Project Manual

Team Middlebury

US Department of Energy
2013 Solar Decathlon

August 22, 2013 middsd@middlebury.edu

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.

November 20, 2012 Revision

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

- Wrote overall lateral narrative
- Revised fire suppression plan
- Developed and expanded quantity takeoff and specifications
- Revised structural calculations
- Revised MEP plans and specifications

February 14, 2013 Revision

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

- Revised fire suppression plan
- Developed and expanded quantity takeoff and specifications
- Designed an engineered a new Photovoltaic Array and Support Structures
- Revised EnergyPlus model and energy budget
- Revised MEP plans and specifications
- Revised anchoring design per SD 2013 Anchoring System Design Parameters

April 5, 2013 Revision

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

- Developed and expanded quantity takeoff and specifications, especially regarding Plumbing and Electrical
- Updated the anchoring design of the Solar Path per SD 2013 Anchoring System Design Parameters
- Revised the Hot Water System to transition from a Solar Plate Collector to an Electric Water Tank and an Electric Tankless Water Heater
- Updated Structural Calculations to reflect and clarify that there will be no lateral displacement

August 22, 2013 Revision

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

- Included the final structural calculations and drawings
- Finalized the quantity take-off and specifications
- Re-evaluated the Energy Model
- Updated the Competition Task Water Budget

The Construction Drawings have been updated from the previous issue. Revisions include:

- Modifications in the locations of the heat pump, intake, supply and return vents, water heater, water meter, domestic pipework, bathroom faucet
- More legible mechanical, electrical, and plumbing plans and views

- Updated PV calculations, one-line and three-line diagrams
- Second bedroom modified - no built-in beds, now hallway storage and closet
- New kitchen counter, cabinet and appliance layout
- Updated fall protection sheet
- New design for ramps, handrails and guardrails
- New landscaping design

Rules Compliance Checklist

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
4-2	Construction Equipment	Drawings showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	O101, O102, O103
4-2	Construction Equipment	Specifications for heavy machinery	Project Manual Construction Specifications Section 41 22 00
4-3	Ground Penetration	Drawings demonstrating locations and depths of all ground penetrations on the competition site	S101
4-4	Impact on the Competition Site	Drawings demonstrating location, contact area, and bearing pressure of every component resting directly within the solar envelope	S101
4-5	Generators	Specifications for generators (including sound rating)	Project Manual Construction Specifications Section 48 10 00
4-6	Spill Containment	Drawings showing the locations of all equipment, containers, and pipes that will contain liquids at any point during the event	H101
4-6	Spill Containment	Specifications for all equipment, containers, and pipes that will contain liquids at any point during the event	Project Manual Construction Specifications Sections 21, 43 40 00
4-7	Lot Conditions	Drawings demonstrating that the structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	S301 C3, S303 A5, S701 D4
4-7	Lot Conditions	Drawings demonstrating shimming methods and materials to be used if 18 in. (45.7 cm) of vertical elevation change exists	S301 C3, S303 A5, S701 D4
5-2	Solar Envelope Dimensions	Drawings demonstrating location of all house and site components relative to the solar envelope	G201
5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	No exemptions requested
6-1	Structural Design Approval	List of, or marking on, all drawing and project manual sheets that have been or 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	S001-S701, Structural Calculations
6-2	Finished Square Footage	Drawings showing all information needed to measure	G101

		the finished square footage electronically	
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
6-3	Entrance and Exit Routes	Drawings demonstrating the accessible public tour route	G103
7-1	Placement	Drawings showing location of all vegetation, and, if applicable, the movement of vegetation designed as part of an integrated mobile system	L101
7-2	Watering Restrictions	Drawings showing the layout and operation of greywater irrigation systems	N/A
8-1	PV Technology Limitations	Specifications for photovoltaic components	E601, Construction Specifications Section 26 31 00
8-3	Batteries	Drawings showing the location and quantity of all primary and secondary batteries and stand-alone, PV powered devices	N/A
8-3	Batteries	Specifications for all primary and secondary batteries and stand-alone, PV-powered devices	N/A
8-4	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	N/A
8-4	Desiccant Systems	Specifications for desiccant system components	N/A
8-5	Village Grid	Completed interconnection application form	Project Manual Page 111
8-5	Village Grid	Drawings showing the locations of the photovoltaics, inverters, terminal box, meter housing, service equipment, and grounding means	E201
8-5	Village Grid	Specifications for the photovoltaics, inverters, terminal box, meter housing, service equipment, and grounding means	Construction Specifications Section 26
8-5	Village Grid	One-line electrical diagram	E601
8-5	Village Grid	Calculation of service/feeder net computed load per NEC 220	E001
8-5	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	E101, G103
8-5	Village Grid	Elevations showing the meter housing, main utility disconnect, and other service equipment	E201
9-1	Container Locations	Drawings showing the location of all liquid containers relative to the finished square footage	H101
9-1	Container Locations	Drawings demonstrating that the primary supply water tank 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	O111
9-2	Team-Provided Liquids	Quantity, characteristics, and delivery dates of all team	N/A

		provided liquids for irrigation, thermal mass, hydronic system pressure testing, and thermodynamic system operation	
9-3	Greywater Reuse	Drawings showing the layout and operation of greywater reuse systems	N/A
9-4	Rainwater Collection	Drawings showing the layout and operation of rainwater collection system	L101
9-6	Thermal Mass	Drawing(s) showing the locations of liquid-based thermal mass systems	N/A
9-6	Thermal Mass	Specifications for components of liquid-based thermal mass systems	N/A
9-7	Greywater Heat Recovery	Drawing(s) showing the layout and operation of greywater heat recovery systems	N/A
9-8	Water Delivery	Drawings showing the complete sequence of water delivery and distribution events	O111
9-8	Water Delivery	Specifications for the containers to which water will be delivered	Project Manual Construction Specifications Section 22 30 00
9-9	Water Removal	Drawings showing the complete sequence of water consolidation and removal events	O111
9-9	Water Removal	Specifications for the containers from which water will be removed	Project Manual Construction Specifications Section 22 30 00
11-4	Public Exhibit	Interior and exterior plans demonstrating accessible tour route	G103

Structural Calculations

Lateral Narrative

The roof panels span horizontally and transfer the lateral shear loads into the perimeter exterior shear walls through the roof panel connections to the perimeter steel beam, and from the steel beams into blocking and the interior layer of plywood on the wall. The shear walls then transfer the lateral shear forces through connections to the dropped PSL beams. The dropped beams transfer the shear forces through the threaded steel bolts in the dropped beams that are welded to the base plates. The steel base plates transfer the shear forces with friction between the steel plate and asphalt to the ground.

No displacement is anticipated through sliding, from the governing Seismic force case.

Also note that uplift in the shear walls will be resisted by gravity dead loads through connections at ends of walls to steel column gravity loads, and connections at ends of the walls to dropped PSL beams.

Structural Basis of Design

Structural Basis of Design

2013 Middlebury College Solar Decathlon

STRUCTURAL BASIS OF DESIGN

Location Middlebury, VT (Permanent) and Irvine, CA (Temporary)

Building Code

Middlebury, VT: 2006 Vermont State Building Code
(2006 International Building Code)

Irvine, CA: 2013 Solar Decathlon Building Code
(2012 International Building Code / 2012 International Residential Code)

Snow Load (Middlebury, VT Controls)
Snow loads are determined in accordance with ASCE 7-05.

Ground snow load:	P_g = 50 psf
Importance factor:	I = 1.0
Terrain category:	B
Roof exposure:	"Partially exposed"
Snow exposure factor:	C_e = 1.0
Thermal factor:	C_t = 1.1
Flat-roof snow load:	P_f = 40 psf (min. – Vermont Building Code)
Sloped roof snow load:	P_s = 40 psf
Unbalanced snow load:	Monoslope Roof (Not Applicable)

(Snow Drift Values will vary, see Snow Drift Map)

Wind Load (Irvine, CA Controls)
Wind loads are determined in accordance with ASCE 7-10.

Basic wind speed (3-second gust):	V = 110 mph (For use with IBC 2012 / ASCE 7-10) V = 85 mph (For use with IRC 2012)
Directionality factor:	K_d = 0.85
Exposure category:	C
Topographic factor:	K_{zt} = 1.00
Gust effect factor:	G = 0.85
Enclosure rating:	*enclosed*
Internal pressure coefficient:	GC_{pi} = ±0.18
Wind calculation procedure:	*Directional Procedure – Enclosed Buildings of All Heights*
Velocity pressure at roof:	q_h = 22.4 psf

External pressure for MWFRS:

Location		External C_p	External pressure
walls	windward	+0.8	+15 psf (@ h=▲')
	leeward	-0.38	-7 psf
	side	-0.7	-13 psf
roof		varies - see ASCE 7	

Seismic Load (Irvine, CA Controls)

2012 International Building Code Calculations:

Zip Code	92618
Mapped spectral response accelerations:	S_s = 1.529g
Site class:	D
Site coefficients:	F_a = 1.00
Design spectral response accelerations:	S_{DS} = 1.019

IBC occupancy category (Table 1604.5):	Category II
Seismic design category:	D
Analysis procedure:	Section 12.14.8 Simplified Lateral Force Analysis Procedure
Seismic force-resisting system:	Building frame / light-framed walls sheathed with wood structural panels rated for shear resistance
Response modification factor:	R = 7
Base shear coefficient:	C_s =0.146
Seismic weight:	W = 59 kips
Base shear:	V = 8.6 kips
Diaphragm flexibility:	Flexible (ASCE 7-10 Section 12.3.1.1)

2012 International Residential Code Criteria:

Seismic design category:	D_2

Foundations (Irvine, CA)

Soil conditions	6" concrete paving
Water table	NA
Frost depth	NA
Allowable bearing pressure	~~2000~~ psf 1500 psf per Solar Decathlon Code Officials, on asphalt

Foundations (Middlebury, VT)

Soil conditions	Middlebury Clay
Frost depth	5 feet below finished grade
Allowable bearing pressure	2000 psf
Seismic Site Class	D

Materials

Concrete	f'_c = 3000 psi, 4000 psi, normal weight
Structural steel	
Wide flange	ASTM A992 or A572 Grade 50 (F_y = 50 ksi)
Tubes	ASTM A500 Grade B (F_y = 46 ksi)
Pipe	ASTM A53 Grade B (F_y = 35 ksi)
Channels, angles, plates	ASTM A36 (F_y = 36 ksi)
Base plates	ASTM A36 (F_y = 36 ksi)
Bolts	ASTM A325N
Anchor bolts	ASTM F1554 (F_y = 36 ksi)
Welding electrode	E70xx
CMU	normal weight, f'_m = 1500 psi

Beam Deflection Limits

construction	Δ_{LL}	Δ_{SL} or Δ_{WL}	sawn lumber: Δ_{DL+LL} eng'd lumber: $\Delta_{0.5DL+LL}$
roof members - plaster ceiling	L/360	L/360	L/240
roof members - nonplaster ceiling	L/240	L/240	L/180
roof members - no ceiling	L/180	L/180	L/120
floor members	L/360	-	L/240
exterior walls - brittle finishes	-	L/240	-
exterior walls - flexible finishes	-	L/120	-

FLOOR AND ROOF LOADS

DL = dead load
LL = live load

Typical Wood Framed Floor (psf)

DL:	2x Joists	5
	¾" sheathing	3
	Insulation	2
	¾" sheathing	3
	Flooring	4
		18
LL:	Residential (one family dwelling)	50
	Means of egress/public (Irvine, CA temporary)	100
	Mechanical – Based on equipment weights	

Extensive Green Roof (psf)

DL	¾" sheathing	3
	2x Joists	5
	¾" sheathing	3
	Insulation	2
	Membrane	3
	Green Roof System	29
		45
LL:	Snow Controls over 20 psf roof live load	

Metal Roof (psf)

DL	¾" sheathing	3
	2x Joists	5
	¾" sheathing	3
	Insulation	2
	Membrane	3
	Metal Roof	2
		20
LL:	Snow Controls over 20 psf roof live load	

Railing Load: 200 lbs concentrated load any direction, 2013 Solar Decathlon Code

WALL WEIGHTS

Typical Wood Framed Wall (psf)

Siding	4
½" sheathing	2
TJI studs	5
Insulation	2
½" sheathing	2
	15

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Project: Middlebury Solar Decathalon
Date: 9/20/2012 11:13:42 AM
Designer: JRT
Description: Irvine, CA

ASCE 7-10 Wind Load
- MWFRS per Chapter 27 Part 1 (Directional Procedure)
- C&C per Chapter 30 Part 1

Notes

This design aid determines wall wind loads acting on the main windforce-resisting system and components and cladding based on the ASCE 7-10 using Chapter 27 Part 1 and Chapter 30 Part 1. Building must be enclosed or partially enclosed, not open and can be rigid (section 27.4.1) or flexible (section 27.4.2). Conservatively uses qi = qh for positive internal pressure evaluation in partially enclosed buildings (see section 27.4.1). Uses Cp leeward per ASCE 7, beware of effects of nearby terrain features and buildings on effective building length and width (may want to use Cp = -0.5 for worst case). Components and cladding based on low-rise buildings with h <= 60 ft.

Input

basic wind speed, V (mph)	110	figure 26.5-1A, 26.5-1B, or 26.5-1C
mean roof height, h (ft)	15	
building length, L (ft)	40	
building width, B (ft)	25	
enclosure classification	e	(p)artially enclosed or (e)nclosed, section 26.10
exposure category	C	section 26.7.3
topographic factor, K_{zt}	1	section 26.8.2
gust effect factor, G	0.85	section 26.9

Output

Main Windforce Resisting System - Internal Pressure

q_h (psf)	22.4	= basic velocity pressure at mean roof height, section 27.3.2
P_i +/-	4.0	= internal pressure, $q_h(GC_{pi})$

Main Windforce Resisting System - Walls

z (ft)	$P_{windward}$ (psf)	$P_{leeward}$ (psf)	P_{total} (psf)
0	15.2	-7.2	22.4
15	15.2	-7.2	22.4

note that there are situations where internal pressure affects the MWFRS including:
- when the trib area of a C&C member is > 700ft^2 and the MWFRS pressures are used
- when only the windward or leeward pressure is present, for example at a walkout basement.

$P_{windward}$ = design windward pressure = q_zGC_p
$P_{leeward}$ = design leeward pressure = q_hGC_p
$P_{total} = P_{windward} - P_{leeward}$

Main Windforce Resisting System - Roof

	Windward							Leeward		
	Angle, θ (degrees)							Angle, θ (degrees)		
h/L	10	15	20	25	30	35	45	10	15	>= 20
<= 0.25	-15.6 -4.0	-11.2 0.0	-6.7 4.5	-4.5 6.7	-4.5 6.7	0.0 8.9	8.9	-6.7	-11.2	-13.4
0.5	-20.1 -4.0	-15.6 -4.0	-8.9 0.0	-6.7 4.5	-4.5 4.5	-4.5 6.7	0.0 8.9	-11.2	-11.2	-13.4
>= 1.0	-29.1 -4.0	-22.4 -4.0	-15.6 -4.0	-11.2 0.0	-6.7 4.5	-4.5 4.5	0.0 6.7	-15.6	-13.4	-13.4

Components and Cladding - Walls

$P = q_h[(GC_p)-(GC_{pi})]$

windward wall >= 3 ft from corner P (psf)	windward wall < 3 ft from corner P (psf)	tributary area (ft^2)	leeward wall >= 3 ft from corner P (psf)	leeward wall < 3 ft from corner P (psf)
26.4	26.4	10	-28.6	-35.3
23.7	23.7	50	-25.9	-29.7
22.4	22.4	100	-24.6	-27.9
21.5	21.5	200	-23.7	-25.3
19.7	19.7	500	-21.9	-21.9

Calculations

Miscellaneous

L/B	1.60	
K_d	0.85	section 26.6
K_h	0.85	= velocity pressure exposure coefficient, Table 27.3-1

Internal Pressure Coefficients

+/- GC_{pi} 0.18

z (ft)	K_z	q_z
0	0.85	22.4
15	0.85	22.4
20	0.90	23.7
25	0.95	24.9
30	0.98	25.9
40	1.04	27.5
50	1.09	28.8
60	1.14	29.9

α	9.5	Table 26.9-1
z_g (ft)	900	Table 26.9-1

$q_z = 2.01(z/z_g)^{2/\alpha}$ for z >= 15'

Wall Pressure Coefficients - Main Windforce Resisting system

C_p (windward wall)	0.8	= windward wall pressure coefficient, Figure 27.4-1
C_p (leeward wall)	-0.38	= leeward wall pressure coefficient, Figure 27.4-1

Roof Pressure Coefficients - Main Windforce Resisting system

	Windward							Leeward		
	Angle, θ (degrees)							Angle, θ (degrees)		
h/L	10	15	20	25	30	35	45	10	15	>= 20
<= 0.25	-0.7 -0.18	-0.5 0.0	-0.3 0.2	-0.2 0.3	-0.2 0.3	0.0 0.4	0.4	-0.3	-0.5	-0.6
0.5	-0.9 -0.18	-0.7 -0.18	-0.4 0.0	-0.3 0.2	-0.2 0.2	-0.2 0.3	0.0 0.4	-0.5	-0.5	-0.6
>= 1.0	-1.3 -0.18	-1.0 -0.18	-0.7 -0.18	-0.5 0.0	-0.3 0.2	-0.2 0.2	0.0 0.3	-0.7	-0.6	-0.6

Wall Pressure Coefficients - Components and Cladding

	windward wall			leeward wall	
tributary area (ft^2)	region 4 GC_p	region 5 GC_p	tributary area (ft^2)	region 4 GC_p	region 5 GC_p
10	1.00	1.00	10	-1.10	-1.40
50	0.88	0.88	50	-0.98	-1.15
100	0.82	0.82	100	-0.92	-1.07
200	0.78	0.78	200	-0.88	-0.95
500	0.70	0.70	500	-0.80	-0.80

a (ft) 3

K_h 0.85

q_h (psf) 22.4

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Project: Middlebury College Solar Decathlon
Date: 9/20/2012 11:14:22 AM
Designer: GS
Description: Middlebury, VT

ASCE 7-05 Wind Load

Notes

This design aid determines wall wind loads acting on the main windforce-resisting system and components and cladding based on the ASCE 7-05 code using Section 6.5, "Method 2 - Analytical Procedure". Building must be enclosed or partially enclosed, not open. Uses Section 6.5.12.2.1 "Rigid Buildings of all Height" for the main windforce-resisting system. Conservatively uses qi = qh for positive internal pressure evaluation in partially enclosed buildings (see section 6.5.12.2.1). Uses Section 6.5.12.4.1 "Low-Rise Buildings and Buildings with h <= 60'" for components and cladding. Uses Cp leeward per ASCE 7, beware of effects of nearby terrain features and buildings on effective building length and width (may want to use Cp = -0.5 for worst case).

Input

basic wind speed, V (mph)	90	figure 6-1
mean roof height, h (ft)	15	
building length, L (ft)	40	
building width, B (ft)	25	
building (p)artially enclosed or (e)nclosed?	e	= "p" or "e"
importance factor, I	1	table 6-1
exposure category	B	section 6.5.6
topographic factor, K_{zt}	1	section 6.5.7
gust effect factor, G	0.85	section 6.5.8

Output

Main Windforce Resisting System

z (ft)	$P_{windward}$ (psf)	$P_{leeward}$ (psf)	$P_{internal}$ (psf)	P_{total} (psf)
0	6.8	-4.3	+/- 1.8	11.1
15	6.8	-4.3	+/- 1.8	11.1

note that there are situations where internal pressure affects the MWFRS including:
- when the trib area of a C&C member is > 700ft^2 and the MWFRS pressures are used
- when only the windward or leeward pressure is present, for example at a walkout basement.

q_h (psf)
10.0 = basic velocity pressure at mean roof height

$P_{windward}$ = design windward pressure = $q_z GC_p$
$P_{leeward}$ = design leeward pressure = $q_h GC_p$
$P_{internal}$ = design internal press. = $q_h(GC_{pi})$
P_{total} = $P_{windward}$ - $P_{leeward}$ (+/-) $P_{internal}$

Components and Cladding

$P = q_h[(GC_p)-(GC_{pi})]$

windward wall >= 3 ft from corner P (psf)	windward wall < 3 ft from corner P (psf)	tributary area (ft^2)	leeward wall >= 3 ft from corner P (psf)	leeward wall < 3 ft from corner P (psf)
14.6	14.6	10	-15.8	-19.5
13.1	13.1	50	-14.3	-16.4
12.3	12.3	100	-13.6	-15.4
11.8	11.8	200	-13.1	-13.9
10.9	10.9	500	-12.1	-12.1

Calculations

Miscellaneous

L/B	1.60
K_d	0.85
K_h	0.57

= velocity pressure exposure coefficient (Table 6-5, case 2 - figure 6-4 is not used)

Internal Pressure Coefficients

+/- GC_{pi}	0.18

z (ft)	K_z	q_z
0	0.57	10.0
15	0.57	10.0
20	0.62	10.9
25	0.66	11.6
30	0.70	12.3
40	0.76	13.4
50	0.81	14.3
60	0.85	15.0

Wall Pressure Coefficients - Main Windforce Resisting system

C_p (windward wall)	0.8	= windward wall pressure coefficient
C_p (leeward wall)	-0.5	= leeward wall pressure coefficient

Wall Pressure Coefficients - Components and Cladding

windward wall			leeward wall		
tributary area (ft^2)	region 4 GC_p	region 5 GC_p	tributary area (ft^2)	region 4 GC_p	region 5 GC_p
10	1.00	1.00	10	-1.10	-1.40
50	0.88	0.88	50	-0.98	-1.15
100	0.82	0.82	100	-0.92	-1.07
200	0.78	0.78	200	-0.88	-0.95
500	0.70	0.70	500	-0.80	-0.80

a (ft)	3
K_h	0.70
q_h (psf)	12.3

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JOB SOLAR DECATHLON
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE 8/29/2012
CHECKED BY _____ DATE _____
SCALE _____

SEISMIC LOAD ASCE 7-10 SIMPLIFIED ALTERNATIVE STRUCTURAL
SECT. 12.14. DESIGN CRITERIA FOR BUILDING FRAME SYSTEMS

$S_S = 1.529$
$S_{DS} = 1.019 \Rightarrow$ SEISMIC DESIGN CATEGORY D

$F_a = 1.00$
$S_{DS} = \frac{2}{3} F_a S_S$

BUILDING FRAME SYSTEM
LIGHT-FRAMED (WOOD) WALLS SHEATHED W/ WOOD STRUCTURAL PANELS

$R = 7$

LOAD COMBINATIONS FOR ASD:

$(1.0 + 0.14 S_{DS})D + 0.7Q_E \Rightarrow$ $1.14D + 0.7Q_E$

$(1.0 + 0.105 S_{DS})D + 0.525Q_E + 0.75L + 0.75S \Rightarrow$ $1.11D + 0.525Q_E + 0.75(L+S)$

$(0.6 - 0.14 S_{DS})D + 0.7Q_E \Rightarrow$ $0.46D + 0.7Q_E$

$V = \frac{FS_{DS}}{R} W = 0.146W = 8.61^k$

$F = 1.0$
$W = 59^k$

FOR DIAPHRAGM LOADING USE $\frac{8.61^k}{1000 FT^2} = 8.6$ PSF

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PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 29 AUG 2012, 9:51AM

ASCE Seismic Base Shear

File: \\EV-VTDATA\Server\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.8.20, Ver:6.12.8.20

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Irvine, CA

Risk Category

Calculations per ASCE 7-10

Risk Category of Building or Other Structure : "II" : All Buildings and other structures except those listed as Category I, III, and IV — *ASCE 7-10, Page 2, Table 1.5-1*

Seismic Importance Factor = 1 — *ASCE 7-10, Page 5, Table 1.5-2*

Gridded Ss & S1values ASCE-7-10 Standard

ASCE 7-10 11.4.1

Max. Ground Motions, 5% Damping :

S_S = 1.529 g, 0.2 sec response
S_1 = 0.570 g, 1.0 sec response

Latitude = 33.642 deg North
Longitude = 117.733 deg West
Location :

Site Class, Site Coeff. and Design Category

Site Classification "D" : Shear Wave Velocity 600 to 1,200 ft/sec = D — *ASCE 7-10 Table 20.3-1*

Site Coefficients Fa & Fv — *ASCE 7-10 Table 11.4-1 & 11.4-2*
(using straight-line interpolation from table values)
Fa = 1.00
Fv = 1.50

Maximum Considered Earthquake Acceleration
S_{MS} = Fa * Ss = 1.529 — *ASCE 7-10 Eq. 11.4-1*
S_{M1} = Fv * S1 = 0.855 — *ASCE 7-10 Eq. 11.4-2*

Design Spectral Acceleration
$S_{DS} = S_{MS} * 2/3$ = 1.019 — *ASCE 7-10 Eq. 11.4-3*
$S_{D1} = S_{M1} * 2/3$ = 0.570 — *ASCE 7-10 Eq. 11.4-4*

Seismic Design Category = D — *ASCE 7-10 Table 11.6-1 & -2*

Resisting System

ASCE 7-10 Table 12.2-1

Basic Seismic Force Resisting System . . . **Building Frame Systems**
Light-framed walls sheathed with wood structural panels rated for shear resistance or steel sheets

Response Modification Coefficient " R " = 7.00
System Overstrength Factor " Wo " = 2.00
Deflection Amplification Factor " Cd " = 4.50

NOTE! See ASCE 7-10 for all applicable footnotes.

Building height Limits :
Category "A & B" Limit: No Limit
Category "C" Limit: No Limit
Category "D" Limit: Limit = 65
Category "E" Limit: Limit = 65
Category "F" Limit: Limit = 65

Redundancy Factor

ASCE 7-10 Section 12.3.4

Seismic Design Category of D, E, or F therefore Redundancy Factor " p " = 1.3

Lateral Force Procedure

ASCE 7-10 Section 12.8.2

Equivalent Lateral Force Procedure

The "Equivalent Lateral Force Procedure" is being used according to the provisions of ASCE 7-10 12.8

Determine Building Period

Use ASCE 12.8-7

Structure Type for Building Period Calculation : All Other Structural Systems
" Ct " value = 0.020
" x " value = 0.75
" hn " : Height from base to highest level = 15.0 ft
" Ta " Approximate fundemental period using Eq. 12.8-7 : Ta = Ct * (hn ^ x) = 0.152 sec
"TL" : Long-period transition period per ASCE 7-10 Maps 22-12 -> 22-16 = 8.000 sec

Building Period " Ta " Calculated from Approximate Method selected = 0.152 sec

ASCE 7-10 Section 12.8.1.1

S_{DS}: Short Period Design Spectral Response	=	1.019	From Eq. 12.8-2, Preliminary Cs	=	0.146
" R " : Response Modification Factor	=	7.00	From Eq. 12.8-3 & 12.8-4 , Cs need not exceed	=	0.534
" I " : Seismic Importance Factor	=	1	From Eq. 12.8-5 & 12.8-6, Cs not be less than	=	0.045

Cs : Seismic Response Coefficient = 0.1456

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 29 AUG 2012, 9:51AM

ASCE Seismic Base Shear

File: \\EV-VTDATA\Server\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.8.20, Ver:6.12.8.20

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Seismic Base Shear

ASCE 7-10 Section 12.8.1

Cs = 0.1456 from 12.8.1.1

W (see Sum Wi below) = 59.00 k

Seismic Base Shear V = Cs * W = 8.59 k

Vertical Distribution of Seismic Forces

ASCE 7-10 Section 12.8.3

" k " : hx exponent based on Ta = 1.00

Table of building Weights by Floor Level...

Level #	Wi : Weight	Hi : Height	(Wi * Hi) ^k	Cvx	Fx=Cvx * V	Sum Story Shear	Sum Story Moment
1	59.00	15.00	885.00	1.00	8.59	8.59	0.00

Sum Wi = 59.00 k Sum Wi * Hi = 885.00 k-ft Total Base Shear = 8.59 k

Base Moment = 128.9 k-ft

Diaphragm Forces : Seismic Design Category "B" to "F"

ASCE 7-10 12.10.1.1

Level #	Wi	Fi	Sum Fi	Sum Wi	Fpx
1	59.00	8.59	8.59	59.00	12.03

Wpx . . . . . Weight at level of diaphragm and other structure elements attached to it.
Fi . . . . . Design Lateral Force applied at the level.
Sum Fi . . . . . Sum of "Lat. Force" of current level plus all levels above
MIN Req'd Force @ Level . . . . . 0.20 * S_{DS} * I * Wpx
MAX Req'd Force @ Level . . . . . 0.40 * S_{DS} * I * Wpx
Fpx : Design Force @ Level . . . . . Wpx * SUM(x->n) Fi / SUM(x->n) wi, x = Current level, n = Top Level

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Project: Middlebury Solar Decathlon
Date: 9/20/2012 11:16:38 AM
Designer: GS
Description: Middlebury, VT

ASCE 7-05 Snow Load

Notes

This design aid determines snow loads based on ASCE 7-05. Drift loads may be reduced by consideration of difference in height between the upper and lower roof or deck. The unbalanced snow load is for hip and gable roof.

Input

P_g (psf)	50	= ground snow load
C_e	1	= exposure factor (Table 7-2)
I	1	= importance factor (Table 7-4)
$P_{f\,min}$ (psf)	40	= minimum flat roof snow load

Insert roof info (up to 8 different conditions)

roof pitch (x/12)	C_t thermal factor (Table 7-3)	W (ft) horiz eave to ridge distance	rafter roof system (Y/N)
4	1.1	-	N

Rafter roof system must have simply supported prismatic members spanning from ridge to eave.

Output

Flat Roof, Sloped Roof and Unbalanced Snow Load

					unobstructed slippery surfaces*				all other surfaces			
							leeward				leeward	
rise	θ (°)	W (ft)	P_f (psf)	ridge to transition distance (ft)	P_s (psf)	windward	ridge to transition	transition to eave	P_s (psf)	windward	ridge to transition	transition to eave
4	18.4	-	40	N/A	34	N/A	N/A	N/A	40	N/A	N/A	N/A

Drifting Snow Surcharge

	leeward drift				windward drift		
l_u (ft)	h_d (ft)	W_d (ft)	P_d (psf)		h_d (ft)	W_d (ft)	P_d (psf)
25	2.0	8	41		1.5	6	31
30	2.2	9	45		1.7	7	34
40	2.6	10	53		1.9	8	40
50	2.9	12	60		2.2	9	45
60	3.2	13	65		2.4	10	49
70	3.4	14	70		2.6	10	53
80	3.6	15	75		2.7	11	56
90	3.9	15	79		2.9	12	59
100	4.0	16	83		3.0	12	62
110	4.2	17	87		3.2	13	65
120	4.4	18	90		3.3	13	68
130	4.6	18	93		3.4	14	70
140	4.7	19	96		3.5	14	72
150	4.8	19	99		3.6	15	75
160	5.0	20	102		3.7	15	77
170	5.1	20	105		3.8	15	79
180	5.2	21	108		3.9	16	81
190	5.4	21	110		4.0	16	83
200	5.5	22	112		4.1	16	84

*For warm roofs (Ct <=1.0) with R<30 for unventilated roofs or R<20 for ventilated roofs, use the sloped and unbalanced snow load for "all other surfaces".

Snow Density

γ (pcf) 20.5 = $0.13P_g+14$

Calculations

Flat Roof, Sloped Roof and Unbalanced Snow Load

Rise	θ (°)	S	C_t	W (ft)	P_f (psf)	h_d (ft)	70/W+0.5	ridge to transition distance (ft)
4	18.4	3.00	1.1	-	40	N/A	N/A	N/A

	unobstructed slippery surfaces					all other surfaces				
				leeward					leeward	
Rise	C_s	P_s (psf)	windward	ridge to transition	transition to eave	C_s	P_s (psf)	windward	ridge to transition	transition to eave
4	0.86	34	N/A	N/A	N/A	1.00	40	N/A	N/A	N/A

Drifting Snow Surcharge

	leeward drift				windward drift		
l_u (ft)	h_d (ft)	W_d (ft)	P_d (psf)		h_d (ft)	W_d (ft)	P_d (psf)
25	2.0	8	41		1.5	6	31
30	2.2	9	45		1.7	7	34
40	2.6	10	53		1.9	8	40
50	2.9	12	60		2.2	9	45
60	3.2	13	65		2.4	10	49
70	3.4	14	70		2.6	10	53
80	3.6	15	75		2.7	11	56
90	3.9	15	79		2.9	12	59
100	4.0	16	83		3.0	12	62
110	4.2	17	87		3.2	13	65
120	4.4	18	90		3.3	13	68
130	4.6	18	93		3.4	14	70
140	4.7	19	96		3.5	14	72
150	4.8	19	99		3.6	15	75
160	5.0	20	102		3.7	15	77
170	5.1	20	105		3.8	15	79
180	5.2	21	108		3.9	16	81
190	5.4	21	110		4.0	16	83
200	5.5	22	112		4.1	16	84

Lateral Sheer Walls and Wall Studs

Greg Sellers

Subject: FW: Solar Decathlon Project Manual revision

Greg Sellers, P.E., LEED AP BD+C

From: Greg Sellers
Sent: Wednesday, November 14, 2012 2:56 PM
To: bgell@middlebury.edu
Cc: SD13 Design Coordinator (sd13design@gmail.com)
Subject: FW: Solar Decathlon Project Manual revision

Brandon,

See my response below and let me know if you have any questions,

-----Original Message-----
From: Gell, Brandon James [mailto:bgell@middlebury.edu]
Sent: Monday, November 12, 2012 9:56 PM
To: Greg Sellers
Subject: Solar Decathlon Project Manual revision

Hi Greg,

The DOE needs revisions to our project manual by November 17th and they had a couple comments on our structural components:

> 1. It appears that you will be using I-joists as wall studs. I dis not find a section of these calculations that addresses the evaluation of the axial loading condition. The plans indicate that these will not be transmitting gravity loads. I am correct to assume that these will transmit lateral forces?

Correct, the exterior wood-framed walls with TJI studs are not load bearing, as the roof trusses are designed to span to the steel beams.

The calculation on page 20 (that you asked about below) is for a TJI stud design to resist out-of-plane applied wind pressure (bending and deflection calculation).

The exterior walls, in general, are designed to take lateral forces acting as shear walls. The shear walls will have horizontal blocking at the horizontal plywood panel joints spanning between the TJI studs.

> 2.Although I have a pretty good idea on the design method, I will still need a summary narrative to confirm my lay assumptions. Provide me with a brief narrative of lateral transference from roof to base of pier. Advise of any lateral displacement proposed through sliding.

The roof panels span horizontally and transfer the lateral shear loads into the perimeter exterior shear walls through the roof panel connections to the perimeter steel beam, and from the steel beams into blocking and the interior layer of plywood on the wall. The shear walls then transfer the lateral shear forces through connections to the dropped PSL

beams (connections were not fully detailed on drawings for previous DD deliverable). The dropped beams transfer the shear forces through the threaded steel bolts in the dropped beams that are welded to the base plates. The steel base plates transfer the shear forces with friction between the steel plate and asphalt to the ground.

The friction between the steel plates and asphalt surface resists the lateral forces from the governing seismic forces (no lateral displacement of base plates due to seismic and wind forces)

Also note that uplift in the shear walls is to be resisted by gravity dead loads through connections at ends of walls to steel column gravity loads, and connections at ends of the walls to dropped PSL beams (again, not fully detailed at this point).

The total dead weight, including green roof, resist the uplift pressures and shear wall uplift forces from overturning (so no lateral displacement of base plates due to lateral seismic and wind forces).

I'm not exactly sure what some of these questions mean, and any information/guidance you have for me would be greatly appreciated. Also, on pg 25 of our project manual the guy editing our plans wasn't sure what the TJI calculation was. Do you have this information and can you get it to me before the 17th. Sorry for the short notice, I have just received an email about this. Thanks!

Brandon

SOLAR DECATHLON - LATERAL SUMMARY

- ROOF PANELS - DISTRIBUTE LATERAL LOADS BY TYING INTO STEEL BEAMS. TO CREATE CONTINUOUS DIAPHRAGM

  - AT SHEAR WALLS: DIAPHRAGM TRANSFERS SHEAR TO SHEAR WALLS THRU 1/4 PLATE / TAB CONNECTION TO INSIDE PANEL OF SHEAR WALL.
    3/8" DIA. BOLT AT 24" oc OK TO 4x4 BLOCKING.

- WALL PANELS - SHEAR WALLS TRANSFER VERTICAL SHEAR THRU PLATE/BOLT CONNECTIONS WHERE NO STEEL PANELS OCCUR.

  - SHEAR WALLS FASTENED TO STEEL COLS FOR UPLIFT:
    700 lb/kft x MIN. 4 BOLTS = 2,800 lbs uplift RESISTED
    BY INSPECTION => OK FOR ALL WALL / COLUMN CONNECTIONS.

  - WHERE NOT ENOUGH POST DL RESISTS UPLIFT, FASTEN SHEAR WALL TO FLOOR PANEL. (OR DROPPED BEAM SYSTEM)

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fax 603.442.9331

JOB SOLAR DECATHLON
SHEET NO. ____ OF ____
CALCULATED BY JRT DATE 8/28/2012
CHECKED BY ____ DATE ____
SCALE ____

SEISMIC WEIGHT

ROOF AREA ~ 1000 FT²

ROOF DEAD LOAD = 45 PSF (CONSERVATIVELY USE GREEN ROOF FOR WHOLE)

WALL AREA ~ $152' * \frac{12'}{2} = 912$ FT²

WALL WEIGHT = 15 PSF

$W = 1000 FT^2 * 45 PSF + 912 FT^2 * 15 PSF = 58.7 K$

$V_{ROOF} = 8.61$ KIPS $(C_s = .146)$

FLOOR

FLOOR AREA ~ 1000 ft² + DECK $(7' \times 20') + (2.5' \times 22') =$

DL = 18 PSF

DL = 5 PSF

$W_{Floor} = 1000 \times (18) + 195 \times 5 = 18 + .98 = 19$ KIPS

$W_{wall} = 912 ft^2 \times 15 PSF = 13.7$ KIPS

TOTAL W @ ROOF = 32.7 KIPS

$V_{FLOOR} = (.146)(32.7k) = 4.77$ KIPS

TOTAL BASE SHEAR

V = 13.4 KIPS

Shear Wall Summary
Middlebury Solar Decathalon
20-Sep-12

SIP screw allowable shear (#)	253
#8 screw allowable shear w/ 2x (#)	125
10d common nail allowable shear w/ 2x (#)	160
16d common nail allowable shear w/ 2x (#)	192
LTP4 allowable shear (#)	575

= calculated cell, unrevised
= calculated cell, revised

					Openings				Shear						Fastener spacing					Overturning						
mark	L_{actual} (ft)	h (ft)	$L_{full\ height}$ (ft)	max op'ng ht (ft)	% full ht	op'ng/h	C_o	L_{adj} (ft)	this lvl (#)	V V_{stud} (#)	V_{stud} (plf)	V_{max} (plf)	shares load with	% load	SIP screw (in)	#8 screw (in)	10d nail (in)	16d nail (in)	LTP4 (in)	$L_{load\ down}$ (ft)	w_{DL} (plf)	R (#)	DL* post 1 (#)	R-0.6DL from abv	R-0.6DL post 1 (#)	DL* post 2 (#)	R-0.6DL from abv	R-0.6DL post 2 (#)	notes
1	16.5	8.5	13.5	7	82%	0.82	0.79	10.67	1030	1030	76	97	-	100%	40	20	25	30	90	15	127.5	-111			-111			-111	
4A	9	8	9	0	100%	0.00	1	9	1700	1700	189	189	-	100%	16	8	10	12	37	7.5	120	1425			1425			1425	
4B	8	9	8	0	100%	0.00	1	8	1520	1520	190	190	-	100%	16	8	10	12	36	7.5	135	1478			1478			1478	
8	9.75	11.5	9.75	0	100%	0.00	1	9.75	2190	2190	225	225	-	100%	14	7	9	10	31	9.25	172.5	2191			2191			2191	
A	14	7.5	10	4	71%	0.53	0.86	8.6	1030	1030	103	120	-	100%	29	15	19	22	67	11.67	112.5	95			95			95	
B	20.5	10.5	14.5	1.5	71%	0.14	1	14.5	2190	2190	151	151	-	100%	20	10	13	15	46	18	157.5	174			174			174	
H	13	9.5	9	3.75	69%	0.39	0.95	8.55	1030	1030	114	120	-	100%	27	13	17	20	60	11.5	142.5	223			223			223	
I	force transfer around openings - see hand calcs /////////// 2720#-0.6*15psf*11.5*9.25/2 = 2240# uplift /////////// 381plf max shear																												

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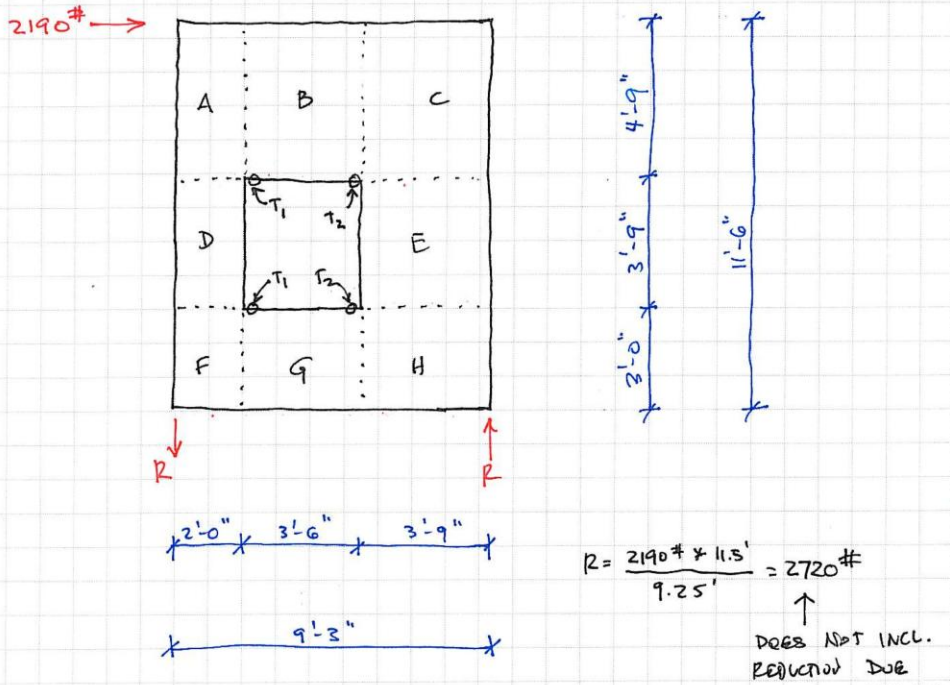
fax 603.442.9331

JOB MIDDLEBURY S.D.
SHEET NO. _____ OF _____
CALCULATED BY JRT DATE 9/6/2012
CHECKED BY _____ DATE _____
SCALE _____

SHEAR WALL I



$R = \frac{2190\# \times 11.5'}{9.25'} = 2720\#$

↑ DOES NOT INCL. REDUCTION DUE TO WALL WEIGHT

Page 18 of 103

PRODUCT 204-1 (Single Sheets) 285-1 (Padded)

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JOB
SHEET NO. OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

SHEAR WALL KEY — SHEAR (PLF)

A — $\frac{2190\# - 351\,PLF * 3.5'}{2' + 3.75'} = 167$ PLF

B — $\frac{2720\#}{3'+4.75'} = 351$ PLF

C — 167 PLF

D — $\frac{2190\#}{2'+3.75'} = 381$ PLF

E — 381 PLF

F — 167 PLF

G — 351 PLF

H — 167 PLF

$T_1 = \frac{2'}{2'+3.75'}(351\,PLF * 3.5') = 427\#$

$T_2 = \frac{3.75'}{2'+3.75'}(351\,PLF * 3.5') = 801\#$

S.P.F. #1/#2

15/32" SHEATHING, 8d NAILS @ 3" oc... $V_{ALLOW} = \frac{980\,PLF * 0.92}{F.S.\ 2} = 451$ PLF ok

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Project: Middlebury SD
Date: 9/20/2012 8:28:58 AM
Designer: JRT
Description: box beam header over windows - 6' span, 12" min. depth

Box Beam

Notes

Checks SIP headers based on box beam theory and 2005 NDS.

Conservative assumptions:
1. Only flanges contribute to bending strength.
2. Only webs contribute to shear strength.

Input

flanges

description	1.25x14 LSL 1.3E	
G_f	0.5	= specific gravity of flanges
b_f (in)	14	= width of flanges (not incl. plywood)
t_f (in)	1.25	= thickness of flanges
C_D	0.9	= load duration factor
F_t (psi)	1075	= allowable tensile stress (with no adjustment factors)
C_F	1	= size factor for F_t (2x4 = 1.5, 2x6 = 1.3)
F_c (psi)	1400	= allowable compression stress parallel to grain (with no adjustment factors)
C_F	1	= size factor for F_c (2x4 = 1.15, 2x6 = 1.1)
F_{cperp} (psi)	680	= allowable compression perpendicular to grain
E (psi)	1300000	

webs

description	7/16" OSB each face - 24/16 span rating	
G_w	0.5	= specific gravity of webs (0.5 for OSB per PDS)
thickness (in)	0.4375	
overall depth (in)	12	
$G_w t_w$ (#/in depth)	83500	
$F_v t_w$ (#/in shear resisting lgth)	165	see PDS table 4A or SIP manuf
duration of load factor	0.9	see PDS Section 4.5

span / loads

span (ft)	6
uniform DL (plf)	100
uniform LL (plf)	0

Output

	allowable	actual	
top flange comp (#)	22050	502	OK
bottom flange tension (#)	16931	502	OK
shear (#)	3564	300	OK

	Δ (in)	ratio
live load	0.00	#DIV/0!
total load	0.01	5195

shear flow per web (#/in) 14 at ends, can reduce by half at quarter points.

min. bearing length (in) 0.03

USE 8d NAILS AT 3"oc EACH FACE

Calculations

bending (considering flanges only)

M (in-#)	5400	= $wL^2/8$
F_c' (psi)	1260	
F_t' (psi)	968	

allowable force

C_{allow} top flange (#)	22050	= $F_c'A$
T_{allow} bot flange (#)	16931	= $F_t'A$

actual force

$T_{act} = C_{act}$ (#)	502	= M/(depth-t_f) OK

shear (considering webs only)

allowable force

V_{allow} (#)	3564	=$F_v t_w$(depth)(2 webs)

actual force

V_{actual} (#)	300	= wL/2 OK

deflection

bending deflection

I each flange (in4)	2.28	
A each flange (#)	17.5	
y bar (in)	6.00	
d (in)	5.375	
I_{gross} (in^4)	1016	= ($I+Ad^2$) x 2 flanges
EI_{gross} (#-in^2)	1320447917	

shear deflection

GA (#)	2004000	
p	0.059	=$2t_s/b_1$
s	0.792	= $2d_f/h$
β	1	= G_f/G_w
K	4.32	see Supp. 2, Fig. 7.2.2
C_{LL} (in-#)	0	= $w_{LL}L^2/8$
C_{TL} (in-#)	5400	= $w_{TL}L^2/8$

	Δ_b (in)	Δ_s (in)	Δ_{total} (in)	ratio
live load	0.000	0.00	0.00	#DIV/0!
total load	0.002	0.01	0.01	5195

$\Delta_b = 5wL^4/384EI$

$\Delta_s = KC/GA$

shear flow

Q (in^3)	94.1	= Ad
shear flow (#/in)	28	= VQ/I gross
shear flow per web (#/in)	14	

minimum bearing at each end

min bearing length (in)	0.03	= $R/(F_{cperp}*b_1)$

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 20 SEP 2012, 11:30AM

Wood Beam

File: \\EV-VTDATA\Server\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.9.13, Ver:6.12.9.13

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Description : king stud at 6'-0" wide window - WL = 27psf C&C x 0.6 load factor per ASCE 7-10 = 16psf

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006IBC&ASCE7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006IBC&ASCE7-05

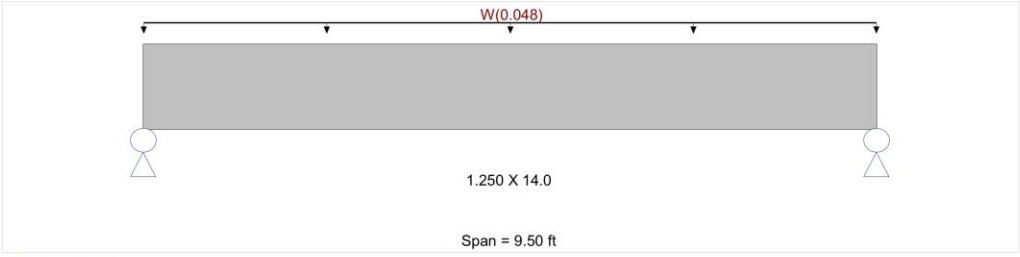
Wood Species : iLevel Truss Joist
Wood Grade : TimberStrand LSL 1.3E - Beam/Col

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	1,700.0 psi
Fb - Compr	1,700.0 psi
Fc - Prll	1,400.0 psi
Fc - Perp	680.0 psi
Fv	400.0 psi
Ft	1,075.0 psi

E : Modulus of Elasticity

Ebend- xx	1,300.0 ksi
Eminbend - xx	660.75 ksi
Density	32.210 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : W = 0.0160 ksf, Tributary Width = 3.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.059 : 1	Maximum Shear Stress Ratio	=	0.023 : 1
Section used for this span		1.250 X 14.0	Section used for this span		1.250 X 14.0
fb : Actual	=	159.13 psi	fv : Actual	=	14.85 psi
FB : Allowable	=	2,720.00 psi	Fv : Allowable	=	640.00 psi
Load Combination		+D+W+H	Load Combination		+D+W+H
Location of maximum on span	=	4.750 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.024 in	Ratio =	4777
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
+D+W+H													0.00	0.00	0.00	0.00
Length = 9.50 ft	1	0.059	0.023	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.54	159.13	2720.00	0.17	14.85	640.00
+D+0.750Lr+0.750L+0.750W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 9.50 ft	1	0.044	0.017	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.41	119.35	2720.00	0.13	11.14	640.00
+D+0.750L+0.750S+0.750W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 9.50 ft	1	0.044	0.017	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.41	119.35	2720.00	0.13	11.14	640.00
+0.60D+W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 9.50 ft	1	0.059	0.023	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.54	159.13	2720.00	0.17	14.85	640.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
W Only	1	0.0239	4.798		0.0000	0.000

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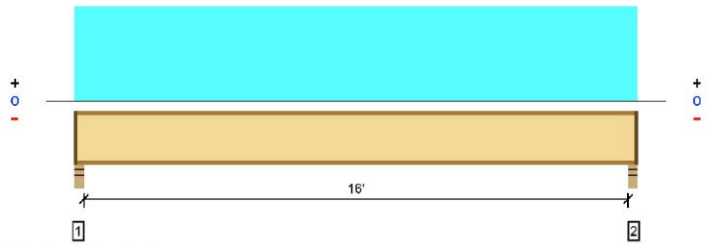
FORTE

SOLUTIONS REPORT *Level, Typ. TJI Wall Stud*

PASSED

Current Solution: : 1 piece(s) 14" TJI® 110 @ 24" OC

Overall Length: 16' 7"



All Dimensions Are Horizontal; Drawing is Conceptual

Design Results	Actual @ Location	Allowed	Result	LDF
Member Reaction (lbs)	578 @ 2 1/2"	1666	Passed (35%)	1.60
Shear (lbs)	565 @ 3 1/2"	2976	Passed (19%)	1.60
Moment (Ft-lbs)	2307 @ 8' 3 1/2"	5984	Passed (39%)	1.60
Live Load Defl. (in)	0.246 @ 8' 3 1/2"	0.404	Passed (L/788)	--
Total Load Defl. (in)	0.246 @ 8' 3 1/2"	0.808	Passed (L/788)	--
TJ-Pro™ Rating	41	25	Passed	--

System : Floor
Member Type : Joist
Building Use : Residential
Building Code : IBC
Design Methodology : ASD

All Product Solutions					
Depth	Series	Plies	Spacing	TJ-Pro™ Rating	Wood Volume
14"	TJI® 110	1	24"	41	0.48

The purpose of this report is for product comparison only. Load and support information necessary for professional design review is not displayed here. Please print an individual Member Report for submittal purposes.

