kitchen, custom grade	18.00	L.F.
0711000	Wet pipe suppression system	1.00	Ea.
0712036	Sinks, stainless steel, single bowl 22" x 25"	1.00	Ea.
08 Mechanical			
0812032	Three fixture bathroom installed with vanity	1.00	Ea.
09 Electrical			
09	LED Lighting 4.5" Downlight	7.00	Ea.
09000	LED Lighting 40 Watt 12" X 12" Downlight	4.00	Ea.
0930006	Air conditioning receptacles using non-metallic sheathed cable	1.00	Ea.
0930010	Disposal wiring using non-metallic sheathed cable	1.00	Ea.
0930014	Dryer circuit using non-metallic sheathed cable	1.00	Ea.
0930026	Furnace circuit & switch using non-metallic sheathed cable	1.00	Ea.
0930034	Heater circuits using non-metallic sheathed cable	1.00	Ea.
0930038	Lighting wiring using non-metallic sheathed cable	1.00	Ea.

Assembly Number	Description	Quantity	Unit
0930042	Range circuits using non-metallic sheathed cable	1.00	Ea.
0930046	Switches, using non-metallic sheathed cable	1.00	Ea.

RSMeans FROM THE GORDIAN GROUP

Cost Estimate Report RSMeansOnline

Date: 08/17/2015

Solar Drury Uniformat
Year 2014 Quarter 3
Assembly Detail Report

Prepared By:
Travis Bond
CrowderDrury-Solar Decathalon

Assembly Number			Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
01 Site Work							
01			Reynobond Fencing	1.00	Ea.	$24,373.00	$24,373.00
011000			Landscaping & Plants	138.00	Ea.	$10.00	$1,380.00
0120000			1 1/2 " tubular steel for fencing	964.00	L.F.	$7.55	$7,278.20
01 Site Work Subtotal							**$33,031.20**
02 Foundation							
02			CP seismic piers & Standard Piers	28.00	Ea.	$78.57	$2,199.96
02 Foundation Subtotal							**$2,199.96**
03 Framing							
03			1/2" Threaded Steel Rods	544.00	L.F.	$9.43	$5,129.92
03			MC 7x19.1 C Channel including fabrication	1.00	Ea.	$14,000.00	$14,000.00
0308042			Exterior wall framing systems, 2" x 6", 16" OC	1,494.00	S.F.	$3.71	$5,542.74
0332042			Shed/flat roof framing systems, 2" x 8", 16" OC, 4/12 pitch	1,000.00	S.F.	$4.51	$4,510.00
03 Framing Subtotal							**$29,182.66**
04 Exterior Walls							
0400000			Lexan	1.00	Ea.	$15,945.00	$15,945.00
0410000			Zip wall sheathing system and tape	52.00	Ea.	$34.20	$1,778.40
0411000			Swiss Pearl Siding	1,494.00	Ea.	$7.82	$11,683.08
0414000			Kawneer windows, doors and fence material	1.00	Ea.	$58,347.00	$58,347.00
04 Exterior Walls Subtotal							**$87,753.48**
05 Roofing							
0511000			Flat Rubber Membrane Roof with 11" batt insulation and 2" rigid; Slope 1/4=1'	409.50	Ea.	$15.58	$6,380.01
0511000			Roof membrane and insulation on bedroom and kitchen modules	591.00	S.F.	$18.23	$10,773.93
05 Roofing Subtotal							**$17,153.94**
06 Interiors							
06			Resilient Modular Carpet Tile	772.00	Ea.	$2.17	$1,675.24
06			Resilient Tile Flooring	228.00	S.F.	$2.17	$494.76
06			Hollow Core Interior Door	3.00	Ea.	$185.00	$555.00
06			Built in Entertainment Center	9.00	L.F.	$400.00	$3,600.00
06			1x4 Base Board	16.00	L.F.	$15.86	$253.76

Assembly Number			Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
0604026			Wall system, 1/2" drywall, taped & finished	1,488.00	S.F.	$2.84	$4,225.92
0608026			1/2" gypsum wallboard, taped & finished ceilings	559.00	S.F.	$2.28	$1,274.52
0609000			MDF Panel Ceiling	414.00	Ea.	$10.30	$4,264.20
06 Interiors Subtotal							**$16,343.40**
07 Specialties							
07			Big Ass Fans	1.00	Ea.	$1,020.00	$1,020.00
07			Bosch Dishwasher	1.00	Ea.	$763.00	$763.00
07			Water Storage Tanks	3.00	Ea.	$700.00	$2,100.00
07			Sun Power X21 335 watt panels; including inverters and structure	57.00	Ea.	$736.84	$41,999.88
07			Wood ramps, 4X4 post foundation	48.00	L.F.	$172.32	$8,271.36
07			Frididaire Refrigerator/Freezer Model#FFHT10F2L	1.00	Ea.	$550.00	$550.00
07			Bosch Tronic 5000 Tankless Electric Water Heater	3.00	Ea.	$905.00	$2,715.00
07			LG WM3997HWA Washer/ Dryer	1.00	Ea.	$1,439.00	$1,439.00
07			Daikin Mini Split HVAC System	2.00	Ea.	$2,000.00	$4,000.00
07			Fridgaire 30" Induction Range	1.00	Ea.	$1,899.00	$1,899.00
07			Ramp Decking	380.00	S.F.	$1.69	$642.20
07			Pressure Treated Wood Deck, 24" OC	677.00	S.F.	$22.50	$15,232.50
0708046			Laminate Countertops	16.00	Ea.	$296.16	$4,738.56
0708046			Kitchen, custom grade	18.00	L.F.	$656.87	$11,823.66
0711000			Wet pipe suppression system	1.00	Ea.	$3,300.00	$3,300.00
0712036			Sinks, stainless steel, single bowl 22" x 25"	1.00	Ea.	$1,805.00	$1,805.00
07 Specialties Subtotal							**$102,299.16**
08 Mechanical							
0812032			Three fixture bathroom installed with vanity	1.00	Ea.	$4,438.53	$4,438.53
08 Mechanical Subtotal							**$4,438.53**
09 Electrical							
09			LED Lighting 4.5" Downlight	7.00	Ea.	$823.50	$5,764.50
09000			LED Lighting 40 Watt 12" X 12" Downlight	4.00	Ea.	$918.50	$3,674.00
0930006			Air conditioning receptacles using non-metallic sheathed cable	1.00	Ea.	$70.00	$70.00
0930010			Disposal wiring using non-metallic sheathed cable	1.00	Ea.	$71.85	$71.85
0930014			Dryer circuit using non-metallic sheathed cable	1.00	Ea.	$127.50	$127.50
0930026			Furnace circuit & switch using non-metallic sheathed cable	1.00	Ea.	$108.50	$108.50
0930034			Heater circuits using non-metallic sheathed cable	1.00	Ea.	$86.00	$86.00
0930038			Lighting wiring using non-metallic sheathed cable	1.00	Ea.	$57.50	$57.50

Assembly Number			Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
0930042			Range circuits using non-metallic sheathed cable	1.00	Ea.	$203.00	$203.00
0930046			Switches, using non-metallic sheathed cable	1.00	Ea.	$53.00	$53.00
09 Electrical Subtotal							**$10,215.85**
10							
10			Trucks	4.00	Ea.	$2,000.00	$8,000.00
10			Lull/fork lift	6.00	Day	$1,025.00	$6,150.00
10							**$14,150.00**
Subtotal							**$316,768.18**
General Contractor's Markup on Subs						**0.00%**	**$0.00**
Subtotal							**$316,768.18**
General Conditions						**0.00%**	**$0.00**
Subtotal							**$316,768.18**
General Contractor's Overhead and Profit						**0.00%**	**$0.00**
Grand Total							**$316,768.18**

DIVISION 05 METAL

05 10 00 Structural Metal Framing
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 05 12 23 Structural Steel for Buildings
- b. 05 12 23 Structural Steel for Buildings
- c. 05 12 23 Structural Steel for Buildings
- d. 05 12 23 Structural Steel for Buildings