Forte Software Operator	Job Notes
John Sellers Engineering Ventures (802) 863-6225 gregs@engineeringventures.com	

9/27/2012 9:13:00 AM
Forte v3.5, Design Engine: V5.5.3.2
decathlon.4te

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Steel Frames

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Steel Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : W12x19 Roof Beam

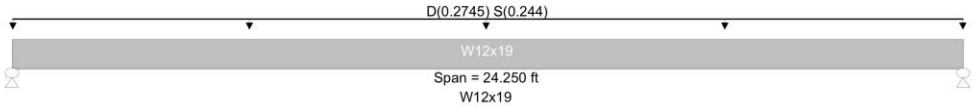
CODE REFERENCES

Calculations per AISC 360-05, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Load Combination 2006 IBC & ASCE 7-05

Fy : Steel Yield : 50.0 ksi
E: Modulus : 29,000.0 ksi



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Uniform Load : D = 0.0450, S = 0.040 ksf, Tributary Width = 6.10 ft, (Roof Load)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.641 : 1	Maximum Shear Stress Ratio =	0.114 : 1
Section used for this span	W12x19	Section used for this span	W12x19
Mu : Applied	39.508 k-ft	Vu : Applied	6.517 k
Mn / Omega : Allowable	61.627 k-ft	Vn/Omega : Allowable	57.340 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	12.125ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.507 in	Ratio =	573
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	1.118 in	Ratio =	260
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
+D													
Dsgn. L = 24.25 ft	1	0.350	0.062	21.57		21.57	102.92	61.63	1.00	1.00	3.56	86.01	57.34
+D+S+H													
Dsgn. L = 24.25 ft	1	0.641	0.114	39.51		39.51	102.92	61.63	1.00	1.00	6.52	86.01	57.34
+D+0.750L+0.750S+H													
Dsgn. L = 24.25 ft	1	0.568	0.101	35.02		35.02	102.92	61.63	1.00	1.00	5.78	86.01	57.34
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 24.25 ft	1	0.568	0.101	35.02		35.02	102.92	61.63	1.00	1.00	5.78	86.01	57.34
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 24.25 ft	1	0.568	0.101	35.02		35.02	102.92	61.63	1.00	1.00	5.78	86.01	57.34

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+S	1	1.1181	12.246		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	6.517	6.517
D Only	3.558	3.558
S Only	2.959	2.959
D+S	6.517	6.517

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Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 8:37AM

Steel Column

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : HSS 4x4x3/16 Column

Code References

Calculations per AISC 360-05, IBC 2006, CBC 2007, ASCE 7-05
Load Combinations Used : 2006 IBC & ASCE 7-05

General Information

Steel Section Name :	HSS4x4x3/16	Overall Column Height	11.0 ft
Analysis Method :	Allowable Stress	Top & Bottom Fixity	Top & Bottom Pinned
Steel Stress Grade			
Fy : Steel Yield	46.0 ksi	Brace condition for deflection (buckling) along columns :	
E : Elastic Bending Modulus	29,000.0 ksi	X-X (width) axis : Unbraced Length for X-X Axis buckling = 11.0 ft, K = 1.0	
Load Combination :	2006 IBC & ASCE 7-05	Y-Y (depth) axis : Unbraced Length for X-X Axis buckling = 11.0 ft, K = 1.0	

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 103.434 lbs * Dead Load Factor
AXIAL LOADS . . .
Roof Load: Axial Load at 11.0 ft, Xecc = 2.500 in, Yecc = 2.500 in, D = 3.560, S = 2.960 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.1518** : 1

Load Combination	+D+S+H
Location of max.above base	0.0 ft
At maximum location values are . . .	
Pa : Axial	6.623 k
Pn / Omega : Allowable	43.630 k
Ma-x : Applied	0.0 k-ft
Mn-x / Omega : Allowable	8.424 k-ft
Ma-y : Applied	0.0 k-ft
Mn-y / Omega : Allowable	8.424 k-ft

PASS Maximum Shear Stress Ratio = **0.001235** : 1

Load Combination	+D+S+H
Location of max.above base	0.0 ft
At maximum location values are . . .	
Va : Applied	0.02470 k
Vn / Omega : Allowable	20.003 k

Maximum SERVICE Load Reactions . .

Top along X-X	0.02470 k
Bottom along X-X	0.02470 k
Top along Y-Y	0.02470 k
Bottom along Y-Y	0.02470 k

Maximum SERVICE Load Deflections . . .

Along Y-Y -0.02041 in at 6.423 ft above base
for load combination : D+S

Along X-X -0.02041 in at 6.423 ft above base
for load combination : D+S

Load Combination Results

Load Combination	Maximum Axial + Bending Stress Ratios: Stress Ratio	Status	Location	Maximum Shear Ratios: Stress Ratio	Status	Location
+D	0.084	PASS	0.00 ft	0.001	PASS	0.00 ft
+D+S+H	0.152	PASS	0.00 ft	0.001	PASS	0.00 ft
+D+0.750L+0.750S+H	0.135	PASS	0.00 ft	0.001	PASS	0.00 ft
+D+0.750L+0.750S+0.750W+H	0.135	PASS	0.00 ft	0.001	PASS	0.00 ft
+D+0.750L+0.750S+0.5250E+H	0.135	PASS	0.00 ft	0.001	PASS	0.00 ft

Maximum Reactions - Unfactored

Note: Only non-zero reactions are listed.

Load Combination	X-X Axis Reaction @ Base	X-X Axis Reaction @ Top	Y-Y Axis Reaction @ Base	Y-Y Axis Reaction @ Top	Axial Reaction @ Base
D Only	0.013	0.013 k	0.013	0.013 k	3.663 k
S Only	0.011	0.011 k	0.011	0.011 k	2.960 k
D+S	0.025	0.025 k	0.025	0.025 k	6.623 k

Maximum Deflections for Load Combinations - Unfactored Loads

Load Combination	Max. X-X Deflection	Distance	Max. Y-Y Deflection	Distance
D Only	-0.0111 in	6.423 ft	-0.011 in	6.423 ft
S Only	-0.0093 in	6.423 ft	-0.009 in	6.423 ft
D+S	-0.0204 in	6.423 ft	-0.020 in	6.423 ft

Steel Section Properties : HSS4x4x3/16

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Steel Column

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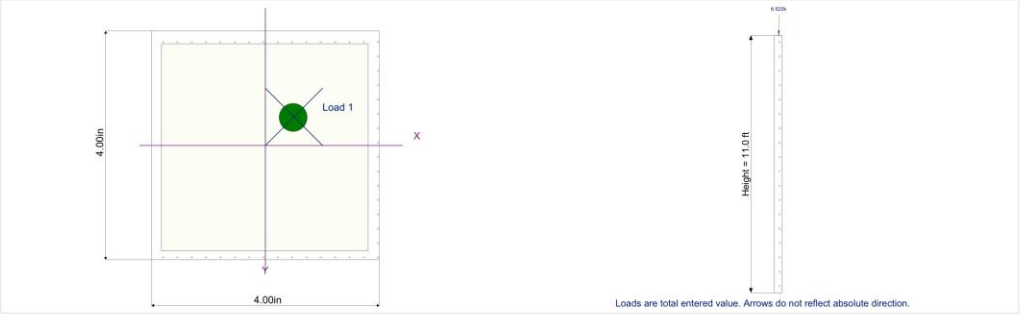
Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : HSS 4x4x3/16 Column

Steel Section Properties : HSS4x4x3/16

Depth	=	4.000 in	I xx	=	6.21 in^4	J	=	10.000 in^4
Web Thick	=	0.000 in	S xx	=	3.10 in^3			
Flange Width	=	4.000 in	R xx	=	1.550 in			
Flange Thick	=	0.187 in						
Area	=	2.580 in^2	I yy	=	6.210 in^4			
Weight	=	9.403 plf	S yy	=	3.100 in^3			
			R yy	=	1.550 in			
Ycg	=	0.000 in						



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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 6-I, 3'x3' plate

Code References

Calculations per AISC 360-05 & Design Guide # 1, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

General Information

Material Properties

AISC Design Method	Allowable Stress Design		ASIF : Allowable Stress Increase Factor	1.0
Steel Plate Fy	=	36.0 ksi	ABIF : Allowable Bearing Increase Factor	1.0
Concrete Support f'c	=	0.0180 ksi	Ω c : ASD Safety Factor.	2.50
Assumed Bearing Area : Full Bearing			Allowable Bearing Fp per J8	0.02125 ksi

Column & Plate

Column Properties

Steel Section : HSS4X4X1/4

Depth	4 in	Area	3.37 in^2
Width	4 in	Ixx	in^4
Flange Thickness	0.233 in	Iyy	in^4
Web Thickness	in		

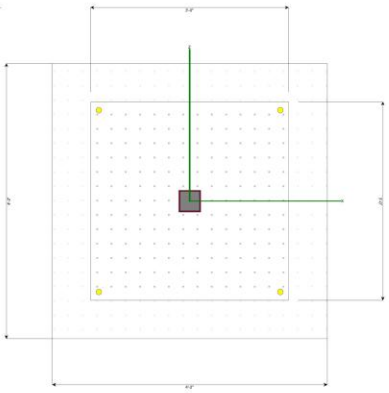
Plate Dimensions

N : Length	36.0 in
B : Width	36.0 in
Thickness	0.50 in

Column assumed welded to base plate.

Support Dimensions

Width along "X"	50.0 in
Length along "Z"	50.0 in

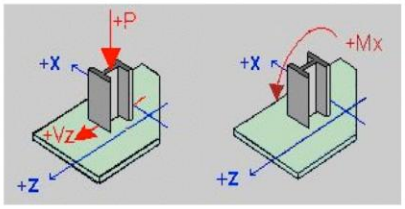


Applied Loads

	P-Y	V-Z	M-X
D : Dead Load	7.410 k	k	k-ft
L : Live	2.625 k	k	k-ft
Lr : Roof Live	k	k	k-ft
S : Snow	k	k	k-ft
W : Wind	k	k	k-ft
E : Earthquake	1.875 k	k	k-ft
H : Lateral Earth	k	k	k-ft

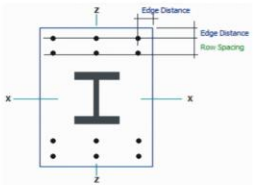
" P " = Gravity load, "+" sign is downward.

"+" Moments create higher soil pressure at +Z edge.
"+" Shears push plate towards +Z edge.



Anchor Bolts

Anchor Bolt or Rod Description	1 1/2"	
Max of Tension or Pullout Capacity.....		k
Shear Capacity.....		k
Edge distance : bolt to plate.....	1.50	in
Number of Bolts in each Row.....	2.0	
Number of Bolt Rows.....	1.0	



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Steel Base Plate

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Description : Grid 6-I, 3'x3' plate

GOVERNING DESIGN LOAD CASE SUMMARY

Plate Design Summary

Design Method	Allowable Stress Design	Mu : Max. Moment	1.036 k-in
Governing Load Combination	+D+0.750Lr+0.750L+0.5250E+H	fb : Max. Bending Stress	16.582 ksi
Governing Load Case Type	Axial Load Only	Fb : Allowable :	21.557 ksi
Design Plate Size	**3'-0" x 3'-0" x 0 -1/2"**	Fy * ASIF / Omega	
Pa : Axial Load	10.363 k	Bending Stress Ratio	0.769
Ma : Moment	0.000 k-ft		**Bending Stress OK**
fv : Actual	0.000 ksi	fu : Max. Plate Bearing Stress	0.008 ksi
Fv : Allowable = 0.60 * Fy / 1.5 (per G2)	0.000 ksi	Fp : Allowable :	0.009 ksi
Shear Stress Ratio	0.000	min(0.85*f'c*sqrt(A2/A1), 1.7* f'c)/Ome	
	Shear Stress OK	Bearing Stress Ratio	0.941
			Bearing Stress OK

Load Comb. : +D

Axial Load Only, No Moment

Loading		Bearing Stresses	
Pa : Axial Load	7.410 k	Fp : Allowable	0.009 ksi
Design Plate Height	36.000 in	fa : Max. Bearing Pressure	0.006 ksi
Design Plate Width	36.000 in	**Stress Ratio**	**0.673**
Will be different from entry if partial bearing used.		Plate Bending Stresses	
A1 : Plate Area	1,296.000 in^2	Mmax = Fu * L^2 / 2	0.741 k-in
A2: Support Area	2,500.000 in^2	fb : Actual	11.856 ksi
sqrt(A2/A1)	1.389	Fb : Allowable	21.557 ksi
		Stress Ratio	**0.550**
Distance for Moment Calculation		Shear Stress	
" m "	16.100 in	fv : Actual	0.000 ksi
" n "	16.100 in	Fv : Allowable	0.000 ksi
X	0.000 in^2	**Stress Ratio**	**0.000**
Lambda	0.000		
n'	0.000 in		
n' * Lambda	0.000 in		
L = max(m, n, n")	16.100 in		

Load Comb. : +D+L+H

Axial Load Only, No Moment

Loading		Bearing Stresses	
Pa : Axial Load	10.035 k	Fp : Allowable	0.009 ksi
Design Plate Height	36.000 in	fa : Max. Bearing Pressure	0.008 ksi
Design Plate Width	36.000 in	**Stress Ratio**	**0.911**
Will be different from entry if partial bearing used.		Plate Bending Stresses	
A1 : Plate Area	1,296.000 in^2	Mmax = Fu * L^2 / 2	1.004 k-in
A2: Support Area	2,500.000 in^2	fb : Actual	16.057 ksi
sqrt(A2/A1)	1.389	Fb : Allowable	21.557 ksi
		Stress Ratio	**0.745**
Distance for Moment Calculation		Shear Stress	
" m "	16.100 in	fv : Actual	0.000 ksi
" n "	16.100 in	Fv : Allowable	0.000 ksi
X	0.000 in^2	**Stress Ratio**	**0.000**
Lambda	0.000		
n'	0.000 in		
n' * Lambda	0.000 in		
L = max(m, n, n")	16.100 in		

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Steel Base Plate

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Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 6-I, 3'x3' plate

Load Comb. : +D+0.750Lr+0.750L+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	9.379	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.851**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.938	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.007	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.696**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.750L+0.750S+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	9.379	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.851**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.938	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.007	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.696**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.723	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.792**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.872	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.957	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.647**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

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Title : Middlebury Solar Decathalon
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Project Desc.:

Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 6-I, 3'x3' plate

Load Comb. : +D-0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.098	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.005	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.554**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.610	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.756	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.453**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.750Lr+0.750L+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	9.379	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.851**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.938	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.007	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.696**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.750Lr+0.750L-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	9.379	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.851**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.938	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.007	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.696**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

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Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 9:30AM

Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 6-I, 3'x3' plate

Load Comb. : +D+0.750L+0.750S+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	9.379	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.851**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.938	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.007	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.696**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.750L+0.750S-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	9.379	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.851**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.938	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.007	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.696**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.750Lr+0.750L+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	10.363	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.941**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	1.036	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.582	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.769**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

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Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 6-I, 3'x3' plate

Load Comb. : +D+0.750Lr+0.750L-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.394	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.006	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.762**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.839	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.432	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.623**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.750L+0.750S+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	10.363	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.941**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	1.036	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.582	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.769**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

Load Comb. : +D+0.750L+0.750S-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.394	k	Fp : Allowable	0.009	ksi
Design Plate Height	36.000	in	fa : Max. Bearing Pressure	0.006	ksi
Design Plate Width	36.000	in	**Stress Ratio .....**	**0.762**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	1,296.000	in^2	Mmax = Fu * L^2 / 2	0.839	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.432	ksi
sqrt(A2/A1)	1.389		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.623**	
Distance for Moment Calculation			Shear Stress		
" m "	16.100	in	fv : Actual	0.000	ksi
" n "	16.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	16.100	in			

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Job # 12130

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 6-I, 3'x3' plate

Load Comb. : +0.60D+0.70E+H

Axial Load Only, No Moment

Loading		
Pa : Axial Load	5.759	k
Design Plate Height	36.000	in
Design Plate Width	36.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	1,296.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	1.389	

Distance for Moment Calculation		
" m "	16.100	in
" n "	16.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	16.100	in

Bearing Stresses	
Fp : Allowable	0.009 ksi
fa : Max. Bearing Pressure	0.004 ksi
Stress Ratio	**0.523**

Plate Bending Stresses	
Mmax = Fu * L^2 / 2	0.576 k-in
fb : Actual	9.214 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.427**

Shear Stress	
fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

Load Comb. : +0.60D-0.70E+H

Axial Load Only, No Moment

Loading		
Pa : Axial Load	3.134	k
Design Plate Height	36.000	in
Design Plate Width	36.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	1,296.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	1.389	

Distance for Moment Calculation		
" m "	16.100	in
" n "	16.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	16.100	in

Bearing Stresses	
Fp : Allowable	0.009 ksi
fa : Max. Bearing Pressure	0.002 ksi
Stress Ratio	**0.284**

Plate Bending Stresses	
Mmax = Fu * L^2 / 2	0.313 k-in
fb : Actual	5.014 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.233**

Shear Stress	
fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 5-B, 2'-6"x2'-6" plate

Code References

Calculations per AISC 360-05 & Design Guide # 1, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

General Information

Material Properties

AISC Design Method	Allowable Stress Design		ASIF : Allowable Stress Increase Factor	1.0	
Steel Plate Fy	=	36.0 ksi	ABIF : Allowable Bearing Increase Factor	1.0	
Concrete Support f'c	=	0.0190 ksi	Ω c : ASD Safety Factor.	2.50	
Assumed Bearing Area : Full Bearing			Allowable Bearing Fp per J8	0.02692 ksi	

Column & Plate

Column Properties

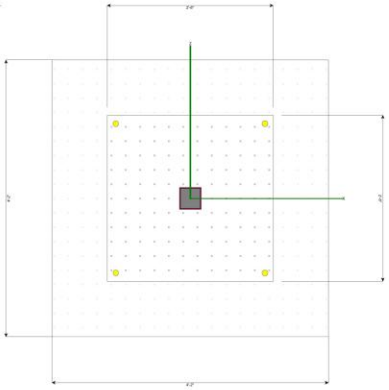
Steel Section : HSS4X4X1/4

Depth	4 in		Area	3.37 in^2	
Width	4 in		Ixx	in^4	
Flange Thickness	0.233 in		Iyy	in^4	
Web Thickness	in				

Plate Dimensions

N : Length	30.0 in	Width along "X"	50.0 in
B : Width	30.0 in	Length along "Z"	50.0 in
Thickness	0.50 in		

Column assumed welded to base plate.

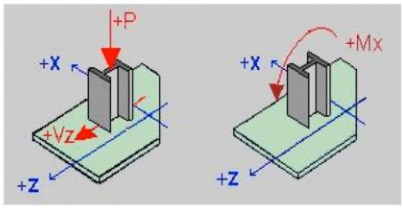


Applied Loads

	P-Y	V-Z	M-X
D : Dead Load	7.550 k	k	k-ft
L : Live	1.90 k	k	k-ft
Lr : Roof Live	k	k	k-ft
S : Snow	k	k	k-ft
W : Wind	k	k	k-ft
E : Earthquake	k	k	k-ft
H : Lateral Earth	k	k	k-ft

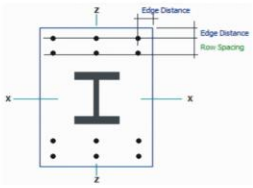
" P " = Gravity load, "+" sign is downward.

"+" Moments create higher soil pressure at +Z edge.
"+" Shears push plate towards +Z edge.



Anchor Bolts

Anchor Bolt or Rod Description	1 1/2"	
Max of Tension or Pullout Capacity.....		k
Shear Capacity.....		k
Edge distance : bolt to plate.....	1.50	in
Number of Bolts in each Row.....	2.0	
Number of Bolt Rows.....	1.0	



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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Steel Base Plate

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : Grid 5-B, 2'-6"x2'-6" plate

GOVERNING DESIGN LOAD CASE SUMMARY

Plate Design Summary

Design Method	Allowable Stress Design
Governing Load Combination	+D+L+H
Governing Load Case Type	Axial Load Only
Design Plate Size	**2'-6" x 2'-6" x 0 -1/2"**
Pa : Axial Load	9.450 k
Ma : Moment	0.000 k-ft
fv : Actual	0.000 ksi
Fv : Allowable = 0.60 * Fy / 1.5 (per G2)	0.000 ksi
Shear Stress Ratio	0.000

Shear Stress OK

Mu : Max. Moment	0.901 k-in
fb : Max. Bending Stress	14.415 ksi
Fb : Allowable :	21.557 ksi
Fy * ASIF / Omega	
Bending Stress Ratio	0.669

Bending Stress OK

fu : Max. Plate Bearing Stress	0.011 ksi
Fp : Allowable :	0.011 ksi
min(0.85*f'c*sqrt(A2/A1), 1.7* f'c)/Ome	
Bearing Stress Ratio	0.975

Bearing Stress OK

Load Comb. : +D

Axial Load Only, No Moment

Loading

Pa : Axial Load	7.550	k
Design Plate Height	30.000	in
Design Plate Width	30.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	900.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	1.667	

Distance for Moment Calculation

" m "	13.100	in
" n "	13.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	13.100	in

Bearing Stresses

Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.008 ksi
Stress Ratio	**0.779**

Plate Bending Stresses

Mmax = Fu * L^2 / 2	0.720 k-in
fb : Actual	11.517 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.534**

Shear Stress

fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

Load Comb. : +D+L+H

Axial Load Only, No Moment

Loading

Pa : Axial Load	9.450	k
Design Plate Height	30.000	in
Design Plate Width	30.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	900.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	1.667	

Distance for Moment Calculation

" m "	13.100	in
" n "	13.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	13.100	in

Bearing Stresses

Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.011 ksi
Stress Ratio	**0.975**

Plate Bending Stresses

Mmax = Fu * L^2 / 2	0.901 k-in
fb : Actual	14.415 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.669**

Shear Stress

fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 5-B, 2'-6"x2'-6" plate

Load Comb. : +D+0.750Lr+0.750L+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.975	k	Fp : Allowable	0.011	ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691	ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.635**	
Distance for Moment Calculation			Shear Stress		
" m "	13.100	in	fv : Actual	0.000	ksi
" n "	13.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	13.100	in			

Load Comb. : +D+0.750L+0.750S+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.975	k	Fp : Allowable	0.011	ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691	ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.635**	
Distance for Moment Calculation			Shear Stress		
" m "	13.100	in	fv : Actual	0.000	ksi
" n "	13.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	13.100	in			

Load Comb. : +D+0.750Lr+0.750L+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.975	k	Fp : Allowable	0.011	ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691	ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.635**	
Distance for Moment Calculation			Shear Stress		
" m "	13.100	in	fv : Actual	0.000	ksi
" n "	13.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	13.100	in			

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Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 9:36AM

Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 5-B, 2'-6"x2'-6" plate

Load Comb. : +D+0.750Lr+0.750L-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	8.975	k	Fp : Allowable	0.011 ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010 ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691 ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.635**
Distance for Moment Calculation			Shear Stress	
" m "	13.100	in	fv : Actual	0.000 ksi
" n "	13.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	13.100	in		

Load Comb. : +D+0.750L+0.750S+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	8.975	k	Fp : Allowable	0.011 ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010 ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691 ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.635**
Distance for Moment Calculation			Shear Stress	
" m "	13.100	in	fv : Actual	0.000 ksi
" n "	13.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	13.100	in		

Load Comb. : +D+0.750L+0.750S-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	8.975	k	Fp : Allowable	0.011 ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010 ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691 ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.635**
Distance for Moment Calculation			Shear Stress	
" m "	13.100	in	fv : Actual	0.000 ksi
" n "	13.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	13.100	in		

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Project Desc.:

Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 5-B, 2'-6"x2'-6" plate

Load Comb. : +D+0.750Lr+0.750L+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.975	k	Fp : Allowable	0.011	ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691	ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557	ksi
Distance for Moment Calculation			**Stress Ratio .....**	**0.635**	
" m "	13.100	in	Shear Stress		
" n "	13.100	in	fv : Actual	0.000	ksi
X	0.000	in^2	Fv : Allowable	0.000	ksi
Lambda	0.000		**Stress Ratio .....**	**0.000**	
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	13.100	in			

Load Comb. : +D+0.750Lr+0.750L-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.975	k	Fp : Allowable	0.011	ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691	ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557	ksi
Distance for Moment Calculation			**Stress Ratio .....**	**0.635**	
" m "	13.100	in	Shear Stress		
" n "	13.100	in	fv : Actual	0.000	ksi
X	0.000	in^2	Fv : Allowable	0.000	ksi
Lambda	0.000		**Stress Ratio .....**	**0.000**	
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	13.100	in			

Load Comb. : +D+0.750L+0.750S+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	8.975	k	Fp : Allowable	0.011	ksi
Design Plate Height	30.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	30.000	in	**Stress Ratio .....**	**0.926**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	900.000	in^2	Mmax = Fu * L^2 / 2	0.856	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.691	ksi
sqrt(A2/A1)	1.667		Fb : Allowable	21.557	ksi
Distance for Moment Calculation			**Stress Ratio .....**	**0.635**	
" m "	13.100	in	Shear Stress		
" n "	13.100	in	fv : Actual	0.000	ksi
X	0.000	in^2	Fv : Allowable	0.000	ksi
Lambda	0.000		**Stress Ratio .....**	**0.000**	
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	13.100	in			

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Project Desc.:

Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 5-B, 2'-6"x2'-6" plate

Load Comb. : +D+0.750L+0.750S-0.5250E+H

Axial Load Only, No Moment

Loading

Pa : Axial Load	8.975	k
Design Plate Height	30.000	in
Design Plate Width	30.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	900.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	1.667	

Distance for Moment Calculation

" m "	13.100	in
" n "	13.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	13.100	in

Bearing Stresses

Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.010 ksi
Stress Ratio	**0.926**

Plate Bending Stresses

Mmax = Fu * L^2 / 2	0.856 k-in
fb : Actual	13.691 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.635**

Shear Stress

fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

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Project Desc.:

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : Grid 3-A, 2'-3"x2'-3" plate

Code References

Calculations per AISC 360-05 & Design Guide # 1, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

General Information

Material Properties

AISC Design Method	Allowable Stress Design		ASIF : Allowable Stress Increase Factor	1.0
Steel Plate Fy	=	36.0 ksi	ABIF : Allowable Bearing Increase Factor	1.0
Concrete Support f'c	=	0.0160 ksi	Ω c : ASD Safety Factor.	2.50
Assumed Bearing Area : Full Bearing			Allowable Bearing Fp per J8	0.02519 ksi

Column & Plate

Column Properties

Steel Section : HSS4X4X1/4

Depth	4 in	Area	3.37 in^2
Width	4 in	Ixx	in^4
Flange Thickness	0.233 in	Iyy	in^4
Web Thickness	0 in		

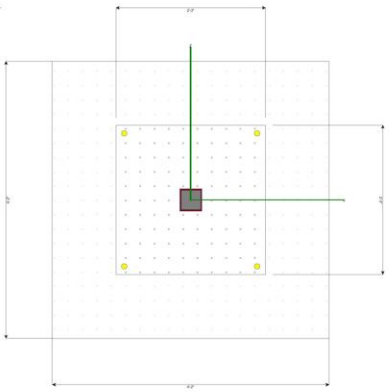
Plate Dimensions

N : Length	27.0 in
B : Width	27.0 in
Thickness	0.3750 in

Column assumed welded to base plate.

Support Dimensions

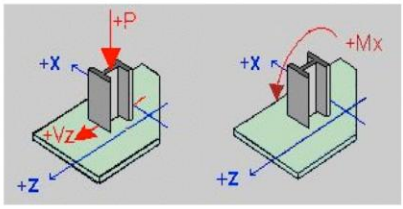
Width along "X"	50.0 in
Length along "Z"	50.0 in



Applied Loads

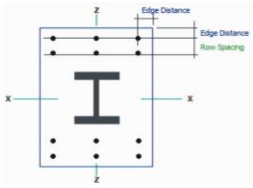
	P-Y	V-Z	M-X
D : Dead Load	5.320 k	0.0 k	0.0 k-ft
L : Live	1.10 k	0.0 k	0.0 k-ft
Lr : Roof Live	0.0 k	0.0 k	0.0 k-ft
S : Snow	0.0 k	0.0 k	0.0 k-ft
W : Wind	0.0 k	0.0 k	0.0 k-ft
E : Earthquake	2.250 k	0.0 k	0.0 k-ft
H : Lateral Earth	0.0 k	0.0 k	0.0 k-ft

" P " = Gravity load, "+" sign is downward.
"+" Moments create higher soil pressure at +Z edge.
"+" Shears push plate towards +Z edge.



Anchor Bolts

Anchor Bolt or Rod Description	1 1/2"	
Max of Tension or Pullout Capacity.....	0.0	k
Shear Capacity.....	0.0	k
Edge distance : bolt to plate.....	1.50	in
Number of Bolts in each Row.....	2.0	
Number of Bolt Rows.....	1.0	



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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Steel Base Plate

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : Grid 3-A, 2'-3"x2'-3" plate

GOVERNING DESIGN LOAD CASE SUMMARY

Plate Design Summary

Design Method	Allowable Stress Design
Governing Load Combination	+D+0.750Lr+0.750L+0.5250E+H
Governing Load Case Type	Axial Load Only
Design Plate Size	**2'-3" x 2'-3" x 0 -3/8"**
Pa : Axial Load	7.326 k
Ma : Moment	0.000 k-ft
fv : Actual	0.000 ksi
Fv : Allowable = 0.60 * Fy / 1.5 (per G2)	0.000 ksi
Shear Stress Ratio	0.000
	Shear Stress OK

Mu : Max. Moment	0.676 k-in
fb : Max. Bending Stress	19.233 ksi
Fb : Allowable :	21.557 ksi
Fy * ASIF / Omega	
Bending Stress Ratio	0.892
	Bending Stress OK
fu : Max. Plate Bearing Stress	0.010 ksi
Fp : Allowable :	0.010 ksi
min(0.85*f'c*sqrt(A2/A1), 1.7* f'c)/Ome	
Bearing Stress Ratio	0.998
	Bearing Stress OK

Load Comb. : +D

Axial Load Only, No Moment

Loading

Pa : Axial Load	5.320	k
Design Plate Height	27.000	in
Design Plate Width	27.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	729.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	1.852	

Distance for Moment Calculation

" m "	11.600	in
" n "	11.600	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	11.600	in

Bearing Stresses

Fp : Allowable	0.010 ksi
fa : Max. Bearing Pressure	0.007 ksi
Stress Ratio	**0.724**

Plate Bending Stresses

Mmax = Fu * L^2 / 2	0.491 k-in
fb : Actual	13.966 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.648**

Shear Stress

fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

Load Comb. : +D+L+H

Axial Load Only, No Moment

Loading

Pa : Axial Load	6.420	k
Design Plate Height	27.000	in
Design Plate Width	27.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	729.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	1.852	

Distance for Moment Calculation

" m "	11.600	in
" n "	11.600	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	11.600	in

Bearing Stresses

Fp : Allowable	0.010 ksi
fa : Max. Bearing Pressure	0.009 ksi
Stress Ratio	**0.874**

Plate Bending Stresses

Mmax = Fu * L^2 / 2	0.593 k-in
fb : Actual	16.854 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.782**

Shear Stress

fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-A, 2'-3"x2'-3" plate

Load Comb. : +D+0.750Lr+0.750L+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.145	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.837**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.567	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.132	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.748**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.750L+0.750S+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.145	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.837**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.567	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.132	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.748**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.895	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.939**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.636	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	18.100	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.840**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-A, 2'-3"x2'-3" plate

Load Comb. : +D-0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.745	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.005	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.510**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.346	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.831	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.456**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.750Lr+0.750L+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.145	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.837**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.567	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.132	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.748**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.750Lr+0.750L-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.145	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.837**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.567	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.132	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.748**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

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Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 9:40AM

Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-A, 2'-3"x2'-3" plate

Load Comb. : +D+0.750L+0.750S+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.145	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.837**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.567	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.132	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.748**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.750L+0.750S-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.145	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.837**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.567	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	16.132	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.748**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.750Lr+0.750L+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	7.326	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.998**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.676	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	19.233	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.892**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

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Engineer:
Project Desc.:

Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-A, 2'-3"x2'-3" plate

Load Comb. : +D+0.750Lr+0.750L-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	4.964	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.676**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.458	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.031	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.604**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.750L+0.750S+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	7.326	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.998**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.676	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	19.233	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.892**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

Load Comb. : +D+0.750L+0.750S-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	4.964	k	Fp : Allowable	0.010	ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.007	ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.676**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.458	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.031	ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.604**	
Distance for Moment Calculation			Shear Stress		
" m "	11.600	in	fv : Actual	0.000	ksi
" n "	11.600	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	11.600	in			

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Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-A, 2'-3"x2'-3" plate

Load Comb. : +0.60D+0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	4.767	k	Fp : Allowable	0.010 ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.007 ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.649**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.440 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	12.514 ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.581**
Distance for Moment Calculation			Shear Stress	
" m "	11.600	in	fv : Actual	0.000 ksi
" n "	11.600	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	11.600	in		

Load Comb. : +0.60D-0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	1.617	k	Fp : Allowable	0.010 ksi
Design Plate Height	27.000	in	fa : Max. Bearing Pressure	0.002 ksi
Design Plate Width	27.000	in	**Stress Ratio .....**	**0.220**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	729.000	in^2	Mmax = Fu * L^2 / 2	0.149 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	4.245 ksi
sqrt(A2/A1)	1.852		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.197**
Distance for Moment Calculation			Shear Stress	
" m "	11.600	in	fv : Actual	0.000 ksi
" n "	11.600	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	11.600	in		

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : Grid 8-C, 2'-0"x2'-0" plate

Code References

Calculations per AISC 360-05 & Design Guide # 1, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

General Information

Material Properties

AISC Design Method	Allowable Stress Design		ASIF : Allowable Stress Increase Factor	1.0
Steel Plate Fy	=	36.0 ksi	ABIF : Allowable Bearing Increase Factor	1.0
Concrete Support f'c	=	0.0160 ksi	Ω c : ASD Safety Factor.	2.50
Assumed Bearing Area : Full Bearing			Allowable Bearing Fp per J8	0.02720 ksi

Column & Plate

Column Properties

Steel Section : HSS4X4X1/4

Depth	4 in	Area	3.37 in^2
Width	4 in	Ixx	in^4
Flange Thickness	0.233 in	Iyy	in^4
Web Thickness	in		

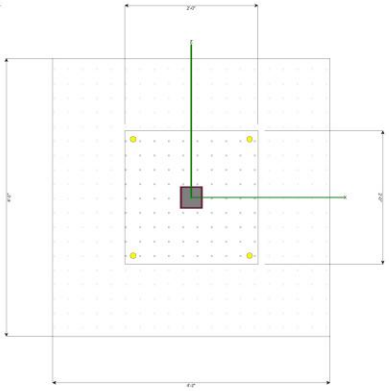
Plate Dimensions

N : Length	24.0 in
B : Width	24.0 in
Thickness	0.3750 in

Column assumed welded to base plate.

Support Dimensions

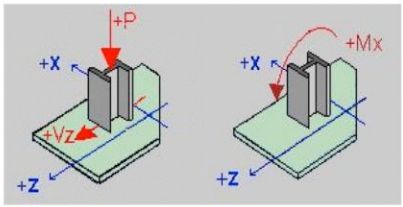
Width along "X"	50.0 in
Length along "Z"	50.0 in



Applied Loads

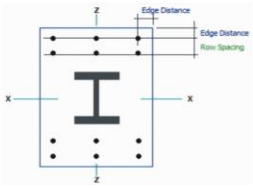
	P-Y	V-Z	M-X
D : Dead Load	3.470 k	k	k-ft
L : Live	1.680 k	k	k-ft
Lr : Roof Live	k	k	k-ft
S : Snow	k	k	k-ft
W : Wind	k	k	k-ft
E : Earthquake	2.90 k	k	k-ft
H : Lateral Earth	k	k	k-ft

" P " = Gravity load, "+" sign is downward.
"+" Moments create higher soil pressure at +Z edge.
"+" Shears push plate towards +Z edge.



Anchor Bolts

Anchor Bolt or Rod Description	1 1/2"	
Max of Tension or Pullout Capacity.....		k
Shear Capacity.....		k
Edge distance : bolt to plate.....	1.50	in
Number of Bolts in each Row.....	2.0	
Number of Bolt Rows.....	1.0	



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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : Grid 8-C, 2'-0"x2'-0" plate

GOVERNING DESIGN LOAD CASE SUMMARY

Plate Design Summary

Design Method	Allowable Stress Design	Mu : Max. Moment	0.554 k-in
Governing Load Combination	+D+0.750Lr+0.750L+0.5250E+H	fb : Max. Bending Stress	15.749 ksi
Governing Load Case Type	Axial Load Only	Fb : Allowable :	21.557 ksi
Design Plate Size	**2'-0" x 2'-0" x 0 -3/8"**	Fy * ASIF / Omega	
Pa : Axial Load	6.253 k	Bending Stress Ratio	0.731
Ma : Moment	0.000 k-ft		**Bending Stress OK**
		fu : Max. Plate Bearing Stress	0.011 ksi
fv : Actual	0.000 ksi	Fp : Allowable :	0.011 ksi
Fv : Allowable = 0.60 * Fy / 1.5 (per G2)	0.000 ksi	min(0.85*f'c*sqrt(A2/A1), 1.7* f'c)/Ome	
Shear Stress Ratio	0.000	Bearing Stress Ratio	0.998
	Shear Stress OK		**Bearing Stress OK**

Load Comb. : +D

Axial Load Only, No Moment

Loading

Pa : Axial Load	3.470	k
Design Plate Height	24.000	in
Design Plate Width	24.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	576.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	2.000	

Distance for Moment Calculation

" m "	10.100	in
" n "	10.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	10.100	in

Bearing Stresses

Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.006 ksi
Stress Ratio	**0.554**

Plate Bending Stresses

Mmax = Fu * L^2 / 2	0.307 k-in
fb : Actual	8.740 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.405**

Shear Stress

fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

Load Comb. : +D+L+H

Axial Load Only, No Moment

Loading

Pa : Axial Load	5.150	k
Design Plate Height	24.000	in
Design Plate Width	24.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	576.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	2.000	

Distance for Moment Calculation

" m "	10.100	in
" n "	10.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	10.100	in

Bearing Stresses

Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.009 ksi
Stress Ratio	**0.822**

Plate Bending Stresses

Mmax = Fu * L^2 / 2	0.456 k-in
fb : Actual	12.972 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.602**

Shear Stress

fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 8-C, 2'-0"x2'-0" plate

Load Comb. : +D+0.750Lr+0.750L+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	4.730	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.755**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.419	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	11.914	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.553**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

Load Comb. : +D+0.750L+0.750S+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	4.730	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.755**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.419	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	11.914	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.553**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

Load Comb. : +D+0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	5.500	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.010	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.878**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.487	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	13.853	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.643**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

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Project Desc.:

Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 8-C, 2'-0"x2'-0" plate

Load Comb. : +D-0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	1.440	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.003	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.230**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.128	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	3.627	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.168**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

Load Comb. : +D+0.750Lr+0.750L+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	4.730	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.755**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.419	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	11.914	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.553**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

Load Comb. : +D+0.750Lr+0.750L-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	4.730	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.008	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.755**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.419	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	11.914	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.553**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

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Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 8-C, 2'-0"x2'-0" plate

Load Comb. : +D+0.750L+0.750S+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	4.730	k	Fp : Allowable	0.011 ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.008 ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.755**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.419 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	11.914 ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.553**
Distance for Moment Calculation			Shear Stress	
" m "	10.100	in	fv : Actual	0.000 ksi
" n "	10.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	10.100	in		

Load Comb. : +D+0.750L+0.750S-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	4.730	k	Fp : Allowable	0.011 ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.008 ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.755**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.419 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	11.914 ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.553**
Distance for Moment Calculation			Shear Stress	
" m "	10.100	in	fv : Actual	0.000 ksi
" n "	10.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	10.100	in		

Load Comb. : +D+0.750Lr+0.750L+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	6.253	k	Fp : Allowable	0.011 ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.011 ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.998**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.554 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.749 ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.731**
Distance for Moment Calculation			Shear Stress	
" m "	10.100	in	fv : Actual	0.000 ksi
" n "	10.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	10.100	in		

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Job # 12130

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Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 8-C, 2'-0"x2'-0" plate

Load Comb. : +D+0.750Lr+0.750L-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.208	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.006	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.512**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.284	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	8.079	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.375**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

Load Comb. : +D+0.750L+0.750S+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	6.253	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.011	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.998**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.554	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	15.749	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.731**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

Load Comb. : +D+0.750L+0.750S-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.208	k	Fp : Allowable	0.011	ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.006	ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.512**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.284	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	8.079	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.375**	
Distance for Moment Calculation			Shear Stress		
" m "	10.100	in	fv : Actual	0.000	ksi
" n "	10.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	10.100	in			

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 8-C, 2'-0"x2'-0" plate

Load Comb. : +0.60D+0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	4.112	k	Fp : Allowable	0.011 ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.007 ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.656**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.364 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	10.357 ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.480**
Distance for Moment Calculation			Shear Stress	
" m "	10.100	in	fv : Actual	0.000 ksi
" n "	10.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	0.000	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	10.100	in		

Load Comb. : +0.60D-0.70E+H

Axial Load Only, No Moment

Loading			Bearing Stresses	
Pa : Axial Load	0.052	k	Fp : Allowable	0.011 ksi
Design Plate Height	24.000	in	fa : Max. Bearing Pressure	0.000 ksi
Design Plate Width	24.000	in	**Stress Ratio .....**	**0.008**
Will be different from entry if partial bearing used.			Plate Bending Stresses	
A1 : Plate Area	576.000	in^2	Mmax = Fu * L^2 / 2	0.005 k-in
A2: Support Area	2,500.000	in^2	fb : Actual	0.131 ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557 ksi
			Stress Ratio	**0.006**
Distance for Moment Calculation			Shear Stress	
" m "	10.100	in	fv : Actual	0.000 ksi
" n "	10.100	in	Fv : Allowable	0.000 ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**
Lambda	0.000			
n'	1.010	in		
n' * Lambda	0.000	in		
L = max(m, n, n")	10.100	in		

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-D, 1'-6"x1'-6" plate

Code References

Calculations per AISC 360-05 & Design Guide # 1, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

General Information

Material Properties

AISC Design Method	Allowable Stress Design		ASIF : Allowable Stress Increase Factor	1.0
Steel Plate Fy	=	36.0 ksi	ABIF : Allowable Bearing Increase Factor	1.0
Concrete Support f'c	=	0.0160 ksi	Ω c : ASD Safety Factor.	2.50
Assumed Bearing Area : Full Bearing			Allowable Bearing Fp per J8	0.02720 ksi

Column & Plate

Column Properties

Steel Section : HSS4X4X1/4

Depth	4 in	Area	3.37 in^2
Width	4 in	Ixx	in^4
Flange Thickness	0.233 in	Iyy	in^4
Web Thickness	0 in		

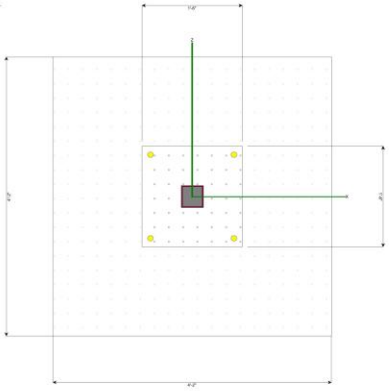
Plate Dimensions

N : Length	18.0 in
B : Width	18.0 in
Thickness	0.3125 in

Column assumed welded to base plate.

Support Dimensions

Width along "X"	50.0 in
Length along "Z"	50.0 in

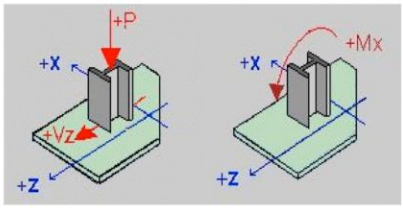


Applied Loads

	P-Y	V-Z	M-X
D : Dead Load	1.70 k	0.0 k	0.0 k-ft
L : Live	1.80 k	0.0 k	0.0 k-ft
Lr : Roof Live	0.0 k	0.0 k	0.0 k-ft
S : Snow	0.0 k	0.0 k	0.0 k-ft
W : Wind	0.0 k	0.0 k	0.0 k-ft
E : Earthquake	0.0 k	0.0 k	0.0 k-ft
H : Lateral Earth	0.0 k	0.0 k	0.0 k-ft

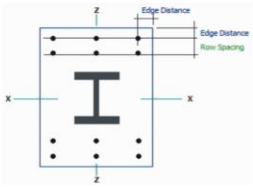
" P " = Gravity load, "+" sign is downward.

"+" Moments create higher soil pressure at +Z edge.
"+" Shears push plate towards +Z edge.



Anchor Bolts

Anchor Bolt or Rod Description	1 1/2"
Max of Tension or Pullout Capacity.....	0.0 k
Shear Capacity.....	0.0 k
Edge distance : bolt to plate.....	1.50 in
Number of Bolts in each Row.....	2.0
Number of Bolt Rows.....	1.0



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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Steel Base Plate

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : Grid 3-D, 1'-6"x1'-6" plate

GOVERNING DESIGN LOAD CASE SUMMARY

Plate Design Summary

Design Method	Allowable Stress Design
Governing Load Combination	+D+L+H
Governing Load Case Type	Axial Load Only
Design Plate Size	**1'-6" x 1'-6" x 0 -5/16"**
Pa : Axial Load	3.500 k
Ma : Moment	0.000 k-ft
fv : Actual	0.000 ksi
Fv : Allowable = 0.60 * Fy / 1.5 (per G2)	0.000 ksi
Shear Stress Ratio	0.000
	Shear Stress OK

Mu : Max. Moment	0.272 k-in
fb : Max. Bending Stress	11.152 ksi
Fb : Allowable :	21.557 ksi
Fy * ASIF / Omega	
Bending Stress Ratio	0.517
	Bending Stress OK
fu : Max. Plate Bearing Stress	0.011 ksi
Fp : Allowable :	0.011 ksi
min(0.85*f'c*sqrt(A2/A1), 1.7* f'c)/Ome	
Bearing Stress Ratio	0.993
	Bearing Stress OK

Load Comb. : +D

Axial Load Only, No Moment

Loading		
Pa : Axial Load	1.700	k
Design Plate Height	18.000	in
Design Plate Width	18.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	324.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	2.000	

Distance for Moment Calculation		
" m "	7.100	in
" n "	7.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	7.100	in

Bearing Stresses	
Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.005 ksi
Stress Ratio	**0.482**
Plate Bending Stresses	
Mmax = Fu * L^2 / 2	0.132 k-in
fb : Actual	5.417 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.251**
Shear Stress	
fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

Load Comb. : +D+L+H

Axial Load Only, No Moment

Loading		
Pa : Axial Load	3.500	k
Design Plate Height	18.000	in
Design Plate Width	18.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	324.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	2.000	

Distance for Moment Calculation		
" m "	7.100	in
" n "	7.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	7.100	in

Bearing Stresses	
Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.011 ksi
Stress Ratio	**0.993**
Plate Bending Stresses	
Mmax = Fu * L^2 / 2	0.272 k-in
fb : Actual	11.152 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.517**
Shear Stress	
fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

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Steel Base Plate

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ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-D, 1'-6"x1'-6" plate

Load Comb. : +D+0.750Lr+0.750L+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

Load Comb. : +D+0.750L+0.750S+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

Load Comb. : +D+0.750Lr+0.750L+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

Title Block Line 1
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Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 9:51AM

Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-D, 1'-6"x1'-6" plate

Load Comb. : +D+0.750Lr+0.750L-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

Load Comb. : +D+0.750L+0.750S+0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

Load Comb. : +D+0.750L+0.750S-0.750W+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

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Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 9:51AM

Steel Base Plate

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Grid 3-D, 1'-6"x1'-6" plate

Load Comb. : +D+0.750Lr+0.750L+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

Load Comb. : +D+0.750Lr+0.750L-0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

Load Comb. : +D+0.750L+0.750S+0.5250E+H

Axial Load Only, No Moment

Loading			Bearing Stresses		
Pa : Axial Load	3.050	k	Fp : Allowable	0.011	ksi
Design Plate Height	18.000	in	fa : Max. Bearing Pressure	0.009	ksi
Design Plate Width	18.000	in	**Stress Ratio .....**	**0.865**	
Will be different from entry if partial bearing used.			Plate Bending Stresses		
A1 : Plate Area	324.000	in^2	Mmax = Fu * L^2 / 2	0.237	k-in
A2: Support Area	2,500.000	in^2	fb : Actual	9.719	ksi
sqrt(A2/A1)	2.000		Fb : Allowable	21.557	ksi
			Stress Ratio	**0.451**	
Distance for Moment Calculation			Shear Stress		
" m "	7.100	in	fv : Actual	0.000	ksi
" n "	7.100	in	Fv : Allowable	0.000	ksi
X	0.000	in^2	**Stress Ratio .....**	**0.000**	
Lambda	0.000				
n'	0.000	in			
n' * Lambda	0.000	in			
L = max(m, n, n")	7.100	in			

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Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:51AM
File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Steel Base Plate

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : Grid 3-D, 1'-6"x1'-6" plate

Load Comb. : +D+0.750L+0.750S-0.5250E+H

Axial Load Only, No Moment

Loading		
Pa : Axial Load	3.050	k
Design Plate Height	18.000	in
Design Plate Width	18.000	in
Will be different from entry if partial bearing used.		
A1 : Plate Area	324.000	in^2
A2: Support Area	2,500.000	in^2
sqrt(A2/A1)	2.000	

Distance for Moment Calculation		
" m "	7.100	in
" n "	7.100	in
X	0.000	in^2
Lambda	0.000	
n'	0.000	in
n' * Lambda	0.000	in
L = max(m, n, n")	7.100	in

Bearing Stresses	
Fp : Allowable	0.011 ksi
fa : Max. Bearing Pressure	0.009 ksi
Stress Ratio	**0.865**

Plate Bending Stresses	
Mmax = Fu * L^2 / 2	0.237 k-in
fb : Actual	9.719 ksi
Fb : Allowable	21.557 ksi
Stress Ratio	**0.451**

Shear Stress	
fv : Actual	0.000 ksi
Fv : Allowable	0.000 ksi
Stress Ratio	**0.000**

Column and Foundation Loads

Column Loads - Gravity Analysis for Irvine, CA

Column	Roof Load (Kips) Area	Dead	Live	Floor Load (Kips) Area	Dead	Live	Added Roof Load	Dead	Live	Wall Load (Kips) Length	Dead	Lateral (kips) Seismic .7E	TotalDL (kips)
1-A	42.00	1.89	0.00	22.00	0.40	1.10	0.00	1.95	0.00	13.50	2.23	0.66	6.47
1-B	0.00	0.00	0.00	60.00	1.08	3.00	0.00	0.00	0.00	15.00	2.48	0.66	3.56
1-H	42.00	1.89	0.00	42.00	0.76	2.10	0.00	1.95	0.00	13.50	2.23	0.86	6.83
2-A	62.00	2.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.79
2-H	62.00	2.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.79
3-A	40.00	1.80	0.00	22.00	0.40	1.10	0.00	0.89	0.00	13.50	2.23	1.80	5.32
3-B	0.00	0.00	0.00	78.00	1.40	3.90	0.00	0.00	0.00	7.00	1.16	1.80	2.56
3-D	11.50	0.52	0.00	11.50	0.21	0.58	0.00	0.00	0.00	6.00	0.99	1.81	1.71
3-H	40.00	1.80	0.00	42.00	0.76	2.10	0.00	0.84	0.00	10.00	1.65	0.85	5.04
3-H.5	11.50	0.52	0.00	11.50	0.21	0.58	0.00	0.00	0.00	5.50	0.91	1.81	1.63
5-B	70.00	3.15	0.00	38.00	0.68	1.90	0.00	2.07	0.00	10.00	1.65	0.00	7.55
5-D	11.50	0.52	0.00	66.00	1.19	3.30	0.00	0.00	0.00	7.50	1.24	1.83	2.94
5-H.5	11.50	0.52	0.00	11.50	0.21	0.58	0.00	0.00	0.00	10.50	1.73	1.83	2.46
5-I	50.00	2.25	0.00	28.00	0.50	1.40	0.00	0.00	0.00	7.50	1.24	2.50	3.99
6-B	73.00	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29
6-D	0.00	0.00	0.00	105.00	1.89	5.25	0.00	0.00	0.00	0.00	0.00	0.00	1.89
6-I	73.00	3.29	0.00	70.00	1.26	3.50	0.00	1.22	0.00	10.00	1.65	2.50	7.41
7-B	73.00	3.29	0.00	30.00	0.54	1.50	0.00	1.22	0.00	9.00	1.49	1.28	6.53
7-C	0.00	0.00	0.00	8.00	0.14	0.40	0.00	0.00	0.00	7.00	1.16	0.00	1.30
7-I	73.00	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29
8-C	52.00	2.34	0.00	8.00	0.14	0.40	0.00	0.00	0.00	6.00	0.99	2.72	3.47
8-D	0.00	0.00	0.00	18.00	0.32	0.90	0.00	0.00	0.00	9.50	1.57	1.36	1.89
8-I	44.00	1.98	0.00	42.00	0.76	2.10	0.00	2.07	0.00	12.00	1.98	1.36	6.79

Load Combinations

D+L	D+S	D+ .75(L+Lr)	D+.7E	D+.75(.7E+L+Lr)	Bearing Area Required (ft^2)	Footing Dimensions	Uplift (at post)	Uplift (foundation)
7.57	0.00	0.00	7.13	7.79	5.19	2.28	2.98	3.22
6.56	0.00	0.00	4.22	6.30	4.37	2.09	0.83	1.47
8.93	0.00	0.00	7.69	9.05	6.03	2.46	2.78	3.24
2.79	0.00	0.00	2.79	2.79	1.86	1.36	1.67	1.67
2.79	0.00	0.00	2.79	2.79	1.86	1.36	1.67	1.67
6.42	0.00	0.00	7.12	7.49	4.99	2.23	1.15	1.39
6.46	0.00	0.00	4.36	6.83	4.56	2.13	-1.11	-0.26
2.29	0.00	0.00	3.52	3.50	2.35	1.53	-0.91	-0.78
7.14	0.00	0.00	5.89	7.26	4.84	2.20	1.72	2.18
2.21	0.00	0.00	3.44	3.42	2.29	1.51	-0.96	-0.83
9.45	0.00	0.00	7.55	8.98	6.30	2.51	4.12	4.53
6.24	0.00	0.00	4.77	6.79	4.53	2.13	-0.78	-0.06
3.03	0.00	0.00	4.29	4.26	2.86	1.69	-0.48	-0.36
5.39	0.00	0.00	6.49	6.92	4.61	2.15	-0.41	-0.11
3.29	0.00	0.00	3.29	3.29	2.19	1.48	1.97	1.97
7.14	0.00	0.00	1.89	5.83	4.76	2.18	0.00	1.13
10.91	0.00	0.00	9.91	11.91	7.94	2.82	1.19	1.95
8.03	0.00	0.00	7.81	8.61	5.74	2.40	2.31	2.64
1.70	0.00	0.00	1.30	1.60	1.13	1.06	0.69	0.78
3.29	0.00	0.00	3.29	3.29	2.19	1.48	1.97	1.97
3.87	0.00	0.00	6.19	5.81	4.13	2.03	-0.72	-0.64
2.79	0.00	0.00	3.25	3.59	2.39	1.55	-0.42	-0.23
8.89	0.00	0.00	8.15	9.38	6.25	2.50	2.26	2.71

Column Loads - Gravity Analysis for Middlebury, VT

Column	Roof Load (Kips) Area	Dead	Snow	Floor Load (Kips) Area	Dead	Live	Added Roof Load	Dead	Snow	Wall Load (Kips) Length	Dead	Lateral (kips) Wind	TotalDL (kips)
1-A	42.00	1.89	1.68	22.00	0.40	0.88	0.00	1.95	1.74	13.50	2.23	0.45	6.47
1-B	0.00	0.00	0.00	60.00	1.08	2.40	0.00	0.00	0.00	15.00	2.48	0.45	3.56
1-H	42.00	1.89	1.68	42.00	0.76	1.68	0.00	1.95	1.74	13.50	2.23	0.75	6.83
2-A	62.00	2.79	2.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.79
2-H	62.00	2.79	2.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.79
3-A	40.00	1.80	1.60	22.00	0.40	0.88	0.00	0.89	0.79	13.50	2.23	1.50	5.32
3-B	0.00	0.00	0.00	78.00	1.40	3.12	0.00	0.00	0.00	7.00	1.16	1.50	2.56
3-D	11.50	0.52	0.46	11.50	0.21	0.46	0.00	0.00	0.00	6.00	0.99	1.50	1.71
3-H	40.00	1.80	1.60	42.00	0.76	1.68	0.00	0.84	0.74	10.00	1.65	0.50	5.04
3-H.5	11.50	0.52	0.46	11.50	0.21	0.46	0.00	0.00	0.00	5.50	0.91	1.50	1.63
5-B	70.00	3.15	2.80	38.00	0.68	1.52	0.00	2.07	1.84	10.00	1.65	0.00	7.55
5-D	11.50	0.52	0.46	66.00	1.19	2.64	0.00	0.00	0.00	7.50	1.24	1.50	2.94
5-H.5	11.50	0.52	0.46	11.50	0.21	0.46	0.00	0.00	0.00	10.50	1.73	1.50	2.46
5-I	50.00	2.25	2.00	28.00	0.50	1.12	0.00	0.00	0.00	7.50	1.24	2.00	3.99
6-B	73.00	3.29	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29
6-D	0.00	0.00	0.00	105.00	1.89	4.20	0.00	0.00	0.00	0.00	0.00	0.00	1.89
6-I	73.00	3.29	2.92	70.00	1.26	2.80	0.00	1.22	1.08	10.00	1.65	2.00	7.41
7-B	73.00	3.29	2.92	30.00	0.54	1.20	0.00	1.22	1.08	9.00	1.49	0.75	6.53
7-C	0.00	0.00	0.00	8.00	0.14	0.32	0.00	0.00	0.00	7.00	1.16	0.00	1.30
7-I	73.00	3.29	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29
8-C	52.00	2.34	2.08	8.00	0.14	0.32	0.00	0.00	0.00	6.00	0.99	2.25	3.47
8-D	0.00	0.00	0.00	18.00	0.32	0.72	0.00	0.00	0.00	9.50	1.57	1.00	1.89
8-I	44.00	1.98	1.76	42.00	0.76	1.68	0.00	2.07	1.84	12.00	1.98	1.00	6.79

Load Combinations

D+L	D+S	D+ .75(L+S)	D+W	D+.75(W+L+S)	Bearing Area Required (ft^2)	Footing Dimensions	Uplift (at post)	Uplift (found)
7.35	9.88	9.69	6.92	10.03	5.01	2.24		
5.96	3.56	5.36	4.01	5.69	2.98	1.73		
8.51	10.24	10.65	7.58	11.21	5.61	2.37		
2.79	5.27	4.65	2.79	4.65	2.64	1.62		
2.79	5.27	4.65	2.79	4.65	2.64	1.62		
6.20	7.71	7.77	6.82	8.90	4.45	2.11	1.45	1.69
5.68	2.56	4.90	4.06	6.02	3.01	1.74	-0.81	0.04
2.17	2.17	2.40	3.21	3.53	1.76	1.33	-0.60	-0.47
6.72	7.39	8.06	5.54	8.44	4.22	2.05		
2.09	2.09	2.32	3.13	3.45	1.72	1.31	-0.65	-0.52
9.07	12.19	12.17	7.55	12.17	6.10	2.47		
5.58	3.40	5.27	4.44	6.39	3.20	1.79		
2.92	2.92	3.15	3.96	4.27	2.14	1.46		
5.11	5.99	6.33	5.99	7.83	3.92	1.98	0.09	0.39
3.29	6.21	5.48	3.29	5.48	3.10	1.76		
6.09	1.89	5.04	1.89	5.04	3.05	1.74		
10.21	11.41	12.51	9.41	14.01	7.01	2.65	1.69	2.45
7.73	10.53	10.43	7.28	10.99	5.49	2.34		
1.62	1.30	1.54	1.30	1.54	0.81	0.90		
3.29	6.21	5.48	3.29	5.48	3.10	1.76		
3.79	5.55	5.27	5.72	6.96	3.48	1.87	-0.25	-0.17
2.61	1.89	2.43	2.89	3.18	1.59	1.26	-0.06	0.13
8.47	10.39	10.75	7.79	11.50	5.75	2.40	2.62	3.07

SLAB D

LEVELER CALCS — VORTEX #4430 — 12-1-12

① – MAX 20 KIPS VERTICAL CAPACITY
WITH F.O.S. = 1.5, ALLOW CAPACITY = 15 KIPS

MAX VERTICAL REACTION AT GRIDS 6-I

$R_{max} = 12.76$ KIPS < 15 KIPS ⇒ OK

② MAX UPLIFT ON LEVELER = 260 lbs.
4 SCREWS from leveling plate to PSL BEAM ACCEPTABLE
(MIN. 2" PENETRATION)

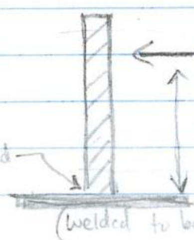
③ WEIGHT OF BASE PLATE + LEVELER ~ 100 lbs.

Check MAX UPLIFT CASE OF: LOCATION 3-B = 260 lbs.

ADD 160 lbs of dead weight to base plate or anchor to asphalt.

④ Check shear/bending for 1" DIA. BOLT ⇒ BASE SHEAR = 13.4 KIPS
(18) BOLT LOCATIONS

(Shear OK BY INSPECTION WITH WELD TO PLATE)



$\frac{13.4k}{18} = 740$ lbs

$Q_E = (.7)(740 \text{ lbs}) = 518$ lbs.

$M_E = 2.08$ k-in

$S = \frac{\pi d^3}{32} = .098$

$S_{reqd} = .063 < .098 = S_{prvd}$ ⇒ OK

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Wood Roof and Floor Framing

Title Block Line 1
You can changes this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 8:43AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : LVL Roof Beam @ Overhang

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASCE 7-05

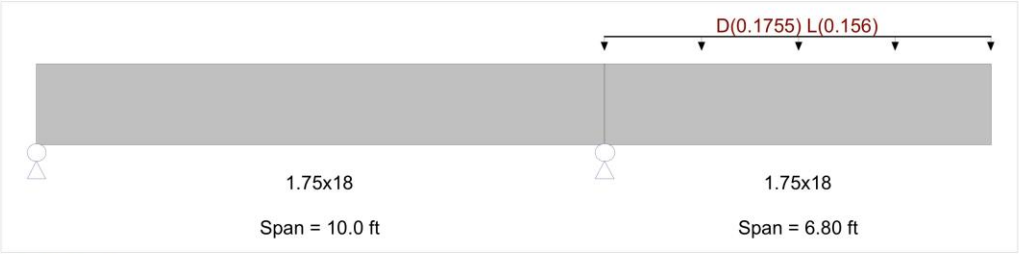
Wood Species : iLevel Truss Joist
Wood Grade : MicroLam LVL 1.9 E

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	2600 psi
Fb - Compr	2600 psi
Fc - Prll	2510 psi
Fc - Perp	750 psi
Fv	285 psi
Ft	1555 psi

E : Modulus of Elasticity

Ebend- xx	1900 ksi
Eminbend - xx	965.71 ksi
Density	32.21 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 2
Uniform Load : D = 0.0450, L = 0.040 ksf, Tributary Width = 3.90 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.382 : 1	Maximum Shear Stress Ratio	=	0.302 : 1
Section used for this span		1.75x18	Section used for this span		1.75x18
fb : Actual	=	993.93 psi	fv : Actual	=	86.01 psi
FB : Allowable	=	2,600.00 psi	Fv : Allowable	=	285.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	10.000 ft	Location of maximum on span	=	10.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.132 in	Ratio =	1238
Max Upward L+Lr+S Deflection	-0.025 in	Ratio =	4802
Max Downward Total Deflection	0.284 in	Ratio =	574
Max Upward Total Deflection	-0.053 in	Ratio =	2252

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios								Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	M	fb	Fb	V	fv	Fv
+D												0.00	0.00	0.00	0.00
Length = 10.0 ft	1	0.206	0.163	1.000	1.000	1.000	1.000	1.000	1.000	4.22	535.93	2600.00	0.97	46.38	285.00
Length = 6.80 ft	2	0.206	0.163	1.000	1.000	1.000	1.000	1.000	1.000	4.22	535.93	2600.00	0.97	46.38	285.00
+D+L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.0 ft	1	0.382	0.302	1.000	1.000	1.000	1.000	1.000	1.000	7.83	993.93	2600.00	1.81	86.01	285.00
Length = 6.80 ft	2	0.382	0.302	1.000	1.000	1.000	1.000	1.000	1.000	7.83	993.93	2600.00	1.81	86.01	285.00
+D+0.750Lr+0.750L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.0 ft	1	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
Length = 6.80 ft	2	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
+D+0.750L+0.750S+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00

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Title Block Line 1
You can changes this area using the "Settings" menu item and then using the "Printing & Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 8:43AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : LVL Roof Beam @ Overhang

Load Combination		Max Stress Ratios								Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	M	fb	Fb	V	fv	Fv
Length = 10.0 ft	1	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
Length = 6.80 ft	2	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
+D+0.750Lr+0.750L+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.0 ft	1	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
Length = 6.80 ft	2	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
+D+0.750L+0.750S+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.0 ft	1	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
Length = 6.80 ft	2	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
+D+0.750Lr+0.750L+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.0 ft	1	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
Length = 6.80 ft	2	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.0 ft	1	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00
Length = 6.80 ft	2	0.338	0.267	1.000	1.000	1.000	1.000	1.000	1.000	6.93	879.43	2600.00	1.60	76.10	285.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
	1	0.0000	0.000	D+L	-0.0533	5.846
D+L	2	0.2838	6.800		0.0000	5.846

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Overall MAXimum	-0.747	3.120	
D Only	-0.387	1.699	
L Only	-0.361	1.421	
D+L	-0.747	3.120	

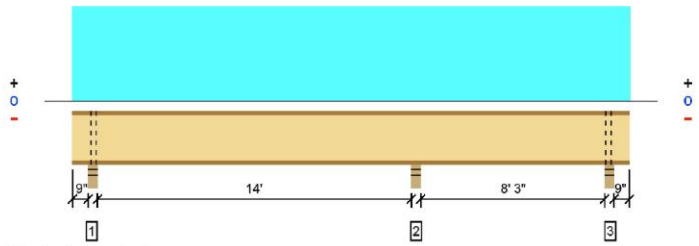
FORTE

SOLUTIONS REPORT *Level, Typ. Floor Joist*

PASSED

Current Solution: : 1 piece(s) 9 1/2" TJI® 210 @ 24" OC

Overall Length: 24' 7 1/2"



All Dimensions Are Horizontal; Drawing is Conceptual

Design Results	Actual @ Location	Allowed	Result	LDF
Member Reaction (lbs)	2042 @ 15' 2 1/4"	2145	Passed (95%)	1.00
Shear (lbs)	1042 @ 15' 1/2"	1463	Passed (71%)	1.00
Moment (Ft-lbs)	-2630 @ 15' 2 1/4"	3000	Passed (88%)	1.00
Live Load Defl. (in)	0.298 @ 7' 6 3/16"	0.357	Passed (L/576)	--
Total Load Defl. (in)	0.393 @ 7' 5 3/4"	0.715	Passed (L/436)	--
TJ-Pro™ Rating	43	40	Passed	--

System : Floor
Member Type : Joist
Building Use : Residential
Building Code : IBC
Design Methodology : ASD

All Product Solutions

Depth	Series	Plies	Spacing	TJ-Pro™ Rating	Wood Volume
9 1/2"	TJI® 210	1	24"	43	0.50

The purpose of this report is for product comparison only. Load and support information necessary for professional design review is not displayed here. Please print an individual Member Report for submittal purposes.

Forte Software Operator	Job Notes
John Sellers Engineering Ventures (802) 863-6225 gregs@engineeringventures.com	

9/27/2012 9:12:17 AM
Forte v3.5, Design Engine: V5.5.3.2
decathlon.4te

Page 1 of 1

Title Block Line 1
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Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:15AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid A

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASCE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASCE 7-05

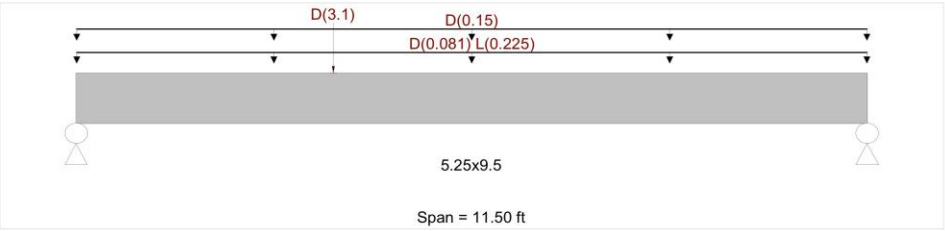
Wood Species : iLevel Truss Joist
Wood Grade : Parallam PSL 2.0E

Fb - Tension	2,900.0 psi
Fb - Compr	2,900.0 psi
Fc - Prll	2,900.0 psi
Fc - Perp	750.0 psi
Fv	290.0 psi
Ft	2,025.0 psi

E : Modulus of Elasticity

Ebend- xx	2,000.0 ksi
Eminbend - xx	1,016.54 ksi
Density	32.210 pcf

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Uniform Load : D = 0.0180, L = 0.050 ksf, Tributary Width = 4.50 ft, (Floor Load)
Uniform Load : D = 0.150 , Tributary Width = 1.0 ft, (Wall Weight)
Point Load : D = 3.10 k @ 3.750 ft, (Roof Point Load)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.766 : 1	Maximum Shear Stress Ratio	=	0.459 : 1
Section used for this span		5.25x9.5	Section used for this span		5.25x9.5
fb : Actual	=	2,221.44 psi	fv : Actual	=	133.12 psi
FB : Allowable	=	2,900.00 psi	Fv : Allowable	=	290.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	3.795 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.119 in	Ratio =	1159
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.439 in	Ratio =	313
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios								Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	M	fb	Fb	V	fv	Fv
+D												0.00	0.00	0.00	0.00
Length = 11.50 ft	1	0.660	0.380	0.900	1.000	1.000	1.000	1.000	1.000	11.33	1,721.56	2610.00	3.30	99.26	261.00
+D+L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 11.50 ft	1	0.766	0.459	1.000	1.000	1.000	1.000	1.000	1.000	14.62	2,221.44	2900.00	4.43	133.12	290.00
+D+0.750Lr+0.750L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 11.50 ft	1	0.578	0.344	1.250	1.000	1.000	1.000	1.000	1.000	13.80	2,096.47	3625.00	4.14	124.65	362.50
+D+0.750L+0.750S+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 11.50 ft	1	0.629	0.374	1.150	1.000	1.000	1.000	1.000	1.000	13.80	2,096.47	3335.00	4.14	124.65	333.50
+D+0.750Lr+0.750L+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00

Title Block Line 1
You can changes this area using the "Settings" menu item and then using the "Printing & Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:15AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid A

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	Moment Values M	fb	Fb	Shear Values V	fv	Fv
Length = 11.50 ft	1	0.452	0.269	1.600	1.000	1.000	1.000	1.000	1.000	13.80	2,096.47	4640.00	4.14	124.65	464.00
+D+0.750L+0.750S+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 11.50 ft	1	0.452	0.269	1.600	1.000	1.000	1.000	1.000	1.000	13.80	2,096.47	4640.00	4.14	124.65	464.00
+D+0.750Lr+0.750L+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 11.50 ft	1	0.452	0.269	1.600	1.000	1.000	1.000	1.000	1.000	13.80	2,096.47	4640.00	4.14	124.65	464.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 11.50 ft	1	0.452	0.269	1.600	1.000	1.000	1.000	1.000	1.000	13.80	2,096.47	4640.00	4.14	124.65	464.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.4395	5.520		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.775	3.697
D Only	3.482	2.403
L Only	1.294	1.294
D+L	4.775	3.697

Title Block Line 1
You can changes this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:16AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid B

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASE 7-05
Load Combination Set : 2006 IBC & ASE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASE 7-05

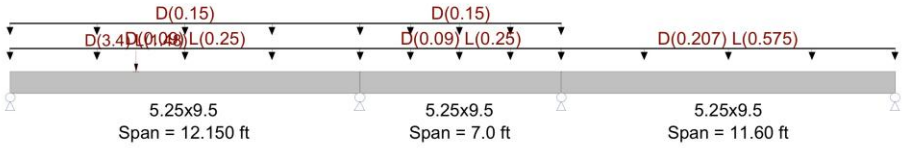
Wood Species : iLevel Truss Joist
Wood Grade : Parallam PSL 2.0E

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	2,900.0 psi
Fb - Compr	2,900.0 psi
Fc - Prll	2,900.0 psi
Fc - Perp	750.0 psi
Fv	290.0 psi
Ft	2,025.0 psi

E : Modulus of Elasticity

Ebend- xx	2,000.0 ksi
Eminbend - xx	1,016.54 ksi
Density	32.210 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 0.0180, L = 0.050 ksf, Tributary Width = 5.0 ft, (Floor Load)
Uniform Load : D = 0.150 , Tributary Width = 1.0 ft, (Wall Weight)
Point Load : D = 3.40, L = 1.480 k @ 4.40 ft, (Roof Point Load)
Load for Span Number 2
Uniform Load : D = 0.0180, L = 0.050 ksf, Tributary Width = 5.0 ft, (Floor Load)
Uniform Load : D = 0.150 , Tributary Width = 1.0 ft, (Wall Weight)
Load for Span Number 3
Uniform Load : D = 0.0180, L = 0.050 ksf, Tributary Width = 11.50 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.940 : 1	Maximum Shear Stress Ratio	=	0.558 : 1
Section used for this span		5.25x9.5	Section used for this span		5.25x9.5
fb : Actual	=	2,725.45 psi	fv : Actual	=	161.77 psi
FB : Allowable	=	2,900.00 psi	Fv : Allowable	=	290.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	4.460 ft	Location of maximum on span	=	11.381 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.204 in	Ratio =	684
Max Upward L+Lr+S Deflection	-0.054 in	Ratio =	1550
Max Downward Total Deflection	0.478 in	Ratio =	304
Max Upward Total Deflection	-0.100 in	Ratio =	838

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios								Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	M	fb	Fb	V	fv	Fv
+D												0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.645	0.365	0.900	1.000	1.000	1.000	1.000	1.000	11.08	1,683.01	2610.00	3.17	95.32	261.00

Title Block Line 1
You can changes this area using the "Settings" menu item and then using the "Printing & Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 9:16AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid B

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	Moment Values M	fb	Fb	Shear Values V	fv	Fv
Length = 7.0 ft	2	0.428	0.365	0.900	1.000	1.000	1.000	1.000	1.000	7.36	1,117.67	2610.00	1.54	95.32	261.00
Length = 11.60 ft	3	0.173	0.365	0.900	1.000	1.000	1.000	1.000	1.000	2.96	450.50	2610.00	1.23	95.32	261.00
+D+L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.940	0.558	1.000	1.000	1.000	1.000	1.000	1.000	17.94	2,725.45	2900.00	5.38	161.77	290.00
Length = 7.0 ft	2	0.606	0.558	1.000	1.000	1.000	1.000	1.000	1.000	11.57	1,758.77	2900.00	4.65	161.77	290.00
Length = 11.60 ft	3	0.521	0.558	1.000	1.000	1.000	1.000	1.000	1.000	9.94	1,510.71	2900.00	4.65	161.77	290.00
+D+0.750Lr+0.750L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.680	0.400	1.250	1.000	1.000	1.000	1.000	1.000	16.22	2,464.84	3625.00	4.83	145.16	362.50
Length = 7.0 ft	2	0.441	0.400	1.250	1.000	1.000	1.000	1.000	1.000	10.52	1,598.49	3625.00	3.79	145.16	362.50
Length = 11.60 ft	3	0.344	0.400	1.250	1.000	1.000	1.000	1.000	1.000	8.20	1,245.47	3625.00	3.79	145.16	362.50
+D+0.750L+0.750S+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.739	0.435	1.150	1.000	1.000	1.000	1.000	1.000	16.22	2,464.84	3335.00	4.83	145.16	333.50
Length = 7.0 ft	2	0.479	0.435	1.150	1.000	1.000	1.000	1.000	1.000	10.52	1,598.49	3335.00	3.79	145.16	333.50
Length = 11.60 ft	3	0.373	0.435	1.150	1.000	1.000	1.000	1.000	1.000	8.20	1,245.47	3335.00	3.79	145.16	333.50
+D+0.750Lr+0.750L+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.531	0.313	1.600	1.000	1.000	1.000	1.000	1.000	16.22	2,464.84	4640.00	4.83	145.16	464.00
Length = 7.0 ft	2	0.345	0.313	1.600	1.000	1.000	1.000	1.000	1.000	10.52	1,598.49	4640.00	3.79	145.16	464.00
Length = 11.60 ft	3	0.268	0.313	1.600	1.000	1.000	1.000	1.000	1.000	8.20	1,245.47	4640.00	3.79	145.16	464.00
+D+0.750L+0.750S+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.531	0.313	1.600	1.000	1.000	1.000	1.000	1.000	16.22	2,464.84	4640.00	4.83	145.16	464.00
Length = 7.0 ft	2	0.345	0.313	1.600	1.000	1.000	1.000	1.000	1.000	10.52	1,598.49	4640.00	3.79	145.16	464.00
Length = 11.60 ft	3	0.268	0.313	1.600	1.000	1.000	1.000	1.000	1.000	8.20	1,245.47	4640.00	3.79	145.16	464.00
+D+0.750Lr+0.750L+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.531	0.313	1.600	1.000	1.000	1.000	1.000	1.000	16.22	2,464.84	4640.00	4.83	145.16	464.00
Length = 7.0 ft	2	0.345	0.313	1.600	1.000	1.000	1.000	1.000	1.000	10.52	1,598.49	4640.00	3.79	145.16	464.00
Length = 11.60 ft	3	0.268	0.313	1.600	1.000	1.000	1.000	1.000	1.000	8.20	1,245.47	4640.00	3.79	145.16	464.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 12.150 ft	1	0.531	0.313	1.600	1.000	1.000	1.000	1.000	1.000	16.22	2,464.84	4640.00	4.83	145.16	464.00
Length = 7.0 ft	2	0.345	0.313	1.600	1.000	1.000	1.000	1.000	1.000	10.52	1,598.49	4640.00	3.79	145.16	464.00
Length = 11.60 ft	3	0.268	0.313	1.600	1.000	1.000	1.000	1.000	1.000	8.20	1,245.47	4640.00	3.79	145.16	464.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.4781	5.383		0.0000	0.000
	2	0.0000	5.383	D+L	-0.1002	3.367
D+L	3	0.2948	6.167		0.0000	3.367

Vertical Reactions - Unfactored

Support notation : Far left is #1 — Values in KIPS

Load Combination	Support 1	Support 2	Support 3	Support 4
Overall MAXimum	5.205	8.129	6.373	3.971
D Only	3.089	5.080	1.433	1.137
L Only	2.116	3.049	4.939	2.834
D+L	5.205	8.129	6.373	3.971

Title Block Line 1
You can changes this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:17AM
File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Wood Beam

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid D

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASE 7-05
Load Combination Set : 2006 IBC & ASE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASE 7-05

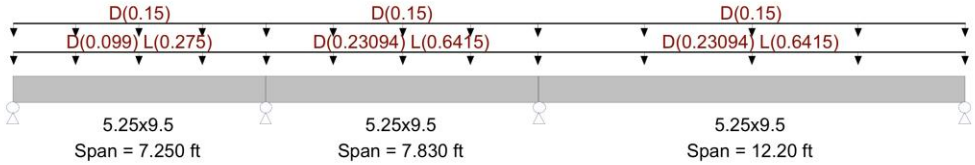
Wood Species : iLevel Truss Joist
Wood Grade : Parallam PSL 2.0E

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	2,900.0 psi
Fb - Compr	2,900.0 psi
Fc - Prll	2,900.0 psi
Fc - Perp	750.0 psi
Fv	290.0 psi
Ft	2,025.0 psi

E : Modulus of Elasticity

Ebend- xx	2,000.0 ksi
Eminbend - xx	1,016.54 ksi
Density	32.210 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 0.0180, L = 0.050 ksf, Tributary Width = 5.50 ft, (Floor Load)
Uniform Load : D = 0.150 , Tributary Width = 1.0 ft, (Wall Weight)
Load for Span Number 2
Uniform Load : D = 0.0180, L = 0.050 ksf, Tributary Width = 12.830 ft, (Floor Load)
Uniform Load : D = 0.150 , Tributary Width = 1.0 ft, (Wall Weight)
Load for Span Number 3
Uniform Load : D = 0.0180, L = 0.050 ksf, Tributary Width = 12.830 ft
Uniform Load : D = 0.150 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.755 : 1	Maximum Shear Stress Ratio	=	0.694 : 1
Section used for this span		5.25x9.5	Section used for this span		5.25x9.5
fb : Actual	=	2,189.11 psi	fv : Actual	=	201.13 psi
FB : Allowable	=	2,900.00 psi	Fv : Allowable	=	290.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	0.000 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 3	Span # where maximum occurs	=	Span # 3

Maximum Deflection

Max Downward L+Lr+S Deflection	0.239 in	Ratio =	612
Max Upward L+Lr+S Deflection	-0.024 in	Ratio =	3906
Max Downward Total Deflection	0.387 in	Ratio =	378
Max Upward Total Deflection	-0.040 in	Ratio =	2338

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios								Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	M	fb	Fb	V	fv	Fv
+D												0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.073	0.102	0.900	1.000	1.000	1.000	1.000	1.000	1.26	191.08	2610.00	0.89	26.65	261.00

Title Block Line 1
You can changes this area using the "Settings" menu item and then using the "Printing & Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 9:17AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid D

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	Moment Values M	fb	Fb	Shear Values V	fv	Fv
Length = 7.823 ft	2	0.304	0.211	0.900	1.000	1.000	1.000	1.000	1.000	5.22	793.40	2610.00	1.83	55.10	261.00
Length = 12.299 ft	3	0.316	0.292	0.900	1.000	1.000	1.000	1.000	1.000	5.43	824.79	2610.00	2.53	76.21	261.00
+D+L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.134	0.190	1.000	1.000	1.000	1.000	1.000	1.000	2.56	389.01	2900.00	1.83	55.09	290.00
Length = 7.823 ft	2	0.726	0.509	1.000	1.000	1.000	1.000	1.000	1.000	13.85	2,105.19	2900.00	4.91	147.54	290.00
Length = 12.299 ft	3	0.755	0.694	1.000	1.000	1.000	1.000	1.000	1.000	14.41	2,189.11	2900.00	6.69	201.13	290.00
+D+0.750Lr+0.750L+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.094	0.132	1.250	1.000	1.000	1.000	1.000	1.000	2.23	339.53	3625.00	1.60	47.98	362.50
Length = 7.823 ft	2	0.490	0.343	1.250	1.000	1.000	1.000	1.000	1.000	11.70	1,777.24	3625.00	4.14	124.43	362.50
Length = 12.299 ft	3	0.510	0.469	1.250	1.000	1.000	1.000	1.000	1.000	12.16	1,848.03	3625.00	5.65	169.90	362.50
+D+0.750L+0.750S+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.102	0.144	1.150	1.000	1.000	1.000	1.000	1.000	2.23	339.53	3335.00	1.60	47.98	333.50
Length = 7.823 ft	2	0.533	0.373	1.150	1.000	1.000	1.000	1.000	1.000	11.70	1,777.24	3335.00	4.14	124.43	333.50
Length = 12.299 ft	3	0.554	0.509	1.150	1.000	1.000	1.000	1.000	1.000	12.16	1,848.03	3335.00	5.65	169.90	333.50
+D+0.750Lr+0.750L+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.073	0.103	1.600	1.000	1.000	1.000	1.000	1.000	2.23	339.53	4640.00	1.60	47.98	464.00
Length = 7.823 ft	2	0.383	0.268	1.600	1.000	1.000	1.000	1.000	1.000	11.70	1,777.24	4640.00	4.14	124.43	464.00
Length = 12.299 ft	3	0.398	0.366	1.600	1.000	1.000	1.000	1.000	1.000	12.16	1,848.03	4640.00	5.65	169.90	464.00
+D+0.750L+0.750S+0.750W+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.073	0.103	1.600	1.000	1.000	1.000	1.000	1.000	2.23	339.53	4640.00	1.60	47.98	464.00
Length = 7.823 ft	2	0.383	0.268	1.600	1.000	1.000	1.000	1.000	1.000	11.70	1,777.24	4640.00	4.14	124.43	464.00
Length = 12.299 ft	3	0.398	0.366	1.600	1.000	1.000	1.000	1.000	1.000	12.16	1,848.03	4640.00	5.65	169.90	464.00
+D+0.750Lr+0.750L+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.073	0.103	1.600	1.000	1.000	1.000	1.000	1.000	2.23	339.53	4640.00	1.60	47.98	464.00
Length = 7.823 ft	2	0.383	0.268	1.600	1.000	1.000	1.000	1.000	1.000	11.70	1,777.24	4640.00	4.14	124.43	464.00
Length = 12.299 ft	3	0.398	0.366	1.600	1.000	1.000	1.000	1.000	1.000	12.16	1,848.03	4640.00	5.65	169.90	464.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.000	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 7.158 ft	1	0.073	0.103	1.600	1.000	1.000	1.000	1.000	1.000	2.23	339.53	4640.00	1.60	47.98	464.00
Length = 7.823 ft	2	0.383	0.268	1.600	1.000	1.000	1.000	1.000	1.000	11.70	1,777.24	4640.00	4.14	124.43	464.00
Length = 12.299 ft	3	0.398	0.366	1.600	1.000	1.000	1.000	1.000	1.000	12.16	1,848.03	4640.00	5.65	169.90	464.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.0295	3.396		0.0000	0.000
	2	0.0000	3.396	D+L	-0.0402	5.749
D+L	3	0.3867	6.795		0.0000	5.749

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2	Support 3	Support 4
Overall MAXimum	1.655	4.695	13.109	5.124
D Only	0.809	2.043	4.941	1.947
L Only	0.846	2.651	8.168	3.177
D+L	1.655	4.695	13.109	5.124

Title Block Line 1
You can changes this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:20AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid 1 (wall support)

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASE 7-05
Load Combination Set : 2006 IBC & ASE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASE 7-05

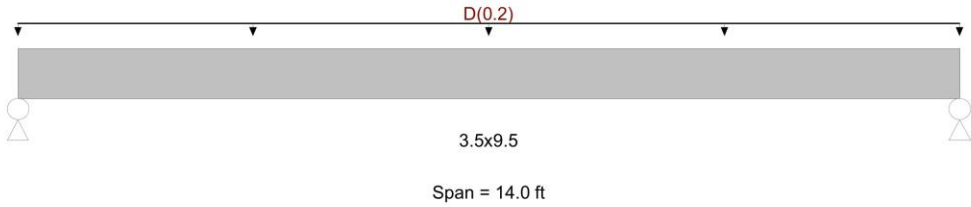
Wood Species : iLevel Truss Joist
Wood Grade : Parallam PSL 2.0E

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	2,900.0 psi
Fb - Compr	2,900.0 psi
Fc - Prll	2,900.0 psi
Fc - Perp	750.0 psi
Fv	290.0 psi
Ft	2,025.0 psi

E : Modulus of Elasticity

Ebend- xx	2,000.0 ksi
Eminbend - xx	1,016.54 ksi
Density	32.210 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Uniform Load : D = 0.20 , Tributary Width = 1.0 ft, (Wall Self Weight)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.444 : 1	Maximum Shear Stress Ratio	=	0.223 : 1
Section used for this span		3.5x9.5	Section used for this span		3.5x9.5
fb : Actual	=	1,158.43 psi	fv : Actual	=	58.30 psi
FB : Allowable	=	2,610.00 psi	Fv : Allowable	=	261.00 psi
Load Combination		+D	Load Combination		+D
Location of maximum on span	=	7.000 ft	Location of maximum on span	=	13.230 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.361 in	Ratio =	464
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination	Max Stress Ratios								Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	M	fb	Fb	V	fv	Fv
+D												0.00	0.00	0.00	0.00
Length = 14.0 ft	1	0.444	0.223	0.900	1.000	1.000	1.000	1.000	1.000	5.08	1,158.43	2610.00	1.29	58.30	261.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D Only	1	0.3614	7.070		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	1.452	1.452
D Only	1.452	1.452

Title Block Line 1
You can changes this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:22AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid 8 (uplift)

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASE 7-05
Load Combination Set : 2006 IBC & ASE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASE 7-05

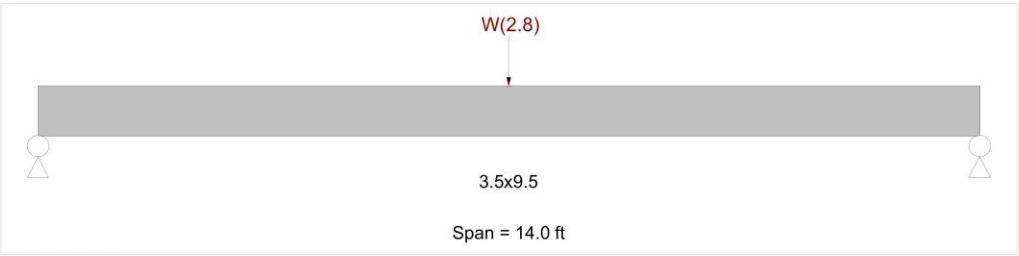
Wood Species : iLevel Truss Joist
Wood Grade : Parallam PSL 2.0E

Beam Bracing : Completely Unbraced

Fb - Tension	2,900.0 psi
Fb - Compr	2,900.0 psi
Fc - Prll	2,900.0 psi
Fc - Perp	750.0 psi
Fv	290.0 psi
Ft	2,025.0 psi

E : Modulus of Elasticity

Ebend- xx	2,000.0 ksi
Eminbend - xx	1,016.54 ksi
Density	32.210 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Point Load : W = 2.80 k @ 7.0 ft, (Uplift Point Load)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.503 : 1	Maximum Shear Stress Ratio	=	0.136 : 1
Section used for this span		3.5x9.5	Section used for this span		3.5x9.5
fb : Actual	=	2,233.80 psi	fv : Actual	=	63.16 psi
FB : Allowable	=	4,439.76 psi	Fv : Allowable	=	464.00 psi
Load Combination		+D+W+H	Load Combination		+D+W+H
Location of maximum on span	=	7.000 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.557 in	Ratio =	301
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	Moment Values M	fb	Fb	Shear Values V	fv	Fv
+D+W+H												0.00	0.00	0.00	0.00
Length = 14.0 ft	1	0.503	0.136	1.600	1.000	1.000	1.000	1.000	0.957	9.80	2,233.80	4439.76	1.40	63.16	464.00
+D+0.750Lr+0.750L+0.750W+H					1.000	1.000	1.000	1.000	0.957			0.00	0.00	0.00	0.00
Length = 14.0 ft	1	0.377	0.102	1.600	1.000	1.000	1.000	1.000	0.957	7.35	1,675.35	4439.76	1.05	47.37	464.00
+D+0.750L+0.750S+0.750W+H					1.000	1.000	1.000	1.000	0.957			0.00	0.00	0.00	0.00
Length = 14.0 ft	1	0.377	0.102	1.600	1.000	1.000	1.000	1.000	0.957	7.35	1,675.35	4439.76	1.05	47.37	464.00
+0.60D+W+H					1.000	1.000	1.000	1.000	0.957			0.00	0.00	0.00	0.00
Length = 14.0 ft	1	0.503	0.136	1.600	1.000	1.000	1.000	1.000	0.957	9.80	2,233.80	4439.76	1.40	63.16	464.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
W Only	1	0.5572	7.000		0.0000	0.000

Page 73 of 103

Title Block Line 1
You can changes this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon Job # 12130
Engineer:
Project Desc.:

Printed: 27 SEP 2012, 9:22AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698 Licensee : ENGINEERING VENTURES

Description : PSL Beam - Grid 8 (uplift)

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	1.400	1.400
W Only	1.400	1.400

Title Block Line 1
You can changes this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 10:37AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Deck 2x10 PT Joist

CODE REFERENCES

Calculations per NDS 2005, IBC 2006, CBC 2007, ASE 7-05
Load Combination Set : 2006 IBC & ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASCE 7-05

Wood Species : Southern Pine
Wood Grade : No.2: 2" - 4" Thick : 10" Wide

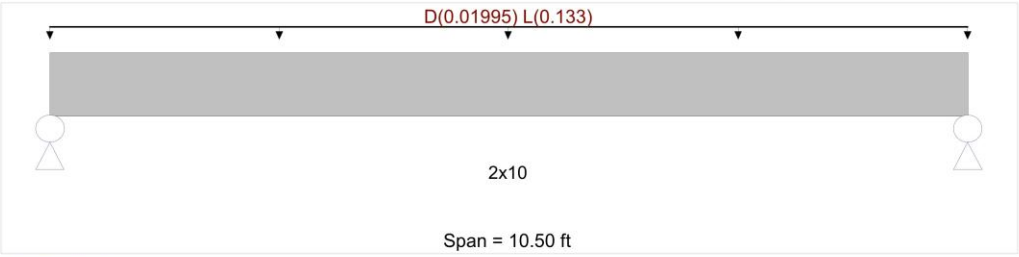
Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	1,050.0 psi
Fb - Compr	1,050.0 psi
Fc - Prll	1,500.0 psi
Fc - Perp	565.0 psi
Fv	175.0 psi
Ft	575.0 psi

E : Modulus of Elasticity

Ebend- xx	1,600.0 ksi
Eminbend - xx	580.0 ksi
Density	35.440 pcf

Repetitive Member Stress Increase



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : D = 0.0150, L = 0.10 ksf, Tributary Width = 1.330 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.979 : 1	Maximum Shear Stress Ratio	=	0.427 : 1
Section used for this span		2x10	Section used for this span		2x10
fb : Actual	=	1,182.49 psi	fv : Actual	=	74.66 psi
FB : Allowable	=	1,207.50 psi	Fv : Allowable	=	175.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	5.250 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.232 in	Ratio =	543
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.266 in	Ratio =	473
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	Moment Values M	fb	Fb	Shear Values V	fv	Fv
+D												0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.142	0.062	0.900	1.000	1.150	1.000	1.000	1.000	0.27	154.24	1086.75	0.09	9.74	157.50
+D+L+H					1.000	1.150	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.979	0.427	1.000	1.000	1.150	1.000	1.000	1.000	2.11	1,182.49	1207.50	0.69	74.66	175.00
+D+0.750Lr+0.750L+H					1.000	1.150	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.613	0.267	1.250	1.000	1.150	1.000	1.000	1.000	1.65	925.42	1509.38	0.54	58.43	218.75
+D+0.750L+0.750S+H					1.000	1.150	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.666	0.290	1.150	1.000	1.150	1.000	1.000	1.000	1.65	925.42	1388.63	0.54	58.43	201.25
+D+0.750Lr+0.750L+0.750W+H					1.000	1.150	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.209	1.600	1.000	1.150	1.000	1.000	1.000	1.65	925.42	1932.00	0.54	58.43	280.00
+D+0.750L+0.750S+0.750W+H					1.000	1.150	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.209	1.600	1.000	1.150	1.000	1.000	1.000	1.65	925.42	1932.00	0.54	58.43	280.00

Title Block Line 1
You can changes this area using the "Settings" menu item and then using the "Printing & Title Block" selection.
Title Block Line 6

Title : Middlebury Solar Decathalon
Engineer:
Project Desc.:

Job # 12130

Printed: 27 SEP 2012, 10:37AM

Wood Beam

File: S:\PROJECTS\0-2012\12130 Middlebury Solar Decathlon\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.7.24, Ver:6.12.7.24

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Deck 2x10 PT Joist

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_r	C_m	C_t	C_L	Moment Values M	fb	Fb	Shear Values V	fv	Fv
+D+0.750Lr+0.750L+0.5250E+H					1.000	1.150	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.209	1.600	1.000	1.150	1.000	1.000	1.000	1.65	925.42	1932.00	0.54	58.43	280.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.150	1.000	1.000	1.000			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.209	1.600	1.000	1.150	1.000	1.000	1.000	1.65	925.42	1932.00	0.54	58.43	280.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.2664	5.303		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.803	0.803
D Only	0.105	0.105
L Only	0.698	0.698
D+L	0.803	0.803

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : Deck 2x10 PT Joist

CODE REFERENCES

Calculations per NDS 2005
Load Combination Set : 2006 IBC & ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASCE 7-05

Wood Species : Southern Pine
Wood Grade : No.2: 2" - 4" Thick : 10" Wide

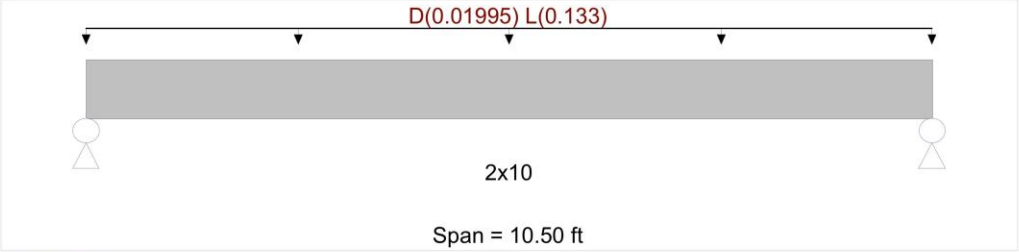
Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	1,050.0 psi
Fb - Compr	1,050.0 psi
Fc - Prll	1,500.0 psi
Fc - Perp	565.0 psi
Fv	175.0 psi
Ft	575.0 psi

E : Modulus of Elasticity

Ebend- xx	1,600.0 ksi
Eminbend - xx	580.0 ksi
Density	35.440 pcf

Repetitive Member Stress Increase



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : D = 0.0150, L = 0.10 ksf, Tributary Width = 1.330 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.979 : 1	Maximum Shear Stress Ratio	=	0.424 : 1
Section used for this span		2x10	Section used for this span		2x10
fb : Actual	=	1,182.49 psi	fv : Actual	=	74.14 psi
FB : Allowable	=	1,207.50 psi	Fv : Allowable	=	175.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	5.250 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.231 in	Ratio =	545
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.266 in	Ratio =	474
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.142	0.061	0.90	1.00	1.00	1.15	1.00	1.00	1.00	0.27	154.24	1086.75	0.09	9.67	157.50
+D+L+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.979	0.424	1.00	1.00	1.00	1.15	1.00	1.00	1.00	2.11	1,182.49	1207.50	0.69	74.14	175.00
+D+Lr+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.102	0.044	1.25	1.00	1.00	1.15	1.00	1.00	1.00	0.27	154.24	1509.38	0.09	9.67	218.75
+D+S+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.111	0.048	1.15	1.00	1.00	1.15	1.00	1.00	1.00	0.27	154.24	1388.63	0.09	9.67	201.25
+D+0.750Lr+0.750L+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.613	0.265	1.25	1.00	1.00	1.15	1.00	1.00	1.00	1.65	925.42	1509.38	0.54	58.02	218.75
+D+0.750L+0.750S+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.666	0.288	1.15	1.00	1.00	1.15	1.00	1.00	1.00	1.65	925.42	1388.63	0.54	58.02	201.25

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

.
Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698
Licensee : ENGINEERING VENTURES

Description : Deck 2x10 PT Joist

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
+D+W+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.080	0.035	1.60	1.00	1.00	1.15	1.00	1.00	1.00	0.27	154.24	1932.00	0.09	9.67	280.00
+D+0.70E+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.080	0.035	1.60	1.00	1.00	1.15	1.00	1.00	1.00	0.27	154.24	1932.00	0.09	9.67	280.00
+D+0.750Lr+0.750L+0.750W+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.207	1.60	1.00	1.00	1.15	1.00	1.00	1.00	1.65	925.42	1932.00	0.54	58.02	280.00
+D+0.750L+0.750S+0.750W+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.207	1.60	1.00	1.00	1.15	1.00	1.00	1.00	1.65	925.42	1932.00	0.54	58.02	280.00
+D+0.750Lr+0.750L+0.5250E+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.207	1.60	1.00	1.00	1.15	1.00	1.00	1.00	1.65	925.42	1932.00	0.54	58.02	280.00
+D+0.750L+0.750S+0.5250E+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.479	0.207	1.60	1.00	1.00	1.15	1.00	1.00	1.00	1.65	925.42	1932.00	0.54	58.02	280.00
+0.60D+W+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.048	0.021	1.60	1.00	1.00	1.15	1.00	1.00	1.00	0.16	92.54	1932.00	0.05	5.80	280.00
+0.60D+0.70E+H					1.00	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 10.50 ft	1	0.048	0.021	1.60	1.00	1.00	1.15	1.00	1.00	1.00	0.16	92.54	1932.00	0.05	5.80	280.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.2658	5.288		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.803	0.803
D Only	0.105	0.105
L Only	0.698	0.698
D+L	0.803	0.803

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : PSL Beam - Dropped Beam supporting deck

CODE REFERENCES

Calculations per NDS 2005
Load Combination Set : 2006 IBC & ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASCE 7-05