2.02. SPECIFICATIONS

a. Structural Steel for Buildings
1. Product: MC7x19.1
2. Manufacture/Supplier:
3. Product Summary:
4. Dimensions:
   Depth: 7”
   Flange Width: 3.45”
   Flange Thickness: 0.5”
   Web Thickness: 0.352”
5. Reference: http://www.constructionknowledge.net

b. Structural Steel for Buildings
1. Product: HSS 1 ½” x 1 ½” x ¼”
2. Manufacture:
3. Product Summary: Tube steel structure for fence
4. Dimensions: Tube Steel- 1 ½” x 1 ½”
5. Reference:

c. Structural Steel for Buildings
1. Product: 0.5” Metal Rod
2. Manufacture:
3. Product Summary:
4. Dimensions: 0.5” thick by 8’-6” and 0.5” thick by 4’-6”
5. Reference: N/A

PART 3 – EXECUTION

3.01. INSTALLATION
- a. Complete install without removing the cover

END OF DIVISION 05 METAL

DIVISION 06 WOOD, PLASTICS, AND COMPOSITES

06 10 00 Rough Carpentry
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. N/A

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 06 10 53 Miscellaneous Rough Carpentry
- b. 06 10 53 Miscellaneous Rough Carpentry

2.02. SPECIFICATIONS
- a. 06 10 53 Miscellaneous Rough Carpentry
  1. Product: Wall Studs
  2. Manufacturer/Supplier: N/A
  3. Product Summary: Wood wall studs
  4. Dimensions: HxWxD (in): 2x4x8' and 2x6x8'
  5. Reference: N/A

- b. 06 10 53 Miscellaneous Rough Carpentry
  1. Product: Wall headers
  2. Manufacturer/Supplier: N/A
  3. Product Summary: Wood wall headers
  4. Dimensions: HxWxD (in): N/A
  5. Reference: N/A

PART 3 – EXECUTION

3.01. INSTALLATION

N/A

06 16 00 Sheathing
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. N/A

PART 2 – PRODUCTS

2.01. PRODUCTS

a. 06 16 36 Wood Panel Product Sheathing
b. 06 16 53 Moisture Resistant Sheathing Board

2.02. SPECIFICATIONS
a. 06 16 36 Wood Panel Product Sheathing
1. Product: Plywood Sheathing
2. Manufacturer/Supplier: Advantech Sheathing
3. Product Summary:
4. Dimensions: 3/4" wall sheathing (in): N/A
5. Reference: http://www.huberwood.com/advantech/products/advantech-flooring

b. 06 16 53 Moisture Resistant Sheathing Board
1. Product: Zip Wall Sheathing
2. Manufacturer/Supplier: Huber
3. Product Summary: Oriented standard structural panels with built-in protective overlays that eliminate the need for building wrap or roofing felt. They function as wall sheathing, code recognized water resistive, and air barrier.
4. Dimensions: 5/8" wall sheathing (in): N/A
5. Reference: http://www.huberwood.com/assets/user/library/ZIPRoofWallDataSheets_v3.pdf

PART 3 – EXECUTION
3.01. INSTALLATION
a. N/A
b. Install the panels, tape the seams with Huber's ZIP system tape, the buildings is rough dried in.

06 40 00 Architectural Woodwork
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS
a. 11 30 00 Residential Equipment
b. 22 40 00 Plumbing Fixtures

PART 2 – PRODUCTS
2.01. PRODUCTS
a. 06 41 13 Wood-Veneer-Faced Architectural Cabinets A
b. 06 41 03 Wood-Veneer-Faced Architectural Cabinets B

2.02. SPECIFICATIONS
a. Wood-Veneer-Faced Architectural Cabinets A
1. Product: Custom wood base cabinets
2. Manufacturer/Supplier: N/A
3. Product Summary: Seamless wood cabinets

4. Dimensions: HxWxD (in): 2’0” depth
5. Reference: N/A

b. Wood-Veneer-Faced Architectural Cabinets B
1. Product: Custom wood wall-mounted cabinets
2. Manufacturer/Supplier: N/A
3. Product Summary: Seamless wood cabinets
4. Dimensions: HxWxD (in): Cup shelf 9” depth, upper cabine 14” depth
5. Reference: N/A

PART 3 – EXECUTION

3.01. INSTALLATION

a. N/A

06 50 00 Structural Plastics

PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS

a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS

a. N/A

PART 2 – PRODUCTS

2.01. PRODUCTS

a. 06 51 00 Structural Plastic Shapes and Plates
b. 06 51 00 Structural Plastic Shapes and Plates

2.02. SPECIFICATIONS

a. 06 51 00 Structural Plastic Shapes and Plates
1. Product: Lexan MR101 Polycarbonate Sheet
2. Manufacturer/Supplier: Sabic
3. Product Summary: Siding the house directly over the waterproofing and underneath the swiss pearl rainscreen. It adds insulation and a layer of protection to the house. (all exterior walls, clear)
Mar/UV-resistant Lexan MR10 sheet combines the impact strength of Lexan polycarbonate sheet with a proprietary abrasion/UV resistant surface that approaches glass in performance. Lexan MR10 Sheet with Margard coating backed by a ten-year limited warranty against yellowing, abrasion resistance, breakage, loss of light transmission, and coating failure£.) Lexan MR10 sheet's unique coating is graffitiresistant
enabling restoration to a like-new condition. In addition, Lexan MR10 sheet offers improved resistance to weathering as well as forced-entry protection.
4. Dimensions: Sheet good (1,600 sf) 0.236” x 72” x 96”
5. Reference: http://www.sabic-ip.com/resins/DataSheet/Internet/PDF/1002002131_1002003947_1002038344_SI.pdf

b. 06 51 00 Structural Plastic Shapes and Plates

1. Product: Lexan MR10 Polycarbonate Sheet
2. Manufacturer/Supplier: Sabic
3. Product Summary: Lites for Accordian Door shields that close to protect the sliding glass door of the house. ½” lexan pieces are inserted between stiles and rails of aluminum doors. (2 walls, clear)
4. Dimensions: Sheet good (400 sf) 0.5” x 57” x 100”
5. Reference: http://sfs.sabic.eu/product/lexan-solid-sheet/margard-coated-sheet/

PART 3 – EXECUTION

3.01. INSTALLATION

a. N/A
b. N/A

END OF DIVISION 06 WOOD, PLASTICS, AND COMPOSITES

DIVISION 07 THERMAL AND MOISTURE PROTECTION

07 20 00 Thermal Protection
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS
a. To be determined

PART 2 – PRODUCTS

2.01. PRODUCTS (List of products in section)
a. 07 21 13.13 Foam Board Insulation
b. 07 21 19 Foamed in Place Insulation

2.02. SPECIFICATIONS (Generalized Specs)
a. 07 21 13.13 Foam Board Insulation
1. Product: Polyiso Rigid Foam Insulation Board
2. Manufacture/Supplier: Home Depot
3. Product Summary: Rigid foam plastic thermal insulation board composed of environmentally sound, closed cell, foam bonded to a durable white-matte aluminum facer ad a reflective reinforced aluminum facer.
4. Dimensions: DxWxH (in): .5x48x96
5. Reference: http://www.homedepot.com/p/Rmax-R-Matte-Plus-3-1-2-in-x-4-ft-x-8-ft-R-3-2-Polyiso-Rigid-Foam-Insulation-Board-754404/100572981?N=5yc1vZbaxx#specifications

b. 07 21 19 Foamed-in-Place Insulation
1. Product:
2. Manufacture/Supplier:
3. Product Summary:
4. Dimensions:
5. Reference:

PART 3 – EXECUTION
3.01. INSTALLATION
a. N/A
b. Easily installs in either wood or metal framing cavities.

07 25 00 Weather Barriers
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings

c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS

2.01. PRODUCTS

a. 07 25 00 Weather Barrier

2.02. SPECIFICATIONS

a. 07 25 00 Refrigerator/ Freezer

1. Product: Protecto Premium Energy Sill Sealer
2. Manufacture/Supplier: Protecto Wrap
3. Product Summary: Self adhering waterproofing membrane
4. Dimensions H x W (in): 3 1/2 x 5 1/2
5. Reference: http://www.protectowrap.com/static-content/pdf/specdata/sillsealer-specdata.pdf

PART 3 – EXECUTION

3.01. INSTALLATION

a. 07 25 00 Refrigerator/ Freezer

1. http://www.protectowrap.com/static-content/pdf/specdata/sillsealer-specdata.pdf

07 42 00 Wall Panels

PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS

a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS

a. 05 10 00 Structural Metal Framing
b. 09 70 00 Wall Finishes

PART 2 – PRODUCTS

2.01. PRODUCTS

a. 07 42 13 Metal Wall Panels
b. 07 42 43 Composite Wall Panels

2.02. SPECIFICATIONS

a. Metal Wall Panels

1. Product: Reynobond Aluminum Fence
2. Manufacturer/Supplier: Alcoa
3. Product Summary: Bone white aluminum fence
4. Dimensions:
5. Reference: https://www.alcoa.com/aap/north_america/en/info_page/product_specifications.asp/

b. Composite Wall Panels

1. Product: Swiss Pearl Carat

2. Manufacture/Supplier: Eternit Switzerland
3. Product Summary: Swiss Pearl is an 8 mm (3/8") fiber cement composite panel with top finishing and core colored through. This product is designed as a rear ventilated rainscreen cladding system, 100% recyclable.
4. Dimensions: 8 mm thickness, custom panel size
5. Reference: http://www.swisspearl.com/products-and-solutions/
6. Colors: J- Jade 7052, C- Crystal 7010, X-Onyx 7091, Y-Onyx 7092, N-Onyx 7094, see elevations

PART 3 – EXECUTION
3.01. INSTALLATION
a. N/A

07 50 00 Membrane Roofing
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS
2.01. PRODUCTS
a. 07 58 00 Roll Roofing

2.02. SPECIFICATIONS
a. 07 58 00 Roll Roofing
1. Product: TPO 45 mil single ply membrane roof
2. Manufacture/Supplier: Tremco Incorporated
3. Product Summary: white
4. Dimensions W x L (ft): 45 mil x 78" x 100'
5. Reference: https://www.tremcoroofing.com/products/single-ply-roofing-products/single-ply-membranes/tpo-single-ply-membrane/

PART 3 – EXECUTION
3.01. INSTALLATION
a. N/A

07 60 00 Flashing and Sheet Metal
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS

a. Product Data

b. Construction and Shop Drawings

c. Standards and Codes

1.02. RELATED SECTIONS

a. 07 71 16 Manufactured Counter Flashing Systems

PART 2 – PRODUCTS

2.01. PRODUCTS (List of products in section)

a. 07 62 00 Metal Flashing and Trim

2.02. SPECIFICATIONS (Generalized Specs)

a. Metal Flashing and Trim
1. Product: Galvalume Trim
2. Manufacture/Supplier: Montopolis Supply Company, LP
3. Product Summary: Trim made from 26 gauge Galvalume coated steel, plain ridge roll.
4. Dimensions: 14” girth, 10’ in length

PART 3 – EXECUTION

3.01. INSTALLATION

a. N/A

END OF DIVISION 07 THERMAL AND MOISTURE PROTECTION

DIVISION 08 – OPENINGS

08 10 00 Doors and Frames
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 08 11 13 Hollow Metal Doors and Frames
- b. 08 11 13 Hollow Metal Doors and Frames
- c. 08 11 13 Hollow Metal Doors and Frames

2.02. SPECIFICATIONS

a. 08 11 13 Hollow Metal Doors and Frames
1. Product:Kawneer AA3200 IR Thermal Sliding Doors (AA3200IR)
2. Manufacture/Supplier: Kawneer Hurricane Resistant Windows and Doors
3. Product Summary: Meeting the challenges of high winds, heavy rain, blizzards and hurricanes. (Quantity 4, Location Living Room)
4. Dimensions: Total opening 17’-10 ½” wide x 9’-11” high
5. Reference: http://www.kawneer.com/kawneer/north_america/en/product.asp?prod_id=4057

b. 08 11 13 Hollow Metal Doors and Frames
1. Product: Kawneer 2000T Terrace Door
2. Manufacture/Supplier: Kawneer Hurricane Resistant Windows and Doors
3. Product Summary: Terrace doors
4. Dimensions: (1) 3’-1 1/4"” W x 7’- 1 1/2” H (kitchen door), (2) 6’-5 ¼” wide x 6’-4 ¼” H at outdoor electrical closet on deck
5. Reference: http://www.kawneer.com/kawneer/north_america/en/product.asp?prod_id=1822

c. 08 11 13 Hollow Metal Doors and Frames
1. Product: Kawneer Casement Window AA4325 Ultra Thermal Window
2. Manufacture/Supplier: Alcoa Kawneer
3. Product Summary: Hurricane Resistant window and glass
4. Dimensions:
   - a. (2) 47 1/4" by 44 3/4" egress window
   - b. (2) 15 " by 44 3/4"
   - c. (4) 42 1/4" by 14 3/4", fixed window

d. 08 11 13 Hollow Metal Doors and Frames

1. Product: Kawneer Bloomsburg Folding Door
2. Manufacture/Supplier: Alcoa Kawneer Hurricane Resistant Windows and Doors
3. Product Summary: 2 sets of 4 Accordian Folding door to protect sliding glass doors with track at head, light bronze
4. Dimensions: 53” W x 116 15/32” H
5. Reference: (Quantity 8 doors)
http://www.kawneer.com/kawneer/united_kingdom/catalog/pdf/brochures/sliding_solutions2.pdf

PART 3 – EXECUTION

3.01. INSTALLATION

a. N/A

b.Intended to be installed in "punched" openings or as a liner frame within other Kawneer framing or curtain wall systems. When sidelites and/or transoms are required the 2000T door frame is installed as a liner frame within other Kawneer framing or curtain wall systems.

c. N/A

END OF DIVISION 08 OPENINGS

DIVISION 09 FINISHES

09 90 00 Painting and Coating
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. 09 70 00 Wall Finishes
- b. 07 10 00 Damp proofing and Waterproofing
- c. 07 80 00 Fire and Smoke Protection

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 09 91 23 Interior Paint
- b. 09 91 23 Interior Paint
- c. 09 96 43 Fire-Retardant Coatings

2.02 SPECIFICATIONS

a. Interior Paint
1. Product: PREMIUM PLUS® Interior Eggshell Enamel
2. Manufacturer/Supplier: BEHR
3. Product Summary: For tough, all-purpose paint with a touch of style, choose BEHR PREMIUM PLUS Interior Eggshell Enamel. This soft, subtle sheen resists dirt and grime, so it's perfect for all of your home's busiest rooms, and its velvety, reflective appearance will also brighten up your hallways; Color: Igloo 760E-1
4. Dimensions: 250-400 Sq. Ft. per Gallon
5. Reference: http://www.behr.com/consumer/ColorDetailView/760E-1

b. Interior Paint
1. Product: PREMIUM PLUS® Interior Eggshell Enamel
2. Manufacturer/Supplier: BEHR
3. Product Summary: For tough, all-purpose paint with a touch of style, choose BEHR PREMIUM PLUS Interior Eggshell Enamel. This soft, subtle sheen resists dirt and grime, so it's perfect for all of your home's busiest rooms, and its velvety, reflective appearance will also brighten up your hallways; Color: Desert Cactus 440 D-4
4. Dimensions: 250-400 Sq. Ft. per Gallon
5. Reference: http://www.homedepot.com/p/BEHR-Premium-Plus-Ultra-8-oz-440D-4-Desert-Cactus-Interior-Exterior-Paint-Sample-440D-4U/202180883

c. Fire Retardant Coatings
1. Product: Flame Stop III
2. Manufacturer/Supplier: Flame Stop INC.
3. Product Summary: Flame Stop III is a water-based, interior, fire-retardant paint additive that protects the material by developing a self-extinguishing reaction. One pint of this additive can be mixed into a gallon of most latex-based paints with up to two pints of water.