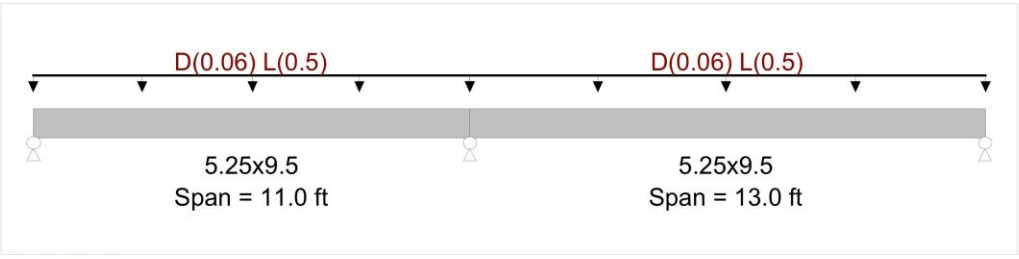
Wood Species : iLevel Truss Joist
Wood Grade : Parallam PSL 2.0E

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	2,900.0 psi
Fb - Compr	2,900.0 psi
Fc - Prll	2,900.0 psi
Fc - Perp	750.0 psi
Fv	290.0 psi
Ft	2,025.0 psi

E : Modulus of Elasticity

Ebend- xx	2,000.0 ksi
Eminbend - xx	1,016.54 ksi
Density	32.210 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 0.0120, L = 0.10 ksf, Tributary Width = 5.0 ft, (Floor Load)
Load for Span Number 2
Uniform Load : D = 0.0120, L = 0.10 ksf, Tributary Width = 5.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.550 : 1	Maximum Shear Stress Ratio	=	0.426 : 1
Section used for this span		5.25x9.5	Section used for this span		5.25x9.5
fb : Actual	=	1,594.81 psi	fv : Actual	=	123.46 psi
FB : Allowable	=	2,900.00 psi	Fv : Allowable	=	290.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	11.000 ft	Location of maximum on span	=	11.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.210 in	Ratio =	743
Max Upward L+Lr+S Deflection	-0.004 in	Ratio =	32046
Max Downward Total Deflection	0.240 in	Ratio =	650
Max Upward Total Deflection	-0.005 in	Ratio =	28054

Maximum Forces & Stresses for Load Combinations

Load Combination	Max Stress Ratios										Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.076	0.059	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	2610.00	0.51	15.38	261.00
Length = 13.0 ft	2	0.076	0.059	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	2610.00	0.51	15.38	261.00
+D+L+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.550	0.426	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.49	1,594.81	2900.00	4.11	123.46	290.00
Length = 13.0 ft	2	0.550	0.426	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.49	1,594.81	2900.00	4.11	123.46	290.00
+D+Lr+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

.
Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : PSL Beam - Dropped Beam supporting deck

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 11.0 ft	1	0.055	0.042	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	3625.00	0.51	15.38	362.50
Length = 13.0 ft	2	0.055	0.042	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	3625.00	0.51	15.38	362.50
+D+S+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.060	0.046	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	3335.00	0.51	15.38	333.50
Length = 13.0 ft	2	0.060	0.046	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	3335.00	0.51	15.38	333.50
+D+0.750Lr+0.750L+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.344	0.266	1.25	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	3625.00	3.21	96.44	362.50
Length = 13.0 ft	2	0.344	0.266	1.25	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	3625.00	3.21	96.44	362.50
+D+0.750L+0.750S+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.374	0.289	1.15	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	3335.00	3.21	96.44	333.50
Length = 13.0 ft	2	0.374	0.289	1.15	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	3335.00	3.21	96.44	333.50
+D+W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.043	0.033	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	4640.00	0.51	15.38	464.00
Length = 13.0 ft	2	0.043	0.033	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	4640.00	0.51	15.38	464.00
+D+0.70E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.043	0.033	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	4640.00	0.51	15.38	464.00
Length = 13.0 ft	2	0.043	0.033	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.31	198.69	4640.00	0.51	15.38	464.00
+D+0.750Lr+0.750L+0.750W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
Length = 13.0 ft	2	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
+D+0.750L+0.750S+0.750W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
Length = 13.0 ft	2	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
+D+0.750Lr+0.750L+0.5250E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
Length = 13.0 ft	2	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
+D+0.750L+0.750S+0.5250E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
Length = 13.0 ft	2	0.268	0.208	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.20	1,245.78	4640.00	3.21	96.44	464.00
+0.60D+W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.026	0.020	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.78	119.21	4640.00	0.31	9.23	464.00
Length = 13.0 ft	2	0.026	0.020	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.78	119.21	4640.00	0.31	9.23	464.00
+0.60D+0.70E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.0 ft	1	0.026	0.020	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.78	119.21	4640.00	0.31	9.23	464.00
Length = 13.0 ft	2	0.026	0.020	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.78	119.21	4640.00	0.31	9.23	464.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.0760	4.302	D+L	-0.0047	10.263
D+L	2	0.2398	7.335		0.0000	10.263

Vertical Reactions - Unfactored

Support notation : Far left is #1 — Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Overall MAXimum	2.187	8.615	2.905
D Only	0.272	1.073	0.362
L Only	1.915	7.542	2.543
D+L	2.187	8.615	2.905

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : PSL Beam - Dropped beam supporting decks

CODE REFERENCES

Calculations per NDS 2005
Load Combination Set : 2006 IBC & ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination 2006 IBC & ASCE 7-05

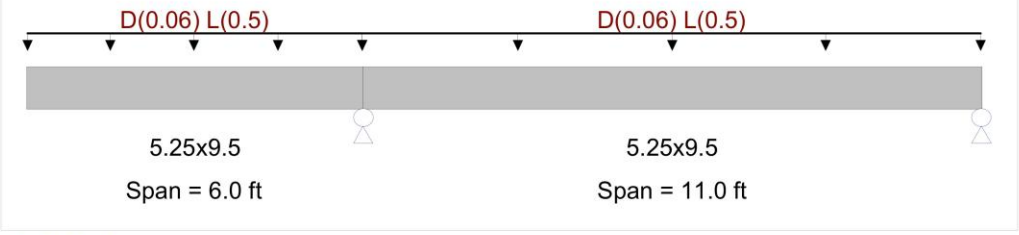
Wood Species : iLevel Truss Joist
Wood Grade : Parallam PSL 2.0E

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	2,900.0 psi
Fb - Compr	2,900.0 psi
Fc - Prll	2,900.0 psi
Fc - Perp	750.0 psi
Fv	290.0 psi
Ft	2,025.0 psi

E : Modulus of Elasticity

Ebend- xx	2,000.0 ksi
Eminbend - xx	1,016.54 ksi
Density	32.210 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 0.0120, L = 0.10 ksf, Tributary Width = 5.0 ft, (Floor Load)
Load for Span Number 2
Uniform Load : D = 0.0120, L = 0.10 ksf, Tributary Width = 5.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.539 : 1	Maximum Shear Stress Ratio	=	0.379 : 1
Section used for this span		5.25x9.5	Section used for this span		5.25x9.5
fb : Actual	=	1,562.26 psi	fv : Actual	=	109.92 psi
FB : Allowable	=	2,900.00 psi	Fv : Allowable	=	290.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	6.000 ft	Location of maximum on span	=	6.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.260 in	Ratio =	552
Max Upward L+Lr+S Deflection	-0.004 in	Ratio =	30986
Max Downward Total Deflection	0.297 in	Ratio =	484
Max Upward Total Deflection	-0.005 in	Ratio =	27126

Maximum Forces & Stresses for Load Combinations

Load Combination	Max Stress Ratios										Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.075	0.052	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	2610.00	0.46	13.69	261.00
Length = 11.0 ft	2	0.075	0.052	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	2610.00	0.46	13.69	261.00
+D+L+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.539	0.379	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.28	1,562.26	2900.00	3.65	109.92	290.00
Length = 11.0 ft	2	0.539	0.379	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.28	1,562.26	2900.00	3.65	109.92	290.00
+D+Lr+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

.
Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : PSL Beam - Dropped beam supporting decks

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 6.0 ft	1	0.054	0.038	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	3625.00	0.46	13.69	362.50
Length = 11.0 ft	2	0.054	0.038	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	3625.00	0.46	13.69	362.50
+D+S+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.058	0.041	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	3335.00	0.46	13.69	333.50
Length = 11.0 ft	2	0.058	0.041	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	3335.00	0.46	13.69	333.50
+D+0.750Lr+0.750L+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.337	0.237	1.25	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	3625.00	2.85	85.86	362.50
Length = 11.0 ft	2	0.337	0.237	1.25	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	3625.00	2.85	85.86	362.50
+D+0.750L+0.750S+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.366	0.257	1.15	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	3335.00	2.85	85.86	333.50
Length = 11.0 ft	2	0.366	0.257	1.15	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	3335.00	2.85	85.86	333.50
+D+W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.042	0.030	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	4640.00	0.46	13.69	464.00
Length = 11.0 ft	2	0.042	0.030	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	4640.00	0.46	13.69	464.00
+D+0.70E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.042	0.030	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	4640.00	0.46	13.69	464.00
Length = 11.0 ft	2	0.042	0.030	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.28	194.63	4640.00	0.46	13.69	464.00
+D+0.750Lr+0.750L+0.750W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
Length = 11.0 ft	2	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
+D+0.750L+0.750S+0.750W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
Length = 11.0 ft	2	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
+D+0.750Lr+0.750L+0.5250E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
Length = 11.0 ft	2	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
+D+0.750L+0.750S+0.5250E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
Length = 11.0 ft	2	0.263	0.185	1.60	1.00	1.00	1.00	1.00	1.00	1.00	8.03	1,220.35	4640.00	2.85	85.86	464.00
+0.60D+W+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.025	0.018	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.77	116.78	4640.00	0.27	8.22	464.00
Length = 11.0 ft	2	0.025	0.018	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.77	116.78	4640.00	0.27	8.22	464.00
+0.60D+0.70E+H					1.00	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.0 ft	1	0.025	0.018	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.77	116.78	4640.00	0.27	8.22	464.00
Length = 11.0 ft	2	0.025	0.018	1.60	1.00	1.00	1.00	1.00	1.00	1.00	0.77	116.78	4640.00	0.27	8.22	464.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.2971	0.000		0.0000	0.000
D+L	2	0.0780	6.760	D+L	-0.0049	0.676

Vertical Reactions - Unfactored

Support notation : Far left is #1 — Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Overall MAXimum		7.503	2.207
D Only		0.935	0.275
L Only		6.568	1.932
D+L		7.503	2.207

Solar Array Structures

ENGINEERING VENTURES PC
208 Flynn Avenue, Suite 2A
Burlington, VT 05401
T: 802-863-6225
F: 802-863-6306

85 Mechanic Street, Suite 350A
Lebanon, NH 03766
T: 603-442-9333
F: 603-442-9331

JOB SOLAR D - SOLAR ARRAY
SHEET NO. ____ OF ____
CALCULATED BY GS DATE ____
CHECKED BY ____ DATE ____
SCALE ____

ARRAY LOADS

ASSUME (4) BENTS AT STRUCTURE #2

AVG. ~~5'~~ SPACING 6'-3" MAX TRIB WIDTH

DEAD LOAD

$W_{DL} = (5')(3.5\ psf) = 17.5\ plf$ $P = 3.5\ PSF$

SAY 5 PSF WITH PURLINS: $(6.25 \times 5) = 31.3\ plf$

SNOW LOAD (VERMONT, 2005 ASCE)

$C_t = 1.2$
$I = 0.8$ → Structure nt essential / normal occupancy
$P_g = 50\ psf$
$C_e = 1.0$

$C_s = 0.7$

$P_r = (.7)(50)(.8) = 28\ psf$

$P_s = (28\ psf)(.7) = 19.6\ psf$ ⇒ USE 20 psf MIN.

$W_{SL} = (6.25)(20\ psf) = 125\ plf$

WIND LOAD (IRVINE, 2012 IBC, EXP C)

DOWN = $(34.6\ psf)(5') = 173\ plf$ (NORMAL TO ROOF) 216.3 plf

UP = $(29.2\ psf)(5') = 141\ plf$ (NORMAL TO ROOF) 176.25 plf

Page 83 of 103

ENGINEERING VENTURES PC

208 Flynn Avenue, Suite 2A
Burlington, VT 05401
tel. 802.863.6225
fax 802.863.6306

18 Division St
Saratoga Springs, NY 12866
tel. 518.224.0004

85 Mechanic Street, Suite B2-2
Lebanon, NH 03766
tel. 603.442.9333
fax 603.442.9331

JOB M100 SOLAR ARRAY
SHEET NO. ____ OF ____
CALCULATED BY GS DATE 2-11-13
CHECKED BY ____ DATE ____
SCALE ____

BASE PLATE : $M_{max} = 8.25$ k-in

$S_{reqd} = \frac{8.25 \text{ k-in}}{(.66)(36)(1.3)} = .27 \text{ in}^3$

(1.3 ↑ WIND INCREASE)

5/16 x 1'-6" x 1'-6" ⇒ $S_{prvd} = \frac{(5/16)^2 (18)}{6} = .29 \text{ in}^3$

$S_{prvd} > S_{reqd} \Rightarrow$ OK

5/16" x 1'-6" x 1'-6" (BP1)
WITH (2) 1" DIA ANCHOR RODS

ENGINEERING VENTURES PC

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85 Mechanic Street, Suite B2-2
Lebanon, NH 03766
tel. 603.442.9333
fax 603.442.9331

JOB MIDD SOLAR ARRAY
SHEET NO. _____ OF _____
CALCULATED BY GS DATE 2-11-13
CHECKED BY _____ DATE _____
SCALE _____

BASE PLATE + ANCHR CALCS

MAX UPLIFT:

T_{ap} = -2.2 KIPS (LOAD COMBO #3) , SHEAR = 292 lbs

Load combination - Base Plate:
900 lbs. shear, 1045 lbs.uplift
282 lbs. shear, 2145 lbs. uplift (governs)

ANCHRS

MAX PULLOUT CAP = 1,250 lbs.
SHEAR CAP = 1,500 lbs.

(2) ANCHRS: T_a = 1250 lbs x 2 = 2,500 lbs. > $\frac{2,200}{2500} + \frac{292}{3,000} = .97 < 1.0$

V_a = 1500 lbs x 2 = 3,000 lbs

(2) 1" DIA. THREADED ANCHRS / PLATE OK

BEARING: ALLOW ON ASPHALT = 1500 psf

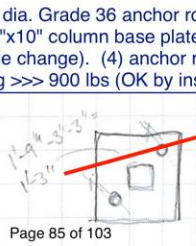
MAX DOWNWARD = 3,843 lbs (LC. 2 DL+WL)

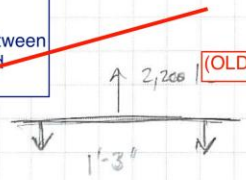
BASE PLATE REQ'D = $\frac{3843}{1500}$ = 2.56 ft² ~ BP1 (1'-6" SQUARE)

(DUE TO 3-SEC GUST IN CALIFORNIA... ASSUME BP1 OK FOR 3 SEC GUST, MONTH INTERVAL,

Base plate on asphalt: 1/2"x1'-10"x1'-10" with (2) 1" dia. Grade 36 threaded anchor rods.
Bearing = 1150 psf < 1500 psf - OK
(2) anchors OK per above
Plate for uplift: Sprovd = .417 in^3 > Sreqd = .406 in^3 for 1/2" thick plate

(4) 3/4" dia. Grade 36 anchor rods welded to plate, fastened to 3/4"x10"x10" column base plate (with Pressure treated block between for grade change). (4) anchor rods shear capacity through wood blocking >>> 900 lbs (OK by inspection)





(OLD)

$M_{MAX} = \frac{PL}{4} = \frac{(2.2^k)(1.25')}{4} = 8.25$ k-in

PRODUCT 204-1 (Single Sheets) 205-1 (Paddes)

Greg Sellers

From: Ariel Lattanzi <amlattanzi@me.com>
Sent: Saturday, January 12, 2013 3:25 PM
To: Greg Sellers
Subject: Fwd: [SD2013] Solar Decathlon Anchoring Information

I wasn't sure if you'd received this information, which might affect your calculations for the Solar Path (and the InSite anchors too).
Thanks,
Ari

Begin forwarded message:

Resent-From: alattanzi@middlebury.edu
From: Patrick Li <patrick.ligc@gmail.com>
Subject: Fwd: [SD2013] Solar Decathlon Anchoring Information
Date: January 12, 2013 2:24:28 PM EST
To: "alattanzi@middlebury.edu" <alattanzi@middlebury.edu>

---------- Forwarded message ----------
From: **Joe Simon** <joseph.simon@nrel.gov>
Date: Sat, Jan 12, 2013 at 12:29 AM
Subject: [SD2013] Solar Decathlon Anchoring Information
To: SD2013@yahoogroups.com

Teams,

In collaboration with Orange County Great Park and the City of Irvine, the Solar Decathlon organizers have determined the design parameters for anchoring of team houses on the competition site. All teams will be required to use the following parameters in their structural calculations to meet the requirements of the Solar Decathlon building code.

Upon arrival on the competition site, the teams will be required to survey their team lot and identify the locations that their anchors will need to be placed. The Solar Decathlon organizers will then have the holes drilled in the asphalt in the appropriate locations.

Solar Decathlon 2013 Anchoring System Design Parameters

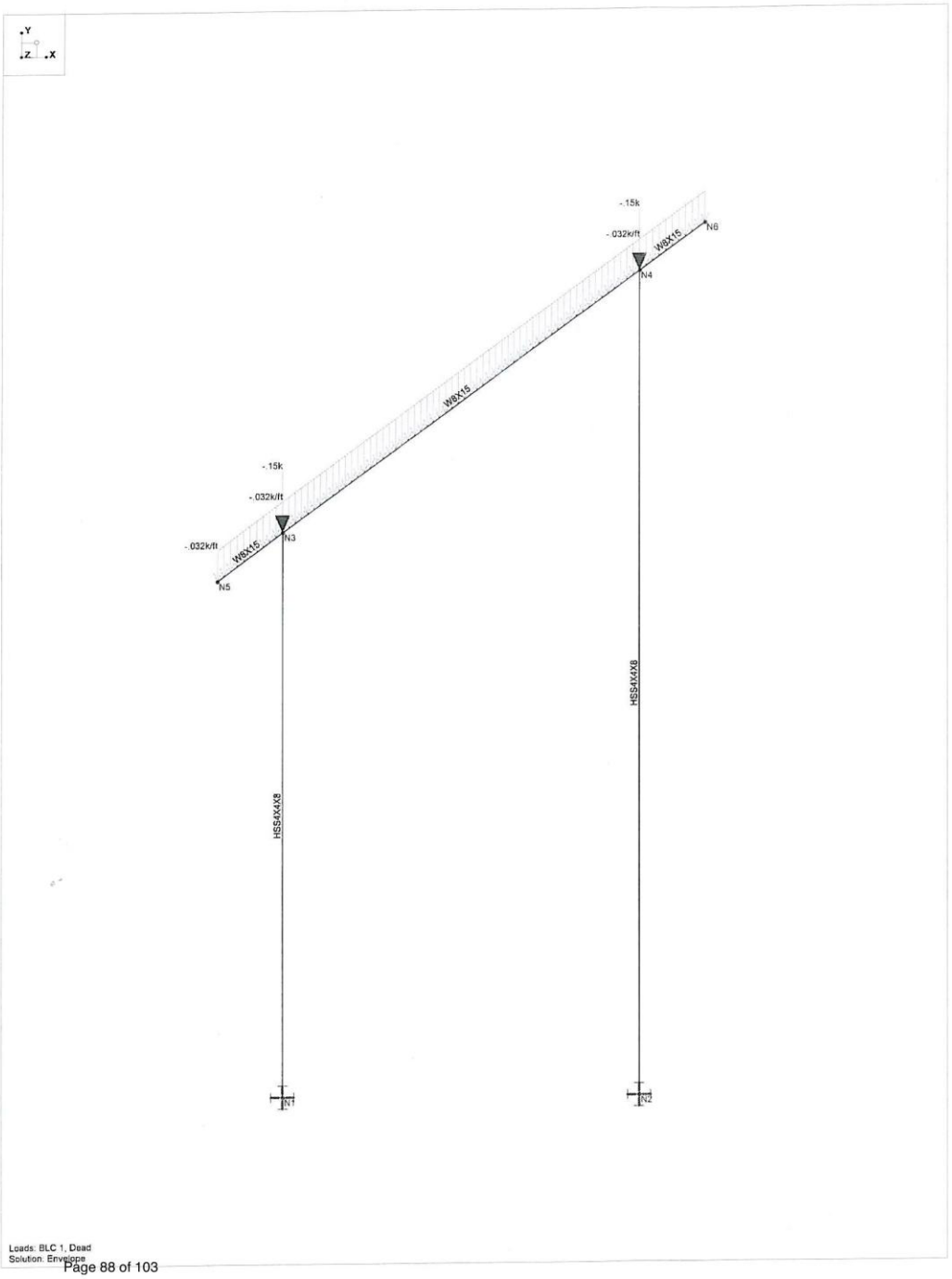
- Ground anchorage shall be 1" diameter steel stakes driven a minimum of 36" into the existing pavement section consisting of asphalt, macadam and underlying soil.
- Assumed pullout design capacity will be 1,250 pounds
- Assumed shear design capacity will be 1,500 pounds
- The quantity and placement of anchors shall be such that the combination of Actual Pullout Load/1,250 + Actual Shear Load/1,500 shall be less than or equal to 1

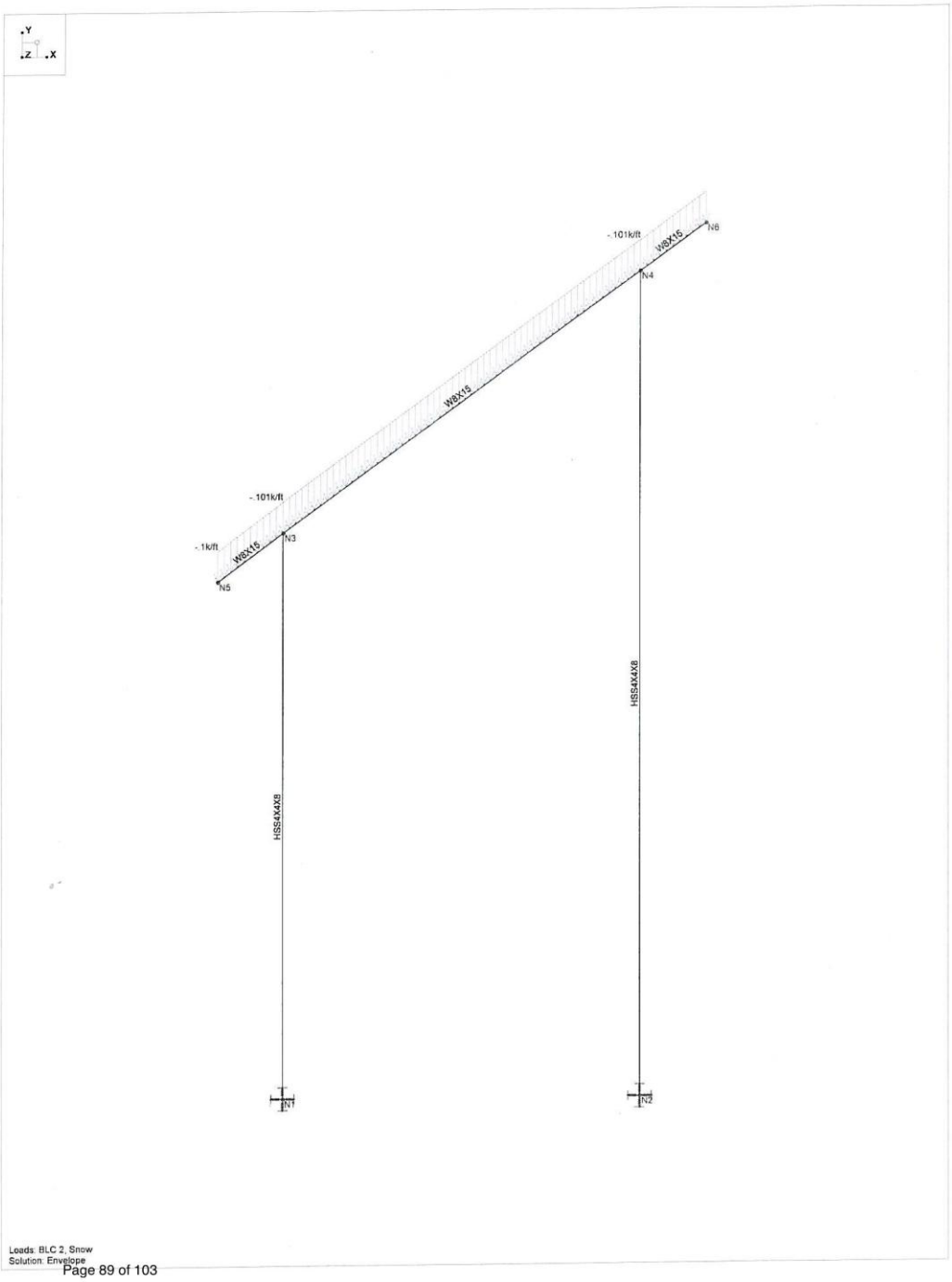
Please work with your structural engineers to develop a design and number of anchors that meets this criteria.

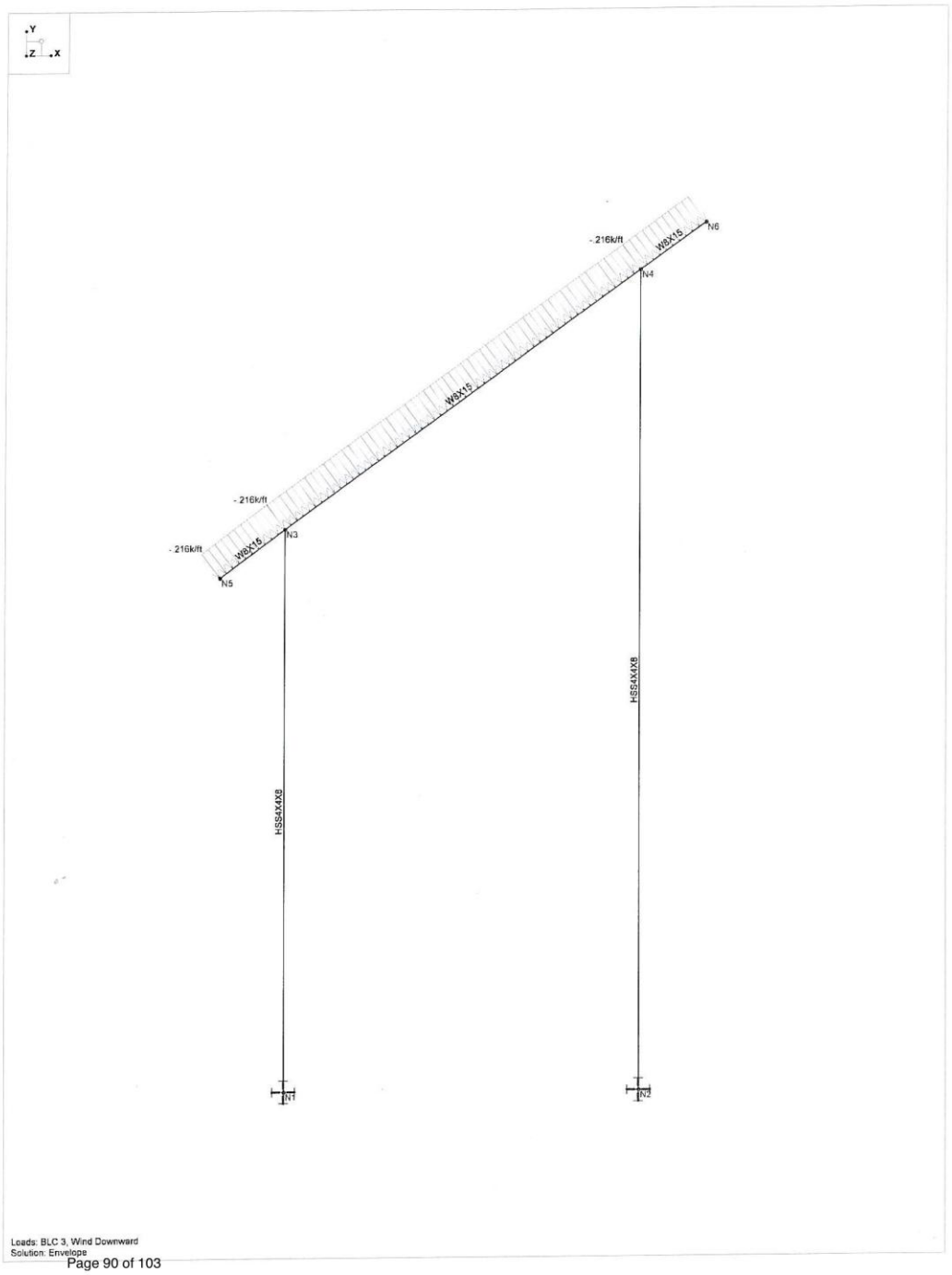
If you have any questions, please contact myself or Tom Meyers.

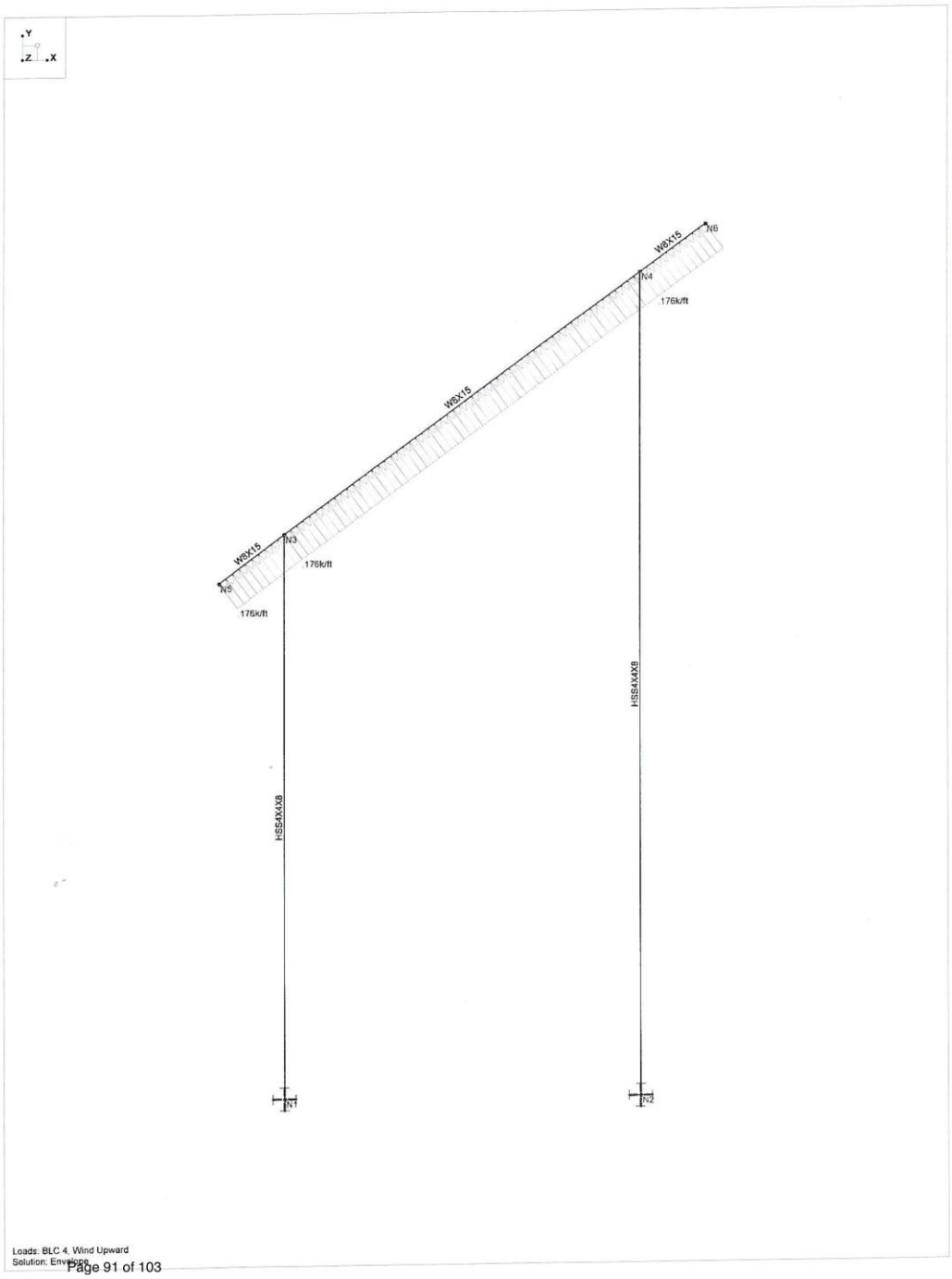
Best regards,

Joe


Y
Z
X
-.15k
-.032k/ft
N6
W8X15
N4
W8X15
-.15k
-.032k/ft
N3
-.032k/ft
W8X15
N5
HSS4X4X8
HSS4X4X8
N1
N2
Loads: BLC 1, Dead
Solution: Envelope


Y
Z
X
-.101k/ft
W8X15
N6
N4
W8X15
-.101k/ft
N3
-.1k/ft
W8X15
N5
HSS4X4X8
HSS4X4X8
N1
N2
Loads: BLC 2, Snow
Solution: Envelope


Y
Z
X
-.216k/ft
W8X15
N6
N4
W8X15
-.216k/ft
N3
-.216k/ft
W8X15
N5
HSS4X4X8
HSS4X4X8
N1
N2
Loads: BLC 3, Wind Downward
Solution: Envelope


Y
Z
X
W8X15
N6
N4
176k/ft
W8X15
W8X15
N3
176k/ft
N5
176k/ft
HSS4X4X8
HSS4X4X8
N1
N2
Loads: BLC 4, Wind Upward
Solution: Envelope

ENGINEERING VENTURES PC
208 Flynn Avenue, Suite 2A
Burlington, VT 05401
T: 802-863-6225
F: 802-863-6306

85 Mechanic Street, Suite 350A
Lebanon, NH 03766
T: 603-442-9333
F: 603-442-9331

JOB SOLAR DECATHLON - SOLAR ARRAY
SHEET NO. _____ OF _____
CALCULATED BY GS DATE _____
CHECKED BY _____ DATE _____
SCALE _____

TEMPORARY PLATFORM / FALL PROTECTION AT SOLAR ARRAY

TEMP. PLATFORM:

(PLAN)

(3) 2x8 NOTCHED (I.V. = .41 << 1.0)

5'-6" CL-COL.

(3) 2x8 OR
(2) 2x10

~25' LENGTH

PLATFORM SYSTEM/MATERIAL BY OTHERS.
PLATFORM CONNECTION TO 2x BY OTHERS

(A) DESIGN CROSS BEAMS / CONNECTION FOR MAX. 1,000 lbs.

CROSS BEAM: 5'-6" SPAN, 1,000 lbs. ⇒ (3) 2x8 SPF #1
(2) 2x10 SPF #1

CLAMP CONNECTION TO COLUMNS. (ACCEPT. TO NOTCH (3) 2x8 1" FOR CONNECTION)

STEEL CLAMP WITH (6) 3/8" DIA. BOLTS ⇒ OK BY INSPECTION FOR 500 lbs. each end.

FALL PROTECTION: DESIGN FOR MAX. 5,000 lb. Vertical Fall Load (Includes impact)
(AND... (2) 5,000 lbs. to occur on system - WORST CASE)

(A) (1) 5,000 lb. on W6x12 BEAM

W6x12

→ Assume max load
=(.33)(5,000 lbs) = 1650 lbs.
(7'-10" MAX SPAN)

5,000 lbs. including impact

W6x12 ok FOR 5,000 VERTICAL LOAD (I.V. = .47 << 1.0)

W6x12 ok FOR 1,650 Horiz. Load (I.V. = .55 << 1.0)

(B) COLUMN FRAME OK FOR 10,000 lbs Total

(HSS 4x4x1/2 Col Capacity = 82,000 lbs. for 12 ft. unbraced length)

(1) 4x4x1/2 COLUMN ALLOWABLE LOAD >> 10,000 lbs -OK BY INS.

ENGINEERING VENTURES PC
208 Flynn Avenue, Suite 2A
Burlington, VT 05401
T: 802-863-6325
F: 802-863-6336

85 Mechanic Street, Suite 350A
Lebanon, NH 03766
T: 603-442-8555
F: 603-442-8331

JOB SOLAR DECATHLON - SOLAR ARRAY
SHEET NO. _____ OF _____
CALCULATED BY GS DATE _____
CHECKED BY _____ DATE _____
SCALE _____

TEMPORARY PLATFORM / FALL PROTECTION AT SOLAR ARRAY

TEMP. PLATFORM:

(A) DESIGN CROSS BEAMS / CONNECTION FOR MAX. 1,000 lbs.

PLATFORM CONNECTION TO 2x BY OTHERS

CROSS BEAM: 5'-6" Span, 1,000 lbs. ⇒ (3) 2x8 SPF #1
(2) 2x10 SPF #1

CLAMP CONNECTION TO COLUMNS. (ACCEPT. TO NOTCH (3) 2x8 1" FOR CONNECTION)

STEEL CLAMP WITH (6) 3/8" DIA. BOLTS ⇒ OK BY INSPECTION FOR 500 lbs each end.

FALL PROTECTION: DESIGN FOR MAX. 5,000 lb. Vertical Fall Load (Includes impact)

(AND... (2) 5,000 lbs. to occur on system - LEAST CASE)

(A) (1) 5,000 lb. on W8x15 BEAM

→ Assume max load
= (.33)(5,000 lbs) = 1650 lbs
(7'-10" MAX SPAN)

5,000 lbs. including impact

W8x15 ok FOR 5,000 VERTICAL LOAD
(I.V. = .28 << 1.0)
W8x15 ok FOR 1,650 Horiz. LOAD.
(I.V. = .49 << 1.0)

(B) COLUMN FRAME OK FOR 10,000 lbs Total

(1) 4x4x1/2 COLUMN ALLOWABLE LOAD >> 10,000 lbs - OK BY INS.

Company : Engineering Ventures
Designer : GS
Job Number :
Middlebury Solar Decathlon
Feb 11, 2013
4:18 PM
Checked By:_____

Load Combinations

	Description	Sol...	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	Dead	Yes	Y		1	1														
2	DL + WL	Yes	Y		1	1	3	1												
3	.6DL - WL	Yes	Y		1	.6	4	1												
4	DL + SL	Yes	Y		1	1	2	1												
5	DL + .75(SL + WL)	Yes	Y		1	1	2	.75	3	.75										
6	Service - Deflection		Y		1	1	3	.7												

Envelope Joint Reactions

	Joint		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
1	N1	max	.672	3	1.532	3	0	1	0	1	0	1	0	1
2		min	-.903	2	-1.045	2	0	1	0	1	0	1	0	1
3	N2	max	.292	3	3.843	2	0	1	0	1	0	1	0	1
4		min	-.282	2	-2.145	3	0	1	0	1	0	1	0	1
5	N3	max	0	1	0	1	0	1	0	1	0	1	0	1
6		min	0	1	0	1	0	1	0	1	0	1	0	1
7	N4	max	0	1	0	1	0	1	0	1	0	1	0	1
8		min	0	1	0	1	0	1	0	1	0	1	0	1
9	N5	max	0	1	0	1	0	1	0	1	0	1	0	1
10		min	0	1	0	1	0	1	0	1	0	1	0	1
11	N6	max	0	1	0	1	0	1	0	1	0	1	0	1
12		min	0	1	0	1	0	1	0	1	0	1	0	1
13	Totals:	max	.964	3	3.097	5	0	1						
14		min	-1.184	2	-.613	3	0	1						

Envelope AISC 13th(360-05): ASD Steel Code Checks

	Member	Shape	Code C...	Loc[ft]	LC	Shear ...	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om ...	Mnzz/om ...	Cb	Eqn
1	M1	HSS4X4X8	.438	8.75	2	.022	0	y	2	113.946	165.82	17.675	17.675	1....	H1-1b
2	M2	HSS4X4X8	.268	12.75	2	.008	0	y	2	74.762	165.82	17.675	17.675	1....	H1-1b
3	M3	W8X15	.226	0	2	.066	6.801	y	2	70.514	132.934	6.662	33.932	1	H1-1b
4	M4	W8X15	.006	1.25	5	.008	1.25	y	5	130.117	132.934	6.662	33.932	2....	H1-1b
5	M5	W8X15	.006	0	5	.008	0	y	5	130.17	132.934	6.662	33.932	2....	H1-1b

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : Wood Purlin

CODE REFERENCES

Calculations per NDS 2005
Load Combination Set : ASCE 7-05

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : ASCE 7-05

Wood Species : Northern White Cedar
Wood Grade : No.1

Beam Bracing : Completely Unbraced

Fb - Tension	750.0 psi
Fb - Compr	750.0 psi
Fc - Prll	500.0 psi
Fc - Perp	370.0 psi
Fv	115.0 psi
Ft	500.0 psi

E : Modulus of Elasticity

Ebend- xx	700.0 ksi
Eminbend - xx	260.0 ksi
Density	19.970 pcf

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 0.0070, W = 0.0350 ksf, Tributary Width = 3.250 ft
Load for Span Number 2
Uniform Load : D = 0.010, W = 0.0350 ksf, Tributary Width = 4.50 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.414 : 1	Maximum Shear Stress Ratio	=	0.229 : 1
Section used for this span		4x6	Section used for this span		4x6
fb : Actual	=	636.45 psi	fv : Actual	=	42.14 psi
FB : Allowable	=	1,538.78 psi	Fv : Allowable	=	184.00 psi
Load Combination		+D+W+H	Load Combination		+D+W+H
Location of maximum on span	=	3.665 ft	Location of maximum on span	=	7.553 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.305 in	Ratio =	314
Max Upward Total Deflection	-0.175 in	Ratio =	260

Maximum Forces & Stresses for Load Combinations

Load Combination	Max Stress Ratios										Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.127	0.076	0.90	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	871.42	0.10	7.88	103.50
Length = 1.90 ft	2	0.067	0.076	0.90	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	876.18	0.07	7.88	103.50
+D+L+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.114	0.068	1.00	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	967.39	0.10	7.88	115.00
Length = 1.90 ft	2	0.060	0.068	1.00	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	973.37	0.07	7.88	115.00
+D+Lr+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

.
Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : Wood Purlin

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 8.0 ft	1	0.092	0.055	1.25	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	1206.44	0.10	7.88	143.75
Length = 1.90 ft	2	0.048	0.055	1.25	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	1216.18	0.07	7.88	143.75
+D+S+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.100	0.060	1.15	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	1110.98	0.10	7.88	132.25
Length = 1.90 ft	2	0.052	0.060	1.15	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	1119.08	0.07	7.88	132.25
+D+0.750Lr+0.750L+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.092	0.055	1.25	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	1206.44	0.10	7.88	143.75
Length = 1.90 ft	2	0.048	0.055	1.25	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	1216.18	0.07	7.88	143.75
+D+0.750L+0.750S+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.100	0.060	1.15	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	1110.98	0.10	7.88	132.25
Length = 1.90 ft	2	0.052	0.060	1.15	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	1119.08	0.07	7.88	132.25
+D+W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.414	0.229	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.94	636.45	1538.78	0.54	42.14	184.00
Length = 1.90 ft	2	0.162	0.229	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.37	251.84	1555.74	0.30	42.14	184.00
+D+0.70E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.072	0.043	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	1538.78	0.10	7.88	184.00
Length = 1.90 ft	2	0.038	0.043	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	1555.74	0.07	7.88	184.00
+D+0.750Lr+0.750L+0.750W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.328	0.182	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.74	504.97	1538.78	0.43	33.57	184.00
Length = 1.90 ft	2	0.131	0.182	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.30	203.51	1555.74	0.24	33.57	184.00
+D+0.750L+0.750S+0.750W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.328	0.182	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.74	504.97	1538.78	0.43	33.57	184.00
Length = 1.90 ft	2	0.131	0.182	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.30	203.51	1555.74	0.24	33.57	184.00
+D+0.750Lr+0.750L+0.5250E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.072	0.043	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	1538.78	0.10	7.88	184.00
Length = 1.90 ft	2	0.038	0.043	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	1555.74	0.07	7.88	184.00
+D+0.750L+0.750S+0.5250E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.072	0.043	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.16	110.58	1538.78	0.10	7.88	184.00
Length = 1.90 ft	2	0.038	0.043	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.09	58.51	1555.74	0.07	7.88	184.00
+0.60D+W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.385	0.212	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.87	592.24	1538.78	0.50	38.99	184.00
Length = 1.90 ft	2	0.147	0.212	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.34	228.44	1555.74	0.27	38.99	184.00
+0.60D+0.70E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.043	0.026	1.60	1.30	1.00	1.00	1.00	1.00	0.99	0.10	66.35	1538.78	0.06	4.73	184.00
Length = 1.90 ft	2	0.023	0.026	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.05	35.11	1555.74	0.04	4.73	184.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+W	1	0.3055	3.888		0.0000	0.000
	2	0.0000	3.888	D+W	-0.1746	1.900

Vertical Reactions - Unfactored

Support notation : Far left is #1 — Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Overall MAXimum	0.510	0.993	
D Only	0.091	0.203	
W Only	0.419	0.790	
D+W	0.510	0.993	

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : Bench Beam

CODE REFERENCES

Calculations per NDS 2005
Load Combination Set : ASCE 7-05

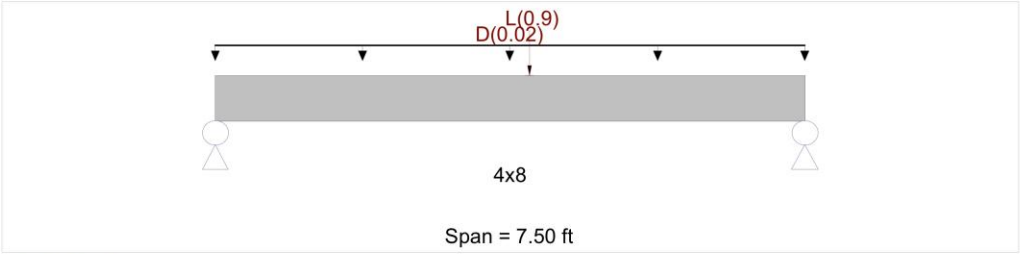
Material Properties

Analysis Method : Allowable Stress Design
Load Combination : ASCE 7-05

Wood Species : Northern White Cedar
Wood Grade : No.1

Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	750.0 psi	*E : Modulus of Elasticity*	
Fb - Compr	750.0 psi	Ebend- xx	700.0 ksi
Fc - Prll	500.0 psi	Eminbend - xx	260.0 ksi
Fc - Perp	370.0 psi		
Fv	115.0 psi		
Ft	500.0 psi	Density	19.970 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Uniform Load : D = 0.010 ksf, Tributary Width = 2.0 ft
Point Load : L = 0.90 k @ 4.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.740 : 1	Maximum Shear Stress Ratio	=	0.285 : 1
Section used for this span		4x8	Section used for this span		4x8
fb : Actual	=	721.34 psi	fv : Actual	=	32.75 psi
FB : Allowable	=	975.00 psi	Fv : Allowable	=	115.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	3.996 ft	Location of maximum on span	=	6.898 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.176 in	Ratio =	512
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.197 in	Ratio =	456
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.074	0.042	0.90	1.30	1.00	1.00	1.00	1.00	1.00	0.17	64.72	877.50	0.07	4.38	103.50
+D+L+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.740	0.285	1.00	1.30	1.00	1.00	1.00	1.00	1.00	1.84	721.34	975.00	0.55	32.75	115.00
+D+Lr+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.053	0.030	1.25	1.30	1.00	1.00	1.00	1.00	1.00	0.17	64.72	1218.75	0.07	4.38	143.75
+D+S+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.058	0.033	1.15	1.30	1.00	1.00	1.00	1.00	1.00	0.17	64.72	1121.25	0.07	4.38	132.25
+D+0.750Lr+0.750L+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.457	0.178	1.25	1.30	1.00	1.00	1.00	1.00	1.00	1.42	557.12	1218.75	0.43	25.66	143.75

Middlebury Solar Decathlon - Insite

Project Title: Middlebury Solar Decathalon
Engineer:
Project Descr:
Project ID: 12130

.
Title Block Line 6

Wood Beam

File = S:\PROJECTS\0-2012\12130M~1\analysis\12130.ec6
ENERCALC, INC. 1983-2012, Build:6.12.12.7, Ver:6.12.12.7

Lic. # : KW-06005698 — Licensee : ENGINEERING VENTURES

Description : Bench Beam

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
+D+0.750L+0.750S+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.497	0.194	1.15	1.30	1.00	1.00	1.00	1.00	1.00	1.42	557.12	1121.25	0.43	25.66	132.25
+D+W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.041	0.024	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.17	64.72	1560.00	0.07	4.38	184.00
+D+0.70E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.041	0.024	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.17	64.72	1560.00	0.07	4.38	184.00
+D+0.750Lr+0.750L+0.750W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.357	0.139	1.60	1.30	1.00	1.00	1.00	1.00	1.00	1.42	557.12	1560.00	0.43	25.66	184.00
+D+0.750L+0.750S+0.750W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.357	0.139	1.60	1.30	1.00	1.00	1.00	1.00	1.00	1.42	557.12	1560.00	0.43	25.66	184.00
+D+0.750Lr+0.750L+0.5250E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.357	0.139	1.60	1.30	1.00	1.00	1.00	1.00	1.00	1.42	557.12	1560.00	0.43	25.66	184.00
+D+0.750L+0.750S+0.5250E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.357	0.139	1.60	1.30	1.00	1.00	1.00	1.00	1.00	1.42	557.12	1560.00	0.43	25.66	184.00
+0.60D+W+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.025	0.014	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.10	38.83	1560.00	0.04	2.63	184.00
+0.60D+0.70E+H					1.30	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.50 ft	1	0.025	0.014	1.60	1.30	1.00	1.00	1.00	1.00	1.00	0.10	38.83	1560.00	0.04	2.63	184.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.1972	3.832		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 — Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.508	0.568
D Only	0.088	0.088
L Only	0.420	0.480
D+L	0.508	0.568