Once mixed, the product assumes the characteristics of the paint. When the mixture of paint and Flame Stop III is applied to drywall, the material shall have a class A rating. When applied on wood, the material shall have a class B rating. Flame Stop III is non-toxic, non-combustible, non-carcinogenic, easy to apply, and contains no PDBE's; Color: Clear

4. Dimensions: Weight per Gallon: 12.5LBS; Average ph: 7.0

5. Reference: http: //www.flamestop.com/fire-retardant-paint.html

PART 3 – EXECUTION

3.01 – INSTALLATION

a. Interior Paint

1. Apply when air and surface temperatures are between 50-90°F (10-32°C).
Stir paint occasionally.
Intermix containers of same product to ensure color and sheen uniformity.
Use a high quality 3/8-1/2" nap roller cover, nylon/polyester brush or airless sprayer (.015-.019" spray tip, 60 mesh filter).
Do not think if using a roller or brush; however, if using a sprayer and thinning is required, thin with water at a rate of no more than 1/2 pint per gallon.
Certain colors may require more than one coat for complete hide.
Darker colors may require additional dry time between coats.
Cooler temperatures or higher humidity may prolong drying time

b. Interior Paint

1. Apply when air and surface temperatures are between 50-90°F (10-` 32°C).
Stir paint occasionally.
Intermix containers of same product to ensure color and sheen uniformity.
Use a high quality 3/8-1/2" nap roller cover, nylon/polyester brush or airless sprayer (.015-.019" spray tip, 60 mesh filter).
Do not think if using a roller or brush; however, if using a sprayer and thinning is required, thin with water at a rate of no more than 1/2 pint per gallon.
Certain colors may require more than one coat for complete hide.
Darker colors may require additional dry time between coats.
Cooler temperatures or higher humidity may prolong drying time

c. Fire Retardant Coatings

1. N/A

END OF DIVISION 09 FINISHES

DIVISION 10 SPECIALTIES

10 20 00 Interior Specialties
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. N/A

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 10 28 19.16 Shower Doors

2.02. SPECIFICATIONS
- a. Shower Doors
  1. Product: Cardinal Glass Shower Swing door Craftsman series
  2. Manufacture/Supplier: Cardinal
  3. Product Summary: Swing shower door with chrome frame and obscure glass
  4. Dimensions: HxWxD (in): 72” x 36” x 5/32”
  5. Reference: http://www.cardinalshower.com/enclosures/swing-door

PART 3 – EXECUTION

3.01. INSTALLATION
- a. N/A

END OF DIVISION 10 SPECIALTIES

DIVISION 11 EQUIPMENT
11 30 00 Residential Equipment

PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. 33 10 00 Water Utilities
- b. 06 40 00 Architectural Woodwork

PART 2 – PRODUCTS
2.01. PRODUCTS
- a. 11 30 13.13 Refrigerator/ Freezer
- b. 11 30 13.14 Cooktop
- c. 11 30 13.15 Oven
- d. 11 30 13.17 Dishwasher
- e. 11 30 13.17 Downdraft Blower System
- f. 11 30 13.18 Washer-Dryer Combo
- g. 11 30 34 Residential Ceiling Fans

2.02. SPECIFICATIONS

a. Refrigerator/ Freezer
1. Product: Refrigerator/ Freezer, Model number FFHT10F2L
2. Manufacture/Supplier: Frigidaire 12 Cu Ft. top Freezer Apartment-Size Refrigerator
3. Product Summary: white
4. Dimensions (in): 60” H x 29” D x 24” W
5. Reference: http://www.frigidaire.ca/Kitchen/Refrigerators/Top-Freezer-Refrigerators/FFET1222QS/

b. Range
1. Product: Frigidaire 30” Induction Range
2. Manufacture/Supplier: Frigidaire Gallery 30” Slide-In Range
3. Product Summary: FGES3065PF
4. Dimensions (in): 30" W x 26-5/16" D x 36 5/8" H

5. Reference: http://www.frigidaire.com/Kitchen-Appliances/Ranges/Electric-Range/FGES3065PF/

c. Dishwasher
1. Product: Dishwasher, Model number: SHP53TL5UC
2. Manufacture/Supplier: Bosch
3. Product Summary: Color: white
4. Dimensions: H x W x D (in): 33 7/8” x23 9/16”x 23 3/4”

Reference: http://www.bosch-home.com/us/products/dishwashers/shop-all-dishwashers/SHP53TL5UC.html

d. Washer-Dryer Combo
1. Product: Washer and Dryer, Model Number: SPWD1800
2. Manufacture/ Supplier: Summit
3. Product Summary: White
4. Dimensions H x W x D (in): 33 1/2 x 23 ½ x 23 63/100
5. Reference: http://www.appliancesconnection.com/summit-spwd1800-i192827.html?ref=bing

e. Residential Ceiling Fans
1. Product: Haiku 60 with SenseME Technology
2. Manufacture: Big Ass Fans
3. Product Summary: The 60-inch Haiku® with SenseME™ brings effortless comfort to bedrooms and other smaller residential spaces. The world's first smart fan technology, SenseME monitors temperature conditions and adjusts the fan speed to keep you comfortable automatically. When you change the speed via the smartphone app or supplied IR remote, SenseME remembers your comfort preferences for the future. Featuring a built-in motion sensor and a variety of control modes, Haiku with SenseME also works with the Nest Learning Thermostat™ to help you save up to 30 percent on home air conditioning costs. Now that's a Smart Ass Fan.
4. Dimensions: Fan Diameter: 60 in. (1.3 m); Fan Height (A): 12.3 in.; Fan Height (B): 12.8 in; Hanging Weight: 13 lb; Color: Black
5. Reference: http://www.bigassfans.com/products/haiku/Haiku60-info-sheet.pdf

PART 3 – EXECUTION
3.01. INSTALLATION
a. Refrigerator/ Freezer
1. N/A
b. Cooktop
1. Drop in Place
c. Oven
1. N/A
d. Dishwasher
1. N/A
e. Downdraft Blower System
1. N/A
f. Washer-Dryer Combo
1. N/A
g. Residential Ceiling Fans
1. http://www.bigassfans.com/onlineguides/haiku/Haiku-S0-Install-GuideOnline.pdf

END OF DIVISION 11 EQUIPMENT

DIVISION 12 FURNISHINGS

12 30 00 Casework
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings

c. Standards and Codes

1.02. RELATED SECTIONS
a. 06 41 13 Wood-Veneer-Faced Architectural Cabinets

PART 2 – PRODUCTS
2.01. PRODUCTS (List of products in section)
a. 12 36 00 Plastic Laminate Countertops

2.02. SPECIFICATIONS (Generalized Specs)
a. Plasitc Laminate Countertops
1. Product: Plastic Laminate
2. Manufacture/Supplier: Formica
3. Product Summary: blackstone
4. Dimensions: 24” deep countertop x 15’-4” long

PART 3 – EXECUTION
3.01. INSTALLATION
a. N/A

12 58 00 Residential Furniture
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS
a. N/A

PART 2 – PRODUCTS
2.01. PRODUCTS
a. 12 52 13 Couches and Loveseats
b. 12 58 19 A Dining Tables and Chairs
c. 12 58 19 B Dining Tables and Chairs
d. 12 58 23 Coffee Tables
e. 12 58 26 Entertainment Centers
f. 12 58 29 Beds
g. 12 58 33 Dressers

2.02. SPECIFICATIONS (Generalized Specs)

a. Dining Tables and Chairs
1. Product: Goliath Table
2. Manufacture/Supplier: Resource Furniture

3. Product Summary: A space saving console table that extends from a console of 17 inches into a dining table 115 inches utilizing an aluminum telescoping cechanism, seats 10, matt white lacquer
4. Dimensions: HxLxD: 29.5”x115”x39.37, quantity 1
5. Reference: http://resourcefurniture.com/product/goliath/

c. Dining Chairs
1. Product: Pocket Chair
2. Manufacture/Supplier: Resource Furniture
3. Product Summary: Compact folding chair with chrome steel frame, seat white satin lacquer
4. Dimensions: HxWxD (in): 30.75” x 17.75” x 18.5”, quantity 10
5. Reference: http://resourcefurniture.com/product/pocket-chair/

d. Bed and Desk Combination
1. Product: Ulisse Desk
2. Manufacture/Supplier: Resource Furniture
3. Product Summary: A queen size fold out murphy wall bed with a 5’ desk on the front.
4. Dimensions: HxWxD (in): 86.6x85x67.5
5. Reference: http://resourcefurniture.com/product/ulisse-desk/

e. Bed and Desk Combination
1. Product: Kali Duo Board
2. Manufacture/Supplier: Resource Furniture
3. Product Summary: Fold out bunk beds with a full-time desk,
4. Dimensions: HxWxD (in): 76.5x85x37.5
5. Reference: http://resourcefurniture.com/product/kali-duo-board/

f. Closet Storage System
1. Product: Double Door
2. Manufacture/Supplier: Resource Furniture
3. Product Summary: This storage system offers 50 storage options. All pieces are modular and customizable and designed to be paired with bed and shelving systems.
4. Dimensions: HxWxD (in): 86.625” x66.75” x12.25”, in master bedroom and 2nd bedroom
5. Reference: http://resourcefurniture.com/product/closet-systems/#.VDSl-vldW1U

PART 3 – EXECUTION

3.01. INSTALLATION

a. N/A

END OF DIVISION 12 FURNISHINGS

DIVISION 21 FIRE SUPPRESSION

21 10 00 Water-Based Fire-Suppression Systems

PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS

a. Product Data
b. Construction and Shop Drawings

c. Standards and Codes

1.02. RELATED SECTIONS
a. 07 10 00 Damp Proofing and Waterproofing
b. 07 80 00 Fire and Smoke Protection
c. 09 96 43 Fire – Retardant Coatings
d. 10 44 00 Fire Protection Specialties

PART 2 – PRODUCTS

2.01. PRODUCTS
a. 21 10 00 Water Based Fire – Suppression Sprinkler System
b. 21 10 00 Water Based Fire – Suppression Sprinkler System

2.02. SPECIFICATIONS
a. 21 10 00 Water Based Fire – Suppression Sprinkler System
1. Product: Uponor AquaSAFE Fire Sprinkler Systems
2. Manufacture/Supplier: Uponor
3. Product Summary: Uponor ProPEX systms is a stand along fire suppression system.
4. Dimensions: 1" Uponor AquaPEX white tubing
5. Reference: http://www.uponor-usa.com/Residential-Fire-Safety.aspx

b. 21 10 00 Water Based Fire – Suppression Sprinkler System
1. Product: Freedom Residential Concealed Horizontal Sidewall Lead Free Sprinkler (VK4800)
2. Manufacturer/Supplier: Viking
3. Product Summary: A small high-sensitivty solder link and lever residential sprinkler designed for installation on concealed pipe systems, where the appearance of a smooth wall is desired. The cover plate is available in several decorative finishes.
4. Dimensions: Overall length of sprinkler, 2"
5. Reference: N/A

PART 3 – EXECUTION

3.01. INSTALLATION
a. N/A

END OF DIVISION 12 FIRE SUPPRESSION

DIVISION 22 – PLUMBING

22 12 00 Facility Potable Water Storage Tanks

PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. 22 11 16 Domestic Water Piping
- b. 22 11 19 Domestic Water Piping Specialties
- c. 22 11 23 Domestic Water Pumps
- d. 22 13 63 Facility Gray Water Tanks
- e. 26 30 00 Facility Electrical Power Generating and Storing Equipment
- f. 33 70 00 Electrical Utilities

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 22 12 19 Facility Potable-Water Storage Tanks

2.02. SPECIFICATIONS
- a. Facility Potable-Water Storage Tanks
  1. Product: 300 Gallon Portable Utility Tanks CRMI-300RT
  2. Manufacturer/Supplier: Custom Roto Mold
  3. Product Summary: Facility for potable-water storage that is portable.
  4. Dimensions: HxWxD (in): 30"Hx48"Wx58"L
     Weight: 115 lbs.
  5. Reference: plastic-mart.com, 1-866-310-2556, direct 1-512-599-8020

PART 3 – EXECUTION

3.01. INSTALLATION
- a. Complete install without removing the cover

22 33 00 Elecric Domestic Water Heaters

PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. N/A

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 22 33 00 Electric Domestic Water Heaters
- b. 22 33 00 Electric Domestic Water Heaters

2.02. SPECIFICATIONS
a. Electric Domestic Water Heaters
1. Product: RTE 3 / 444250
2. Manufacture/Supplier: Bosch Tronic 5000 WH17
3. Product Summary: Whole house electric tankless water heater
4. Dimensions: W x L x H (in): 12 ½" x 15 ¼" x 4 ½
5. Reference: http://www.bosch-climate.us/products-bosch-thermotechnology/electric-tankless-water-heaters/bosch-tronic-wh27-wh17.htm/

PART 3 – EXECUTION
3.01. INSTALLATION
1. N/A

22 40 00 Plumbing Fixtures
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS
a. 06 41 13 Wood-Veneer-Faced Architectural Cabinets

PART 2 – PRODUCTS
2.01. PRODUCTS
a. 22 41 16.13 Residential Lavatories
b. 22 41 16.16 Residential Sinks
c. 22 41 39 Residential Faucets, Supplies, and Trim
d. 22 41 23 Residential Showers

2.02. SPECIFICATIONS
a. Residential Lavatories
1. Product: Maverick II (267), Oval, single faucet center
2. Manufacture/Supplier: Mansfield
3. Product Summary: White vitreous china, self-rimming lavatory
4. Dimensions: (Basin): 20" x 17" oval
5. Reference: http://www.mansfieldplumbing.com/wp-content/uploads/2015/03/267.pdf

b. Residential Sinks
1. Product: Kitchen Sink Carrington, CLS-2522, one hole, 8" depth
2. Manufacture/Supplier: Revere
3. Product Summary: 25" x 22" x 8" depth, diamond-glo stainless steel, single bowl drop-in kitchen sink with one hole faucet
4. Dimensions: (in): 21" x 15 1/4"" x 8", fits 30" cabinet
5. Reference: http://www.reveresink.com/products/carringtons.pdf

c. Residential Faucets, Supplies, and Trim

1. Product: Delta Trinsic, single Handle Pull-Out faucet, one hole installation
2. Manufacture/Supplier: Delta
3. Product Summary: Kitchen faucet
4. Dimensions HxW (in): 6 7/16" L x 7 7/8" H, 4159-DST, chrome
5. Reference: http://www.deltafaucet.com/kitchen/details/9159-dst.html

d. Residential Faucets, Supplies, and Trim
1. Product: Delta Compel, 561-MPU-DST, one hole installation, 6 7/16" L x 7 3/8" H
2. Manufacture/Supplier: Delta
3. Product Summary: Kitchen faucet
4. Dimensions HxW (in): 6 7/16" L x 7 7/8" H, 4159-DST, chrome

5. Reference: N/A

d. Residential Showers
1. Product: Sterling Advantage Shower
2. Manufacture/Supplier: Sterling/Kohler
3. Product Summary: Shower base and wall surround made of Vikrell material with durable swirl gloss finish.
4. Dimensions: WxDxH (in): 32x34x72

PART 3 – EXECUTION

3.01. INSTALLATION

a. Residential Lavatories
1. N/A

b. Residential Sinks
2. N/A

c. Residential Faucets, Supplies, and Trim
3. N/A

d. Residential Showers
1. Tongue and groove four piece modular design allows for easy snap together installation. Some caulk is required for proper installation.
2. Double studding is recommended for pivot shower door installation.
3. Studs should be positions as shown in illustration

END OF DIVISION 22 PLUMBING

DIVISION 23 CENTRAL HEATING EQUIPMENT

23 57 00 Heat Exchagers for HVAC
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. N/A