Panel Lifting

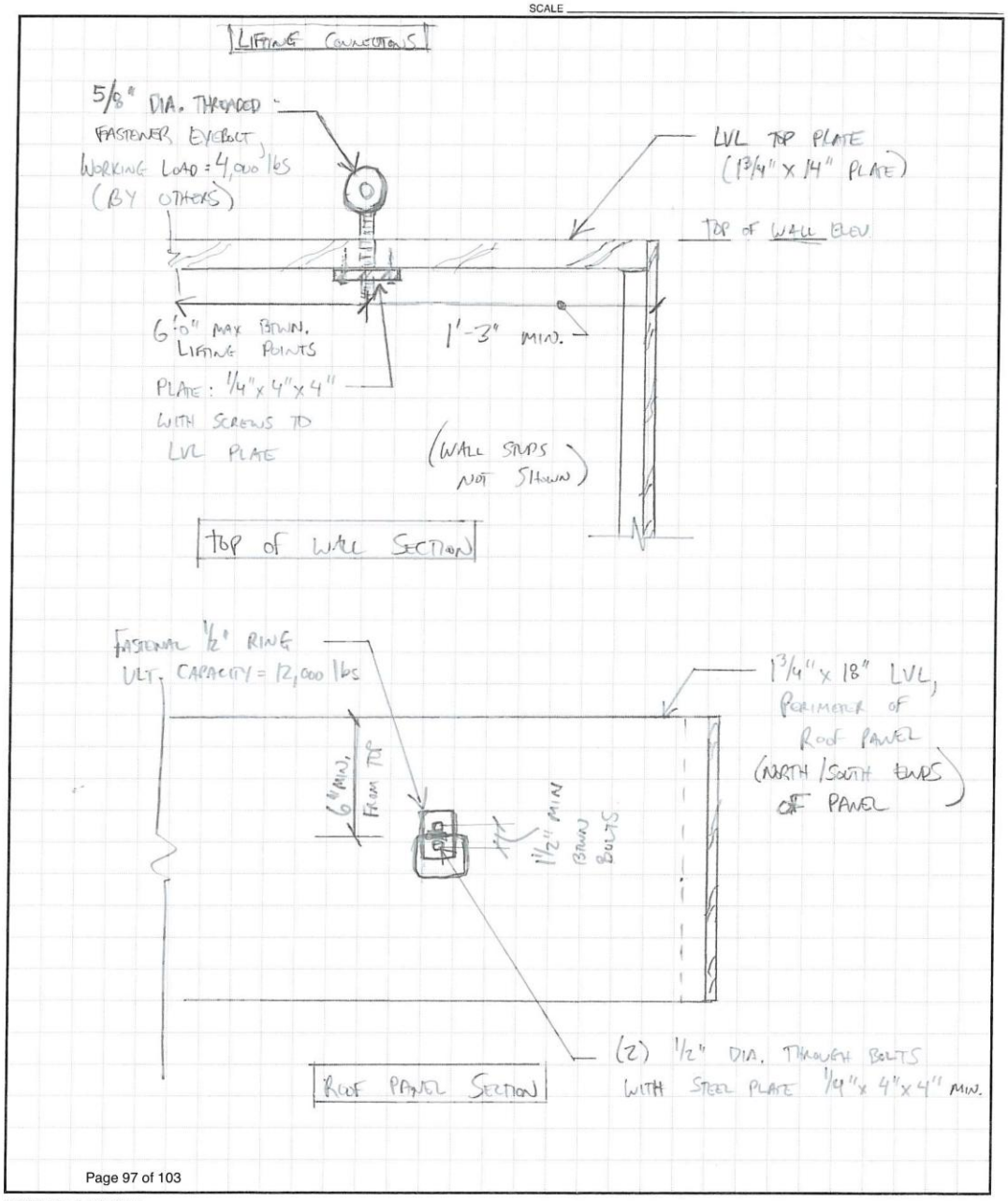
ENGINEERING VENTURES PC

208 Flynn Avenue, Suite 2A
Burlington, VT 05401
tel. 802.863.6225
fax 802.863.6306

18 Division St
Saratoga Springs, NY 12866
tel. 518.224.0004

85 Mechanic Street, Suite B2-2
Lebanon, NH 03766
tel. 603.442.9333
fax 603.442.9331

JOB SOLAR DECATHLON
SHEET NO. ____ OF ____
CALCULATED BY GS DATE ____
CHECKED BY ____ DATE ____
SCALE ____



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PRODUCT 204-1 (Single Sheets) 208-1 (Padded)

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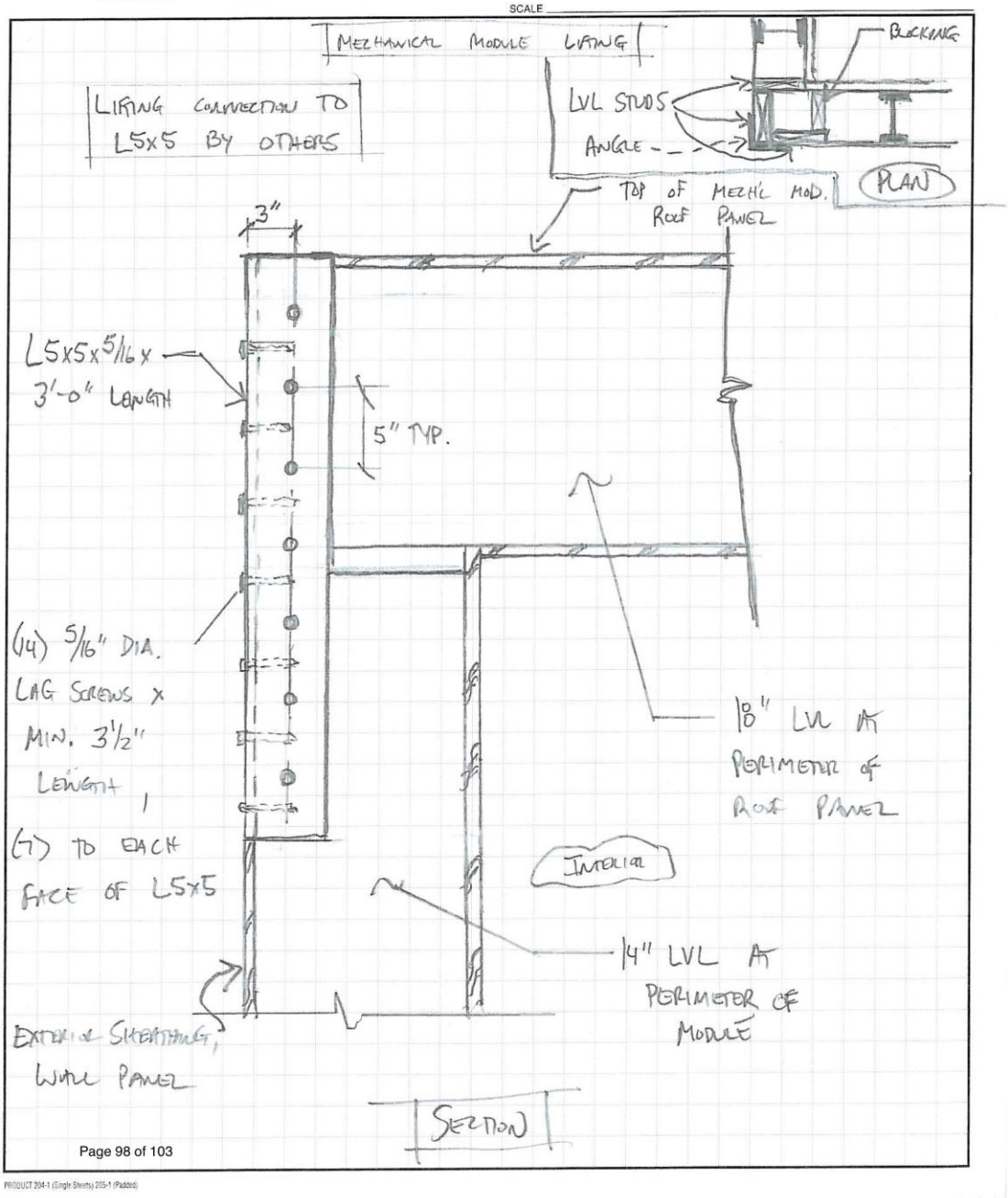
tel. 603.442.9333
fax 603.442.9331

JOB SOLAR D - LIFTING CALCS
SHEET NO. _____ OF _____
CALCULATED BY GS DATE 7-11-13
CHECKED BY _____ DATE _____
SCALE _____



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PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

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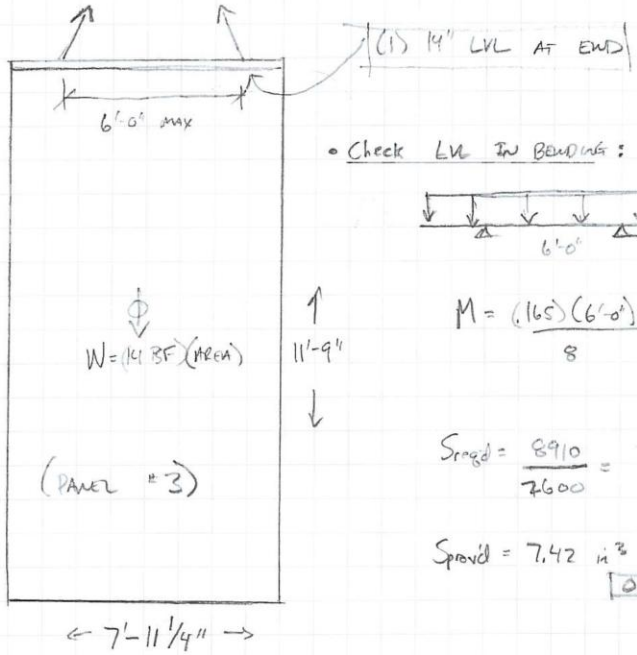
JOB SOLAR DECA. - WALL PANELS
SHEET NO. 1 OF 2
CALCULATED BY GS DATE 12/5/12
CHECKED BY DATE
SCALE

PANEL LIFTING CALCS

WALL PANELS

WALL PANEL 3

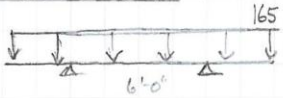


PANEL WEIGHT = 14 PSF

$W = (14\ PSF)(7.94')(11.75')$
$= 1306\ lbs.$

$W = (14\ PSF)(AREA)$

• Check LVL IN BENDING:



$M = \frac{(165)(6'-0")^2}{8} = .74\ K\text{-}ft$
$= 8910\ lb\text{-}in$

$S_{reqd} = \frac{8910}{2600} = 3.42\ in^3$

$S_{provd} = 7.42\ in^3 >> 3.42\ in^3$ OK

• Check Nailing of sheathing: NAILS AT 6" oc from either side:

$\frac{165\ PLF}{2} = 41\ lbs$ per attachment

10d NAILS: CAPACITY = 105 lb >> 41 lbs ⇒ ok.

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208 Flynn Avenue, Suite 2A
Burlington, VT 05401
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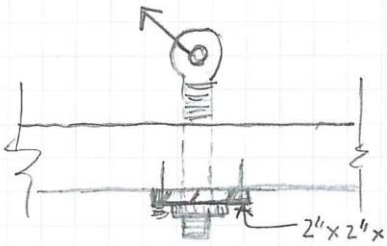
85 Mechanic Street, Suite 330A
Lebanon, NH 03766
T: 603-442-9333
F: 603-442-9331

JOB SUM DECA - WALL PANELS
SHEET NO. 2 OF 2
CALCULATED BY GS DATE 12/5/12
CHECKED BY DATE
SCALE

· Check lifting connection: Check for 1 lifting connection to support full panel:

→ MIN. 5/8" DIA. THREADED FASTENER EYEBOLT ⇒ WORKING LOAD = 4,000 lbs.
(BY FASTENAL) 4,000 lbs >> 1366 lbs.

OK



→ MIN. 2"x2" steel plate : (STEEL PL., NUT OK BY INSPECTION)

Bearing on LVL ⇒ $F_{c\perp}$ = 625 psi MIN

2"x2"x 625 psi = 2,500 lbs >> 1366 lbs ⇒ OK

EYEBOLT, STEEL PLATE, LVL ACCEPTABLE

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T: 603-442-9333
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JOB SOLAR DECA - ROOF PANELS
SHEET NO. 1 OF 1
CALCULATED BY GS DATE 12/5/12
CHECKED BY DATE
SCALE

ROOF / ~~FLOOR~~ PANELS

ROOF PANEL # 2

FLOOR BY MIN. 3 SLINGS NOT BY EV

PANEL WEIGHT = 15 PSF

W = (15 PSF)(8'-8" AVG.)(26'-8")
= 3469 lbs.

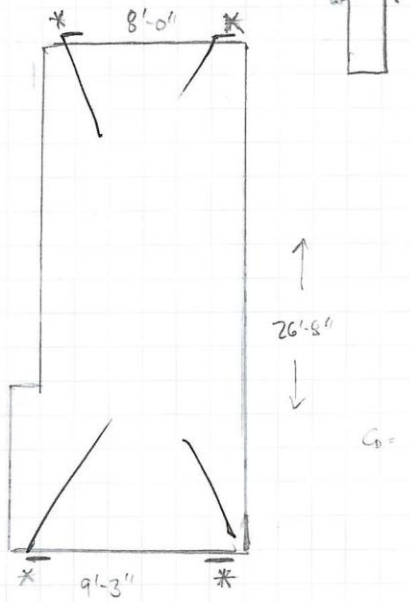
ASSUME (4) ATTACHMENT POINTS

CHECK FOR (2) POINTS TAKING TOTAL LOAD

$\frac{3469\ lb}{2}$ = 1735 lb PER ATTACHMENT

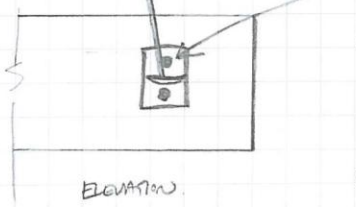
FASTENER ½" RING W/ MOUNTING BRACKET
ULT. CAPACITY = 12,000 lbs

WORKING (SAFE) CAPACITY =
$\frac{12{,}000\ lbs}{3}$ = 4,000 lbs ⇒ OK.



APPLIED LOAD ON WOOD MEMBER:
USE C_D ~ 1.5 (short duration load)

$\frac{1735}{1.5}$ = 868 lbs. = REQ'D



Check fasteners on LVL:

(2) 5/8" DIA THRU-BOLTS:

CAPACITY = 430 lbs x 2 = 860 lbs.

CAP ~ REQ'D ⇒ OK

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ENGINEERING VENTURES PC

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JOB SOLAR DECATHLON
SHEET NO. _____ OF _____
CALCULATED BY GS DATE _____
CHECKED BY _____ DATE _____
SCALE _____

ROOF PANEL LIFTING CALCS CONT'D.

- 1735 lbs per attachment point

- FASTENERS ON LVL: ASSUME (2) 1/2" DIA THRU BOLTS

$C_D = 1.25$ ASSUME MIN. 1 1/2" BRWN, BOLTS

$C_g = 1.0$

LOAD/BOLT = $\frac{1735 \text{ lbs}}{(2 \text{ BOLTS})(1.5)}$ = 578 lbs/BOLT

BRWN 10 MINUTES (1.6)
7 DAYS (1.25)

C_Δ, MIN. SPACING

D = 3/8" DIA

3D = 1 1/2"

DOUBLE SHEAR: $Z_\perp$ = 595 lbs (LVL MATERIAL)

GK FOR 1/2" DIA. BOLTS

ENGINEERING VENTURES PC
208 Flynn Avenue, Suite 2A
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T: 802-863-5225
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85 Mechanic Street, Suite 350A
Lebanon, NH 03766
T: 603-442-9333
F: 603-442-9331

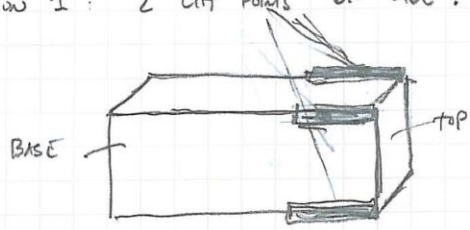
JOB SOLAR D - LIFTING CALCS
SHEET NO. ____ OF ____
CALCULATED BY GS DATE 2-11-13
CHECKED BY ____ DATE ____
SCALE ____

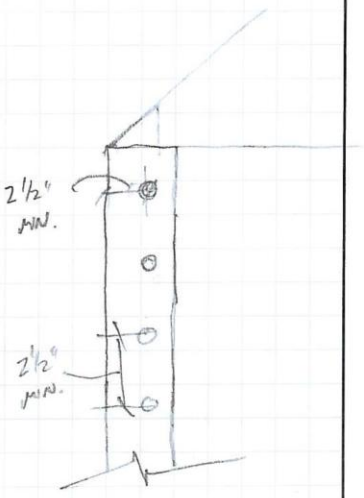
MECHANICAL MODULE LIFTING

WEIGHT ~ 6,800 lbs. (TOTAL) BASED ON 2/1/13 MODEL HEIGHT + PLAN DIM.

(PANELS ~ 14 PSF FULLY INSULATED)

OPTION 1: 2 LIFT POINTS ON SIDE:





EACH POINT TO SUPPORT $\frac{6,800}{2} = 3,400$ lbs

L4x4x¼ ANGLE X MIN. 3'-0" LENGTH AT EACH CORNER

OF LAG SCREWS FROM ANGLE TO WOOD MEMBERS: 5/16" DIA.

$Z_{\perp}$ ~ 180 lbs x 1.5 = 270 lbs

↑ CONSTRUCTION LOAD

OF FASTENERS = $\frac{3,400 \text{ lbs}}{270 \text{ lbs}}$ = 13 LAG SCREWS. (SPECIFY 14)

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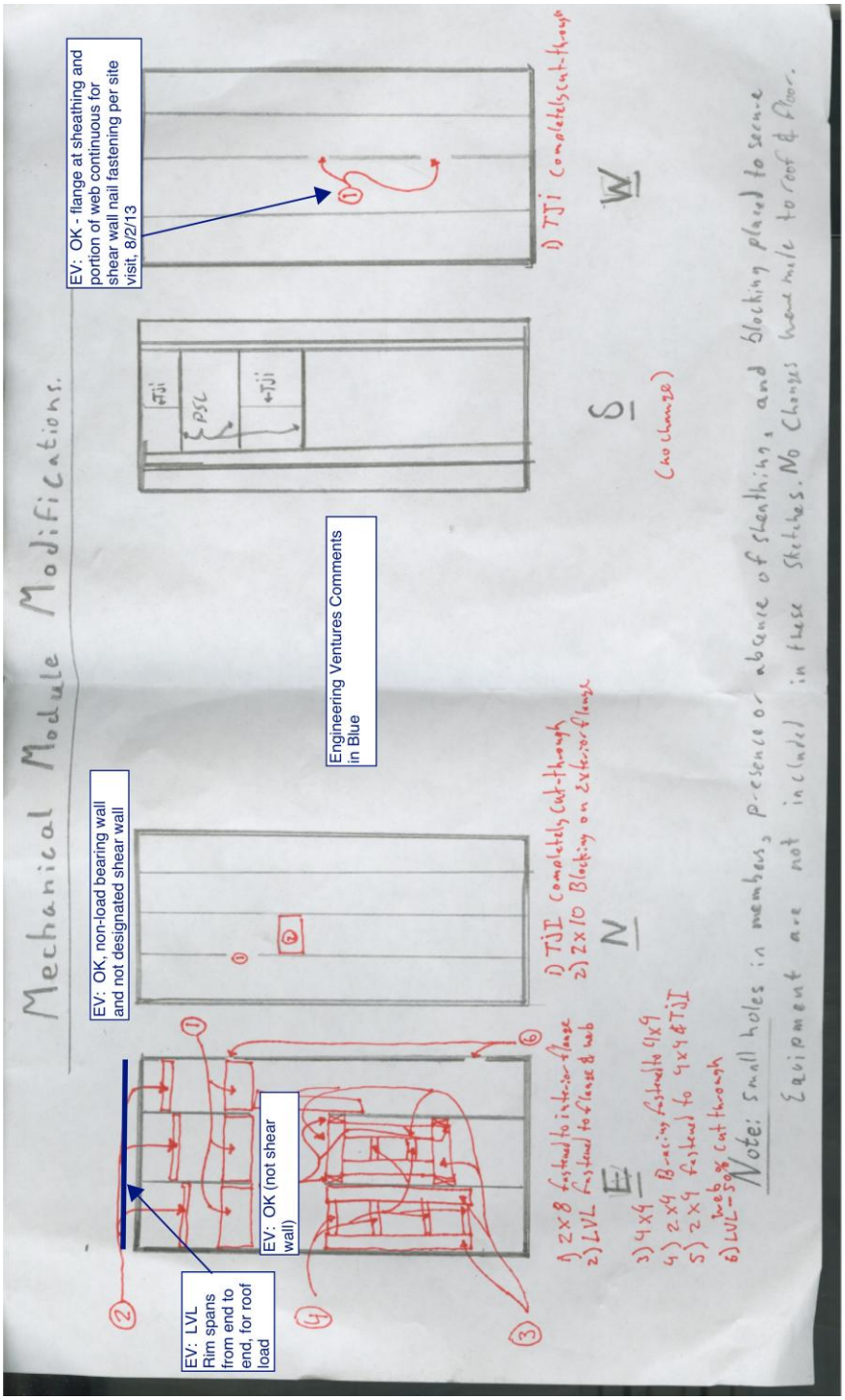
Mechanical Module Modifications



Detailed Water Budget

Competition Tasks

FUNCTION	WATER USE (GALLONS)	CALCULATIONS		NOTES	HOT WATER
		GALLONS	EVENTS		
Hot Water Draws	240	15	16		Y
Water Vaporization	3.75	0.75	5	Start with 96oz, vaporize 80oz	
Dishwasher	14.75	2.95	5	Using the highest efficiency dishwasher	Y
Clothes Washer	84	10.5	8	Using the highest efficiency clothes washer	Y
Dinner Party	50	25	2	Cooking, rinsing (all water is team-provided)	Y
Movie Night	25	25	1	Cooking, rinsing (all water is team-provided)	Y
Vegetation	100	50	2	Native drought resistent plants selected	
Fire Protection	300	300	1		
Testing	18	9	2	Charge system	
Initial Systems Fill	50	50	1		
Safety Factor	200			Fill tanks to capacity to allow for error in these estimates	
WATER REQUIRED	1085.5				413.75

Projected Usage in Final Residential Installation

ITEM	USE RATE	FLOW RATE	# OF PERSONS	DAILY TOTAL	HOT WATER
Toilet	4 flushes per person per day	1.6	3	19.2	
Shower	5 minutes per person per day	2.5	3	37.5	Y
Bathroom Faucet	10 minutes washing hands, face, brushing teeth per person per day	1.5	3	45	Y
Kitchen Faucet	10 minutes per person rinsing and cooking per day	1.8	3	54	Y
Total Daily Usage				155.7 gal./day	
Item	LOADS PER WEEK	GALLONS PER LOAD	NOTES	WEEKLY TOTAL	HOT WATER
Washing Machine	3	10.5	Clothes, towels and sheets for a three person household	31.5	Y
Dishwasher	4	2.95	14-place setting capacity, three person household	11.8	Y
Total Weekly Usage				43.3 gal/week	
Total Annual Usage				59,082 gallons	

Interconnection Application Form

MIDDLEBURY COLLEGE LOT 110

PV Systems

Module Manufacturer	Short Description of Array	DC Rating of Array (sum of the DC ratings)
Lumos	10 × 240W V Modules wired in series	2400W
Lumos	16 × 240W V Modules wired in series	3840W

Total DC power of all arrays is 6.2 kW (in tenths)

INVERTERS

Inverter Manufacturer	Model Number	Voltage	Rating (kVA or KW)	Quantity
Power One	Aurora Uno PVI-6000-TL	240V Output	6kW	1

Total AC power of all inverters is 6 kW (in whole numbers)

REQUIRED INFORMATION	Location
One-Line Electrical Schematic	E-601
Calculations of service/feeder net computed load and neutral load (NEC 220)	E-001
Plan view of the lot showing the house, decks, ramps, tour paths, the service point, and the distribution panel or load center	E-101, G-103

Energy Analysis Results and Discussion

Summary

We have conducted multiple energy analyses with a program called Energy Plus. Energy Plus is an energy simulation software that calculates energy and water use in buildings. By modeling the heating, cooling, hot water, and ventilation usages, we were able to optimize our design in order to be as energy efficient as possible. For the climate of Irvine, California in the month of October, with the energy and water consumption dictated by the competition challenges, we project an energy demand of 696.72 kWh.

Discussion

In addition to determining the size of our photovoltaic array, our energy model indicated the best ways to incorporate passive techniques into our home's design. Recognizing that we are dealing with two different climates in California and Middlebury, we have incorporated methods that function in both climates. The window locations optimize natural light throughout the large social space of our home, where the residents will spend most of their time. The home's extensive southern glazing maximizes solar heat gain during the cold winter months, but by installing our low-emission glass windows to the interior of the 14-inch-thick walls, only a small portion of the solar irradiation from the high summer sun actually passes through the glass to heat our home. Our thick walls are packed with cellulose insulation which keeps our home tightly sealed to prevent heat transfer.

Mechanical Chimney Core

Another feature of our home is the mechanical room, the shape of which reflects the chimney structure of a traditional New England home. This structure emphasizes our mechanical core where all of our systems are condensed into one space. This core embodies all of the vital functions of our home--the heating, cooling, hot water and ventilation systems. Furthermore, this height of the mechanical chimney helps create a stack effect within the home that promotes a passive cooling ventilation system. Cool air enters through a louver low on the north façade and pushes warm air up out of the large public space through a louver between the kitchen and the mechanical chimney, and out of an exterior louver high on the northern face of the mechanical chimney. The energy model proved that the natural air currents would produce such this cooling effect even in our relatively small space, and determined the necessary sizes of the louvers.

Remarks

Though we want to use as many passive techniques as possible, we recognize the need to use active systems in order to meet the competition challenges. Therefore, we integrate both passive and active methods in order to reduce the overall energy usage. We have chosen appliances and systems that will meet the needs of our home and its residents, while consuming as little energy and water as possible. Our Building Management System will continue the work of our Energy Model to document the functionality of our home and encourage sustainable practices.

Energy Analysis Results

Simulation for competition loads in Irvine, California in the month of October

Program Version:EnergyPlus-Windows-64 8.0.0.008, YMD=2013.08.21 11:07
Environment: OCTOBER ** Climate Zone 8 CA USA CTZRV2 WMO#=690140
Simulation Timestamp: 2013-08-21 11:07:58

Site and Source Energy

	Total Energy [kWh]	Energy Per Total Building Area [kWh/m2]	Energy Per Conditioned Building Area [kWh/m2]
Total Site Energy	696.72	9.10	9.10
Net Site Energy	-395.0	-5.2	-5.2
Total Source Energy	2206.50	28.83	28.83
Net Source Energy	-1250.8	-16.3	-16.3

Site to Source Energy Conversion Factors

	Site → Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050

Building Area

	Area [m2]
Total Building Area	76.53
Net Conditioned Building Area	76.53
Unconditioned Building Area	0.00

End Uses by Subcategory

	Subcategory	Electricity [kWh]	Natural Gas [kWh]	Other Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	General	4.00	0.00	0.00	0.00	0.00	0.00
Cooling	General	164.24	0.00	0.00	0.00	0.00	0.00
Interior Lighting	General	74.97	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	General	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	General	53.55	0.00	0.00	0.00	0.00	0.00
	Laundry	27.68	0.00	0.00	0.00	0.00	0.00
	Dishwasher	14.34	0.00	0.00	0.00	0.00	0.00
	Refrigerator	28.86	0.00	0.00	0.00	0.00	0.00
	Cooking	124.35	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	General	0.00	0.00	0.00	0.00	0.00	0.00
Fans	General	17.83	0.00	0.00	0.00	0.00	0.00
Pumps	General	0.36	0.00	0.00	0.00	0.00	0.00
Heat Rejection	General	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	General	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	General	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	Water Heater	186.54	0.00	0.00	0.00	0.00	0.00
	General	0.00	0.00	0.00	0.00	0.00	6.06
Refrigeration	General	0.00	0.00	0.00	0.00	0.00	0.00
Generators	General	0.00	0.00	0.00	0.00	0.00	0.00

NORMALIZED METRICS

Utility Use Per Conditioned Floor Area

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Other Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	0.98	0.00	0.00	0.00	0.00	0.00
HVAC	4.87	0.00	0.00	0.00	0.00	0.08
Other	3.25	0.00	0.00	0.00	0.00	0.00
Total	9.10	0.00	0.00	0.00	0.00	0.08

Electric Loads Satisfied

	Electricity [kWh]	Percent Electricity [%]
Fuel-Fired Power Generation	0.00	0.00
High Temperature Geothermal*	0.00	0.00
Photovoltaic Power	1091.68	156.69
Wind Power	0.00	0.00
Net Decrease in On-Site Storage	0.00	0.00
Total On-Site Electric Sources	1091.68	156.69
Electricity Coming From Utility	350.61	50.32
Surplus Electricity Going To Utility	745.58	107.01
Net Electricity From Utility	-395.0	-56.7
Total On-Site and Utility Electric Sources	696.72	100.00
Total Electricity End Uses	696.72	100.00

On-Site Thermal Sources

	Heat [kWh]	Percent Heat [%]
Water-Side Heat Recovery	0.00	
Air to Air Heat Recovery for Cooling	0.00	
Air to Air Heat Recovery for Heating	0.00	
High-Temperature Geothermal*	0.00	
Solar Water Thermal	0.00	
Solar Air Thermal	0.00	
Total On-Site Thermal Sources	0.00	

Water Source Summary

	Water [m3]	Percent Water [%]
Rainwater Collection	0.00	0.00
Condensate Collection	0.00	0.00
Groundwater Well	0.00	0.00
Total On Site Water Sources	0.00	0.00
-	-	-
Initial Storage	0.00	0.00
Final Storage	0.00	0.00
Change in Storage	0.00	0.00
-	-	-
Water Supplied by Utility	6.06	100.00
-	-	-
Total On Site, Change in Storage, and Utility Water Sources	6.06	100.00
Total Water End Uses	6.06	100.00

Comfort and Setpoint Not Met Summary

	Degrees [deltaC]
Tolerance for Time Heating Setpoint Not Met	0.20
Tolerance for Time Cooling Setpoint Not Met	0.20

	Facility [Hours]
Time Setpoint Not Met During Occupied Heating	0.00
Time Setpoint Not Met During Occupied Cooling	2.25
Time Not Comfortable Based on Simple ASHRAE 55-2004	734.25

Program Version and Build	EnergyPlus-Windows-64 8.0.0.008, YMD=2013.08.21 11:07
RunPeriod	YEAR
Weather File	Climate Zone 8 CA USA CTZRV2 WMO#=690140
Latitude [deg]	33.60
Longitude [deg]	-117.7
Elevation [m]	117.00
Time Zone	-8.0
North Axis Angle [deg]	0.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	744.00

ENVELOPE

Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [m2]	137.76	35.30	30.31	41.84	30.31
Window Opening Area [m2]	21.09	2.23	6.22	9.29	3.34
Window-Wall Ratio [%]	15.31	6.32	20.53	22.20	11.03

Conditioned Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [m2]	137.76	35.30	30.31	41.84	30.31
Window Opening Area [m2]	21.09	2.23	6.22	9.29	3.34
Window-Wall Ratio [%]	15.31	6.32	20.53	22.20	11.03

PERFORMANCE

Zone Summary

	Area [m2]	Conditioned (Y/N)	Part of Total Floor Area (Y/N)	Volume [m3]	Multi-pliers	Wall Area [m2]	Window Glass Area [m2]	Lighting [W/m2]	People [m2 per person]	Plug and Process [W/m2]
BATH	5.04	Yes	Yes	15.57	1.00	1.06	0.00	3.7677		2.6912
KIDS BR	7.25	Yes	Yes	16.11	1.00	16.61	1.49	3.7677	6.97	2.6912
LIVING	48.57	Yes	Yes	152.03	1.00	82.58	18.12	3.7677	16.19	37.1973
MASTER BR	11.15	Yes	Yes	29.04	1.00	17.97	1.49	3.7677	6.97	2.6912
MECH	4.53	Yes	Yes	20.02	1.00	19.53	0.00	3.7677		23.5346
Total	76.53			232.77		137.76	21.09	3.7677	13.57	25.8223
Conditioned Total	76.53			232.77		137.76	21.09	3.7677	13.57	25.8223
Uncondition ed Total	0.00			0.00		0.00	0.00			
Not Part of Total	0.00			0.00		0.00	0.00			

Report: Demand End Use by Subcategory
For: Entire Facility
Timestamp: 2013-08-21 11:07:58

	Subcategory	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	Steam [W]	Water [m3/s]
Heating	General	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	General	749.71	0.00	0.00	0.00	0.00	0.00
Interior Lighting	General	72.09	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	General	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	General	51.49	0.00	0.00	0.00	0.00	0.00
	Laundry	76.54	0.00	0.00	0.00	0.00	0.00
	Dishwasher	58.82	0.00	0.00	0.00	0.00	0.00
	Refrigerator	42.59	0.00	0.00	0.00	0.00	0.00
	Cooking	509.96	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	General	0.00	0.00	0.00	0.00	0.00	0.00
Fans	General	52.83	0.00	0.00	0.00	0.00	0.00
Pumps	General	8.06	0.00	0.00	0.00	0.00	0.00
Heat Rejection	General	0.00	0.00	0.00	0.00	0.00	0.00

Humidification	General	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	General	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	Water Heater	4311.24	0.00	0.00	0.00	0.00	0.00
	General	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	General	0.00	0.00	0.00	0.00	0.00	0.00
Generators	General	0.00	0.00	0.00	0.00	0.00	0.00

Report: Source Energy End Use Components Summary
For: Entire Facility
Timestamp: 2013-08-21 11:07:58
Values gathered over 744.00 hours

Source Energy End Use Components Summary

	Source Electricity [kWh]	Source Natural Gas [kWh]	Source Additional Fuel [kWh]	Source District Cooling [kWh]	Source District Heating [kWh]
Heating	12.67	0.00	0.00	0.00	0.00
Cooling	520.14	0.00	0.00	0.00	0.00
Interior Lighting	237.43	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00
Interior Equipment	787.89	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00
Fans	56.48	0.00	0.00	0.00	0.00
Pumps	1.13	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00
Water Systems	590.76	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00
Total Source Energy End Use Components	2206.50	0.00	0.00	0.00	0.00

Report: Object Count Summary

Surfaces by Class

	Total	Outdoors
Wall	38	18
Floor	5	5
Roof	6	6
Internal Mass	0	0
Building Detached Shading	58	58
Fixed Detached Shading	0	0
Window	13	13
Door	1	1
Glass Door	0	0
Shading	0	0
Overhang	0	0
Fin	0	0
Tubular Daylighting Device Dome	0	0

Space Usage Type

	Space Area [m2]	Regularly Occupied Area [m2]	Unconditioned Area [m2]	Typical Hours/Week in Operation [hr/wk]
ONE KIDS BR	7.25	7.25	0.00	168.00
ONE LIVING	48.57	48.57	0.00	168.00
ONE MASTER BR	11.15	11.15	0.00	168.00
ONE BATH	5.04	5.04	0.00	0.00
ONE MECH	4.53	4.53	0.00	0.00
Totals	76.53	76.53	0.00	

Quantity Takeoff of Competition Prototype House

SPECIFICATION NUMBER	BRIEF DESCRIPTION	DETAILED DESCRIPTION	QTY	UNIT
Division 01	General Requirements			
01 54 19	Temporary Crane	Hopse Crane Grove TMS 9000E	7	Day
01 54 00	Telescope Forklift	LULL 1044C54 SERIES	10	Day
01 54 23	Temporary Scaffold and Platforms	Standard supported platform, 5’ tall, 18” wide planks, one 20’ long 12” wide aluminum plank	4	Levels
Division 02	Existing Conditions			
02 21 13	Site Survey, locate project on site	Boundary & survey markers	0.5	Acre
Division 03	Concrete			
Division 04	Masonry			
Division 05	Metals			
05 XX XX	Foundation Support Jacks	Adjustable Steel Jacks	26	Ea.
05 XX XX	Foundation Base Plate 1	5/16" x 1'-6" x 1'-6" Steel	28	Ea.
05 XX XX	Foundation Base Plate 2	3/8" x 2'-0" x 2'-0" Steel	2	Ea.
05 XX XX	Foundation Base Plate 3	3/8" x 2'-3" x 2'-3" Steel	7	Ea.
05 XX XX	Foundation Base Plate 4	1/2" x 2'-6" x 2'-6" Steel	4	Ea.
05 XX XX	Foundation Base Plate 5	1/2" x 3'-0" x 3'-0" Steel	1	Ea.
05 XX XX	Foundation Base Plate 6	5/16" x 1'-0" x 1'-0" Steel	2	Ea.
05 54 00	Column Anchor Plate	Anchor Plate for AES columns, 4" x 2'-4" x 3/4"	18	Ea.
05 54 00	Floor Joint Strip	AES Strip covers joint of floor panels 13'-11" x 4" x 1/4"	1	Ea.
05 54 00	Floor Joint Strip	AES Strip covers joint of floor panels 17'-4 1/2" x 4" x 1/4"	3	Ea.

05 54 00	Floor Joint Strip	AES Strip covers joint of floor panels 19' 4 1/2" x 4" x 1/4"	3	Ea.
05 12 13	House Steel Column - Square Tube	AES 4" x 4" x 3/16" Tube, 6'-0"	3	Ea.
05 12 13	House Steel Column - Square Tube	AES 4" x 4" x 3/16"Tube, 7'-10"	3	Ea.
05 12 13	House Steel Column - Square Tube	AES 4" x 4" x 3/16" Tube, 8'-7"	3	Ea.
05 12 13	House Steel Column - Square Tube	AES 4" x 4" x 3/16" Tube, 9'-0"	1	Ea.
05 12 13	House Steel Column - Square Tube	AES 4" x 4" x 3/16" Tube, 10'-9"	4	Ea.
05 12 13	House Steel Beam - I-beam	AES W12X19, 21'-9"	3	Ea.
05 12 13	House Steel Beam - I-beam	AES W12X19, 24'-9"	3	Ea.
05 12 13	House Steel Beam - I-beam	AES W12X19, 19'-3 1/2"	1	Ea.
05 XX XX	Path Ground Plate	1'-10" x 1'-10" x 1/2" with 4x 3/4" diameter 16" threaded rod	18	Ea.
05 XX XX	Path Anchor Rods	36” long 1” diameter ASTM threaded rod	36	Ea.
05 XX XX	Path Base Plate	10" x 10" x 1/2" Steel Plate	18	Ea.
05 XX XX	Path Steel Column - Square Tube	HSS 4" x 4" x1/2" Tube, 7'-1"	4	Ea.
05 XX XX	Path Steel Column - Square Tube	HSS 4" x 4" x1/2" Tube, 10'-8"	4	Ea.
05 XX XX	Path Steel Column - Square Tube	HSS 4" x 4" x1/2" Tube, 9'-0"	5	Ea.
05 XX XX	Path Steel Column - Square Tube	HSS 4" x 4" x1/2" Tube, 12'-7"	5	Ea.
05 XX XX	Path Cap Plate	1/2" x 12" x 4" joins columns to I-beam cross-piece	18	Ea.
05 XX XX	Path Steel Cross Piece – I-beam	W6X12, 9'-1"	9	Ea.
05 XX XX	Path Steel Connector Piece - I-beam	W6X12, 7'-5"	4	Ea.
05 XX XX	Path Steel Connector Piece - I-beam	W6X12, 3'-11 1/2"	4	Ea.
05 XX XX	Path Steel Connector Piece - I-beam	W6X12, 3'-4"	4	Ea.

05 XX XX	Path Steel Connector Piece - I-beam	W6X12, 7'-4"	2	Ea.
05 XX XX	Path Long Clip Angle	L3x2x1/4 x 4"	72	Ea.
05 XX XX	Path Stiffener Plate	1/4" x 4" x 6 1/2" Steel, welded to column, bolts to connector piece	36	Ea.
05 XX XX	Path Bolts	3/4" diameter x 2" fasten W8x15 to cap plate, fasten W6x12 to stiffener plate	64	Ea.
05 XX XX	Path Lag Screws	3/8" diameter x 2 ½" attach cedar purlins to steel angle clips on W8x15	144	Ea.
05 XX XX	Fasten Master Headlok	2 7/8" Heavy Duty Flathead Fasteners – attach LSXRail to cedar purlin	100	Ea.
05 XX XX	Angle Iron	4" x 6" x 5"	264	Ea.
05 XX XX	Handrail Metal Support	1"x3/16" flat steel	146	L.F.
05 73 16	Metal Cable Railing	264 cable tensioners, 3/16" dia cable	3,168	L.F.
05 XX XX	Mechanical Fasteners for EPDM	2" Barbed Seam Plate	2	C.
05 XX XX	Mechanical Fasteners for EPDM	1 5/8" Screw Drill Point	2	C.
Division 06	Wood, Plastics and Composites			
06 15 33	Wood Ramps	Pressure-treat 2"x10" structural frame, 5/4" x 6" white cedar overlay	265	S.F.
06 15 33	Patio Decking	Pressure-treat 2"x10" structural frame, white cedar decking, 5/4" x 6"	556	S.F.
06 43 16	Wooden Railing posts	4x4 cedar posts	348	L.F.
06 43 16	Wood Guardrail	1x4 cedar	100	L.F.
06 43 16	Wood Handrail	1x1 ½ cedar	146	L.F.
06 16 53	Plywood Flooring	AdvanTech Flooring, Huber Engineered Woods, Tongue and Groove	1000	S.F.
06 16 53	Plywood Wall Sheathing	ZIP System Wall Sheathing, Huber Engineered Woods, 1/2"	4,400	S.F.
06 16 53	Finished Plywood Sheathing	¾" FSC Finished Birch Plywood	2,100	S.F.
06 17 23	LSL	Laminated Strand Lumber 1 1/4" x 9 1/2"	164	L.F.
06 XX XX	LSL	Laminated Strand Lumber 1 1/4" x 14"	102	L.F.
06 XX XX	LSL	Laminated Strand Lumber 1 3/4" x 9 1/2"	268	L.F.
06 17 53	LVL	Laminated Veneer Lumber, 1 3/4" x 14"	794	L.F.

06 17 13	LVL	Laminated Veneer Lumber, 1 3/4" x 18"	370	L.F.
06 XX XX	FSC Certified Lumber	2" x 4"	352	L.F.
06 XX XX	FSC Certified Lumber	2" x 8"	40	L.F.
06 XX XX	Cedar Purlin	4" x 6" x 12’	12	Ea.
06 XX XX	Cedar Purlin	4" x 6" x 8’	4	Ea.
06 XX XX	Lumber Framing Post	4" x 4" dimensional	56	L.F.
06 17 33	TJI 110	Joist Framing 14"	0.057	M.L.F.
06 17 33	TJI 210	Joist Framing 9 1/2"	0.2875	M.L.F.
06 17 53	Roof Truss	Open-web Parallel Chord Truss 18"	2500	L.F.
06 15 13	Patio Decking	Deck framing, treated lumber, white cedar decking, 5/4" x 6"	556	S.F.
06 XX XX	Siding	Reclaimed Barn Wood	1759	S.F.
Division 07	Thermal and Moisture Protection			
07 62 00	Sheet Metal Flashing and Trim	Sheet metal flashing, aluminum, flexible, mill finish, .013" thick, including up to 4 bends	600	S.F.
07 71 23	Aluminum Gutters	integrated with green roof system	62	L.F.
07 33 63	Green Roof	Eco Roof Green Tray 12" x 24" x 3.3"	300	Ea.
07 XX XX	Roof Cap	18 1/2" x 4" Green Roof Cap	62	L.F.
07 XX XX	Roof Cap	7" x 4" Green Roof Cap	121	L.F.
07 XX XX	Roofing Nails	2" 1LB EG Roofing Nail	2	Ea.
07 21 26	Cellulose Insulation	National Fiber Cel-Pak Blown Cellulose Insulation, variable thickness, R3.8 per lineal inch	4245	C.F.
07 21 26	Denim Insulation	Ultra Touch Recycled Denim Insulation	250	C.F.
07 27 26	EPDM	Rubber Waterproofing Membrane, 0.60mm x 10' x 100'	986	S.F.
07 XX XX	Drainage Layer	J-Drain GRS	600	S.F.
07 XX XX	Caulking	Zip-A-Way 10.1 oz Removable Weather Stripping (Irvine)	7	Ea.
07 XX XX	Caulking	GE Clear Window Seal 10.1 oz	7	Ea.
07 XX XX	Flashing Tape	4" x 100' Tyvek Flashing Tape	4	Ea.
07 XX XX	Shims	Millwork Pine Shims 14CT	8	Ea.
07 XX XX	Drip Cap	1/8" White Drip Cap 10'	7	Ea.
07 46 23	Wood Siding	Reclaimed barn siding (also listed in section 6)	1759	S.F.
07 42 13	Metal Wall Panels	Mechanical Module Exterior Walls	180	S.F.

Division 08	Openings			
08 14 13	Exterior Door	Intus EFORTE GRSN70416+18H+Grud4+18H+GrudSel4 42 11/16” × 88 1/8”	1	Ea.
	Exterior Door	Intus EFORTE GrudSel4+18H+Grud4+20H+Grud4 42 11/16” × 90 1/8”	1	Ea.
08 16 13	Exterior Door	Mechanical Room Exterior Door	1	Ea.
08 15 16	Bedroom Door	Pocket door	2	Ea.
08 53 13	Window	Intus EFORTE Tilt nrG4×20H×F4×18H×nrG4 71" × 16 1/2"	1	Ea.
08 53 13	Window	Intus EFORTE Tilt/Turn nrG4×20H×F4×18H×nrG4 23" X 46 1/2"	2	Ea.
08 53 13	Window	Intus EFORTE GrudSel4+18H+Grud4+20H+GrudSel4 42 5/8" × 22 1/2"	1	Ea.
08 53 13	Window	Intus EFORTE Tilt GrudSel4+18H+Grud4+20H+GrudSel4 77" x 69"	1	Ea.
08 53 13	Window	Intus EFORTE Tilt/Turn nrG4 × 20H × F4 × 18H × nrG4 47" X 46 1/2"	3	Ea.
08 53 13	Window	Intus EFORTE Tilt/TurnGrudSel6+16H+Grud4+18H+GrudSel6 77" × 69"	1	Ea.
08 53 13	Window	Intus EFORTE Tilt nrG4 × 20H × F4 × 18H × nrG4 62" × 69"	1	Ea.
08 53 13	Window	Intus EFORTE nrG4 × 20H × F4 × 18H × HxnrG4 47" × 22 1/2"	1	Ea.
08 91 19	Louver	Ruskin ELF375DX Extrudable Aluminum Drainable Stationary Louvers	2	Ea.
08 91 19	Louver	Ruskin ACL445 Formed Steel Stationary Acoustical Louver	1	Ea.
08 XX XX	Window	Bay Window	1	Ea.
Division 09	Finishes			
09 30 13	Ceramic Tiling	Porcelain 4"x24" Floor and Wall Tile	200	S.F.
09 30 33	Slate Tiling	Vermont slate floor tiling	38	S.F.

09 91 23	Interior Paint	Paints & Coatings, walls & ceilings, interior, concrete, drywall or plaster, zero voc latex, 3 coats, smooth finish, roller	1200	S.F.
09 93 23	Floor Finish	Vermont Natural Coatings PolyWhey Floor Finish	4	Gal
09 93 23	Wood Stain	Vermont Natural Coatings Heirloom Wipe-on PolyWhey	10	Qt
09 93 23	Exterior Wood Stain	Vermont Natural Coatings PolyWhey Exterior Siding	15	Gal
09 93 23	Furniture Finish	Vermont Natural Coatings PolyWhey Satin Furniture Finish	2	Gal
09 93 23	Wood Tint	Vermont Natural Coatings Woodtone Series Concentrated Tints in Cherry	2	Qt
09 97 13	Steel Coating	TNEMEC H.B. Tneme-TufCoat Dark Bronze	5	Gal
09 64 29	Wood Flooring and Trim	3/4" Sugar Maple Strip and Plank Flooring and Trim	959	S.F.
09 XX XX	Finished Birch Plywood	3/4" on walls and ceilings (also listed in Section 6)	2100	S.F.
Division 10	Specialties			
10 28 13	Mirror	Kohler Loure mirror K-11579-CP	1	Ea.
10 28 13	Towel Bar	Kohler Toobi towel bar	1	Ea.
10 28 13	Toilet Paper Holder	Kohler Toobi toilet tissue holder K-5672-CP	1	Ea.
Division 11	Equipment			
11 XX XX	Induction Range Top	Frigidaire Gallery 30", Black FGIC3067MB	1	Ea.
11 XX XX	Oven	Frigidaire 27”, FFEW2725LS	1	Ea.
11 XX XX	Range Hood	Whirlpool 36" Island Hood, GXI6536DXS	1	Ea.
11 XX XX	Refrigerator/Freezer	Frigidaire 17 ft.3 Top-freezer Refrigerator, FFHT1725PS	1	Ea.
11 XX XX	Dishwasher	Frigidaire Gallery, 24” FGHD2472	1	Ea.
11 XX XX	Clothes Washer	Bosch Axxis, 24" WAS20160UC	1	Ea.
11 XX XX	Clothes Dryer	Bosch Axxis, 24", WTE86300US	1	Ea.

Division 12	Furnishings			
12 XX XX	Under Counter Cabinets	Custom Cabinets, 34” tall, rule of thumb: kitchen cabinets, excl. counters & appliances, maximum	14	L.F.
12 XX XX	Shelves over Counter and Appliances	Custom Cabinets, rule of thumb: kitchen cabinets, excl. counters & appliances, maximum	16	L.F.
12 XX XX	Island Cabinetry	Custom Cabinets, rule of thumb: kitchen cabinets, excl. counters & appliances, maximum	7	L.F.
12 XX XX	Vanity	Custom Cabinets, rule of thumb: Bath cabinets, excl. counters & fixtures, maximum	2.5	L.F.
12 XX XX	Double door Laundry Cabinet	28"x60" Custom Cabinets, rule of thumb: Bath cabinets, excl. counters & fixtures, maximum	2	L.F.
12 36 13	Concrete Countertop	Stone Soup Pre-Cast Concrete (Kitchen and Bathroom)	110	S.F.
Division 13	Special Construction			
Division 14	Conveying Equipment			
Division 21	Fire Suppression			
21 13 13	Typical Wet Fire Sprinkler System	Sprinkler System Components, 6" fire cycle system, controls, includes panel, batteries, solenoid valves & pressure switches	930	SF/living
	Sprinkler head		8	Ea
Division 22	Plumbing			
22 11 23	Water Pump	Grundfos Pressure Boosting Pump MQ 3-35	1	Ea.
22 11 16	Typical Copper Rough Plumbing Waste Water System, Piping, Fittings, 1 kitchen & 1 bath		1	Project
22 33 13	Electric Water Heater	EcoSmart ECO11 Tankless Electric Water Heater	1	Ea.
22 33 30	Electric Water Heater	AO Smith Conservationist 40 Gallon Electric Water Tank	1	Ea.

22 41 13	Toilet	NIAGARA CONSERVATION Stealth 0.8 GPF UHET	1	Ea.
22 41 16	Kitchen Sink	KOHLER VAULT SINGLE BASIN SINK	1	Ea.
22 41 39	Kitchen Faucet	Kohler Simplice Polished Chrome	1	Ea.
22 XX XX	Vanity Bowl	Handmade ceramic vanity bowl	1	Ea.
22 41 23	Shower	Tiled Shower enclosure	1	Ea.
22 41 39	Showerhead	Kohler Awaken G90 2.0 GPM multifunction showerhead	1	Ea.
22 41 39	Vanity Faucet	Kohler Toobi Bathroom Sink Faucet	1	Ea.
Division 23	Heating, Ventilating, and Air-Conditioning			
23 31 13	Ductwork Rule of Thumb, cost per square foot of living area, Maximum	1/2 average	461	SF/living
23 72 00	Air-Air Heat Exchanger (Indoor Unit)	Daikin AC FTQ18PBVJU	1	Ea.
23 72 00	Air-Air Heat Exchanger (Outdoor Unit)	Daikin AC RZQ18PVJU9	1	Ea.
23 72 00	Energy Recovery Ventilator	UltimateAir, Inc. RecoupAerator Model 200DX	1	Ea.
Division 25	Integrated Automation			
25 XX XX	Control Damper	Ruskin CD60 Low Leakage Control Damper	1	Ea.
25 XX XX	Control Damper	Ruskin CDT!-50 Low Temperature Insulated Control Damper	2	Ea.
25 10 00	Generic Sensors, Router, Software for monitoring electrical circuits, heat and humidity		1	Project
Division 26	Electrical			

26 XX XX	PV Mounting Rack and Ground Lugs	Lumos LSXRail, Perforated - sized to array, ground lug per section of rail	1	Ea.
26 31 00	PV Panels	Lumos LSX240-60M-C Clear Glass Backing	26	Ea.
26 XX XX	PV Wire Extension	#10AWG PV wire with MC4 connectors, three lengths with male and female connectors	50	L.F.
26 XX XX	PV Array EGC	#6 AWG bare stranded copper – ground rail to rail across splice, ground end of rail to steel structure and junction box	25	L.F.
26 XX XX	Junction Box	NEMA 4X 8”x8” outdoor rated	2	Ea.
26 XX XX	Terminal Blocks	McMaster-Carr 7606k62 terminal blocks – rated 600V, 65 A, AWG18-6	6	Ea.
26 XX XX	Jumpers	McMaster-Carr 7606k37 jumpers	2	Ea.
26 XX XX	PV Source Circuit	#10 AWG THWN-2	100	L.F.
26 XX XX	PV Source Circuit	#6 AWG Bare Solid Copper	100	L.F.
26 XX XX	Inverter/DC Disconnect	PowerOne Aurora Uno PVI-6000-TL	1	Ea.
26 XX XX	AC Disconnect	SquareD Disconnect DU222RB 240V AC 2P 60A	1	Ea.
26 XX XX	Load Panel	SquareD 225A 42Circuit Main Lug Only Panel QO142L225G	1	Ea.
26 XX XX	Meter/Utility Disconnect	Milbank 200A 4 Meter Socket with 200A Breaker, U3990-XL-200	4	Ea.
26 XX XX	SE EGC	#4 AWG Bare Solid Copper	50	L.F.
26 XX XX	SE Cabling	300MCM Aluminum	50	L.F.
	Cable Cover	DO-Max Drop Over Cable Protector (where conduit crosses tour route to Organizer Panel)	1	Ea.
26 05 19	Home Circuits	#12-2 w/GG NM-B	500	L.F.
26 05 19	Home Circuits	#12-3 w/GG NM-B	50	L.F.
26 05 19	Home Circuits	#8-2 w/GG NM-B	30	L.F.
26 XX XX	Circuit Breakers	See E-603 for an itemized list of circuit breaker sizes		
26 05 19	Wire Splice Kit	Nsi - 2 Wire w/GG -- #12 - #14 AWG UL Listed	150	Ea.
26 05 19	Wire Splice Kit	Nsi - 3 Wire w/GG -- #12 - #14 AWG UL Listed	50	Ea.
26 XX XX	Indoor Receptacles	180VA AFCI	15	Ea.
26 XX XX	Indoor Receptacles	180VA GFCI	12	Ea.
26 XX XX	GFCI Weather Resistant Receptacle	Leviton WT599-KW Weather resistant 120V Duplex Receptacle	2	Ea.
26 XX XX	240V Receptacle		2	Ea.
26 XX XX	Receptacle Enclosure	Receptacle Enclosure for Weatherproofing	2	Ea.

26 XX XX	Light Switch	2-Way Toggle	10	Ea.
26 XX XX	Light Switch	2-Way Dimmer	2	Ea.
26 XX XX	Light Switch	3-Way Dimmer	2	Ea.
26 51 13	Pendant	Graypants Scrap Moon Pendant	1	Ea.
26 51 13	Pendant	SeaGull Single-Light Stainless Pendant 6519-98	1	Ea.
26 51 13	Pendant	E20263-10 – Hagen LED Pendant	2	Ea.
26 51 13	Sconce	Costanzina 120V White	2	Ea.
26 51 13	VANITY LIGHT	Lighting House LED Light Bar	1	Ea.
26 51 13	LED Strip	Coronis 240 Waterproof High Output LED Strip Light	9	L.F.
26 51 13	LED Strip	Coronis 240 High Output LED Strip Light	150	L.F.
26 56 00	Sconce	Lighting House 6” Cord Mount Cylinder	1	Ea.
26 56 00	Sconce	RAB SLIM18Y Bronze LED wallpack	2	Ea.
Division 27	Communications			
Division 28	Electronic Safety and Security			
28 31 00	Fire & Carbon Monoxide Alarm	First Alert AC powered alarm with battery backup. Model SC9120B	3	Ea.
Division 31	Earthwork			
Division 32	Exterior Improvements			
32 93 13	Ground Cover	Hay bales and potted plants	300	S.F.

Construction Specifications

Division 21 – Fire Suppression

21 00 10 Fire Suppression Piping

Division 22 – Plumbing

22 05 00 Plumbing General Provisions
22 10 05 Plumbing Piping
22 30 00 Plumbing Equipment
22 40 00 Plumbing Fixtures

Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)

23 05 00 Mechanical General Provisions
23 05 13 Common Motor Requirements for HVAC Equipment
23 05 16 Expansion Fittings and Loops for HVAC Piping
23 05 19 Meters and Gauges
23 05 48 Vibration and Seismic Controls for HVAC and Piping and Equipment
23 05 53 Identification for HVAC and Plumbing Piping and Equipment
23 05 93 Testing, Adjusting, and Balancing for HVAC
23 07 13 Duct Insulation
23 07 16 HVAC Equipment Insulation
23 07 19 HVAC Piping Insulation
23 23 00 Refrigerant Piping
23 31 00 HVAC Ducts and Casings
23 33 00 Air Duct Accessories
23 37 00 Air Outlets and Inlets
23 41 00 Air Filters
23 72 27 Air to Air Heat Recovery Units
23 81 27 Small Split-System Heating and Cooling

Division 25 – Integrated Automation

25 00 00 HVAC Instrumentation and Controls

Division 26 – Electrical

26 05 19 Low-Voltage Electrical Power Conductors and Cables
26 05 26 Grounding and Bonding for Electrical Systems
26 05 29 Hangers and Supports for Electrical Systems
26 05 34 Conduit
26 05 37 Boxes
26 05 53 Identification for Electrical Systems
26 24 16 Panelboards
26 27 01 Electrical Service Entrance
26 27 16 Electrical Cabinets and Closures
26 27 17 Equipment Wiring
26 27 26 Wiring Devices

SECTION 05 12 13
AESS (ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING)

PART 1 - GENERAL

1.01 DEFINITIONS

A. Architecturally Exposed Structural Steel: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.

1.02 SUBMITTALS

A. Shop Drawings: Show fabrication of AESS components. [Shop Drawings for structural steel may be used for AESS provided items of AESS are specifically identified and requirements below are met for AESS.]
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.[Indicate grinding, finish, and profile of welds.]
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.[Indicate orientation of bolt heads.]
   5. Indicate exposed surfaces and edges and surface preparation being used.
   6. Indicate special tolerances and erection requirements.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category [ACSE] [CSE].

1.04 DELIVERY, STORAGE, AND HANDLING

A. Use special care in handling to prevent twisting, warping, nicking, and other damage. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.05 PROJECT CONDITIONS

A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

1.06 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 - PRODUCTS

2.01 BOLTS, CONNECTORS, AND ANCHORS

A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

2.02 Finish: [Plain] [Mechanically deposited zinc coating].

A. Corrosion-Resisting (Weathering Steel), Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 3, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

2.03 PRIMER

A. Primer: Comply with [Division 09 painting Sections.] [Division 09 Section "High-Performance Coatings."] [Division 09 painting Sections and Division 09 Section "High-Performance Coatings."]

2.04 FABRICATION

A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.

B. In addition to special care used to handle and fabricate AESS, comply with the following:

1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
2. Grind sheared, punched, and flame-cut edges of [Category 1] <Insert categories> AESS to remove burrs and provide smooth surfaces and edges.
3. Fabricate [Category 1] <Insert categories> AESS with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
4. Fabricate [Category 1 and Category 2] <Insert categories> AESS with exposed surfaces free of seams to maximum extent possible.
5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
7. Fabricate [Category 1] <Insert categories> AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
8. Fabricate [Category 2 and Category 3] <Insert categories> AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.
9. Seal-weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates for [Category 1] <Insert categories> AESS.

C. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch (3.2 mm) with a tolerance of 1/32 inch (0.8 mm) for [Category 1] <Insert categories> AESS

D. Bolt Holes: Cut, drill, [mechanically thermal cut,]or punch standard bolt holes perpendicular to metal surfaces

E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
    1. Cut, drill, or punch holes perpendicular to steel surfaces.[Do not thermally cut bolt holes or enlarge holes by burning.]
    2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
    3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.05 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified
B. Joint Type: [Snug tightened] [Pretensioned] [Slip critical].

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
    1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
A. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
    1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work
    2. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION

A. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
    1. Erect [Category 1] <Insert categories> AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
B. Do not use thermal cutting during erection[unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M].

3.04 FIELD CONNECTION

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: [Snug tightened] [Pretensioned] [Slip critical].
2. Orient bolt heads [as indicated on Drawings] [in same direction for each connection and to maximum extent possible in same direction for similar connections].

B. Weld Connections: Comply with requirements in "Weld Connections" Paragraph in "Shop Connections" Article.

1. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for AESS.
2. Remove erection bolts in AESS, fill holes, and grind smooth.
3. Fill weld access holes in AESS and grind smooth.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 – GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Shop Drawings showing details of fabrication and installation.

PART 2 - PRODUCTS

2.01 METALS

A. Mechanical room grating. 1” aluminum I-bar, ped. span 56”. SGI series.

2.02 STEEL AND IRON FINISHES

A. Hot-dip galvanize steel fabrications at exterior locations.
B. Steel panel & interior ribbing architectural steel

PART 3 - EXECUTION

3.01 INSTALLATION

A. Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack.
B. Fit exposed connections accurately together to form hairline joints.

END OF SECTION

SECTION 05 52 00
METAL RAILINGS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Provide railings capable of withstanding a uniform load of 50 lbf/ ft. (0.73 kN/m) and a concentrated load of 200 lbf (0.89 kN) applied to handrails and top rails of guards in any direction. Uniform and concentrated loads need not be assumed to act concurrently.

B. Provide railing infill capable of withstanding a concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m). Infill load and other railing loads need not be assumed to act concurrently.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Fabricated by Lou Nop's Metal Shop to match drawings.

2.02 METALS

A. Stainless-Steel Strip: ASTM A 554, 1" width, 3/8" depth, length of hand rails

2.03 FABRICATION

A. Cut steel strips to dimension in shop.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install each strip sequentially, abutting ends in the middle of railing posts.

B. Set railings accurately in location, alignment, and elevation.

END OF SECTION

SECTION 06 16 00
SHEATHING (ZIP SYSTEM)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Combination wall sheathing, water-resistive barrier, and air barrier.
   2. Combination roof sheathing and roof underlayment.
   3. Self-adhering flexible flashing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. For panels with integral water resistive barrier, include data on air-/moisture-infiltration protection based on testing according to referenced standards.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Capable of demonstrating that all wood procurement operations are conducted in accordance with procedures and policies of the Sustainable Forestry Initiative (SFI) Program.

B. Code Compliance: Comply with requirements of the following:
   1. International Code Council (ICC), ICC-ESR1473 (ZIP System Roof Sheathing).
   2. International Code Council (ICC), ICC-ESR1474 (ZIP System Wall Sheathing).
   3. International Code Council (ICC), ICC-ESR2227 (ZIP System Tape).

1.04 DELIVERY, STORAGE, AND HANDLING

A. Outdoor Storage: Comply with manufacturer's recommendations
   1. Set panel bundles on supports to keep off ground.
   2. Cover panels loosely with waterproof protective material.
   3. Anchor covers on top of stack, but keep away from sides and bottom to assure adequate air circulation.
   4. When high moisture conditions exist, cut banding on panel stack to prevent edge damage.

1.05 WARRANTY

A. Include special Project warranties only in those Sections where availability has been verified with contractors and manufacturers. When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sheathing system that fail due to manufacturing defects within specified warranty period.
   1. System Warranty Period: 15 years from date of Substantial Completion.
   2. Panel Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 WOOD PANEL PRODUCTS

A. All Huber Engineered Woods panels contained in this Section are manufactured using orientated strand board.

B. Oriented Strand Board: DOC PS 2.

C. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

D. Factory mark panels to indicate compliance with applicable standard.

2.02 COMBINATION WALL SHEATHING, WATER-RESISTIVE BARRIER, AND AIR BARRIER

A. Oriented-Strand-Board Wall Sheathing: With integral water-resistive barrier, Exposure 1 sheathing.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Huber Engineered Woods LLC; ZIP System Wall Sheathing.
2. Span Rating and Nominal Thickness: Not less than 32/16; 1/2 inch (13 mm).
3. Edge Profile: Self-spacing profile.
4. Provide fastening guide on top panel surface with pre-spaced fastening symbols for 24-inches (610 mm) on centers spacings.
5. Performance Standard: DOC PS2 and ICC-ES ESR-1474.Factory laminated integral water-resistive barrier facer.
6. Perm Rating of Integral Water-Resistive Barrier: 12-16 perms.
7. Assembly maximum air leakage of 0.0072 cfm/sq. ft. (0.037 L/s x sq. *m) infiltration and 0.0023 cfm/ sq. ft. (0.012 L/s x sq.*m) exfiltration at a pressure differential of 1.57 psf (75 Pa).
8. Exposure Time: Designed to resist weather exposure for 120 days.

2.03 COMBINATION ROOF SHEATHING AND ROOF UNDERLAYMENT

A. Oriented-Strand-Board Roof Sheathing: [With integral water-resistive barrier, Exposure 1, Structural I] [With integral water-resistive barrier, Exposure 1] sheathing.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Huber Engineered Woods LLC; ZIP System Roof Sheathing.
2. Span Rating and Nominal Thickness: Not less than; 5/8 inch (15.9 mm)
3. Edge Profile: Tongue and groove.
4. Provide fastening guide on top panel surface with pre-spaced fastening symbols for 24-inches (610 mm) on center spacings.
5. Performance Standard: DOC PS2 and ICC-ES ESR-1473.
6. Factory laminated integral roofing underlayment facer.
7. Exposure Time: Designed to resist weather exposure for 120 days.

ZIP system™ ROOF & WALL SHEATHING

HUBER ENGINEERED WOODS

The all-in-one solution for roof and wall sheathing.

ZIP SYSTEM® ROOF AND WALL SHEATHING

MANUFACTURER

Huber Engineered Woods LLC
10925 David Taylor Drive, Suite 300, Charlotte, NC 28262
800.933.9220 • Technical Service: 800.933.9220 x2716
ZIPSystem.com • HuberArchitectLibrary.com

BASIC USE AND APPLICATIONS

ZIP System Roof and Wall Sheathing panels are oriented strand board (OSB) structural panels with built-in protective overlays that eliminate the need for building wrap or roofing felt. Install the panels, tape the seams with Huber's ZIP System tape, and the building is rough dried-in. A wide range of roof coverings and wall claddings can be installed directly over ZIP System Sheathing.

When used on a wall, ZIP System Sheathing functions as a combination wall sheathing, code-recognized water-resistive and air barrier. The sheathing panel seams are sealed with ZIP System tape, protecting the wall from water intrusion.

When Huber's ZIP System Sheathing is utilized for roof applications, felt underlayments are not required. In rwall and roof coverings systems requiring multiple layers of water-resistive barriers or underlayments, ZIP System is intended to replace only the first layer.

ZIP System Sheathing uses a tough, phenolic resign-impregnated overlay to provide permanent weather resistance, in concert with a proprietary seam tape that has been extensively tested for long-term adhesion and flexibility. This combination meets performance requirements for Grade D weather-resistive barriers in accordance with ICC Acceptance Criteria AC38.

ZIP System Sheathing may be used for roofs and walls in Type V construction, in Type III construction as roof sheathing only, and other construction permitted under the International Residential Code.

AVAILABLE SIZES

ZIP System Roof and Wall Sheathing panels are available in 4' x 8' sheets with self-spacing edge profiles and tongue and groove edge profile (5/8 only). ZIP System panels are Exposure 1 rated and are available in the following span ratings and performance categories:

- 24/16, Rated Sheathing, 7/16 PERF CAT (4' x 8')
- 24/16, Structural 1, 7/16 PERF CAT (4' x 9' and 4' x 10' only)

ZIP System Benefits

Superior Moisture Resistance	Continuous vapor permeable moisture barrier that blocks out liquid water but still allows walls to dry out.
Ease of Installation	No more delays because of felt or building wraps blowing off.
Energy Efficiency	Code-recognized built-in weather and air barrier.

- 32/16, Structural 1, 1/2 PERF CAT
- 40/20, Structural 1, 5/8 PERF CAT

Longer length panels are available for wall applications. Third party independent testing of ZIP System Roof and Wall Sheathing by Timberco, Inc. (TECO).

LIMITATIONS

When used as roof sheathing, ZIP System sheathing is limited to roofs with slopes of 2:12 (16.67 percent) or greater. Felt underlayment is not required on the roof. In roof covering systems requiring multiple layers of underlayment, ZIP System is intended to replace only the first layer. In wall covering systems requiring multiple layers of water-resistive barriers, ZIP System is intended to replace only the first layer.

ZIP System Sheathing should not be used with adhesively-attached EIFS, but can be used with mechanically attached EIF systems. Avoid exposing ZIP System Sheathing for more than 180 days.

SUSTAINABLE DESIGN CONTRIBUTIONS

- Low-Emitting Material: No added urea formaldehyde
- Sustainable Forestry Initiative Certified Wood: Harvested, transported, manufactured and distributed utilizing sustainable practices
- Renewable Forest Resources: Composed of primarily young growth bio-based resources
- Regional Materials: Made in the United States at one of our 4 regional manufacturing facilities.

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POTENTIAL LEED CREDIT CONTRIBUTIONS

- IEQ 4.4 Low-Emitting Materials, Composite Wood and Agrifiber: ZIP System Roof and Wall Sheathing contains no added urea formaldehyde
- MR 5.1 or 5.2 Regional Materials: Materials harvested, processed and manufactured within 500 miles of site
- MR 2.2 Environmentally Preferable Products - Local Production (LEED for Homes)
- EA 3 Air Infiltration - Meet air leakage requirements

APPLICATION

SUBSTRATE

Before beginning installation, verifying framing is properly spaced and aligned to support panels.

PANEL INSTALLATION

Install ZIP System Roof and Wall Sheathing in accordance with the following:

- ZIP System Sheathing Installation Manual
- ICC-ES ESR-1473
- ICC-ES ESR-1474
- Requirements of authorities having jurisdiction

When used as roof sheathing, install panels with moisture barrier surface facing out, with long edge perpendicular to framing members, spanning at least three framing members, and with short edges fully supported. Stagger short edge seams. Long edges are self-spacing; 4-foot panel edges should be manually spaced apx. 1/8 inch (3 mm) apart.

When used as wall sheathing, install panels positioned with the water-resistive barrier facing out. The panels may be installed with the long side of the panel oriented either horizontally or vertically to the framing members. Walls that are designed to resist lateral shear forces and sheathed with wood structural panels typically require solid framing or blocking behind all panel edges. Long edges are self-spacing; 4-foot panel edges should be manually spaced apx. 1/8 inch (3 mm) apart.

Fasteners:
Install fasteners approved by applicable building code. Install fasteners 3/8 inch (9.5 mm) from panel edges. Space fasteners 6-inches (152 mm) on centers on supported panel ends and 12-inches (305 mm) on centers at intermediate supports unless otherwise specified. ZIP System panels have a printed fastening guide for 16-inch (406 mm) and 24-inch (610 mm) on center fastener locations.

Tape Installation:
Install ZIP System tape in accordance with manufacturer's written instructions at seams, openings and penetrations. Install windows and window flashing in accordance with window manufacturer's written instructions. Details of installation recommendations are available in AutoCAD and .pdf formats at ZIPSystem.com and HuberArchitectLibrary.com.

STORAGE AND HANDLING

Store and handle products according to manufacturer's written recommendations. Support panel bundles off the ground. Cover stored panels with weatherproof protective material; allow sides of protective material to remain loose to assure adequate air circulation. In high-moisture conditions, cut bundle banding to prevent edge damage to panels.

AVAILABILITY

Huber Engineered Wood's ZIP System Roof and Wall panels are manufactured at multiple locations in the U.S. and are available through distributors nationwide; visit ZIPSystem.com or contact Huber Engineered Woods for a retailer near you.

WARRANTY

ZIP System Roof and Wall Sheathing is furnished with a 30-year system warranty as well as a 30-year warranty against manufacturing defects. Visit ZIPSystem.com for limitations and restrictions.

NOTES AND LIMITATIONS

- Do not use on roof with slopes less than 2:12.
- Do not install ZIP System tape in temperatures less than 20° F.
- Roof panels edge clips are only required with 7/16 inch thick ZIP System sheathing on supports spaced more than 16-inches oc. Panel edge clips approved to be used with ZIP System Sheathing are: Simpson Strong-Tie,® PSCA, PSCL and Tamlyn™ PCS models.

TECHNICAL SERVICES

Detailed information including specifications, product literature, test reports, installation instructions and special applications is available through Huber Engineered Woods. Please visit ZIPSystem.com or call 800.933.9220 x2716 to speak to a technical representative.

AVAILABLE RESOURCES

Section 06 16 00 SHEATHING guide specifications for ZIP System Roof and Wall Sheathing products in CSI 3-part format are available in MasterSpec,® ARCAT.com, BSD SpecLink,® ZIPSystem.com and HuberArchitectLibrary.com.

ZIP System Benefits		
Exposure Durability Classification	DOC PS 2	Exposure 1
Panel Grade	DOC PS 2	Structural 1 (except 4' x 8' 7/16 PERF CAT)
Moisture Barrier	AC38	Grade D WRB
Water Penetration	ASTM E331	Passed
Vapor Transmission	ASTM E96-B (panel overlay)	12-16 perms
Air Barrier Assembly	ASTM E2357	0.037 L/(s*m2)
Air Barrier Material	ASTM E2178	0.0016 L/(s*m2) @300 Pa
Wind Driven Rain	TAS 100 (at 100 mph)	Passed

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HUB-6360 06/13

2.04 FASTENERS

A. For roof and wall sheathing, determine type and spacing of fasteners acceptable to authority having jurisdiction.

B. General: Provide fasteners of size and type that comply with requirements specified in this article by the authority having jurisdiction, International Building Code, International Residential Code, Wood Frame Construction manual, and National Design Specification.

2.05 MISCELLANEOUS MATERIALS

A. Self-Adhering Tape: Pressure-sensitive, self-adhering, cold-applied, proprietary seam tape consisting of polyolefin film with acrylic adhesive.

1. Basis-of-Design Product: Subject to compliance with requirements provide Huber Engineered Woods; ZIP System Tape.
2. Thickness: 0.012 inch (0.3 mm).
3. Code Compliance: Comply with requirements of authorities having jurisdiction and ICC Evaluation Service, Inc. "AC148 (2006) - Acceptance Criteria for Flexible Flashing Material."

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Chapter 23 in ICC's "International Building Code."
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings.
4. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
5. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
6. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
7. Only mechanically attached and drainable EIFS and exterior insulation should be used with ZIP System wall sheathing.

3.02 WOOD STRUCTURAL PANEL INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:
    1. Wall and Roof Sheathing:
        a. Nail to wood framing.
        b. Screw to cold-formed metal framing.
        c. APA Recommends spacing panels 1/8 inch apart at edges and ends.
        d. Space panels 1/8 inch (3 mm) apart at edges and ends.
        e. Install fasteners 3/8 inch (9.5 mm) to 1/2 inch (12.7 mm) from panel edges.
        f. Space fasteners in compliance with requirements of authority having jurisdiction.

3.03 SHEATHING JOINT TREATMENT

A. Seal sheathing joints according to sheathing manufacturer's written instructions.
    1. Apply proprietary seam tape to joints between sheathing panels.
    2. Utilize self-adhering tape gun or hard rubber roller provided by manufacturer to ensure tape is completely adhered to substrates.

3.04 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturers written instructions.
    1. After flashing has been applied, roll surfaces with a hard rubber to ensure that flashing is completely adhered to substrates.

END OF SECTION

SECTION 06 17 53
TJI AND SHOP FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Truss Joist TJI Joist as structural wood for floors and wall sections.
   2. 18 inch Open-Web Wood Joist

1.02 QUALITY ASSURANCE

A. Manufacturer Qualifications: Capable of demonstrating that all wood procurement operations are conducted in accordance with procedures and policies of the Sustainable Forestry Initiative (SFI) Program.

B. Code Compliance: Comply with requirements of the following:
   1. International Code Council (ICC), ICC ES ESR-1153
   2. International Code Council (ICC), ICC ES ESR-1387

1.03 STORAGE AND HANDLING

A. Outdoor Storage: Comply with manufacturer's recommendations
   1. Protect product from sun and water
   2. Use support blocks at 10' on-center to keep bundles out of mud and water
   3. Use caution when handling wrapped product in icy or rainy conditions

B. Handling
   1. Do not walk on joists until braced.
   2. Do not stack building materials on unsheathed joists. Stack only over beams or walls.
   3. Do not walk on joists that are lying flat.

PART 2 - PRODUCTS

2.01 TRUSS JOIST TJI JOIST

A. As specified in construction documentation.

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.02 18" OPEN-WEB WOOD JOIST

A. As specified in construction documentation.

PART 3 - EXECUTION

3.01 INSTALLATION OF TJI, GENERAL

A. Do not use materials with defects that impair quality of wall or floor structure.

B. Cut beams at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. All blocking, hangers, rim boards, and rim joists at the end supports of the TJI® joists must be completely installed and properly nailed.
D. Lateral strength, like a braced end wall or an existing deck, must be established at the ends of the bay. This can also be accomplished by a temporary or permanent deck (sheathing) fastened to the first 4 feet of joists at the end of the bay.
E. Safety bracing of 1x4 (minimum) must be nailed to a braced end wall or sheathed area (as in note 2) and to each joist. Without this bracing, buckling sideways or rollover is highly probable under light construction loads—such as a worker or one layer of unnailed sheathing.
F. Sheathing must be completely attached to each TJI® joist before additional loads can be placed on the system.
G. Ends of cantilevers require safety bracing on both the top and bottom flanges. 6. The flanges must remain straight within a tolerance of 1⁄2" from true alignment.
H. DO NOT use sawn lumber for rim board or blocking as it may shrink after installation. Use only engineered lumber wood backer less than 5".
I. DO NOT bevel cut joist beyond inside face of wall.
J. DO NOT install hanger overhanging face of plate or beam. Flush bearing plate with inside face of wall or beam.

END OF SECTION

SECTION 06 18 00
GLUE LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Parallel Strand Lumber (PSL), Trus Joist, Parallam
   2. Laminated Veneer Lumber (LVL), Trus Joist, Microllam

1.02 QUALITY ASSURANCE

A. Manufacturer Qualifications: Capable of demonstrating that all wood procurement operations are conducted in accordance with procedures and policies of the Sustainable Forestry Initiative (SFI) Program.

B. Code Compliance: Comply with requirements of the following:
   1. International Code Council (ICC), ICC ES ESR-1387
   2. US Housing and Urban Development (HUD), HUD MR 1265

1.03 STORAGE AND HANDLING

A. Outdoor Storage: Comply with manufacturer's recommendations
   1. Protect product from sun and water
   2. Use support blocks at 10' on-center to keep bundles out of mud and water
   3. Use caution when handling wrapped product in icy or rainy conditions

1.04 WARRANTY

A. Limited Lifetime Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace LVLs and PSLs that fail due to delamination or manufacturing defects and pay cost of labor for the replacement.

PART 2 - PRODUCTS

2.01 Parallel Strand Lumber, Trus Joist, Parallam

A. As specified in construction documentation.

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.02 Laminated Veneer Lumber, Trus Joist, Microllam

A. As specified in construction documentation.

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of wall or floor structure.

B. Cut beams at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

END OF SECTION

SECTION 06 40 00
ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, Division 01 - General Requirements, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

1.02 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for architectural woodwork as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

1.03 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. American Wood Council (AWC):
   1. AWC DCA, "Design for Code Acceptance.

C. Architectural Woodwork Institute (AWI):
   1. AWI AWS, "Architectural Woodwork Standards."

D. ASTM (ASTM):
   1. ASTM D 523, "Standard Test Method for Specular Gloss."
   2. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials."

E. Forest Stewardship Council (FSC):
   1. FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

F. Hardwood Plywood and Veneer Association (HPVA):
   1. ANSI/HPVA HP-1, "American National Standard for Hardwood and Decorative Plywood" (copyrighted by HPVA, ANSI approved).
   2. HPVA HPH, "Hardwood Plywood Handbook."
   3. HPVA VSG, "Veneer Species Guide."

1.04 SUBMITTALS

A. General: See Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Submit product data for each type of product and process specified and incorporated into items of architectural woodwork during fabrication, finishing, and installation.

C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data, including, but not limited to, location of each item in dimensioned plans and elevations, large scale details, attachment devices, and other components.

D. Samples:
   1. Submit samples for initial selection. Submit samples of each specified finish. Submit samples in form of manufacturer's charts showing veneers and finishes available.

2. Submit samples for verification purposes. Additional samples may be required to show fabrication techniques and workmanship.

E. Quality Control Submittals:
   1. Fire Retardant Treatment Data: Submit fire retardant treatment data for material treated to reduce combustibility.

F. Submittals that comply with Middlebury Solar Decathlon environmental standards:
   1. Recycled Content Materials: Provide product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
   2. Regional Materials: Provide product data for regional materials indicating location and distance from the Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Distance shall be within 500 miles (805 Km) of the Project Site. Include statement indicating cost for each regional material and, if applicable, the fraction by weight that is considered regional.
   3. Certified Wood: Provide product invoice documentation, including, but not limited to, product description, FSC-claim, and chain-of-custody certificates, confirming what quantity, if any, of wood-based materials are certified in accordance with the Forest Stewardship Council (http://www.fsc.org) guidelines for wood products.
   4. Low-Emitting Materials: Submit cut sheet and/or CARB TPC certification by the manufacturer confirming that products (i.e., plywood, particleboard, medium density fiberboard, insulation, etc.) contain no added urea-formaldehyde resins

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

B. Quality Standard: Comply with AWI AWS for grades of architectural woodwork, construction, finishes, and other requirements. Provide AWI certification labels or AWI certificates of compliance indicating that woodwork meets requirements of grades specified

C. Surface Burning Characteristics: Provide materials with the following characteristics as determined by testing identical products per ASTM test method indicated below, by Underwriters Laboratories, Inc. (UL), Intertek Testing Services (ITS), Hardwood Plywood and Veneer Association (HPVA), or another inspecting and testing agency acceptable to authorities having jurisdiction.
   1. Surface burning characteristics shall not exceed values indicated below, tested per ASTM E 84.
   2. FLAME SPREAD OF 200 OR BELOW IS ACCEPTABLE FOR CLASS III (CLASS C) CODE REQUIREMENTS.
      a. Flame Spread: 200.
      b. Smoke Developed: 450.
   3. Veneer of a thickness of 1/28 inch (0.9 mm) or less can be applied to a fire-resistant core and still retain fire-resistant core properties according to AWC DCA.

A. Mock-Ups: Prior to installation of the work, fabricate and erect mock-ups for each type of finish and application required to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups using materials indicated for final unit of work.

A. Pre-Installation Conference: Conduct pre-installation conference in accordance with Section 01 31 19 - Project Meetings. Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Mock-ups shall be reviewed during the pre-installation conference. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Architect.

1.06 STORAGE AND HANDLING

A. Store decorative hardwood plywood and fabricated products in dry interior locations where temperature is maintained between 60°F (16°C) and 90°F (32°C) and relative humidity is maintained between 30 percent and 55 percent
B. Remove or loosen plastic wrappings. Sticker individual panels to hasten acclimatization.
C. Cover decorative hardwood plywood panels and fabricated products to protect from exposure to light until installed.
D. Protect decorative hardwood plywood from edge and surface damage

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install work until building is enclosed, wet-work is completed and nominally dry, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction perioD

PART 2 - PRODUCTS

2.01 MATERIALS

A. Core Hardwood Plywood: Provide PureBond® process domestic veneer core hardwood plywood as manufactured by Columbia Forest Products, as specified in construction documentation.
B. Thickness: As shown on the Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
    1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.02 PREPARATION

A. Condition work to average prevailing humidity conditions in installation areas before installing. Before installing work, examine shop-fabricated work for completion and complete work as required.

3.03 INSTALLATION

A. General: Install in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.
B. Quality Standard: Install architectural woodwork to comply with AWI AWS for the same grades specified in Part 2 - Products of this Section for type of architectural woodwork involvedd

C. Fire Retardant-Treated Wood: Handle, store, and install fire retardant-treated wood to comply with recommendations of chemical treatment manufacturer, including, but not limited to, those for adhesives used to install architectural woodwork.
D. Installation Tolerances: Install architectural woodwork plumb, level, true, and straight with no distortions. Shim as required with concealed shims.

3.04 ADJUSTING AND CLEANING

A. Repair damaged and defective work where possible to eliminate functional and visual defects. Where not possible to repair, replace the work.
B. Clean architectural woodwork on exposed and semi-exposed surfaces. Touch-up shop-applied finishes to restore damaged or soiled areas.

3.05 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the work shall be without damage at time of Substantial Completion.

END OF SECTION

SECTION 06 40 13
EXTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

Submittals: Shop Drawings.

Quality Standard: Architectural Woodwork Institute's "Architectural Woodwork Quality Standards."

Forest Certification: Provide woodwork produced from wood either sustainably harvested from Middlebury College's own forests or from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

PART 2 - PRODUCTS

2.01 MATERIALS

A. Hardboard: AHA A135.4.
B. Softwood Plywood: DOC PS 1.
C. Preservative Treatment: Comply with WDMA I.S.4 for items indicated to receive water-repellent preservative treatment.
D. Fasteners for Exterior Woodwork:
    1. Nails: hot-dip galvanized or stainless steel.
    2. Screws: hot-dip galvanized or stainless steel.

2.02 EXTERIOR WOODWORK

A. Wood Siding. Reclaimed barn wood. Variable width, 45° bevel.
B. Wood Moisture Content: 7 to 12 percent.
C. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
D. Exterior Standing and Running Trim: reclaimed barn wood as indicated on drawings.
E. Exterior Frames and Jambs: reclaimed barn wood.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install woodwork to comply with referenced quality standard for grade specified.
B. Install woodwork true and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.
D. Anchor woodwork to anchors or blocking in removable units to be attached to walls upon assembly. Fasten with countersunk concealed fasteners and blind nailing. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork.

E. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches (900 mm) long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.

END OF SECTION

SECTION 06 40 23
INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Shop Drawings

B. Quality Standard: Architectural Woodwork Institute's "Architectural Woodwork Quality Standards."

C. Forest Certification: Provide woodwork produced from wood obtained from Middlebury College Forests or from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

D. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is completed, and HVAC system is operating.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Includes material for kitchen cabinetry, desk, window sills, dining table, partition screens, bathroom vanity, closet doors and gussets

1. Hardboard: AHA A135.4.
2. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
3. Softwood Plywood: DOC PS 1.
4. Hardwood Plywood and Face Veneers: HPVA HP-1, made with adhesive containing no urea formaldehyde.
5. Maple hardwood, finish grade lumber.

2.02 INTERIOR WOODWORK

A. Complete fabrication to maximum extent possible before shipment to Project site. Disassemble components only as necessary, to completed in as few pieces as possible for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

C. Interior Standing and Running Trim for Transparent Finish: Premium maple or white birch.

D. Interior Standing and Running Trim for Opaque Finish: Premium eastern white pine.

E. Flush Wood Paneling for Transparent Finish: Premium grade.

1. Wood Species: Hard Maple
2. Matching of Adjacent Veneer Leaves: Book
3. Veneer Matching within Panel Face: Center-balance match.
4. Panel Matching: No matching between panels is required. Select and arrange panels for similarity of grain pattern and color between adjacent panels

F. Interior Ornamental Work for Transparent Finish: Premium maple or white birch.
G. Shop Finish of Interior Architectural Woodwork
    1. Finishes: Same grades as items to be finished.
    2. Finish architectural woodwork at the fabrication shop; defer only final touch up until after installation.
        a. Apply one coat of sealer or primer to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces.
        b. Transparent Finish: Vermont Natural Coatings clear furniture finish.
        c. Transparent Finish: Vermont Natural Coatings clear furniture finish.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
B. Install woodwork to comply with referenced quality standard for grade specified.
C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Fasten with countersunk concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed nailing, countersunk and filled flush with woodwork.
F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches (900 mm) long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
G. Anchor paneling to supports with concealed panel-hanger clips and by blind nailing on back-up strips, splined-connection strips, and similar associated trim and framing.
H. Cabinets: Install so doors and drawers are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation.
    1. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for 2-inch (50-mm) penetration into wood framing, blocking, or hanging strips.
I. Anchor countertops securely to base units. Seal space between backsplash and wall.

END OF SECTION

SECTION 06 43 16
RAILINGS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Comply with IRC, NFPA and ADAAG guidelines.

B. Supply construction drawings.

PART 2- PRODUCTS

2.01 Wood Products

A. 4”x4” cedar posts, 45° bevel on bottom to exterior of surface

B. 1”x5” cedar guardrail, 3/16” round on edges

C. 1” x 1 ½” cedar handrail, 3/16” round on edges

2.01 Metal

A. 1” x 3/16” steel strips, length of hand rails

B. Four 1” x 1” x ½” square steel tube handrail extensions – 1’ past the post, 1’ vertical

C. RailEasy cable and tensioner rail system

2.03 REFERENCE STANDARDS

A. ICC/ANSI 117.1 – Accessible and Usable Buildings and Facilities

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount the posts along the edge of the deck and ramps, flush and plumb. Secure with two 3/8” countersunk lag screws.

B. Install the RailEasy cable and tensioners.

C. Install guardrails and handrails. With handrails, leave 1” flat on top for attachment point, bevel remainder at 15° angle.

D. Apply tension to the cables.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submit manufacturer's product data, including installation instructions

B. Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended applications.

C. Warranty: submit manufacturer's standard warranty.

PART 2- PRODUCTS

2.01 INSULATION PRODUCTS

A. Cellulose insulation pneumatically blown dry into floors, walls, and roof assemblies/cavities.

NATIONAL FIBER
CEL-PAK INSULATION
Professional Cellulose for Cellulose Professionals

Cel-Pak Class 1 Cellulose Insulation

- SPECIFICATIONS -

National Fiber's Cel-Pak is a high quality, cellulose insulation for dense pack wall and ceiling applications. It is also installed as loose fill in flat attic areas in new construction and retrofit.

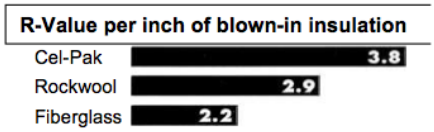
Cel-Pak is a premium, all-borate cellulose insulation. It is made almost primarily from over-issue news, which is the highest quality newsprint available. Our paper provides the best quality and fiber length for superior insulation. The quality of this newsprint and the purity and effectiveness of our special, all-borate chemical formulation, carefully blended in our state-of-the-art equipment, provide the optimum density for unsurpassed coverage and performance.

Cel-Pak's long, flexible fibers ensure void-free filling of the space to be insulated by sealing around wiring, plumbing, and other obstacles. This reduces air infiltration and results in a less drafty, more comfortable home.

ADVANTAGES OF CEL-PAK

- Low settled density provides superior coverage,
- Highly efficient thermal barrier (measured in R-value per inch),

  **R-value means resistance to heat flow. The higher the R-value, the greater the insulating capacity*



- Proven energy savings (conserves energy by reducing fuel consumption)
- Permanent fire resistance, with superior flame retardant qualities
- Significant sound barrier and moisture control (enhanced by dense fiber structure and naturally hygroscopic properties of the cellulose fiber)
- Contains no formaldehyde, asbestos or glass fibers
- Very clean (minimal dust)
- Highest recycled content of all common insulating materials, helping to preserve the environment

There are other factors to consider. The amount of insulation you need depends mainly on the climate you live in. In the Northeast, for example, R-38 is recommended for attics. Your energy savings also depend on the type and size of your home, your family size, and your comfort preferences.

To obtain the level of thermal insulation (R-Value) indicated, this insulation must be installed at the coverage rates shown in the chart below. Initial installed thicknesses were determined using a Krendl

2000 machine with shredder. Settings are not adjustable.

Average net weight 25 lbs

R-Value @75°F	Initial Installed Thickness (in.)	Minimum Settled Thickness (in.)	Bags Per 1000 sq.ft. No joists	Net Coverage sq.ft./Bag No joists	Minimum Weight lb/sq.ft.
Net Coverage - Attics - 25 lbs. - Settled Density 1.40 lbs/cu.ft.					
13	4.3	3.8	11.7	85.8	0.29
19	5.9	5.3	19.8	50.5	0.50
22	6.8	6.1	24.0	41.6	0.60
30	9.1	8.1	35.4	28.3	0.88
38	11.4	10.2	46.8	21.4	1.17
49	14.5	13.1	62.6	16.0	1.56
60	17.7	16.0	78.4	12.8	1.96
Net Coverage - Sidewalls - 25 lbs. - Settled Density 3.1 lbs/cu.ft.					
13	2 x 4	3.5	36.2	27.6	0.90
20	2 x 6	5.5	56.9	17.6	1.42

READ THIS BEFORE YOU BUY

What you should know about R-Values. The above chart shows the R-Value of this insulation. R means the resistance to heat flow. The higher the R-Value, the greater the insulating power. Compare insulation R-Values of cellulose with other insulating materials before you buy.

To get the indicated R-Value, it is essential that this insulation be installed properly. If you do it yourself, get instructions and follow them carefully. Instructions do not come with this package.

R & D Services Inc.
Classified
Cel-Pak Cellulose Insulation
Reference File: RDS-LF9256

This product meets the amended CPSC standard for flame resistance and corrosiveness of cellulose insulation.

Cel-Pak is periodically retested by R & D Services to assure compliance with Federal Specifications. In addition, we maintain a fully equipped on-site laboratory for monitoring product quality on a daily basis.

CPSP Standard HH-I-515E; 16CFR 1209

Meets ASTM C739 Class 1/A Building Material

Classified in accordance with the following ASTM C 739 characteristics

Flammability Characteristics

Critical Radiant Flux	Greater than or Equal to 0.12 W/cm^2
Smoldering Combustion	Less Than or Equal to 15.0%

Environmental Characteristics

Corrosiveness	Acceptable
Fungi resistance	Acceptable

Physical Characteristics

Density (Settled)	1.4 lb/ft^3
Thermal Resistance	3.8 R/in. (at 4 in.)
Moisture Vapor Sorption	Acceptable
Odor Emission	Acceptable

B. Denim insulation installed in cavities in panels.

specifications

UltraTouch™ Denim Insulation

UltraTouch™ can be used in both interior and exterior walls as well as most ceiling applications. The product easily installs in either wood or metal framing cavities by using a simple friction fit. The product is safe to handle and install without the need for protective clothing or special respiratory equipment.

- **Environmentally Safe**
- **Class-A Fire Rated**
- **Maximum R-value**
- **Superior Acoustics**
- **Resists Mold and Mildew**
- **No Formaldehyde**
- **No Itch or Skin Irritation**
- **LEED™ Eligible Product**

wood framing:

PRODUCT CODE	R-VALUE*	THICKNESS	(MM)	WIDTH	(MM)	LENGTH	(M)	SQ. FT.	PCS./BAG	WT. LBS.
10002-81532	8	2.0"	51	15"	381	32'	9.75	120	3	20
10002-82332	8	2.0"	51	23"	584	32'	9.75	122.66	2	20
10002-01315	13	3.5"	89	15"	381	93"	2.32	77.52	8	32
10002-01323	13	3.5"	89	23"	584	93"	2.32	118.8	8	49
10002-01915	19	5.5"	140	15"	381	93"	2.32	48.45	5	28
10002-01923	19	5.5"	140	23"	584	93"	2.32	74.25	5	43
10002-02115	21	5.5"	140	15"	381	93"	2.32	48.45	5	32
10002-02123	21	5.5"	140	23"	584	93"	2.32	74.25	5	49
10002-03015	30	8.0"	203	15"	381	48"	1.22	25.0	5	22
10002-03023	30	8.0"	203	23"	584	48"	1.22	38.35	5	34

metal framing:

PRODUCT CODE	R-VALUE*	THICKNESS	(MM)	WIDTH	(MM)	LENGTH	(M)	SQ. FT.	PCS./BAG	WT. LBS.
10000-81632	8	2.0"	51	16.25"	413	32'	9.75	129.99	3	22
10000-82432	8	2.0"	51	24.25"	616	32'	9.75	129.34	2	22
10002-01316	13	3.5"	89	16.25"	413	94"	2.36	84.88	8	35
10002-01324	13	3.5"	89	24.25"	616	94"	2.36	126.63	8	54
10002-01916	19	5.5"	140	16.25"	413	94"	2.36	53.04	5	31
10002-01924	19	5.5"	140	24.25"	616	94"	2.36	79.15	5	46
10002-02116	21	5.5"	140	16.25"	413	94"	2.36	53.04	5	35
10002-02124	21	5.5"	140	24.25"	616	94"	2.36	79.15	5	52
10002-03016	30	8.0"	203	16.25"	413	48"	1.22	27.10	5	24
10002-03024	30	8.0"	203	24.25"	616	48"	1.22	40.40	5	36

*Tested in accordance with ASTM C-518 at a temperature of 75° F. Higher R-values equal greater insulating power.
Note: Full recovery may take up to 72 hrs. after removal from package.

MADE FROM 100% RECYCLED DENIM

technical information

product compliances:

UltraTouch™ Insulation meets the requirements, specifications, standards and building practices of the following trade organizations.

BOCA Building Officials & Code Administrators
CABO Council of American Building Officials
ICBO International Conference Building Officials
LEED Leadership in Energy & Environmental Design
SBCCI Southern Building Code Congress International
California Bureau Thermal Insulation License # TI-1367, Reg. # CA-T367AZ
Environmental Spec. #1350 **ICC Evaluation** Report #1134 **LARR** ICC ER #1134

physical properties:

PROPERTY	PERFORMANCE	TEST METHOD
Surface Burning Characteristics	Flame Spread 5 (Class-1)	ASTM E-84
Fire Hazard Classification	Smoke Developed 35 (Class-1)	UL-723
Corrosion Resistance	Passed	ASTM C-739
Fungi Resistance	Passed: (No Growth)	ASTM C-739
Bacteria Resistance	Passed: (No Growth)	ASTM C-739
Moisture Absorption	Passed: (Less than 15%)	ASTM C-739
Fire Test of Building Material	Passed: (1-Hour Rating)	ASTM E-119/UL-263

accoustical performance:

R-VALUE	THICKNESS	(MM)	ABSORPTION COEFFICIENTS @ OCTAVE BAND FREQUENCIES (HZ) 125	250	500	1,000	2,000	4,000	NRC/STC
R-13	3.5"	89	0.95	1.3	1.19	1.08	1.02	1.0	1.15 NRC
R-13	3.5"	89	21	40	48	52	46	48	45 STC
R-19	5.5"	140	0.97	1.37	1.23	1.05	1.0	1.01	1.15 NRC
R-19	5.5"	140	40	53	57	63	53	63	57 STC

Sound Absorption was tested in accordance with ASTM E90-02, ASTM C423 (Type A mounting per ASTM E 795)

Bonded Logic INC.

www.BondedLogic.com

BONDED LOGIC, INC. 24053 S. Arizona Avenue Chandler, Arizona 85248 phone 480.812.9114 fax 480.812.9633

2.01 MANUFACTURER

A. National Fiber Cel-Pak: www.nationalfiber.com

B. Bonded Logic Ultra Touch Denim Insulation: www.bondedlogic.com

2.03 REFERENCE STANDARDS

A. ASTM C 739 – Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation.

B. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

C. ASTM E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials.

D. CPSC Standard 16 CFR Parts 1209 and 1404.

E. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Blown in cellulose insulation in areas and in thicknesses indicated or required to produce R-values indicated.

B. Cut pieces from batts and fit tightly around obstructions and fill voids with denim insulation in areas between panel joints.

3.02 QUALITY CONTROL

A. Manufacturer’s Qualifications for cellulose: Manufacturer regularly engauged for past 10 years in manufacture of cellulose insulation of similar type to that specified.

B. Installer's Qualifications:

1. Installer regularly engauged, for past 1 year, in installation of cellulose insulation of similar type to that specified.
2. Employ persons trained for installation of cellulose insulation.
3. Installer: Certified by cellulose insulation manufacturer.

C. Installer’s Equipment: Approved by cellulose insulation manufacturer.

D. For denim, insulation can be installed by decathlete without special equipment

END OF SECTION

SECTION 07 33 63
GREEN ROOF

PART 1 - GENERAL

1.01 SCOPE

A. Provide equipment, materials, tools, and labor to install vegetated roofing modules. Modules to include growth media and plants. This work shall also include edge treatments, custom shaping of modules, and installing paver stones or ballast, slip sheet/root barrier and irrigation system, if specified.

1.02 SUBMITTALS

A. Product data for vegetated roofing systems.
B. Planting mix design indicating species.
C. Shop Drawings: Indicating layout of modules, pavers, irrigation, and green roof area (ft^2 or m^2).
D. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
E. Maintenance instructions for inclusion into owner's manuals.

1.03 QUALITY ASSURANCE

A. No deviation should be made from this specification. Installer assumes liability for any deviations from specification.
B. Only EcoRoof Certified Installer personnel shall complete all work.
C. Prior to installing EcoRoof modules, the following procedures are to be conducted:
    1. The building Owner, Architect, or Engineer shall verify that the roof is properly designed and constructed to adequately support the load of the EcoRoof system.
    2. The roof is to be flood tested for water tightness for 24 hours. Water testing shall be witnessed and confirmed in writing by Owner's Representative and/or Design Professional, Waterproofing Contractor, Membrane Manufacturer, and Installation Contractor.
    3. Slip sheet/root barrier to be properly installed, seams overlapped and bonded, in accord with architect's and manufacturer's specifications.
    4. The roof is to be inspected and determined ready to accept the EcoRoof modules by a Technical Representative of the Installer.

A. During the EcoRoof installation and afterward, an inspection is to be conducted by a Technical Representative of the installer to verify that the EcoRoof modules have been installed tight against each other, in straight rows, corners aligned, properly oriented, and tight against the edging.

1.04 PRE-INSTALLATION MEETING

A. Installer to convene one week before starting work of this section. Review LiveRoof Installation Standardized Procedures with supervisory staff and installation team.
B. Schedule certified installation personnel to supervise entire green roof installation.
C. Ensure that the slip sheet material meets membrane and green roof manufacturer specifications.
D. Ensure that edging is perforated at the bottom to allow water to drain freely and is installed between modules and stone ballast or wherever parapet or paver is of insufficient height/thickness to contain the soil from the subterranean green roof modules.Ensure that soil and debris will be swept clean before placing each module.
E. Configure installation to minimize or eliminate walking on the plants during installation.

PART 2 - PRODUCTS

2.01 VEGETATED ROOFING MANUFACTURER

A. Eco
   1. Any other products must confirm to all performance criteria, documentation, submittals, soil specification, planting methods and plant material.
   2. Any other products must be approved by architect and owner prior to award.