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 23 57 00 Heat Exchangers for HVAC

2.02. SPECIFICATIONS
- a. Heat Exchangers for HVAC
  1. Product: Daikin Ductless LV Series .75 ton Slim Duct Built-in Concealed Ceiling Unit
  2. Manufacture/Supplier: Daikin
  3. Product Summary: Ceiling mount built in unit that connects to an single outdor unit.
  4. Energy Efficiency Levels:
     SEER 19.5
     HSPF 11.3
  5. Reference:
     http://www.daikinac.com/content/assets/DOC/SubmittalDataSheets/2015/Single%20Split%20Systems/Slim%20Duct-STD%20EFF/GENERATED_FDXS09LVJURXS09LVJU.pdf

- b. Heat Exchangers for HVAC-Outdoor Unit
  1. Product: Daikin Outdoor unit heat pump
  2. Manufacture/Supplier: Daikin
  3. Product Summary: Heating and cooling that connect indoor units to a single outdor unit.
  4. Energy Efficiency Levels:
     SEER 19.5
     HSPF 11.3
  6. Reference:
     http://www.daikinac.com/content/assets/DOC/SubmittalDataSheets/2015/Single%20Split%20Systems/Slim%20Duct-STD%20EFF/GENERATED_FDXS09LVJURXS09LVJU.pdf

PART 3 – EXECUTION

3.01. INSTALLATION
1. N/A

END OF DIVISION 23 CENTRAL HEATING EQUIPMENT

DIVISION 26 ELECTRICAL

26 05 00 Common Work Results for Electrical
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 26 05 13.13 Medium-Voltage Open Conductors
- b. 26 05 13.13 Medium-Voltage Open Conductors
- c. 26 05 13.13 Medium-Voltage Open Conductors
- d. 26 05 13.13 Medium-Voltage Open Conductors
- e. 26 05 13.13 Medium-Voltage Open Conductors
- f. 26 05 13.13 Medium-Voltage Open Conductors
- g. 26 05 13.13 Medium-Voltage Open Conductors

2.02. SPECIFICATIONS

a. 26 05 13.13 Medium-Voltage Open Conductors
1. Product: 12/3 NM-B Wire
2. Manufacture/Supplier: Romex
3. Product Summary: Solid bare copper strands, additional 12 awg uninsulated bare ground wire, indoor only cable, 107 lbs per 1000 feet, 20 AMPS, yellow, PVC Jacket, 600 volts
4. Dimensions: 50’, 250’, 1000’ lengths available
5. Reference: http://www.wesbellwireandcable.com/Romex/Romexnmb12-3.html

b. 26 05 13.13 Medium-Voltage Open Conductors
1. Product: 10/3 NM-B Wire
2. Manufacture/Supplier: Romex
3. Product Summary: Solid bare copper strands, additional 10 awg uninsulated bare ground wire, indoor only cable, 164 lbs per 1000 feet, 30 AMPS, orange, PVC jacket, 600 volts
4. Dimensions: 50’, 250’, 1000’ lengths available
5. Reference: http://www.wesbellwireandcable.com/Romex/Romexnmb10-3.html

c. 26 05 13.13 Medium-Voltage Open Conductors
1. Product: 10/4 NM-B Wire
2. Manufacture/Supplier: Romex
3. Product Summary: Solid bare copper strands, additional 10 awg, nylon jacketed, 600 volts, 30 AMPS, 201 lbs per 1000 feet
4. Dimensions (DxHxW): 50’, 250’, 1000’ lengths available
5. Reference: http://www.crownindustrial.com/10-4-romex-nmb.html

d. 26 05 13.13 Medium-Voltage Open Conductors

1. Product: 10 AWG, Type THHN or THWN-2 Conductor
2. Manufacture/Supplier: Southwire
3. Product Summary: gasoline and oil resistant, 600 volts, annealed copper, insulated with high-heat and moisture resistant PVC, jacketed with nylon, 37 lbs per 1000 feet, 30 AMPS
4. Dimensions: 20 mils insulation thickness, 4 mils jacket thickness
5.Reference:http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=prodcatsheetOEM120

e. 26 05 13.13 Medium-Voltage Open Conductors
1. Product: 6 AWG, Type THHN or THWN-2 Conductor
2. Manufacture/Supplier: Southwire
3. Product Summary: gasoline and oil resistant, 600 volts, annealed copper, insulated with high-heat and moisture resistant PVC, jacketed with nylon, 95 lbs per 1000 feet, 75 AMPS
4. Dimensions (DxHxW): 30 mils insulation thickness, 5 mils jacket thickness
5.Reference:http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=prodcatsheetOEM120

f. 26 05 13.13 Medium-Voltage Open Conductors
1. Product: 4 AWG, Single Copper Conductor
2. Manufacture/Supplier: Southwire
3. Product Summary: gasoline and oil resistant, 1000 volts, annealed copper, insulated with high-heat and moisture resistant PVC, jacketed with nylon, 164 lbs per 1000 feet, 135 AMPS
4. Dimensions (DxHxW): .08” insulation thickness, .39” in diameter
5.Reference:http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=prodcatsheetOEM161

g. 26 05 13.13 Medium-Voltage Open Conductors
1. Product: 2/0 AWG Service Entry Cable
2. Manufacture/Supplier: Southwire
3. Product Summary: gasoline and oil resistant, 1000 volts, annealed copper, insulated with high-heat and moisture resistant PVC, jacketed with nylon, 480 lbs per 1000 feet, 285 AMPS
4. Dimensions (DxHxW): .095” insulation thickness, .59” in diameter
5.Reference:http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=prodcatsheetOEM161

26 24 00 Switchboards and Panelboards
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS
2.01. PRODUCTS
a. 26 24 16 Panelboards
b. 26 24 16 Panelboards
c. 26 24 16 Panelboards

d. 26 24 16 Panelboards

2.02. SPECIFICATIONS

a. 26 24 16 Panelboards

1. Product: Fusible Outdoor General-Duty Safety Switch, #TG4323R
2. Manufacture/Supplier: GE
3. Product Summary: Ideal for residential and commercial applications, 3-point mounting, galvanized steel enclosure, single-phase, 3-pole, 100 amp, 240-volt maximum
4. Dimensions (DxHxW): 9.06” x 21.31” x 10.3”
5. Reference: http://www.homedepot.com/p/GE-100-Amp-240-Volt-Fusible-Outdoor-General-Duty-Safety-Switch-TG3223R/202978656?N=5yc1vZbm0hZ1z11za5

b. 26 24 19 Panelboards (Load Center)

1. Product: Homeline Indoor Main Plug-On Neutral Breaker Load Center with Cover, #HOM4080M200PCVP
2. Manufacture/Supplier: Square D
3. Product Summary: 200 amp 40-Space 80-Circuit, for residential and commercial power distribution, built with plate aluminum, fully distributed neutral bar, accepts full-size, tandem or quad breakers, up to (3) #10-14 equipment grounds, rate 120/240 VAC and 22,000 AIR short circuit current rating, three ground bar mounting locations
4. Dimensions (DxHxW): 3.75 x 39.37 x 14.25
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-200-Amp-40-Space-80-Circuit-Indoor-Main-Plug-On-Neutral-Breaker-Load-Center-with-Cover-Value-Pack-HOM4080M200PCVP/204836379?N=5yc1vZbm2w

a. 26 24 16 Panelboards (Boxes)

1. Product: Non-Metallic Switch and Outlet Box
2. Manufacture/Supplier: Carlon
3. Product Summary: For residential and commercial light use, thermoplastic construction, sized for standard devices and switches, permissible for use with 90 degree C-conductors, UL classified for 2-hour fire wall, meets NEMA OS-2
4. Dimensions (DxHxW): 2.83 x 4.16 x 3.51
5. Reference: http://www.homedepot.com/p/Carlon-1-Gang-18-cu-in-Zip-Box-Non-Metallic-Switch-and-Outlet-Box-Blue-Case-of-100-B118A/100404124

a. 26 24 16 Panelboards (Boxes)