B. 100 mil. thick (sidewall) recycled polypropylene and colored black or gray with dimensions of 1' x 2' x 3.3" for the Standard System.

C. Saturated weight with mature vegetation: approximately 27-29 lbs/ft² for the Standard System.

D. Module clearance above roof deck: ½ inch.

E. EcoRoof module is to be planted with green roof plants specified in Section 2.3. Plants are to be grown to maturity (appx. 95%+ soil coverage).

2.02 GROWING MEDIUM

A. Growing medium is an engineered blend of inorganic and organic components based upon German FLL granulometric guidelines and to contain ecologically sustainable levels of organic content.

2.03 SLIP SHEET

A. Provided by Membrane Manufacturer. Confirm compatibility of slip sheet and waterproofing membrane with manufacturer

B. Conventional Membrane Roof Assembly
   1. Minimum 1-1.5 mm (40-60 mi) thickness with overlapped and effectively bonded seams to ward against root penetration and to keep waterproofing layer safe and clean from soil during installation. Slip sheet/root barrier typified as follows:
      a. Welded Seam Types - 1 mm (40 mil) or greater thickness
         - TPO, with seams heat welded
         - PVC, with seams heat welded
         - Polypropylene, with seams heat welded
         - HDPE, with seams heat welded
      b. Glued Seam Types - 1 mm (40 mil) or greater thickness
         - EPDM, with seams overlapped a minimum of 75 mm and glued with roll out adhesive or double sided tape adhesive of the type that is impervious to and not affected by moisture, and recommended by the manufacturer.
         - Low profile drain board of appx. 0.5 mm (17 mil) thickness, with edges overlapped 75 mm and glued with manufacturer approved adhesive.
   2. Protected Membrane Roof Assembly
      a. A minimum .25mm (10 mil) thick slip sheet of woven polyethylene or other non-moisture holding material to be installed above the membrane and below the insulation, as specified by membrane manufacturer.
      b. A minimum .25mm (10 mil) thick slip sheet of woven polypropylene or other non-moisture holding material to be installed above the insulation and below the green roof modules, as specified by membrane manufacturer.

C. Do not use duct tape or adhesive for seaming that is not approved by the membrane manufacturer.

D. Never use moisture holding fabric, such as needle-punched polyethylene or felt, under the green roof system. Such materials are trap aggregate and are impossible to sweep during installation and stay wet and encourage root growth and root penetration, which is especially detrimental if woody plants

become established as such plants have woody root systems and may potentially cause roof leaks. This could lead to impeded drainage and compromise plant health.

E. In cases where electronic leak detection may be desired, a fiber-backed drainboard may be used. Fiber-backed drainboards are only recommended when electronic leak detection is desired, and only when vegetated with Sedums or Sempervivums, or other succulents, as these plants are sparsely-rooted and not prone to rooting into the fiber of the drainboard.

PART 3 - EXECUTION

3.01 PREPARATION OF ROOF SURFACE

A. Slip sheet/root barrier (JDRain GRS), specified by architect and approved by EcoRoof and membrane manufacturer, of 1-1.5 mm (40-60 mil) thickness with overlapped and effectively bonded seams to ward against root penetration and to keep waterproofing layer safe and clean from soil during installation.
    1. Do not use duct tape or adhesive for seaming that is not approved by the membrane manufacturer.
    2. Never use moisture holding fabric, such as needle-punched polyethylene or felt, under the green roof system.
B. Experienced Contractor to install slip sheet/root barrier in accordance with manufacturer's recommendations.
C. All surfaces to be smooth, free of debris, soil, and grit prior to placing modules. All materials to be tested water tight and free draining prior to module placement.
D. All surfaces to be maintained clean and free of debris, soil, and grit during installation process via use of broom. Never walk upon such materials as they may damage membranes.

3.03 INSTALLATION SEASON

A. Module Installation to be conducted when plants are:
    1. Properly adapted and acclimatized to local weather conditions.
    2. When weather is above 35° F and there is no ice on the roof and LiveRoof soil is unfrozen.
    3. No later than the cut off date required by the green roof system provider's warranty terms.
    4. When plants cover 95% or more of soil surface.

3.04 DELIVERY, STORAGE, HANDLING, PROTECTION

A. EcoRoof modules are to be delivered in good condition free from shipping damage.
B. Keep EcoRoof modules out of sun on job site if plastic wrapped to avoid overheating.
C. EcoRoof modules are to be installed on the roof top within 8 hours of delivery.
D. On the job site, EcoRoof modules are to be handled to prevent damage to the modules themselves and all roofing components.
E. To ensure optimum plant condition and safety, modules must be conveyed to the roof using Hoppits or similar rack designed specifically for this use and constructed according to engineer approved and stamped plans. DO NOT stack modules during conveyance to rooftop or installation.
F. EcoRoof modules are to be conveyed to roof surface with equipment that is designed to carry the collective load of the EcoRoof modules and transport vehicle or Hoppit®. Account for decreasing load limits when boom (of crane or fork lift) is extended. Use crane stabilizers and take all necessary precautions to protect building and personnel.
G. Never exceed the load capacity of the roof deck when placing LiveRoof modules on the roof.

H. When suspending EcoRoof modules and conveyance vehicle or Hoppit® above deck, take precautions to stabilize vehicle and prevent twisting of conveyance vehicle or Hoppit®. Two layers of Styrofoam or 4 to 8 tires laid on the deck are recommended.
I. Surround area below conveyance vehicle and/or crane with caution/stay clear tape to prevent potential injury.
J. During installation, protect the roof deck and membranes with appropriate material such as plywood sheeting. Never scrape or puncture slip sheet or membranes. Keep roof surfaces free of soil, grit, or debris at all times with broom not blower. Never set LiveRoof modules on top of soil, dirt or grit.
K. Transport carts to have pneumatic tires, to be wheeled about only upon protective plywood sheeting, and to be loaded so as not to exceed weight capacity of roof deck.

3.05 SAFEGUARDING SYSTEM INTEGRITY

A. Before working on roof, all Installers and Laborers to be:
    1. Properly instructed in safety procedures and provided LiveRoof Guide to Standardized Installation Procedures.
    2. Instructed to keep all work surfaces clean and debris free.
    3. To report immediately any damage to membranes, protective sheeting, or drain elements to supervisor, and to make appropriate repairs before proceeding.
    4. Instructed in proper methods of EcoRoof installation by certified representative of installation company.

3.06 LAYING (PLACING) MODULES

A. EcoRoof module installation to follow behind installation of slip sheet/root barrier, irrigation system, pavers, ballast, and edging.
B. EcoRoof installation to be conducted in strict accordance with LiveRoof installation guidelines. Surface to be swept clean and free of soil, dirt, stones or grit before placing each module. Rows to be straight, modules to be tight against each other with edges overlapping and arranged in proper directional orientation.
C. EcoRoof modules to be placed directly on top of appropriate JDRain-GRS barrier.
D. It is recommended that any custom cutting/fitting be oriented on the high side (top), or sides of the roof. It is recommended that the cut side of the module be set tight against the edging or toward the side of an intact module so as to prevent soil spillage. If custom cutting must be done on the low, draining, side of the roof, it is imperative that no filter cloth be inserted as it could impede drainage. It is best to orient the cut side against another module, facing upstream.
E. After installing modules, they should be immediately watered so as to thoroughly moisten the media from top to bottom. Water shall be of suitable quality for plant growth and irrigation system or hoses and sprinklers may be used for such purpose. Note: it takes approximately 1 inch of water for the Standard System, or 1 ¼ gallons per module for the Standard System to moisten each module thoroughly.
F. First maintenance visit to be conducted two (2) weeks after installation is completed and continued according to Section 3.8.

3.07 WARRANTY

A. 20 Year Module Limited Warranty: EcoRoof, LLC shall provide limited twenty (20) year guarantee that product will be free of material defects and against photodegradation.
    1. Installer shall complete and submit warranty registration form and post-installation punch list to EcoRoof, LLC within 60 days of delivery to complete warranty registration.

3.08 MAINTENANCE

A. Documentation
   1. Upon email request, EcoRoof, LLC shall provide twice monthly informational email maintenance protocol, free of charge, that shares current best maintenance practices, seasonal topics related to plant care, and chronologically guides the maintenance contractor though the various steps of the maintenance protocol beginning March 15 and ending Nov. 1 of each year.
   2. Record all green roof maintenance events. Include name of person, date and activity.
      a. If soil test, record lab, test, and results
      b. If fertilizer, record type and amount applied per 1000sf
      c. Record time needed for bi-weekly weed walk and drain inspection
      d. If irrigation, record duration and quantity

B. Foot Traffic: Limit foot traffic to a random path a couple times per week by one person. Avoid walking in a single path, standing in one place, or trampling plants. If parapet or adjoining wall must be serviced, plants may be covered with plywood or foam sheeting for up to 4 hours intermittently, provided foliage is not wet or frozen and conditions are not too hot or sunny.

C. Spring Maintenance (March to June)
   1. Soil Testing and Fertilization. Approximately 2-3 weeks before spring "growth flush," administer an annual soil test for PH and fertility levels. Growth flush varies by region, consult biweekly maintenance protocol email for specific recommended testing date in project's region.
   2. Maintain pH in the range of 6.5 to 8.0. In the event that pH falls below 6.0, consult the testing lab for appropriate recommendations to increase alkalinity. If the soil is above 8.0, it can be made more acidic with elemental sulphur or an application of acidifying fertilizer.
   3. Maintain fertility in the normal range using a typical field soil fertility test as provided by A&L labs or equivalent testing lab. Evaluate the various nutrient levels such as Nitrogen (N or NO_3N), Potassium (K), Phosphorus (P). If the soil contains a low (L) amount of these nutrients, conduct a single application of controlled release fertilizer, such as Nutricote® or Osmocote®, at the lab recommended rate. Ensure that the chosen fertilizer contains NO Herbicides or Pesticides. Follow the fertilizer labeled directions for application rate and use a rotary spreader to ensure even fertilizer application. Runoff potential does exist and should be evaluated by the applicator in accord with the site specifics; the greater the runoff sensitivity, the lower the application rate. All applications of fertilizer are the sole responsibility of the applicator.
   4. Mowing (optional)
      a. If desired, conduct a single annual mowing in early April. Set the mower blade just above the foliage in order to remove dried seed heads. Do not bag the clippings; instead, blow them into the green roof so that they can decompose and nourish the soil.
      b. Be safe, use protective equipment, including harnesses if required. Make sure the roof is free of frost or other slipping hazards.
   5. Conduct Biweekly Inspections
      a. Weed Walk: Pull and dispose of all weeds before they flower and set seed. NEVER allow any woody plant to establish in a green roof system, as they have deep root systems which can damage roofing membranes.
      b. Displaced Soil: Nesting birds may displace soil. Replace lost soil using only LiveRoof brand engineered green roof soil.

c. Drainage Inspection: Inspect roof drains for any debris, pebbles or leaves and remove to ensure proper drainage.
d. Debris Removal: Remove any debris blown onto the roof immediately to ensure no damage to plants.
e. Pest Control: Monitor pest presence, as most pest problems are the result of an imbalance in the relationship of pest organism and its natural biological controls and these problems may self-correct. If pest problems are persistent, use organic and natural biological control agents to restore balance. Pesticide use is discouraged and should always be considered secondary to cultural and biological control measures, as pesticides can contaminate runoff water and cause environmental damage. Pesticides shall only be applied by qualified and licensed applicators, and only as required. All applications of pesticides are the sole responsibility of the applicator.

D. Summer Maintenance (June to September)
1. Conduct Biweekly Inspections
2. Irrigation
a. When planted with drought tolerant succulents, irrigation recommended as a temporary management tool during prolonged hot dry weather to prevent plant thinning or death. Prolonged hot dry weather is generally defined as periods of 75° F weather with less than 1" of rainfall persisting for 2 weeks for the Lite system and 4 weeks for all other systems. This time period will be less if the temperatures are hotter, the climate warmer, on sloping roofs, and roofs exposed to persistent winds or reflected sunlight. Such conditions can dry out the soil and can cause plant dormancy or, in extreme cases, death.
b. There are no absolutes when it comes to irrigation. Check the plants for wilting in the afternoon. Water thoroughly to runoff to remoisten entire soil profile if the plants show signs of wilting.
c. Shaded areas require less irrigation

E. Fall Maintenance (October to November)
1. Conduct Biweekly Inspections, unless ice or frost is present.
2. Do Not Fertilize during the fall. It may stimulate tender growth and compromise the cold hardiness of the plant material.
3. Do Not Water Period: For the northern temperate zone, LiveRoof recommends that you do not water within 4 weeks of the expected average frost date. Normally, there is plenty of moisture this time of year, and adding additional water may compromise the durability of the plants to endure winter's cold. For this reason, watering during the winter is also not recommended.
4. Rake, bag and remove fallen and matted leaves. These can smother the green roof plants.

F. Winter Maintenance
1. Northern Temperate Climates
a. Watering is not recommended.
b. Avoid walking on frozen plants and roof surfaces as they are slippery and dangerous.
c. If clear pathways are needed, avoid using salt and other deicing chemicals, which may kill plants and damage pavers. Instead, use sand or cat litter as an anti-slip agents. Consider use of heat strips with pavers, provided they can be applied without damage to the roofing membrane.

2. Avoid piling the snow in a single place. Disperse snow evenly over the green roof plantings as excess snow piling can potentially damage plants by insulating the plants and keeping them warm and wet, thereby triggering fungal diseases.
3. Warm Climates
    a. Conduct Biweekly Inspections, unless ice or frost is present.

3.09 ACCEPTANCE

A. Conduct post installation inspection to determine acceptance of modules. Inspection to be made by General Contractor's Representative or by Owner's Representative upon General Contractor's request; five working days notice required.
B. Installer is responsible to complete requirements to obtain confirmation of warranty from the green roof systems manufacturer.
C. Installer is responsible to ensure proper module/plant maintenance until work has been accepted by representative of Owner or General Contractor.
D. Upon acceptance, Owner assumes responsibility for module/plant maintenance unless otherwise specified.

3.10 CLEAN UP

A. Throughout installation, keep all work surfaces clean and free of grit, dirt, or debris. Use broom not blower, do not sweep soil under modules or slip sheet. Following installation, remove all excess materials and tools from job site. Ensure that any damage that occurs as a result of installation is appropriately and immediately repaired.

END OF SECTION

SECTION 07 61 00
SHEET METAL ROOFING & ACCESSORIES

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data and Color Samples.

B. Comply with SMACNA's "Architectural Sheet Metal Manual" unless otherwise indicated.

C. Warranties: Provide manufacturer's standard written warranty, signed by manufacturer agreeing to promptly repair or replace roofing sheet metal that shows evidence of deterioration of factory-applied finishes within 25 years from date of Substantial Completion

D. Warranties: Standard form in which roofing Installer agrees to repair or replace sheet metal roofing that fails in materials or workmanship within two years from date of Substantial Completion and Installation on the Middlebury College campus.

PART 2 - PRODUCTS

2.01 ACCESSORIES

A. Roof Accessories

1. Metal ridge cap: Custom design to match metal roofing.

B. Custom fabricated boots at all roof penetrations. Metal to match roofing

C. Metal flashing at eave and rake. Custom fabricated as drawn. Metal to match roofing.

D. Flashing to cover heat dissipaters for solar hot water system. Metal to match roofing

2.02 FABRICATION

A. Fabricate sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of installation indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Anchor roofing securely in place, with provisions for thermal and structural movement. Install with concealed fasteners unless otherwise indicated.

B. Separate dissimilar metals with a bituminous coating or polymer-modified, bituminous sheet underlayment.

C. Seal joints as shown and as required for leakproof construction. Note that roof panel seams will need provision of a neoprene, or approved equal, gasket for ease of assembly and disassembly.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data, Shop Drawings, and Samples.

B. Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

C. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.01 SHEET METAL

A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, not less than 0.032 inch (0.8 mm) thick; and with mill finish.

2.02 FABRICATION

A. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.

B. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

PART 3 – EXECUTION

3.01 INSTALLATION

A. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

B. Fabricate nonmoving seams in sheet metal with flat-lock seams. For aluminum, form seams and seal with epoxy seam sealer. Retain first paragraph below only if using copper, stainless steel, or zinc-tin alloy-coated stainless steel.

END OF SECTION

SECTION 07 63 16
SHEET METAL ROOFING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes information about Ridge Caps used to connect the sides of roof panels for waterproofing purposes over the EPDM membrane.

B. Related sections:

1. Section 07 62 00 - Sheet Metal Flashings and Trim: Sheet metal flashings, counter flashings, and trim installed as part of roof system to prevent water penetration.
2. Section 07 92 00 - Joint Sealants: Sealants and backing material used for installation of sheet metal.

PART 2 - PRODUCTS

2.01 RIDGE CAPS

A. Type: Manufactured sheet metal fabrication designed to cover ridge and hips for sloped roof system and prevent water penetration.

B. Fabrication: Fabricate sections to profiles and dimensions indicated on Drawings and reviewed shop drawings.

C. Edges: Edges: Turn back all exposed edges to form 1/2 inch hem.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate provision of ornamental sheet metal roofing specialties with type and installation of exterior walls and parapets, roof deck and membrane, wood blocking and nailers, gutters and other work related to sheet metal.

B. Prior to submittal of shop drawings and fabrication, field verify required sizes and installation tolerances for sheet metal roofing specialties.

C. Deliver ornamental sheet metal roofing specialties to site in time for accurate placement and coordination with other work.

Verify roof membrane terminations and base flashings are in place, sealed, and secure.

INSTALLATION

A. Install ornamental sheet metal roofing specialties in accordance with Drawings, reviewed shop drawings, manufacturer's instructions and NRCA Roofing Manual and SMACNA Architectural Sheet Metal Manual standards of workmanship.

B. Fit sheet metal fabrications tight in place. Make corners square, and surfaces true and straight in planes.

C. Secure sheet metal in place using concealed fasteners unless shown otherwise. Lap and seal all joints. Exposed fasteners shall be covered with sealant.

END OF SECTION

SECTION 08 30 00
DOORS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Door schedule and drawings.

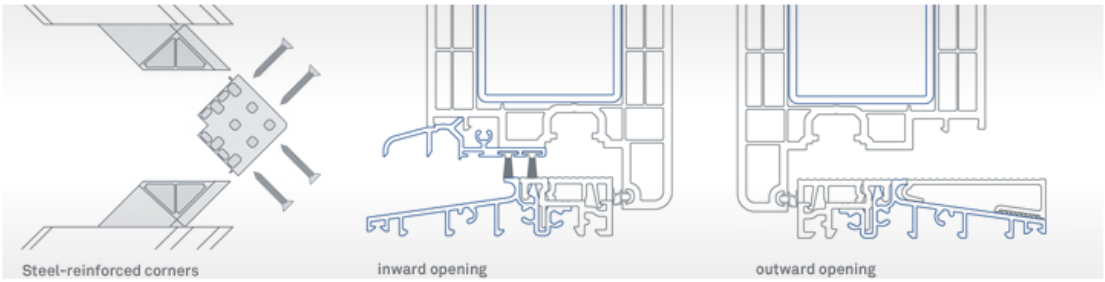
PART 2 - PRODUCTS

2.01 DOORS

A. Manufacturers:

1. Intus Eforte Doors

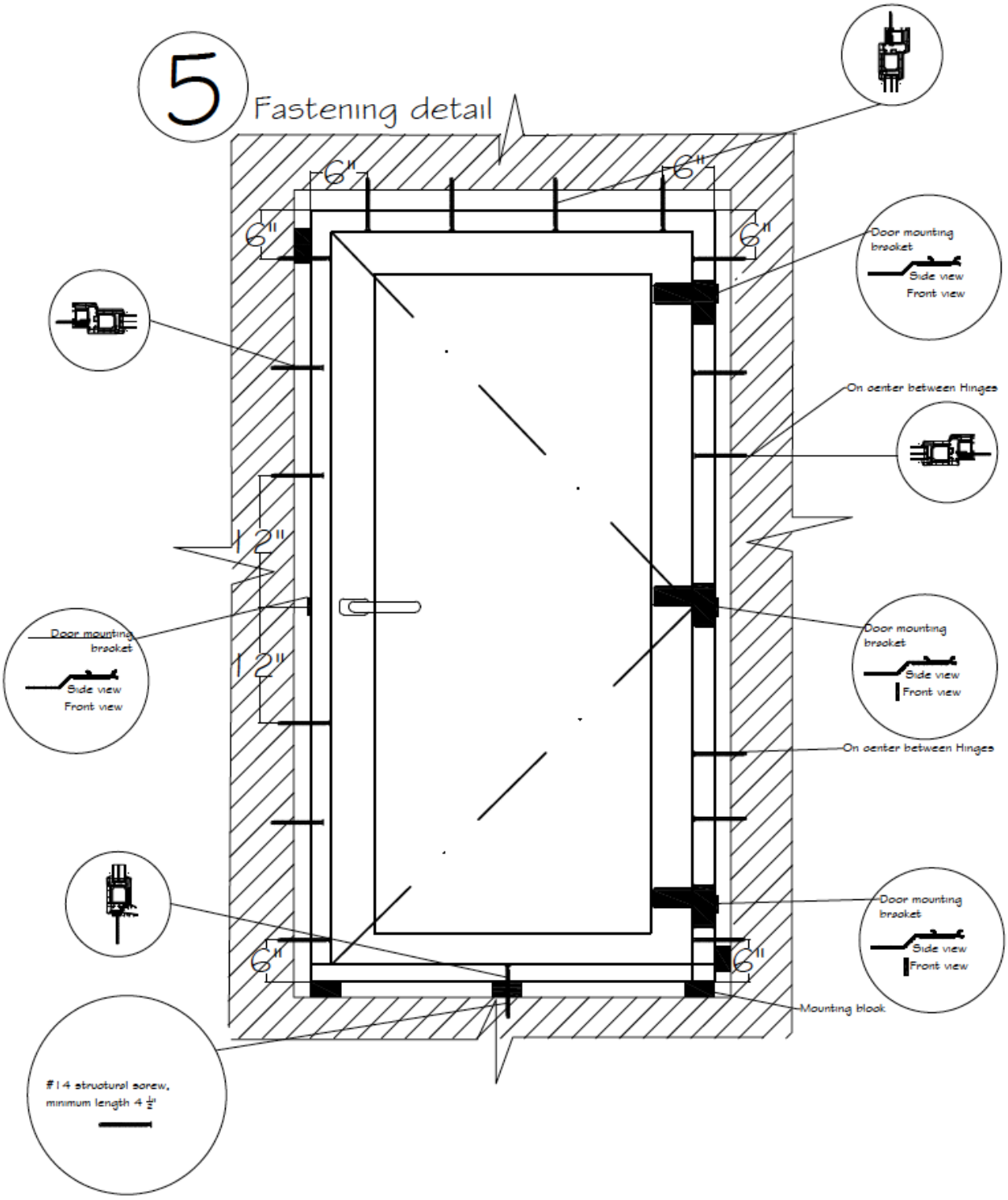
- ***Thermal Performance*** • ***Uf=0.264*** Btu/(h.ft2.F)
- ***Rigid Frames***
- ***Triple glazing*** - up to Ug=0.07 Btu/(h.ft2.F) For increased thermal insulation. Superior noise insulation up to 47 dB
- ***Double door seal*** - provides air tightness.
- ***Value*** - amazing performance without additional insulation. Therefore reducing door cost.
- ***Passive House*** - suitable for Passive House installations.
- ***Multi-lock system*** - provides security and protection.
- ***Steel reinforcements*** - provide rigidity and strength. Allow floor to ceiling windows and doors.
- ***Warm edge spacers*** - better room climate. Higher inside glass surface temperatures Reduced condensation on the edge of the glass.
- ***Deep Glazing Insertion*** - thermal bridge reduction, reduced condensation.
- ***Deuctone Color Concept*** - unmatched color selection. Wood laminates with pearl like structure. Aluminum look finish.
- ***Adaptivity*** - new construction and replacement applications for Commercial (high rise, schools, office), residential and industrial use.
- ***Hardware*** - solid hardware with multi-point locking system.All popular entrance door types available: regardless of single or double sash



PART 3 - EXECUTION

3.01 INSTALLATION

A. Install doors as recommended by the Intus unless otherwise indicated.
B. Mount doors in out-swing assembly.
C. Mount doors to exterior of wall section.
D. Trim around the door opening.



END OF SECTION

SECTION 08 50 00
WINDOWS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Window schedule and drawings.

PART 2 - PRODUCTS

2.01 WINDOWS

A. Manufacturers:

1. Intus Eforte Winows

2.01 TAPE

A. Manufacturers:

1. SIGA: Wigluv

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install windows as recommended by the Intus unless otherwise indicated.
B. Mount window blocks to the interior of southern windows, which are set into the home.
C. Mount window blocks to the exterior of all other window openings, where windows will be set to the outside of the wall cavity.
D. Seal the window blocks with Siga Wigluv tape.
E. Place the window into the opening and secure the tabs.
F. Install the finished sheathing and flashing.

AAMA/WDMA/CSA 101/I.S.2/A440-05
AAMA/WDMA/CSA 101/I.S.2/A440-08

STRUCTURAL PERFORMANCE TEST REPORT SUMMARY

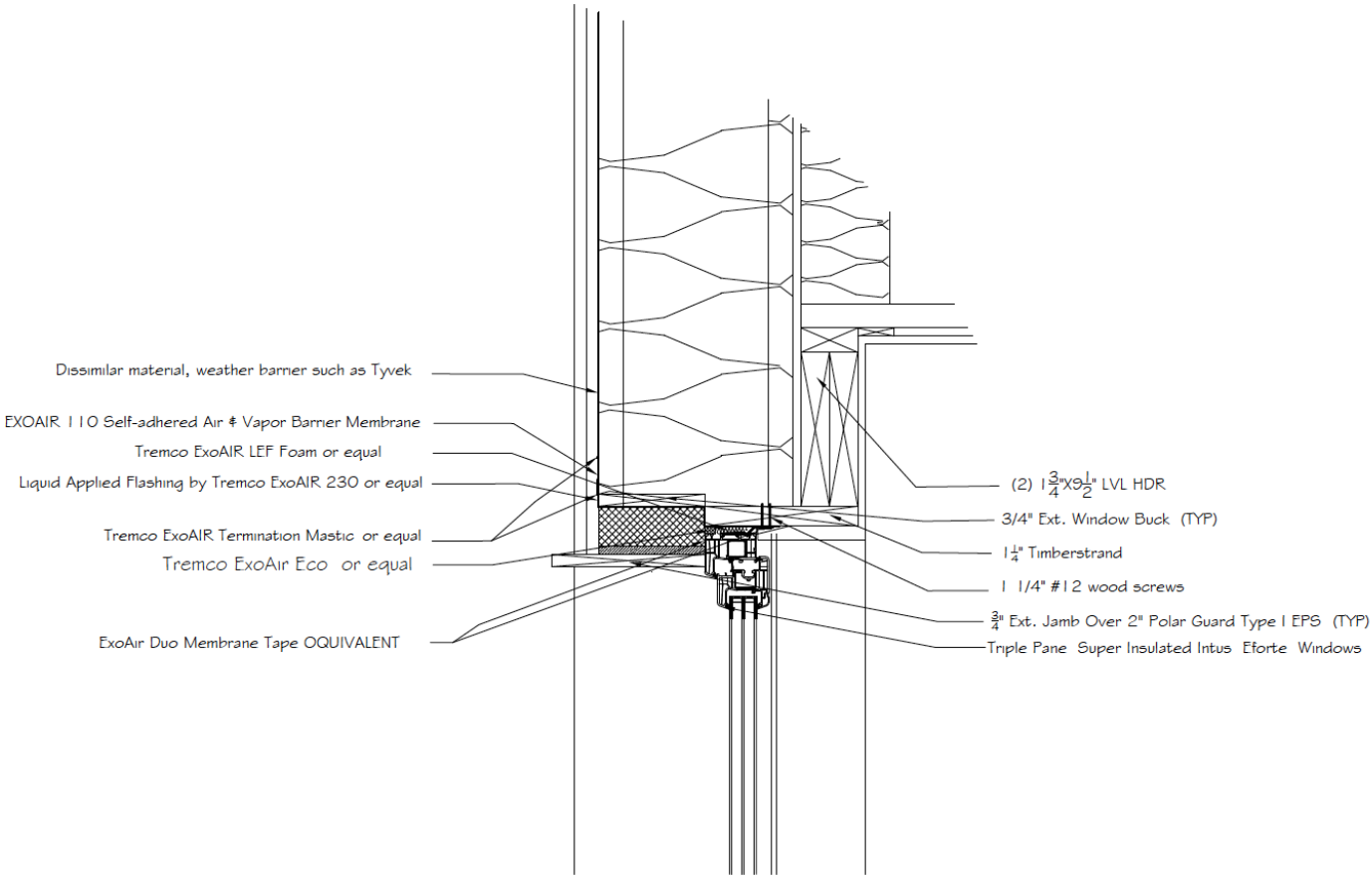
RENDERED TO:

Intus Windows LLC
1042 Wisconsin Ave. NW, 2nd Floor
Washington, DC 20007

MODEL/TYPE: "Eforte" Inswing Casement

TITLE	SUMMARY OF RESULTS
Primary Product Designator	2005: C-C 70 1000 x 2302 mm (39-3/8 x 90-5/8) 2008: Class CW-PG70: Size tested 1000 x 2302 mm (39-3/8 x 90-5/8in)-Type C
Air Infiltration/Exfiltration	Infiltration Rate: 0.5 L/s/m^2 (0.10 cfm/ft^2) (0.03 cfm/ft^2 measured)
Water Penetration Resistance	720 pa (15.0 psf)
Design Pressure	± 3360 pa (70.0 psf)
Uniform Load Structural Test	± 5040 pa (105.0 psf)
Forced Entry Resistance	Passed ASTM F588-07 Grade 10

Test Completion Date: 09/14/11
Test Expiration Date: 09/14/15


Dissimilar material, weather barrier such as Tyvek
EXOAIR 110 Self-adhered Air & Vapor Barrier Membrane
Tremco ExoAIR LEF Foam or equal
Liquid Applied Flashing by Tremco ExoAIR 230 or equal
Tremco ExoAIR Termination Mastic or equal
Tremco ExoAir Eco or equal
ExoAir Duo Membrane Tape OQUIVALENT
(2) 1 3/4"X9 1/2" LVL HDR
3/4" Ext. Window Buck (TYP)
1 1/4" Timberstrand
1 1/4" #12 wood screws
3/4" Ext. Jamb Over 2" Polar Guard Type 1 EPS (TYP)
Triple Pane Super Insulated Intus Eforte Windows

Technical data sheet:
SIGA-*Wigluv*®

SIGA

Updated on: 11/12/2012

Distributor: SIGA Cover, Inc.

Type of application: durably rainproof and windtight joints on facades and inclined roofs

Instructions for application: see Manual

Construction: vapor permeable special PO film, elastic, impermeable to water, UV-stable, with SIGA acrylic pressure sensitive adhesive

Packaging unit:

Wigluv 60	10 rolls / box
Wigluv 100	6 rolls / box
Wigluv 150	4 rolls / box
Wigluv 230	2 rolls / box

Characteristics:

			Standards	Units	Values
Dimensions		Length / width	Wigluv 60	m / m feet / inch	40 / 0.06 131 / 2.4
			Wigluv 100	m / m feet / inch	25 / 0.10 82 / 3.9
			Wigluv 150	m / m feet / inch	25 / 0.15 82 / 5.9
			Wigluv 230	m / m feet / inch	25 / 0.23 82 / 9.06
Temperature resistance				°F °C	- 40 °F to + 212 °F - 40 °C to + 100 °C
Processing temperature				°F °C	from + 14 °F from - 10 °C
Atmospheric exposure					max. 12 months
Water vapor transmission			ASTM E-96A	US perm	> 1.72
Water resistance			AATCC-127	cm	500
Ageing resistance			high permanent adhesive strength, non-drying and non-embrittling since without caoutchouc, resin or solvent, can reliably and durably absorb structural movements		
Suitability for storage			unlimited store in a cool, dry place in its original box		

www.sigacover.com

SIGA Stick with us.®

KM6847

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Hardware schedule.

PART 2 - PRODUCTS

2.01 HARDWARE

A. Manufacturers:
   1. Hewi (Exterior Doors), Emtek (Interior Doors)

B. Hinges:
   1. Stainless-steel hinges with stainless-steel pins for exterior.
   2. Non-removable hinge pins for exterior and public interior exposure.
   3. 3 hinges for 1-3/4-inch- (45-mm-) thick doors 90 inches (2300 mm) or less in height; 4 hinges for doors more than 90 inches (2300 mm) in height.

C. Locksets and Latchsets:
   1. BHMA A156.2, Series 4000, Grade 1 for bored locks and latches.
   2. Lever handles on locksets and latchsets.
   3. Provide trim on exit devices matching locksets.

D. Key locks to Middlebury College's existing master-key system.
   1. Cylinders with five and removable cores.
   2. Provide cylinders for other locking doors that do not require other hardware.
   3. Provide construction keying.

E. Provide wall stops or floor stops for doors without closers.

F. Provide hardware finishes as follows:
   1. Hinges: Matching finish of lockset/latchset.
   2. Locksets, Latchsets, and Exit Devices: Matching finish of lockset/latchset
   3. Other Hardware: Matching finish of lockset/latchset.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount hardware in locations recommended by the Door and Hardware Institute unless otherwise indicated.

END OF SECTION

SECTION 09 29 00
FINISHED PLYWOOD

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing and inspecting agency.

2.02 PANEL PRODUCTS

A. Provide in maximum lengths available to minimize end-to-end butt joints.

B. Interior Plywood: ASTM C 1396/C 1396M, in thickness indicated, with manufacturer's standard edges. Regular type unless otherwise indicated. ¾" Finished FSC Birch Plywood.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install finished birch plywood on interior of wall and ceiling panels, plumb and square.

B. Finishing Plywood.

1. Fill holes with wood filler, sand and stain or paint.

END OF SECTION

SECTION 09 64 00
WOOD FLOORING AND WALL PANELING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Material Samples.

PART 2 - PRODUCTS

2.01 FIELD-FINISHED WOOD FLOORING

A. Solid-Wood Strip and Kiln dried and as follows:

1. Species and Grade: sugar maple
2. Cut: Plain sawn.
3. Thickness: 3/4 inch (19 mm).
4. Face Width: 3”, 4”, 5”, and 6” widths to minimize waste.
5. Lengths: Random-length strips.

2.02 FINISHING MATERIALS

A. Use Vermont Natural Coatings floor finish. Apply as recommended by manufacturer.

2.03 ACCESSORY MATERIALS

A. Fasteners: As recommended in NWFA's "Installation Guidelines: Wood Flooring."

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide expansion space at walls and other obstructions and terminations of flooring of not less than 1/2 inch (19 mm)

B. Solid-Wood, Strip and Plank Flooring: Blind nail or staple flooring to substrate.

1. Plank Flooring: For flooring of face width more than 3 inches (75 mm), install countersunk screws at each end of each piece in addition to blind nailing. Cover screw heads with wood plugs glued flush with flooring.

3.02 SANDING AND FINISHING

A. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that would be noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.

B. Fill open-grained hardwood.

C. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated.

END OF SECTION

SECTION 09 91 00
PAINTING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals:
   1. Product Data. "MPI Approved Products List" with product highlighted.
   2. Samples.

B. Mockups: Full-coat finish Sample of each type of coating, color, and substrate, applied where directed.

C. Extra Materials: Plan for extra supply of [1 gal. (3.8 L)] of each color and type of finish coat paint used on Project, in containers, properly labeled and sealed.

PART 2 - PRODUCTS

2.01 PAINT & COATINGS

A. Products:
   1. Tnemec Series 1 primer and Series 73 paint
   1. C2 Arcylic Latex Primer
   2. C2 Acrylic paint, egg-shell finish
   3. Vermont Natural Coatings Furniture Finishes
   4. Vermont Natural Coatings Exterior Wood Finish
   5. Vermont Natural Coatings Floor Finish

A. MPI Standards: Provide materials that comply with MPI standards indicated and listed in its "MPI Approved Products List."

B. Material Compatibility: Provide materials that are compatible with one another and with substrates.
   1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

D. Colors
   1. Wall Paint: C2 LoVo paint “Chantilly Lace” White
   2. Exterior Wood Finish: Vermont Natural Coatings “Caspian Clear”
   3. Wood Finish (unless otherwise specified): Vermont Natural Coatings “Caspian Clear”
   4. Cabinet Finish: Vermont Natural Coatings Woodtone Series Pre-mixed PolyWhey “Cherry”
   5. Ceiling Finish: Vermont Natural Coatings Heirloom Wipe-On PolyWhey

PART 3 - EXECUTION

3.01 PREPARATION

A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, lighting fixtures, and similar items that are not to be painted. Mask items that cannot be removed. Reinstall items in each area after painting is complete.

C. Clean and prepare surfaces in an area before beginning painting in that area. Schedule painting so cleaning operations will not damage newly painted surfaces.

3.02 APPLICATION

A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Paint exposed surfaces unless otherwise indicated on drawings or in specifications.
   1. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
   2. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Do not paint prefinished items, items with an integral finish, operating parts, and labels unless otherwise indicated.
C. Apply paints according to manufacturer's written instructions.
   1. Use brushes only where the use of other applicators is not practical.
   2. Use rollers for finish coat on interior walls.
   3. Use paint sprayer for exterior siding.
D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
   1. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
E. Apply stains and transparent finishes to produce surface films without color irregularity, cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other imperfections. Use multiple coats to produce a smooth surface film of even luster.

3.03 EXTERIOR PAINT APPLICATION SCHEDULE

A. Steel:
   1. Aliphatic Acrylic Polurethane: Two coats over modified aromatic polyurethane primer: EXT 5.1P.
B. Reclaimed Barnwood Siding:
   1. Whey-based Clear Protective Coating: Two coats: MPI EXT 6.4D.

3.04 INTERIOR PAINT APPLICATION SCHEDULE

A. Steel:
   1. Aliphatic Acrylic Polurethane: Two coats over modified aromatic polyurethane primer: MPI INT 5.1J.
B. Dressed Lumber: Including architectural woodwork, millwork, trim, doors.
   1. Semigloss or Eggshell Latex: Two coats over primer: MPI INT 6.3T.
   2. Whey-based Clear Wood Finish: Two coats: MPI INT 6.3C.
C. Wood Paneling and Casework:
   1. Semigloss or Eggshell Latex: Two coats over primer: MPI INT 6.3T.
   2. Whey-based Clear Wood Finish or Whey-based Concentrated Tint Wood Finish: MPI INT 6.3C.
E. Wood Floors:
   1. Whey-based Clear Wood Finish: MPI INT 6.3C.

END OF SECTION

SECTION 10 28 13
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, No. 4 finish (satin), 0.0312-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.

B. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

C. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.02 TOILET AND BATH ACCESSORIES

A. Toilet Tissue Dispenser:

1. Basis-of-Design Product: Kohler Toobi toilet tissue holder K-5672-CP.
2. Type: Single-roll dispenser.
3. Mounting: Surface mounted with concealed anchorage.
4. Material: Polished chrome finish.

B. Mirror Unit:

1. Basis of design Product: Kohler Loure mirror K-11579-CP.
2. Material: Polished chrome finish.

C. Towel Bar:

1. Basis-of-Design Product: Kohler Toobi towel bar.
2. Mounting: Surface mounted with concealed fasteners.
3. Length: 24 inches (610 mm) and 18 inches (457.2 mm).
4. Material and Finish: Polished chrome.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install accessories using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Install grab bars to withstand a downward load of at least 250 lbf (1112 N), when tested according to method in ASTM F 446.

B. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items. Remove temporary labels and protective coatings.

END OF SECTION

SECTION 11 31 00
RESIDENTIAL APPLIANCES

PART 1 – GENERAL

1.01 SECTION REQUIREMENTS

A. Allowances: See Division 01 Section "Price and Payment Procedures" for appliance allowances.

B. Submittals: Product Data.

C. Regulatory Requirements: Comply with provisions of the following product certification

1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. UL and NEMA: Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.
3. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.
4. NAECA: Provide residential appliances that comply with NAECA standards.

A. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines

B. Energy Ratings: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

PART 2 - PRODUCTS

2.01 RESIDENTIAL APPLIANCES

24" Compact Washer
Axxis Plus - White
WAS24460UC

BOSCH

Features and Benefits

Key Features

- Large Capacity on Compact Footprint
- 15 Wash Cycles and 8 Options
- Large LED Display with Remaining Time
- Unique Raindrop Stainless Steel Drum
- AntiVibration Technology for Second Floors Installation

Design

- Neat White - European Design
- See-thru Silver Door
- Large LED Display with Remaining Time
- Advance Touch Control Technology
- Snag Free Stainless Steel Structured Drum
- Stackable - Space Saving
- AntiVibration Design Reduces Vibration by up to 30%

Performance

- Sensor-controlled Automatic Washing Programs
- Unique Raindrop Drum Pattern for Powerful & Gentle Cleaning
- Up to 1200 rpm Maximum Spin Speed
- 5 Temperature and Spin Speed Settings
- 3D Sensor controls imbalance
- Sanitary Cycle Heats Water Up to 161° F to Kills Bacteria
- KidsCare™ Cycle Removes Toughest Stains with Ease
- Refresh Cycle Refreshes Loads Up to 4 lbs
- Sport Wear Cycle

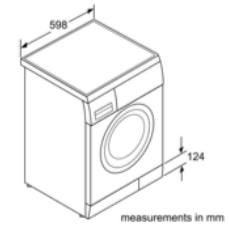
Notes: All height, width and depth dimensions are shown in inches. *Please refer to installation instructions prior to making cutout. BSH reserves the absolute and unrestricted right to change product materials and specifications, at any time, without notice.Consult the product's installation instructions for final dimensional data and other details. Applicable product warranty can be foundin a ccompanying product literature or you may contact your account manager for further details.

For more information on our entire line of products, go to boschappliances.com or call 1-800-944-2904.

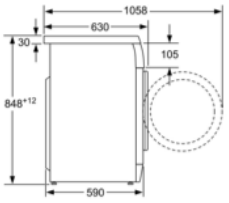
Litho Date: 08/2013

24" Compact Washer
Axxis Plus - White
WAS24460UC

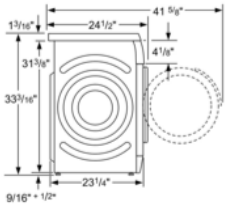
BOSCH



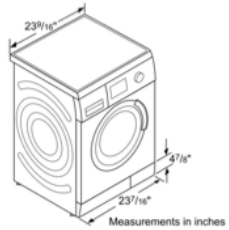
measurements in mm



measurements in mm



Measurements in inches



Measurements in inches

Features

UPC code	825225855613
Variant color	White
Door ring	silver-grey
Buttons	silver
Dial	white
Alternative colors available	
Noise level washing (dB(A) re 1 pW)	54
Watts (W)	2300
Current (A)	12
Volts (V)	208-240
Frequency (Hz)	60
Total annual energy consumption (kWh)	145
Water Consumption (gal/y)	3904
Energy Star® qualified	Yes
Power cord included	Yes
Power Cord Length	69"
Plug type	240V-3 prong
Length outlet hose (in)	59.05
Length inlet hose (in)	47.24
AQUASTOP® Hose	Yes
Overall appliance dimensions (HxWxD) (in)	33 3/16" x 23 9/16" x 24 1/2"
Product packaging dimensions (HxWxD) (in)	34 3/4" x 25 1/2" x 26 3/4"
Net weight (lbs)	168
Gross weight (lbs)	171
Capacity (cu. ft.)	2.2

Technical Specification

Leak protection system	Multiple water protection
Number of Options	8
Maximum spin speed (rpm)	1200
Spin speed options	Variable
Internal Water Heater	Yes
Display	Yes
Status indicator	LED-display

Notes: All height, width and depth dimensions are shown in inches. *Please refer to installation instructions prior to making cutout. BSH reserves the absolute and unrestricted right to change product materials and specifications, at any time, without notice.Consult the product's installation instructions for final dimensional data and other details. Applicable product warranty can be foundin a ccompanying product literature or you may contact your account manager for further details.

For more information on our entire line of products, go to boschappliances.com or call 1-800-944-2904.

Litho Date: 08/2013

24" Compact Condensation Dryer
Axxis - White
WTE86300US

BOSCH

Features and Benefits

Key Features

- Ventless Drying Required No Ducting
- Large Capacity on Compact Footprint
- 11 Drying Cycles and 4 Drying Options
- LED Display with Remaining Time
- Long-lasting One Piece Stainless Steel Structured Drum

Design

- Neat White - European Design
- See-thru Silver Door
- LED Display with Remaining Time
- Advance Touch Control Technology
- Stackable - Space Saving

Performance

- Sensor-controlled Automatic Drying Programs
- Unique Drum Pattern Creates Air Cushions to Protect Clothes
- 4 Temperature Settings
- Intelligent Sensors Prevents Overheating
- Wool Cycle for Machine-Washable Woolen Textiles
- Touch Up - 20 min Cycle for Extreme Sensitive Fabrics
- 40 Minutes Timed Program
- Short Program for Small Loads
- Low Heat Option Reduces Heat on Specified Program
- Easy Ironing Option
- Extended WrinkleBlock Up to 120 min After the Drying Cycle

Notes: All height, width and depth dimensions are shown in inches. *Please refer to installation instructions prior to making cutout. BSH reserves the absolute and unrestricted right to change product materials and specifications, at any time, without notice.Consult the product's installation instructions for final dimensional data and other details. Applicable product warranty can be foundin a ccompanying product literature or you may contact your account manager for further details.

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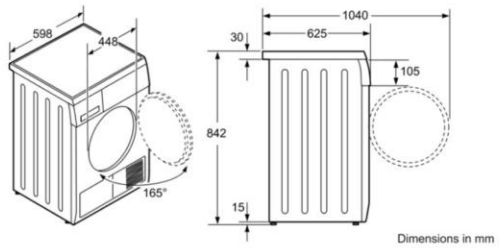
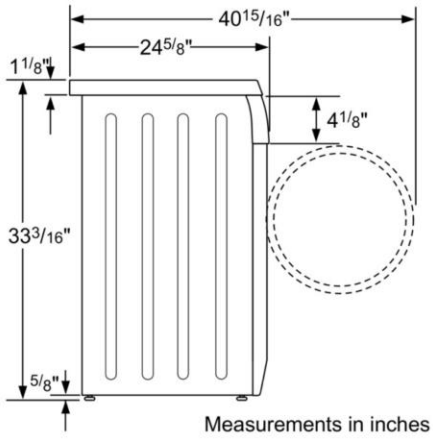
Litho Date: 08/2013

24" Compact Condensation Dryer
Axxis - White
WTE86300US

BOSCH





Features

UPC code	825225845812
Door ring	Silver
Buttons	silver
Dial	white
Door Hinge	Right
Alternative colors available	
Silence level (dBA)	67
Energy Source	Electric
Watts (W)	2800
Current (A)	12
Volts (V)	208-240
Frequency (Hz)	60
Power cord included	Yes
Power Cord Length	57"
Plug type	240V-4 prong
Length outlet hose (in)	
Length inlet hose (in)	
Overall appliance dimensions (HxWxD) (in)	33 3/16" x 23 9/16" x 24 5/8"
Product packaging dimensions (HxWxD) (in)	34.25 x 24.80 x 26.77
Net weight (lbs)	92
Gross weight (lbs)	95
Tub Material	Stainless steel
Capacity (cu. ft.)	3.9
Stackability	Yes
Dryer Type	Condensing

Technical Specification

Number of Options	4
Timed Dry	Yes
Location of Vent	
Display	Yes
Status indicator	LED

Notes: All height, width and depth dimensions are shown in inches. *Please refer to installation instructions prior to making cutout. BSH reserves the absolute and unrestricted right to change product materials and specifications, at any time, without notice.Consult the product's installation instructions for final dimensional data and other details. Applicable product warranty can be foundin a ccompanying product literature or you may contact your account manager for further details.

For more information on our entire line of products, go to boschappliances.com or call 1-800-944-2904.

Litho Date: 08/2013

FRIGIDAIRE
GALLERY.

Dishwashers

FGHD2465N F/W/B

24" Built-In

Signature Features

Best Cleaning Dishwasher[1]
Exclusive OrbitClean™ Technology provides 4 times better water coverage and a clean no other dishwasher can beat.

Best Drying Performance[2]
With SaharaDry™, there's no need to towel-dry before putting dishes away.

Quietest Dishwasher in Its Class[3]
Quietest dishwasher, so it won't interrupt your time at home.

Eco-Friendly
ENERGY STAR® qualified dishwasher also features an Energy Saver Plus Cycle that uses less energy without compromising cleaning performance.

Product Dimensions

Height (Adjustable)	33-1/2"-35"
Width	24"
Depth (Including Door)	25"

More Easy-To-Use Features

Built With American Pride
Appliances that are high-performing, more accessible, and more innovative than ever — designed, built and engineered in the U.S.A.

Quick Clean
Clean dishes faster with Quick Clean.

SpaceWise® Organization System
Our SpaceWise® Organization system features adjustable racks and the Largest Silverware Basket[4] so there's a place for virtually anything.

Delay Start
Most adaptable delay start (1- to 24-hour options).

NSF® Certified
Sanitize cycle removes 99.9% of common household bacteria.

Smudge-Proof Stainless Steel[5]
Real Stainless Steel with a protective coating reduces fingerprints and smudges so it's easy to clean.

PowerPlus® Cycle
For an extra-heavy wash performance.

Largest Silverware Basket[4]
There's room for over 180 items in our largest, multicompartment silverware basket.

ENERGY STAR®
NSF® International Certification

Available in:

Stainless (F) · White (W) · Black (B)

[1] Based on ANSI-AHAM-DW-1-2010 for plastic interior dishwashers. March 2012.
[2] Based on industry drying tests using SaharaDry™.
[3] In its class based on published manufacturer specifications for similar MSRP models.
[4] Among leading brands.
[5] Select model only.

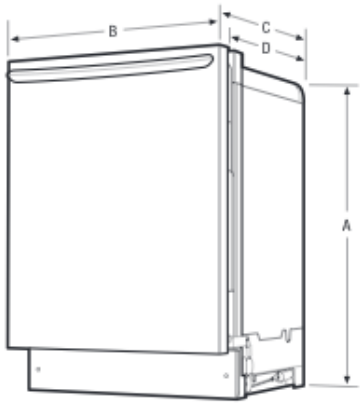
FRIGIDAIRE
GALLERY.