1. Product: Non-Metallic Old Work Switch and Outlet Box
2. Manufacture/Supplier: Carlon
3. Product Summary: Residential and commercial use, use with non-metallic cable, thermoplastic construction, mounting ears and swing clamps, sized for standard devices and switches, extra capacity for wiring, built-in cable clamps to hold wires firmly in place, UL listed and fire rated
4. Dimensions (DxHxW): 4.3 x 2.78 x 3.96
5. Reference: http://www.homedepot.com/p/Carlon-2-Gang-25-cu-in-Non-Metallic-Old-Work-Switch-and-Outlet-Box-B225R-UPC/100404169

26 27 00 Low-Voltage Distribution Equipment

PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS

a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS

2.01. PRODUCTS

a. 26 27 26 Wiring Devices
b. 26 27 26 Wiring Devices
c. 26 27 26 Wiring Devices
d. 26 27 26 Wiring Devices
e. 26 27 26 Wiring Devices
f. 26 27 26 Wiring Devices
g. 26 27 26 Wiring Devices
h. 26 27 26 Wiring Devices
j. 26 27 26 Wiring Devices
k. 26 27 26 Wiring Devices
l. 26 27 26 Wiring Devices
m. 26 27 26 Wiring Devices
n. 26 27 26 Wiring Devices
o. 26 27 26 Wiring Devices

2.02. SPECIFICATIONS

a. 26 27 26 Wiring Devices
1. Product: Switches & Motor Controls 1453-21
2. Manufacture/Supplier: Leviton
3. Product Summary: 15 Amp, 120 Volt, Toggle Framed 3-Way AC Quiet Switch, Residential Grade, Grounding, Quickwire Push-In & Side Wired
4. Dimensions:
5. Reference: http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=1453-2I&section=41455&minisite=10251

b. 26 27 26 Wiring Devices
1. Product: Switches & Motor Controls 1453-ICP
2. Manufacture/Supplier: Leviton
3. Product Summary: 15 Amp, 120 Volt, Toggle Framed 3-Way AC Quiet Switch, Residential Grade, Non-Grounding, Quickwire Push-In & Side Wired
4. Dimensions:
5. Reference: http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=1453-ICP&section=41455&minisite=10251

c. 26 27 26 Wiring Devices
1. Product: Tamper-Resistant Receptacles TBR15-1
2. Manufacture/Supplier: Leviton
3. Product Summary: 15 Amp, 125 Volt, NEMA 5-15R, 2P, 3W, Tamper-Resistant, Narrow Body Duplex Receptacle, Straight Blade, Commercial Grade, Self Grounding, Back & Side Wired, Steel Strap
4. Dimensions:

5. Reference: http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=TBR15-I&section=42524&minisite=10251

d. 26 27 26 Wiring Devices
1. Product: Tamper-Resistant Receptacles TBR20-1
2. Manufacture/Supplier: Leviton
3. Product Summary: 20 Amp, 125 Volt, NEMA 5-20R, 2P, 3W, Tamper-Resistant, Duplex Receptacle, Straight Blade, Commercial Grade, Self Grounding, , Back & Side Wired, Steel Strap
4. Dimensions:
5. Reference: http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=TBR20-I&section=42525&minisite=10251

e. 26 27 26 Wiring Devices
1. Product: USB Charger Devices T5830-I
2. Manufacture/Supplier: Leviton
3. Product Summary: Combination Receptacle/Outlet And Usb Charger. 20A-125V, 2Pole, 3-Wire Grounding Decora Tamper Resistant Receptacle/Outlet
4. Dimensions:
5. Reference: http http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=T5830-I&section=63492&minisite=102511. Product: Tamper-Resistant Receptacles TBR20-1

f. 26 27 26 Wiring Devices
1. Product: CFCI Receptacles N7899-HGI
2. Manufacture/Supplier: Leviton
3. Product Summary: 20 Amp, 125 Volt Receptacle, Hospital Grade, 20 Amp Feed-Through, SmartLock Pro Slim GFCI, monochromatic, back and side wired, wallplate and self grounding clip included
4. Dimensions:
5. Reference: http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=N7899-HGI&section=65900&minisite=10251

g. 26 27 26 Wiring Devices
1. Product: Occupancy Sensors IPP0R-1LI
2. Manufacture/Supplier: Leviton
3. Product Summary: Manual-On Occupancy Sensor Remote, 15A 120VAC, 60Hz, provides 3-way occupancy detection when used with an IPP15 or Vizia Dimmer, 180 Degree, 900 Sq. Ft. Coverage, Decora® Passive Infrared Wall Switch- Ivory, California Title 24 2005 Compliant
4. Dimensions:
5. Reference: http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=IPP0R-1LI&section=38557&minisite=10251

h. 26 27 26 Wiring Devices
1. Product: Straight Blade Wiring Devices 279
2. Manufacture/Supplier: Leviton
3. Product Summary: 50 Amp, 125/250 Volt, NEMA 14-50R, 3P, 4W, Flush Mtg Receptacle, Straight Blade, Industrial Grade, Grounding, , Side Wired, Steel Strap, - Black
4. Dimensions:
5. Reference: http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=279&section=42418&minisite=10251

i. 26 27 26 Wiring Devices
1. Product: Homeline 20 Amp Single-Pole AFCI Circuit Breaker Model # HOM120AFIC
2. Manufacture/Supplier: Schneider Electric Homeline
3. Product Summary: Single-Pole AFCI Circuit Breaker features an AFCI for arc-fault, overload and short-circuit protection of your electrical system
4. Dimensions:
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-20-Amp-Single-Pole-AFCI-Circuit-Breaker-HOM120AFIC/100128763?cm_mmc=shopping-_-googleads-_-pla-_-100128763&ci_sku=100128763&ci_gpa=pla&ci_src=17588969&gclid=CjwKEAjw876oBRCYr86w6KGfpkgSJAAClidwN73xClM4nenzJhNu3uXzSF9Q1n2xw-dApZFu5rjoXhoCb9Hw_wcB

j. 26 27 26 Wiring Devices
1. Product: Homeline 20 Amp Single-Pole Circuit Breaker
2. Manufacture/Supplier: Schneider Electric Homeline
3. Product Summary: The Square D by Schneider Electric Homeline 20 Amp One-Pole Circuit Breaker is used for overload and short-circuit protection of your electrical system. This breaker is compatible with Homeline load centers and CSED devices. The ANSI-certified and UL-listed unit is rated for 120/240 VAC and 10,000 AIR.
4. Dimensions:
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-20-Amp-Single-Pole-Circuit-Breaker-HOM120CP/100045009?N=5yc1vZbm3aZ1z11yyo

k. 26 27 26 Wiring Devices
1. Product: Homeline 15 Amp Single-Pole Circuit Breaker
2. Manufacture/Supplier: Schneider Electric Homeline
3. Product Summary: The Square D by Schneider Electric Homeline 15 Amp One-Pole Circuit Breaker is used for overload and short-circuit protection of your electrical system. This breaker is compatible with Homeline load centers and CSED devices. The ANSI-certified and UL-listed unit is rated for 120/240 VAC and 10,000 AIR
4. Dimensions:
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-15-Amp-Single-Pole-Circuit-Breaker-HOM115CP/100153952?N=5yc1vZbm3aZ1z11z3t

l. 26 27 26 Wiring Devices

1. Product: Homeline 40 Amp Two-Pole Circuit Breaker
2. Manufacture/Supplier: Schneider Electric Homeline
3. Product Summary: used for overload and short-circuit protection of your electrical system. This breaker is compatible with Homeline load centers and CSED devices. The ANSI-certified and UL-listed unit is rated for 120/240 VAC and 10,000 AIR
4. Dimensions:
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-40-Amp-Two-Pole-Circuit-Breaker-HOM240CP/202353324?N=5yc1vZbm1eZ1z11spb

m. 26 27 26 Wiring Devices

1. Product: Homeline 15 Amp Two-Pole Circuit Breaker
2. Manufacture/Supplier: Schneider Electric Homeline
3. Product Summary: used for overload and short-circuit protection of your electrical system. This breaker is compatible with Homeline load centers and CSED devices. The ANSI-certified and UL-listed unit is rated for 120/240 VAC and 10,000 AIR
4. Dimensions:
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-15-Amp-Two-Pole-Circuit-Breaker-HOM215CP/202353317?N=5yc1vZbm1eZ1z11z3t

n. 26 27 26 Wiring Devices

1. Product: Homeline 30 Amp Two-Pole Circuit Breaker
2. Manufacture/Supplier: Schneider Electric Homeline
3. Product Summary: used for overload and short-circuit protection of your electrical system. This breaker is compatible with Homeline load centers and CSED devices. The ANSI-certified and UL-listed unit is rated for 120/240 VAC and 10,000 AIR
4. Dimensions:
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-30-Amp-Two-Pole-Circuit-Breaker-HOM230CP/202353325?N=5yc1vZbm1eZ1z11vjb

o. 26 27 26 Wiring Devices

1. Product: Homeline 90 Amp Two-Pole Circuit Breaker
2. Manufacture/Supplier: Schneider Electric Homeline
3. Product Summary: used for overload and short-circuit protection of your electrical system. This breaker is compatible with Homeline load centers and CSED devices. The ANSI-certified and UL-listed unit is rated for 120/240 VAC and 10,000 AIR
4. Dimensions:
5. Reference: http://www.homedepot.com/p/Square-D-Homeline-90-Amp-Two-Pole-Circuit-Breaker-HOM290CP/100206837?N=5yc1vZbm1eZ1z11srr

26 50 00 Lighting
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS
2.01. PRODUCTS
a. 26 50 00 Lighting A
b. 26 50 01 Lighting B
c. 26 50 02 Lighting C

2.02. SPECIFICATIONS
a. Lighting A
1. Product: LED45 4.5" round LED Downlight
2. Manufacture/Supplier: H.E. Williams, Inc.
3. Product Summary: Rated for 50,000 hours at 70% lumen maintenance, 1100-lumen module
4. Dimensions: H x WxL (in): 8 1/8'' x 12" x 16 ¼"
5. Reference: http://hewilliams.com/specification/70441.pdf

c. Lighting B
1. Product: HET 1' x 1' Square Architectural downlight-LED
2. Manufacture/Supplier: H. E. Williams, Inc
3. Product Summary: Compact, LED downlight, rated for 50,000 hours at 70% lumen maintenance
4. Dimensions: H x WxL (in): 6 5/16" '' x 17" x 23"
5. Reference: http://hewilliams.com/specification/70339.pdf

c. Lighting C
1. Product: LLMS-2-LED UT11-S-RD-WRS/120, Architectural Slimline Surface mount
2. Manufacture/Supplier: H. E. Williams, Inc
3. Product Summary: Rated for 50,000 hours at 70% lumen maintenance, slim, low profile, frosted, round, extruded acrylic lens
4. Dimensions: Pan Size W x H (in): 2' long x 3 7/16" x 2 5/8"
5. Reference: http://hewilliams.com/specification/70402.pdf

PART 3 – EXECUTION
3.01. INSTALLATION
a. Lighting A
1. N/A
b. 26 50 01 Lighting B
1.N/A
c. 26 50 02 Lighting C

1. N/A

26 56 00 Exterior Lighting
PART 1 – GENERAL
1.01. SECTIONS REQUIREMENTS
a. Product Data
b. Construction and Shop Drawings
c. Standards and Codes

1.02. RELATED SECTIONS

PART 2 – PRODUCTS
2.01. PRODUCTS
a. 26 56 29 Site Lighting

PART 3 – EXECUTION
3.01. INSTALLATION

END OF DIVISION 26 ELECTRICAL

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 90 00 Planting
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. N/A

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 32 91 13.16 Mulching
- b. 32 93 23 Plants and Bulbs
- c. 32 94 00 Planting Accessories

2.02. SPECIFICATIONS

a. Mulching
1. Product: Mulch (in planters)-NONE
2. Manufacturer: N/A
3. Product Summary: N/A
4. Dimensions: N/A
5. Reference: N/A

b. Plants and Bulbs
1. Product: Type A, Liriope ground cover, plants will remain in nursery pots
2. Supplier: Green Thumb Nursery, Lake Forest, CA 949-847-3040
3. Product Summary: plants in 5 gallon containers
4. Dimensions: N/A
5. Reference: N/A

c. Plants and Bulbs
1. Product: Type B Native California grass, 5 gallon, plants will remain in nursery pots
2. Supplier: Green Thumb Nursery, Lake Forest, CA 949-847-3040
3. Product Summary: Creeping Red Fescue, 3'x3', in 5 gallon containers
4. Dimensions: N/A
5. Reference: N/A

c. Plants and Bulbs
1. Product: Type C Variety of herbs such as Rosemary, Thyme, Sage, Basil
2. Supplier: Green Thumb Nursery, Lake Forest, CA 949-847-3040
3. Product Summary: herbs in pots, plants remain in nursery pots
4. Dimensions: N/A
5. Reference: N/A

e. Planting Accessories
1. Product: Planter- 2 x 4 wood skirt with ½” plywood on top
2. Manufacturer: N/A
3. Product Summary: N/A
4. Dimensions WxLxH (in): 1’x8’x4” tall
5. Reference: N/A

PART 3 – EXECUTION

3.01. INSTALLATION

a. N/A

END OF DIVISION 32 EXTERIOR IMPROVEMENTS

DIVISION 48 – ELECTRICAL POWER GENERATION

48 10 00 Electrical Power Generation Equipment
PART 1 – GENERAL

1.01. SECTIONS REQUIREMENTS
- a. Product Data
- b. Construction and Shop Drawings
- c. Standards and Codes

1.02. RELATED SECTIONS
- a. 26 05 19 Low-Voltage Electrical Power Conductors and Cables
- b. 26 31 00 Photovoltaic Collectors
- c. 45 45 00 Electrical Equipment, Appliance, and Component Manufacturing Equipment
- d. 48 19 00 Electrical Power Control Equipment

PART 2 – PRODUCTS

2.01. PRODUCTS
- a. 48 14 00 Solar Energy Electrical Power Generation Equipment
- b. 48 14 00 Solar Energy Electrical Power Generation Equipment
- c. 48 14 13 Solar Energy Collector
- d. 48 14 00 Solar Energy Electrical Power Generation Equipment

2.02. SPECIFICATIONS

a. Solar Energy Electrical Power Generation Equipment
1. Product: Sunny Boy Inverter SB3000TL-US with integrated AFCI
2. Manufacture: Sunny Boy
3. Product Summary: convert solar energy DC to AC.
4. Dimensions: 24"Hx18.5"Wx9"D
   Weight: 141 lbs.
5. Reference: http://www.sma-america.com/en_US/home.html

b. Solar Energy Electrical Power Generation Equipment
1. Product: Sunny Boy Inverter SB4000TL-US with integrated AFCI
2. Manufacture: Sunny Boy
3. Product Summary: convert solar energy DC to AC.
4. Dimensions: 24"Hx18.5"Wx9"D
   Weight: 141 lbs.
5. Reference: http://www.sma-america.com/en_US/home.html

c. Solar Energy Collector
1. Product: Sun Power Solar Panels X-21-335
2. Manufacture: Sun Power
3. Product Summary: The Sun Power Solar Panels generate more energy per square foot and produce more energy per rated watt.
4. Dimensions: 41.2"Hx61.4"Wx1.81"D
   Weight: 41 lbs.
5. Reference: http://us.sunpower.com

d. Solar Energy Electrical Power Generation Equipment
   1. Product: Solar mount
   2. Manufacture/Supplier: Unirac
   3. Product Summary: Clear Anodized
   4. Dimensions: W x L (in): 1'' x 1 ¼''
   5. Reference:http://unirac.com/sites/default/files/solarmounttechdata sheet.pdf

PART 3 – EXECUTION

3.01. INSTALLATION

a. N/A

END OF DIVISION 48 ELECTRICAL POWER GENERATION