Dishwashers

FGHD2465N F/W/B **24" Built-In**

Features	
Control Design	Fully-Integrated Express-Select®
Digital Display	Yes
Door Latch/Stay-Put Door Hinge Design	Yes/Yes
Low Rinse-Aid Indicator Light	
Interior Design/Interior Color	Tall Tub/GraniteGrey™
Wash System	OrbitClean™ Technology
Wash Levels/Wash Speeds	5/5
DishSense™ Technology	Yes
AquaSurge™ Technology	Yes
Sound Package	UltraQuiet™ Plus
Filter/Filter Trap	S. Steel/Removable
Soft Food Disposer	Yes
dB Level	53
Drying System	SaharaDry™
Cycles	
Number of Cycles	7
PowerPlus® (Heavy)	Yes
Normal	Yes
Light	
Quick	Yes
Favorite	Yes
China Crystal	
Rinse Only	Yes
Energy Saver Plus	Yes
Upper Rack Wash Only	Yes
Cycle Indicator Light/Control Lock	No/Yes
Options	
Heat/No Heat Dry	Yes/Yes
Hi-Temp Wash	Yes
NSF® Certified Sanitize Rinse	Yes
Delay Start	1-24 Hour
Rack System	
Rack Design	Premium
Rack Coating	Nylon TufRacks™
Upper Rack –	
Rack Handles	Yes
Stemware/Champagne Glass Holders	Yes
Fold-Down Tines	Yes
Cup Shelves/Clips	2/2
Versa-Tray™	Yes
Adjustable Rack	Yes
Lower Rack –	
SpaceWise® Silverware Basket	3-Piece Split
Fold-Down Tines	2 Full Rows
Small Items Cover	2
Certifications	
ENERGY STAR®	Yes
NSF® International Certification	Yes
Specifications	
Water Inlet Location	Left Bottom Front
Water Usage (Gallons)	4.9 – 8.5
Water Pressure (PSI)	20 – 120
Integral Air Gap on Supply	Yes
Leveling Legs	4
Power Supply Connection Location	Right Bottom Front
Voltage Rating	120V/60 Hz/15A
Connected Load (kW Rating) @ 120 Volts[1]	1.44
Amps @ 120 Volts	10
Shipping Weight (Approx.)	83

[1] *For use on an adequately wired 120V, dedicated circuit having 2-wire service with a separate ground wire. Appliance must be grounded for safe operation.*



c UL us
Meets requirements of ASSE 1006

NOTE: For planning purposes only. Always consult local and national electric and plumbing codes. Refer to Product Installation Guide for detailed installation instructions on the web at frigidaire.com.

Product Dimensions	
A - Height (Adjustable)	33-1/2" - 35"
B - Width	24"
C - Depth (Including Door)	25"
D - Depth (To Tub Flange)	22-1/2"
Depth with Door Open 90°	49-1/4"

Cutout Dimensions	
Height (Min.)	34-1/4"
Height (Max.)	35-1/4"
Width (Min.)	24"
Depth (Min.)	24"

Accessories information available on the web at frigidaire.com

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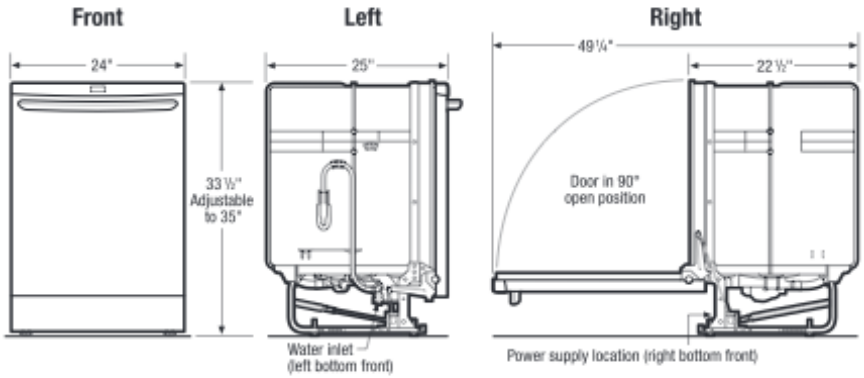
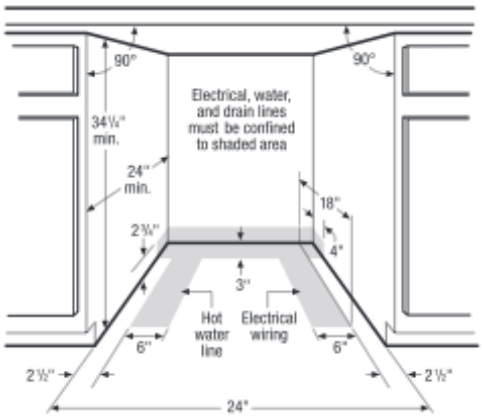
Specifications

FRIGIDAIRE
GALLERY.

Dishwashers

FGHD2465N F/W/B **24" Built-In**





Dishwasher Specifications

- Product Shipping Weight (approx.) – 83 Lbs.
- Voltage Rating – 120V/60 Hz/15 Amps *(maximum 20 Amps if connected with disposer)*
- Connected Load (kW Rating) @ 120 Volts = 1.44 kW (For use on adequately wired 120V, dedicated circuit having 2-wire service with a separate ground wire. Appliance must be grounded for safe operation.)
- Amps @ 120V = 10 Amps
- Always consult local and national electric & plumbing codes. Meets requirements of ASSE 1006—integral air gap on supply.
- Water Pressure – Hot water line to dishwasher must provide between 20 and 120 pounds per square inch (psi).
- Make sure location has right drain, water and electrical outlets to make connections.
- Keep back free of drain, water & electrical supply.
- Electrical and water supplies should enter cabinet opening on floor, or through back or side walls, as shown in shaded areas.
- Connections preferably located toward left side of dishwasher. Do not cross drain, water or electrical lines in front of motor, blower or frame.
- When installing adjacent to wall, cabinet or other obstruction that extends beyond front edge of unit, allow 2" minimum clearance between opened door and obstruction.
- When installing at end of cabinet line, sides must be fully enclosed.
- Do not install unit under a cooktop, damage will occur.

Note: For planning purposes only. Refer to Product Installation Guide on the web at frigidaire.com for detailed instructions.

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Meets requirements of ASSE 1006 c UL us

Specifications subject to change

FRIGIDAIRE

Top Mount Refrigerator

FFHT1725PS

17 Cu. Ft. Top Mount

Signature Features

SpaceWise® Adjustable Glass Shelves

Easily adjust shelves up and down to create more space for taller items.

Store-More™ Humidity-Controlled Crisper Drawers

Keep your fruits and vegetables fresh in our humidity-controlled crisper drawers.

Store-More™ Gallon Door Shelf

Door storage gives you room for larger items like a gallon of milk.

Full-Width Freezer Shelf

Gives you more usable space to organize and store more.

Product Dimensions

Height (Including Hinges & Rollers)	65-5/8"
Width	28"
Depth (Including Door)	29-5/8"

More Easy-To-Use Features

Full-Width Freezer Racks
Gives you more usable door space for accessibility.

Cool Zone™ Drawer
Conveniently located in the fresh food section, the Cool Zone™ Drawer is ideal for deli meats, cheeses and sandwich fixings or any food items that are frequently used.

Clear Dairy Door

Attractive Stainless Steel Exterior

Reversible Door
Door can be installed to open left or right based on your needs.

A.D.A. Compliant[1]
ENERGY STAR®

Available in:

Stainless (S)

[1]When properly installed, meets the appliance standards in the Americans with Disabilities Act and the Architectural Barriers Act Accessibility Guidelines as published by the United States Access Board on June 23, 2004, as amended August 5, 2005.

frigidaire.com

FRIGIDAIRE

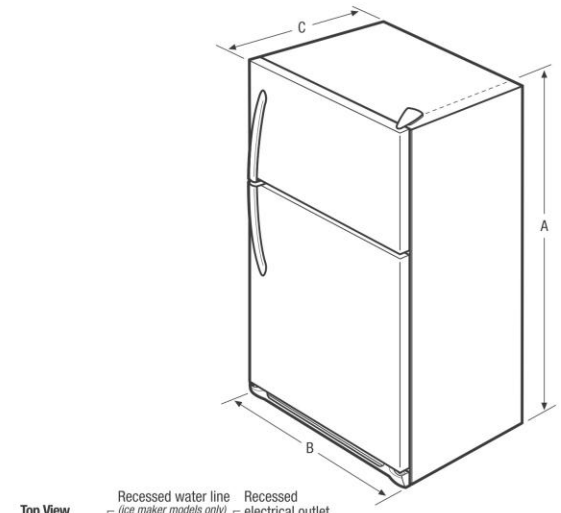
Top Mount Refrigerator

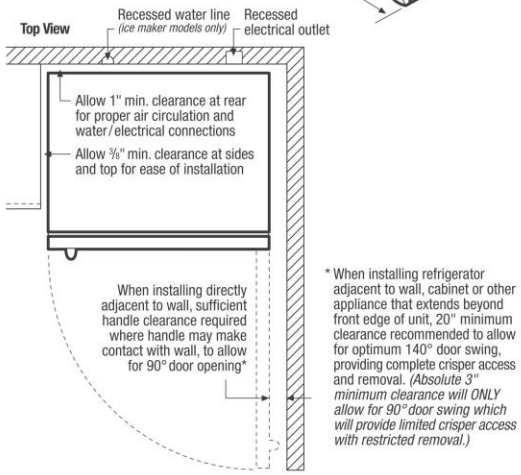
FFHT1725PS **17 Cu. Ft.**

Features	
Door Design	Square
Door Handle Design	Black
Cabinet Finish (Textured)	Black
Door Stops	Yes
Door Hinge Covers	Black
Door Reverse Option	Yes
Rollers – Front/Rear	Fixed/Yes
Sound Package	
Toe Grille	Black
Refrigerator Features	
Interior Lighting	Standard
Refrigerator Shelves	2 Sliding SpaceWise® Adjustable Glass
Cool Zone™ Drawer	Clear
Wine/Can Rack	
Store-More™ Crisper Drawers	2 Clear
Humidity Controls	2
Dairy Compartment	Clear Dairy Door
Door Bins	2 Full-Width White
Door Racks	1 Full-Width White
Non-Slip Bin Liner	
Tall Bottle Retainers	
Gallon Door Storage	2
Freezer Features	
Door Bins	
Door Racks	2 Full-Width White
Freezer Shelves	1 Full-Width Wire
Factory Ice Maker w/ Large Ice Bin	Optional (PN# IM115)
Lighting	
Certifications	
A.D.A. Compliant[1]	Yes
ENERGY STAR®	Yes
Specifications	
Total Capacity (Cu. Ft.)	16.5
Refrigerator Capacity (Cu. Ft.)	12.8
Freezer Capacity (Cu. Ft.)	3.7
Power Supply Connection Location	Right Bottom Rear
Water Inlet Connection Location	Bottom Right
Voltage Rating	120V/60Hz/15 or 20A
Connected Load (kW Rating) @ 120 Volts[2]	.72
Amps @ 120 Volts	6.0
Minimum Circuit Required (Amps)	15
Shipping Weight (Approx.)	190 Lbs.

[1]*When properly installed, meets the appliance standards in the Americans with Disabilities Act and the Architectural Barriers Act Accessibility Guidelines as published by the United States Access Board on June 23, 2004, as amended August 5, 2005.*

[2]*For use on adequately wired 120V, dedicated circuit having 2-wire service with a separate ground wire. Appliance must be grounded for safe operation.*





NOTE: For planning purposes only. Always consult local and national electric and plumbing codes. Refer to Product Installation Guide for detailed installation instructions on the web at frigidaire.com.

C US

Product Dimensions	
A - Height (Incl. Hinges & Rollers)	65-5/8"
B - Width	28"
C - Depth (Incl. Door)	29-5/8"
Depth with Door Open 90°	56"

Accessories information available on the web at ***frigidaire.com***

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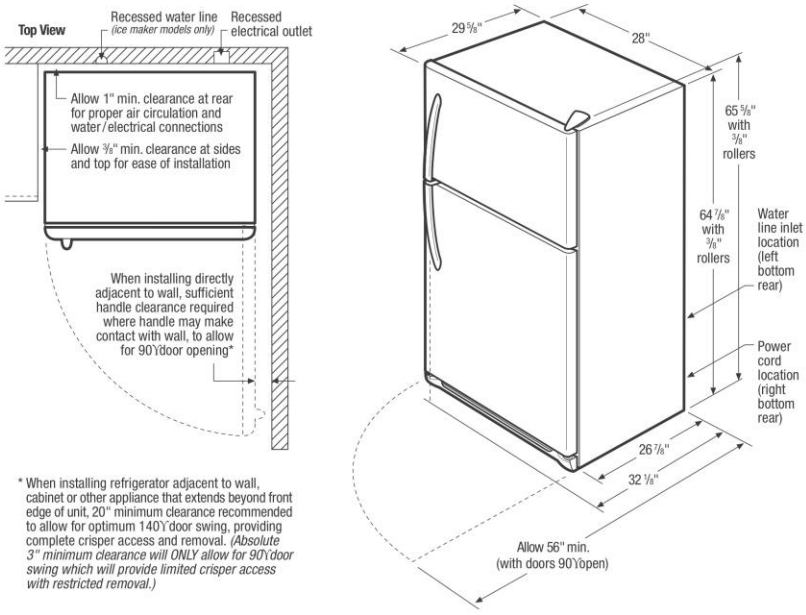
FFHT1725P 04/13

Specifications subject to change.

FRIGIDAIRE

Top Mount Refrigerator

FFHT1725PS **17 Cu. Ft.**



* When installing refrigerator adjacent to wall, cabinet or other appliance that extends beyond front edge of unit, 20" minimum clearance recommended to allow for optimum 140° door swing, providing complete crisper access and removal. *(Absolute 3" minimum clearance will ONLY allow for 90° door swing which will provide limited crisper access with restricted removal.)*

Top Mount Refrigerator Specifications

- Product Shipping Weight (approx.) – 190 Lbs.
- An electrical supply with grounded three-prong receptacle is required. The power supply circuit must be installed in accordance with current edition of National Electrical Code (NFPA 70) and local codes & ordinances.
- Voltage Rating – 120V/60 Hz/15 or 20 Amps
- Connected Load (kW Rating) @ 120 Volts = .72 kW
- Amps @ 120 Volts = 6.0 Amps
- Always consult local and national electric & plumbing codes.
- Floor should be level surface of hard material, capable of supporting fully loaded refrigerator.
- Minimum 3/8" clearance required for sides and top of refrigerator with 1" clearance at rear to allow for ease of installation, proper air circulation, and plumbing/electrical connections.
- When installing refrigerator adjacent to wall, cabinet or other appliance that extends beyond front edge of unit, 20" minimum clearance recommended to allow for optimum 140° door swing, providing complete crisper access and removal. *(Absolute 3" minimum clearance will ONLY allow for 90° door swing which will provide limited crisper access with restricted removal.)*
- To ensure optimum performance, do not install in areas where temperature drops below 55° F or rises above 110° F and avoid installing in direct sunlight or close proximity to range, dishwasher or other heat source.
- For proper ventilation, front grille MUST remain unobstructed.
- Recess electrical outlet when possible.
- Optional Ice Maker Kit (PN # IM115) available for installation in ice maker-ready models only.
- Water recess on rear wall recommended to prevent water line damage.
- Water Pressure – Cold water line must provide between 30 and 100 pounds per square inch (psi).
- Copper tubing with 1/4" O.D. recommended for water supply line with length equal to distance from rear of unit to household water supply line plus 7 additional feet. Optional Water Supply Installation Kits available.

Note: For planning purposes only. Refer to Product Installation Guide on the web at frigidaire.com for detailed instructions.

Optional Accessories

- Ice Maker Kit – (PN # IM115)

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FFHT1725P 04/13

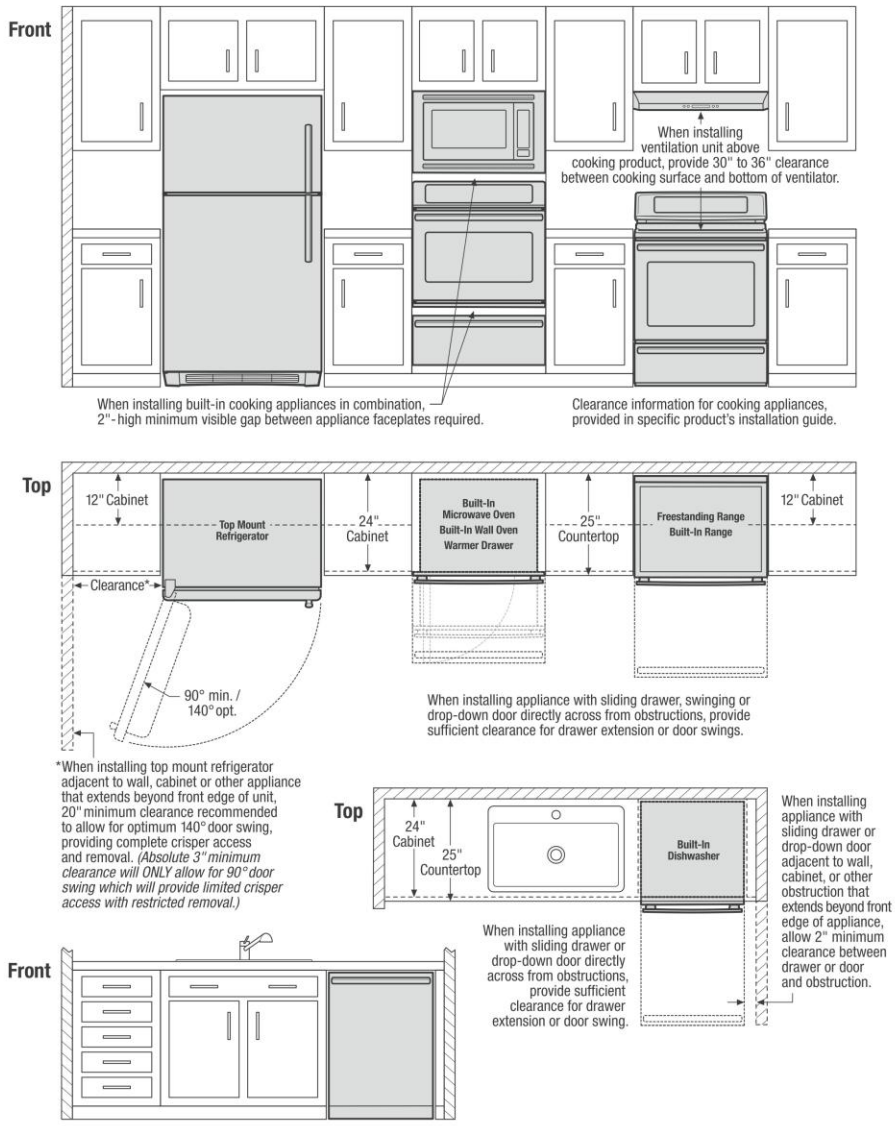
Specifications subject to change.

FRIGIDAIRE

General Installation Guidelines

with Top Mount Refrigerator

Use these dimensions and clearance instructions for planning purposes only. For detailed installation instructions, refer to installation guide, packed with product, or on the web at frigidaire.com.



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INSTGDLNS_TMR FR 04/13

Specifications subject to change.

Whirlpool®

36" (91.4 CM) ISLAND-MOUNT CANOPY RANGE HOOD

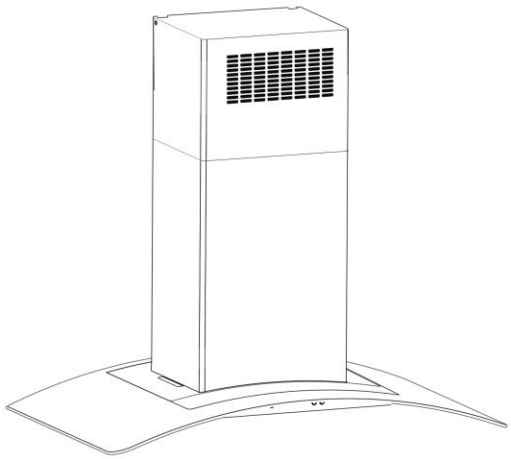
Installation Instructions and Use & Care Guide

For questions about features, operation/performance parts, accessories or service, call: **1-800-253-1301**.
In Canada, for assistance, installation and service, call: **1-800-807-6777**
or visit our website at...
www.whirlpool.com or **www.whirlpool.ca**

HOTTE DE CUISINIÈRE CONFIGURÉE EN ÎLOT 36" (91,4 CM)

Instructions d'installation et Guide d'utilisation et d'entretien

Au Canada, pour assistance, installation ou service composez le **1-800-807-6777**
ou visitez notre site web à **www.whirlpool.ca**



IMPORTANT: READ AND SAVE THESE INSTRUCTIONS.
FOR RESIDENTIAL USE ONLY.
IMPORTANT : LIRE ET CONSERVER CES INSTRUCTIONS.
POUR UTILISATION RÉSIDENTIELLE UNIQUEMENT.

LI3YRB/W10292168D

For non-vented (recirculating) installations, you will also need:

- Recirculating Kit Part Number W10294734 for non-vented (recirculating) installations only. See “Assistance or Service” section to order.
- 6" (15.2 cm) round metal vent duct. Length required is determined by ceiling height.

Parts supplied

Remove parts from packages. Check that all parts are included.

- Hood ventilator assembly with vent transition, back draft damper, and light bulb installed.
- Canopy glass
- 2 - Retainer brackets for hood glass canopy.
- 2 - Rubber seals (canopy glass)
- Metal grease filter
- 68 - 4 x 8 mm screws
- 4 - 5 x 45 mm screws
- T10 Torx® adapter
- T20® Torx®† adapter
- 4 - Vent covers
- 4 - Plastic vent clips
- Mounting template
- Upper horizontal support bracket
- Horizontal support
- 8 - Vertical supports
- 2- Vent cover supports

Location Requirements

IMPORTANT: Observe all governing codes and ordinances.

Have a qualified technician install the range hood. It is the installer's responsibility to comply with installation clearances specified on the model/serial rating plate. The model/serial rating plate is located behind the left filter on the rear wall of the vent hood.

Canopy hood location should be away from strong draft areas, such as windows, doors and strong heating vents.

Cabinet opening dimensions that are shown must be used. Given dimensions provide minimum clearance.

Grounded electrical outlet is required. See “Electrical Requirements” section.

Because of the size and weight of this island hood, the chimney support must be securely attached to the ceiling.

- For plaster or drywall ceilings, the chimney support must be attached to joists. If this is not possible, you must build a support structure behind the plaster or drywall. The support structure must be able to support 80 lbs (36.6 kg).

The range hood is factory set for venting through the roof or wall.

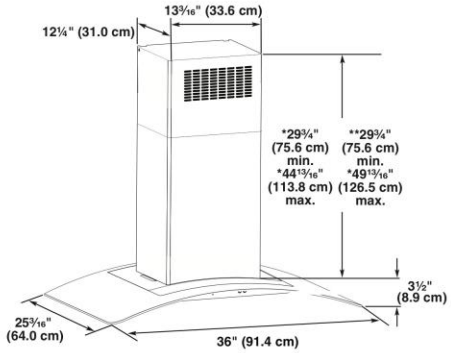
For non-vented (recirculating) Installation see “Non-vented (recirculating) Installation” in “Install Range Hood” section. Recirculating Kit Part Number W10294734 is available from your dealer or an authorized parts distributor.

All openings in ceiling and wall where range hood will be installed must be sealed.

For Mobile Home Installations

The installation of this range hood must conform to the Manufactured Home Construction Safety Standards, Title 24 CFR, Part 328 (formerly the Federal Standard for Mobile Home Construction and Safety, Title 24, HUD, Part 280) or when such standard is not applicable, the standard for Manufactured Home Installation 1982 (Manufactured Home Sites, Communities and Setups) ANSI A225.1/NFPA 501A, or latest edition, or with local codes.

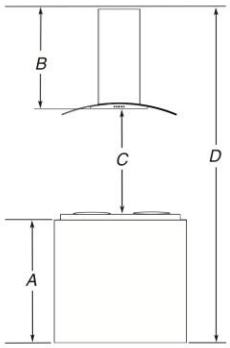
Product Dimensions



*Vented installations only

**Non-vented (recirculating) installations only

Installation Dimensions



A. Countertop height

B. Hood height from ceiling to bottom of the range hood filter surface: D-A-C=B

C. Hood height: 24" (61.0 cm) min. from electric cooking surface, 27" (68.6 cm) min. from gas cooking surface, suggested 36" (91.4 cm) max.

D. Ceiling height

IMPORTANT:

Minimum distance “C”: 24" (61.0 cm) from electric cooking surface, 27" (68.6 cm) from gas cooking surface
Suggested maximum distance “C”: 36" (91.4 cm)

†®TORX and T20 are registered trademarks of Saturn Fasteners, Inc.

The chimneys can be adjusted for different ceiling heights. See the following chart.

Vented Installations		
	Min. ceiling height	Max. ceiling height
Electric cooking surface	7' 8" (2.34 m)	9' 10" (3.0 m)
Gas cooking surface	7'11" (2.41 m)	9' 10" (3.0 m)
Non-vented (recirculating) Installations		
	Min. ceiling height	Max. ceiling height
Electric cooking surface	7' 8" (2.34 m)	10' 3" (3.12 m)
Gas cooking surface	7'11" (2.41 m)	10' 3" (3.12 m)

***NOTE:** The range hood chimneys are adjustable and designed to meet varying ceiling or soffit heights depending on the distance "C" between the bottom of the range hood and the cooking surface. For higher ceilings, a Stainless Steel Chimney Extension Kit Part Number W10272078 is available from your dealer or an authorized parts distributor. The chimney extension replaces the chimney shipped with the range hood.

Venting Requirements

- Vent system must terminate to the outside, except for non-vented (recirculating) installations.
- Do not terminate the vent system in an attic or other enclosed area.
- Do not use 4" (10.2 cm) laundry-type wall caps.
- Use metal vent only. Rigid metal vent is recommended. Do not use plastic or metal foil vent.
- The vent system must have a damper. If the roof or wall cap has a damper, do not use the damper supplied with the range hood.

For the most efficient and quiet operation:

- Use a straight run or as few elbows as possible.
- Use no more than three 90° elbows.
- Make sure there is a minimum of 24" (61.0 cm) of straight vent between the elbows if more than 1 elbow is used.
- Do not install 2 elbows together.
- Use vent clamps to seal all joints in the vent system.
- Use caulking to seal exterior wall or roof opening around the cap.
- The size of the vent should be uniform.

Cold Weather Installations

An additional back draft damper should be installed to minimize backward cold air flow and a thermal break should be installed to minimize conduction of outside temperatures as part of the vent system. The damper should be on the cold air side of the thermal break.

The break should be as close as possible to where the vent system enters the heated portion of the house.

Makeup Air

Local building codes may require the use of makeup air systems when using ventilation systems greater than specified CFM of air movement. The specified CFM varies from locale to locale. Consult your HVAC professional for specific requirements in your area.

Venting Methods

This island hood is factory set for venting through the roof.

A 6" (15.2 cm) round vent system is needed for installation (not included). The hood exhaust opening is 6" (15.2 cm) round.

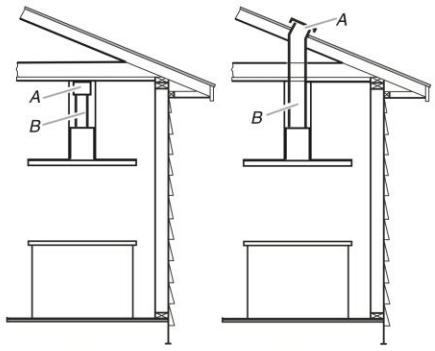
NOTE: Flexible vent is not recommended. Flexible vent creates back pressure and air turbulence that greatly reduce performance.

Vent system can terminate either through the roof or wall. To vent through a wall, a 90° elbow is needed.

For Non-Vented (recirculating) Installations

If it is not possible to vent cooking fumes and vapors to the outside, the hood can be used in the non-vented (recirculating) version, fitting a charcoal filter and the deflector. Fumes and vapors are recycled through the top of the grille. To order, see the "Assistance or Service" section.

Non-vented (recirculating) **Roof Venting**



A. Deflector
B. 6" (15.2 cm) round vent

A. Roof cap
B. 6" (15.2 cm) round vent

NOTE: Wall venting can be an option for 2-story homes.

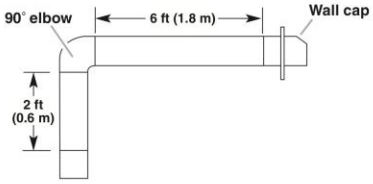
Calculating Vent System Length

To calculate the length of the system you need, add the equivalent feet (meters) for each vent piece used in the system.

Vent piece	6" (15.2 cm) round	
45° elbow	2.5 ft (0.8 m)	
90° elbow	5.0 ft (1.5 m)	

Maximum equivalent vent length is 35 ft (10.7 m).

Example Vent System



The following example falls within the maximum vent length of 35 ft (10.7 m).

1 - 90° elbow	= 5.0 ft (1.5 m)
1 - wall cap	= 0.0 ft (0.0 m)
8 ft (2.4 m) straight	= 8.0 ft (2.4 m)
System length	= 13 ft (3.9 m)

Electrical Requirements

Observe all governing codes and ordinances.

Ensure that the electrical installation is adequate and in conformance with National Electrical Code, ANSI/NFPA 70 (latest edition), or CSA Standards C22.1-94, Canadian Electrical Code, Part 1 and C22.2 No. 0-M91 (latest edition) and all local codes and ordinances.

If codes permit and a separate ground wire is used, it is recommended that a qualified electrician determine that the ground path is adequate.

A copy of the above code standards can be obtained from:

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

CSA International
8501 East Pleasant Valley Road
Cleveland, OH 44131-5575

- A 120 volt, 60 Hz., AC only, 15-amp, fused electrical circuit is required.
- If the house has aluminum wiring, follow the procedure below:
  1. Connect a section of solid copper wire to the pigtail leads.
  2. Connect the aluminum wiring to the added section of copper wire using special connectors and/or tools designed and UL listed for joining copper to aluminum.

  Follow the electrical connector manufacturer's recommended procedure. Aluminum/copper connection must conform with local codes and industry accepted wiring practices.
- Wire sizes and connections must conform with the rating of the appliance as specified on the model/serial rating plate. The model/serial plate is located behind the filter on the rear wall of the range hood.
- Wire sizes must conform to the requirements of the National Electrical Code, ANSI/NFPA 70 (latest edition), or CSA Standards C22. 1-94, Canadian Electrical Code, Part 1 and C22.2 No. 0-M91 (latest edition) and all local codes and ordinances.

INSTALLATION INSTRUCTIONS

Prepare Location

- Lay out the vent duct system before installing the range hood to determine the best routing for the vent duct.
- It is recommended that the vent system be installed before the range hood is installed.
- Before making cutouts, make sure there is proper clearance within the ceiling for exhaust vent.
- Range hood is to be installed 24" (61.0 cm) min. for electric cooking surfaces, 27" (68.6 cm) min. for gas cooking surfaces, to a suggested maximum of 36" (91.4 cm) above the cooking surface.
- Remove film from metal surfaces as needed prior to assembly.
- Check your ceiling height and the range hood height maximum before you install your hood.

1. Disconnect power.
2. Determine which venting method to use: roof, wall or non-vented.
3. Select a flat surface for assembling the range hood. Place covering over that surface. Place two 3" (7.6 cm) high spacers (not included) onto the covered surface.

   NOTE: Cover the spacers to avoid damage to the range hood surface.

⚠WARNING

Excessive Weight Hazard

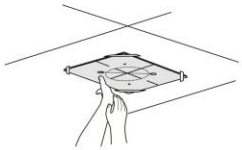
Use two or more people to move and install range hood.

Failure to do so can result in back or other injury.

4. Using 2 or more people, lift range hood onto covered spacers.

Range Hood Mounting Screws Installation

1. Determine and mark the centerline on the ceiling where the range hood will be installed, considering the requirements for ceiling support structures. See the "Location Requirements" section. Make sure the range hood is centered over the cooking surface.
2. Tape template in place on the ceiling at the marked centerline. The line for the front of the range hood should be parallel to the front of the cooktop.



3. Use a pencil to mark the mounting screws, wire access and duct hole locations on the ceiling.

   NOTE: Mounting hole locations should be into a ceiling support structure capable of holding 80 lbs (36.6 kg).

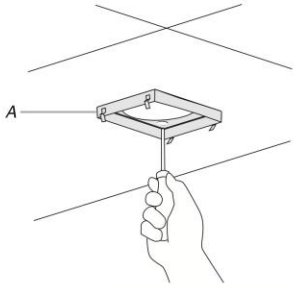
   Remove the template.
4. Drill 4 - 3⁄16" (4.8 mm) pilot holes for mounting the upper horizontal support.

Complete Preparation

1. Determine the required location for the home power supply cable and drill a ½" (1.3 cm) diameter hole for wire access.
2. Run ½" (1.3 cm) conduit and wires or home power supply cable according to the National Electrical Code or CSA Standards and local codes and ordinances. There must be enough ½" conduit and wires or home power supply cable from the fused disconnect (or circuit breaker) box to make the connection in the hood's electrical terminal box.

   NOTE: Do not reconnect power until installation is complete.
3. **For vented installations only:** Using a jigsaw or keyhole saw, cut a 6½" (16.5 cm) diameter hole for the vent duct.
4. Attach the upper horizontal support bracket with 4 - 5 x 45 mm wood screws.

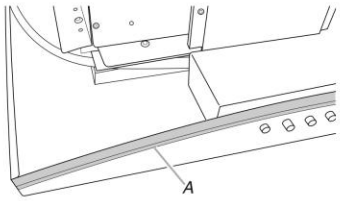
   NOTE: Upper horizontal support screws must be into a ceiling support structure capable of holding 80 lbs (36.6 kg).



A. Upper horizontal support

Assemble Range Hood

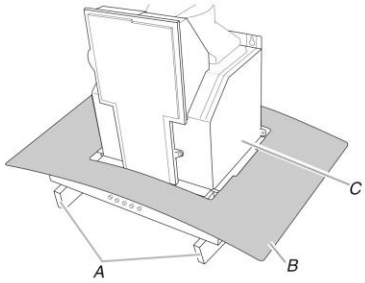
1. Assemble rubber seals to the front and back flange of the ventilator assembly.



A. Rubber seal

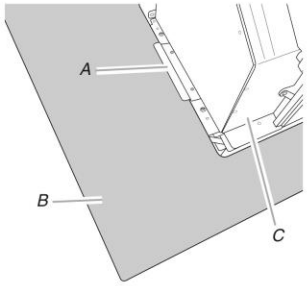
2. Assemble and center glass canopy to ventilator assembly.

   NOTE: The range hood should be sitting on covered spacers for assembling the glass canopy to the ventilator assembly.



A. Covered spacers
B. Glass canopy
C. Ventilator assembly

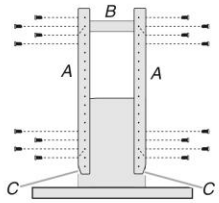
3. Install retainer bracket to both sides and secure with 4 - 4 x 8 mm screws to hold glass canopy to ventilator assembly.



A. Retainer bracket
B. Glass canopy
C. Ventilator assembly

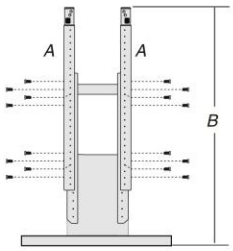
4. Position the 4 vertical supports (A) with the notches at the bottom and attach to the range hood using 16 - 4 x 8 mm screws.

5. Attach the horizontal support (B) using 8 - 4 x 8 mm screws.



A. Vertical supports
B. Horizontal support
C. Notched end

6. Attach a second set of vertical supports (A) and set the vertical height (B). See "Installation Dimensions" in the "Location Requirements" section to help determine the desired dimension for vertical height "B."

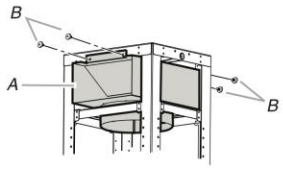


A. Vertical supports
B. Vertical height

Install Range Hood

Non-Vented (recirculating) Installation

1. Attach the air deflector to the upper horizontal support using 4 mounting screws.

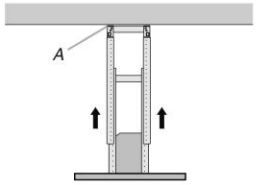


A. Deflector
B. Mounting screws

2. Measure the length of 6" (15.2 cm) duct needed to connect the transition to the deflector.
   NOTE: Vent should fit up inside the deflector 1" (2.5 cm) minimum.
3. Install vent between the transition and the deflector.
   NOTE: To make vent installation easier, temporarily remove the deflector from the chimney support bracket and replace after vent section is in place.
4. Seal all connections with vent clamps. Continue with "Range Hood Installation" in this section.

Range Hood Installation

1. Using 2 or more people, lift the range hood assembly and attach it by snapping the vertical supports to the spring clips in the upper horizontal support bracket that is mounted to the ceiling.
2. Install 16 - 4 x 8 mm screws and tighten to secure.



A. Mounting screws

Connect Vent System

1. Install vent system.
2. Push duct over the exhaust outlet. Seal all connections with vent clamps.
3. Use caulk to seal all openings.

Make Electrical Connection

⚠WARNING

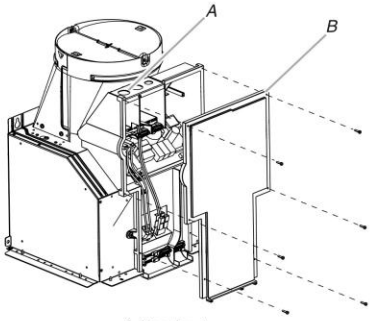
Electrical Shock Hazard

Disconnect power before servicing.

Replace all parts and panels before operating.

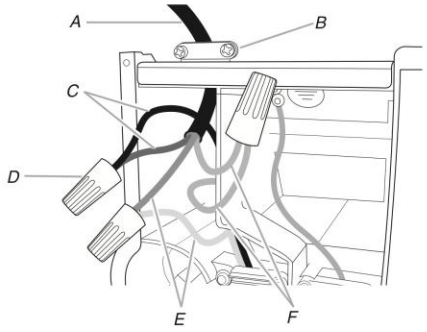
Failure to do so can result in death or electrical shock.

1. Disconnect power.
2. Remove terminal box cover.
3. Remove the knockout in the terminal box cover and install a UL listed or CSA approved ½" strain relief.



A. Knockout
B. Terminal box cover

4. Run home power supply cable through strain relief, into terminal box.



A. Home power supply cable
B. UL listed or CSA approved strain relief
C. Black wires
D. UL listed wire connectors
E. White wires
F. Green (or bare) and yellow-green ground wires

5. Use UL listed wire connectors and connect black wires (C) together.
6. Use UL listed wire connectors and connect white wires (E) together.

⚠WARNING

Electrical Shock Hazard

Electrically ground blower.

Connect ground wire to green and yellow ground wire in terminal box.

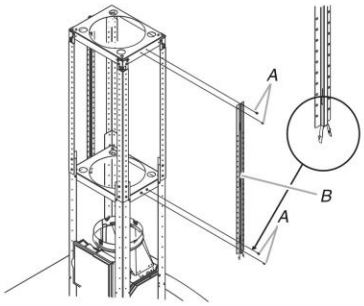
Failure to do so can result in death or electrical shock.

7. Connect green (or bare) ground wire from home power supply to yellow-green ground wire (F) in terminal box using UL listed wire connectors.
8. Tighten strain relief screw.
9. Install terminal box cover.
10. Check that all light bulbs are secure in their sockets.
11. Reconnect power.

Install Duct Covers

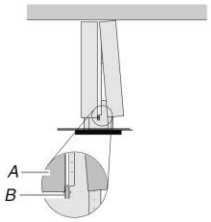
NOTE: Remove the film from the vertical duct cover supports and the duct covers.

1. Attach the vertical duct cover supports using 8 - 4 x 8 mm screws.



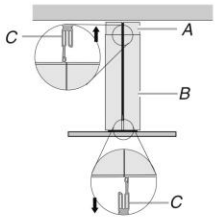
A. Screws
B. Vertical duct cover support

2. Slide the upper duct covers into place, and insert 3 tabs on each side of the duct covers into the mating slots of the vertical duct cover supports. Slide the duct covers up until the springs "click" and the tabs are locked in place.



A. Upper duct cover
B. Spring

3. Slide the lower duct covers over the upper duct covers.
4. Attach the lower duct covers together using a plastic bracket at each top and bottom corner of the lower duct covers (4 places).



A. Upper duct cover
B. Lower duct cover
C. Plastic brackets

Complete Installation

1. For non-vented (recirculating) installations only, install charcoal filters over grille on blower housing. See the "Range Hood Care" section.
2. Install metal filters. See the "Range Hood Care" section.
3. Check the operation of the range hood blower and light. See the "Range Hood Use" section.

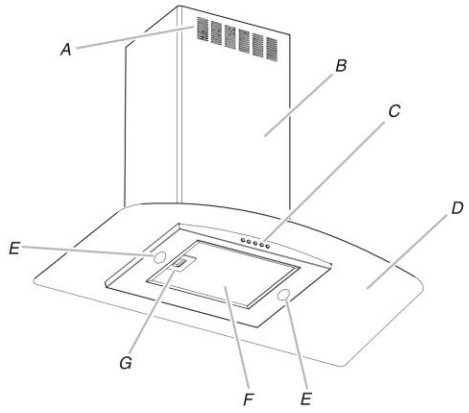
   If range hood does not operate, check to see whether a circuit breaker has tripped or a household fuse has blown.

NOTE: To get the most efficient use from your new range hood, read the "Range Hood Use" section.

RANGE HOOD USE

The range hood is designed to remove smoke, cooking vapors and odors from the cooktop area. For best results, start the hood before cooking and allow it to operate several minutes after the cooking is complete to clear all smoke and odors from the kitchen.

The hood controls are located on the front side of the canopy.



A. Duct cover holes
B. Duct cover
C. Control panel
D. Glass canopy
E. Halogen lamps
F. Grease filter
G. Grease filter release handle

Range Hood Controls

A. On/Off light button
B. Blower Off button
C. Blower speed minimum button
D. Blower speed medium button
E. Blower speed maximum button

Operating the light

The On/Off light button controls both lights. Press once for On and again for Off.

Operating the blower

The Blower Speed buttons turn the blower on and control the blower speed and sound level for quiet operation. The speed can be changed anytime during fan operation by pressing the desired blower speed button.

The Blower Off button turns the blower Off.

RANGE HOOD CARE

Cleaning

IMPORTANT: Clean the hood and grease filters frequently according to the following instructions. Replace grease filters before operating hood.

Exterior Surfaces:

To avoid damage to the exterior surface, do not use steel wool or soap-filled scouring pads.

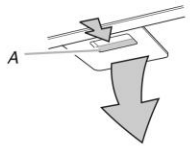
Always wipe dry to avoid water marks.

Cleaning Method:

- Liquid detergent soap and water, or all-purpose cleanser
- Wipe with damp soft cloth or nonabrasive sponge, then rinse with clean water and wipe dry.

Metal Grease Filter

1. Remove each filter by pulling the spring release handle and then pulling down the filter.



A. Spring release handle

2. Wash metal filters as needed in dishwasher or hot detergent solution.
3. Reinstall the filter by making sure the spring release handles are toward the front. Insert aluminum filter into upper track.
4. Push in spring release handle.
5. Push up on metal filter and release handle to latch into place.

Non-Vented (recirculating) Installation Filters

The charcoal filter is not washable. It should last up to 6 months with normal use. Replace with Charcoal Filter Kit Number W10412939.

To replace charcoal filter:

1. Remove metal grease filter from range hood. See “Metal Grease Filter” in this section.
2. Bend spring clips away from metal grease filter.

3. Place charcoal filter into top side of metal filter.
4. Bend spring clips back into place to secure the charcoal filter to the metal filter.

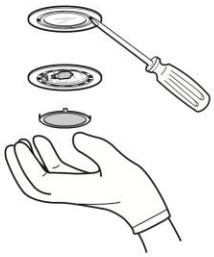
5. Replace metal grease filter. See “Metal Grease Filter” in this section.

Replacing a Halogen Lamp

Turn off the range hood and allow the halogen lamp to cool. To avoid damage or decreasing the life of the new bulb, do not touch bulb with bare fingers. Replace bulb, using tissue or wearing cotton gloves to handle bulb.

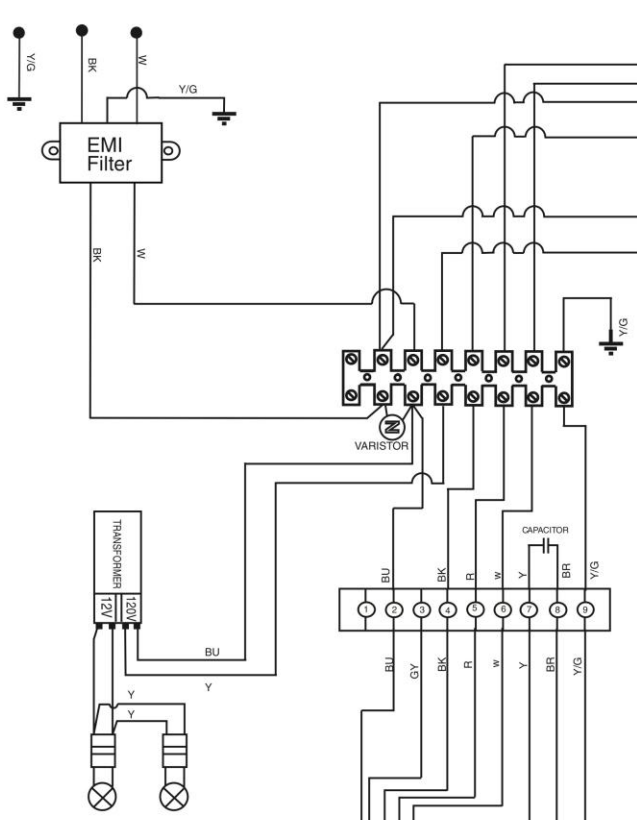
If new lights do not operate, make sure the lamps are inserted correctly before calling service.

1. Disconnect power.
2. Use a flat-blade screwdriver and gently pry the light cover loose.



3. Remove the lamp and replace with a 12-volt, 20-watt maximum, halogen lamp made for a G-4 base.
4. Replace the light cover.
5. Reconnect power.

WIRING DIAGRAM



Switch Operation	
Position	Connection
Off	No Connection
High Speed	L-Black (3)
Med Speed	L-Red (2)
Low Speed	L-White (1)
Lamps	L-Yellow (LA)

Motor Characteristics	
Power Supply	120VAC
Frequency	60HZ
Power	240W

Motor Resistance	(Ohms)
Blue Red	37.7
Blue Gray	30.3
Blue Black	20.8 (MAX)
Blue White	45.1 (MAX)
Room Temp.	73˚F (23˚C)

12

FRIGIDAIRE

Single Wall Ovens

FFEW2725L S/W/B

27" Electric

Signature Features

Ready-Select® Controls
Easily select options or control cooking temperature with our easy-to-use controls.

Even Baking Technology
Our latest technology ensures even baking every time.

Self-Cleaning
Ovens clean themselves—so you don't have to.

Vari-Broil™ Option
Allows you to choose between two heat levels.

Product Dimensions

Height	29"
Width	27"
Depth	24-1/2"

More Easy-To-Use Features

Attractive Stainless Steel Exterior[1]

Keep Warm

Timer Lock-Out

Oven Rack Handles
Oven racks are designed with space for you to easily pull out the racks, even when wearing an oven mitt.

Extra-Large Window
Our extra-large oven window lets you easily see what's inside.

Bright Oven Lighting
Our bright lighting makes it easy to see what's inside.

Delay Clean
Set the oven to begin cleaning on your schedule.

Delay Start

Timed Cook Option

Auto Shut-Off
As an extra safety measure, the oven will automatically shut off after 12 hours.

A.D.A. Compliant[2]

Sabbath Mode (Star-K® Certified)

Available in:

Stainless (S) · White (W) · Black (B)

[1]Select models only.

[2]When properly installed, meets the appliance standards in the Americans with Disabilities Act and the Architectural Barriers Act Accessibility Guidelines as published by the United States Access Board on June 23, 2004, as amended August 5, 2005.

frigidaire.com

FRIGIDAIRE

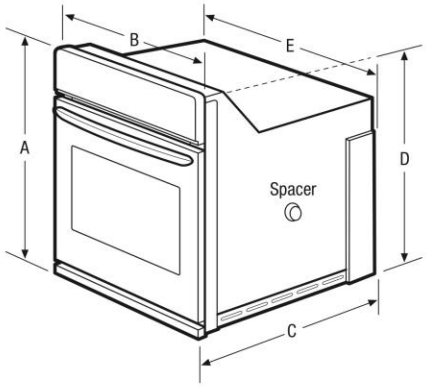
Single Wall Ovens

FFEW2725L S/W/B **27" Electric**

Features	
Oven Control/Timing System	Ready-Select®
Window	Extra-Large
Exterior Door Finish	Stainless Steel (S), Color-Coordinated (W/B)
Handle Design	Stainless Steel (S), Color-Coordinated (W/B)
Oven Cleaning System	Self Clean
Oven Controls	
Bake/Broil	Yes/ Variable (Hi - Lo)
Convection Conversion	
Convection Bake/Broil/Roast	
Quick Bake Convection	
PowerPlus®/Quick Preheat	
My Favorite	
Chicken Nugget Button	
Pizza Button	
Keep Warm	Yes
Add-a-Minute	
Delay Start	Yes
Self-Clean	Yes
Rapid/Quick Clean Option	Quick
Delay Clean	2, 3 Hours
Kitchen Timer	Yes
Timed Cook Option	Yes
Control Lock	Yes
Auto Oven Shut-Off	12 Hours
Oven Lock-Out	Yes
Oven Features	
Capacity (Cu. Ft.)	3.5
Convection System	
Oven Light	1
Hidden Bake Element	
Rack Configuration	2 Handle Racks
Baking System	Even Baking Technology
Broiling System	Vari-Broil™
Bake/Broil Element (Watts)	2,300/3,400
Optional Accessories	
3"-High Bottom Trim - Stainless Steel (S)/White (W)/Black (B)	(S) PN# 903114-901S (W) PN# 903114-9011 (B) PN# 903114-9010
Certifications	
A.D.A. Compliant[1]	Yes
Sabbath Mode (Star-K® Certified)	Yes
Specifications	
Oven Interior (H x W x D)	16-1/2" x 20-1/2" x 18-1/32"
Power Supply Connection Location	Left Bottom Rear
Voltage Rating	240V/208V/60Hz
Connected Load (kW Rating) @ 240/208 Volts[2]	3.4/2.6
Amps @ 240/208 Volts	14.2/12.5
Minimum Circuit Required (Amps)	20
Approved for Under-Counter Installation	Yes
Shipping Weight (Approx.)	155 Lbs.

[1]*When properly installed, meets the appliance standards in the Americans with Disabilities Act and the Architectural Barriers Act Accessibility Guidelines as published by the United States Access Board on June 23, 2004, as amended August 5, 2005.*

[2]*Single phase 3- or 4-wire cable, 120/240 or 120/208 Volt, 60 Hertz AC only electrical supply with ground required on separate circuit fused on both sides of line.*



NOTE: For planning purposes only. Always consult local and national electric codes. Refer to Product Installation Guide for detailed installation instructions on the web at frigidaire.com.

Product Dimensions	
A - Height	29"
B - Width	27"
C - Depth	24-1/2"
D - Height (Wrapper)	27-3/16"
E - Width (Wrapper)	24-5/8"
Depth with Door Open 90°	45-1/2"

Cutout Dimensions	
Height (Min.)	27-1/4"
Height (Max.)	28-5/8"
Width (Min.)	24-7/8"
Width (Max.)	25-1/4"
Depth (Min.)	23-1/2"

*Accessories information available on the web at **frigidaire.com***

FRIGIDAIRE

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CANADA • 5855 Terry Fox Way • Mississauga, ON L5V 3E4 • 1-800-265-8352 • **frigidaire.ca**

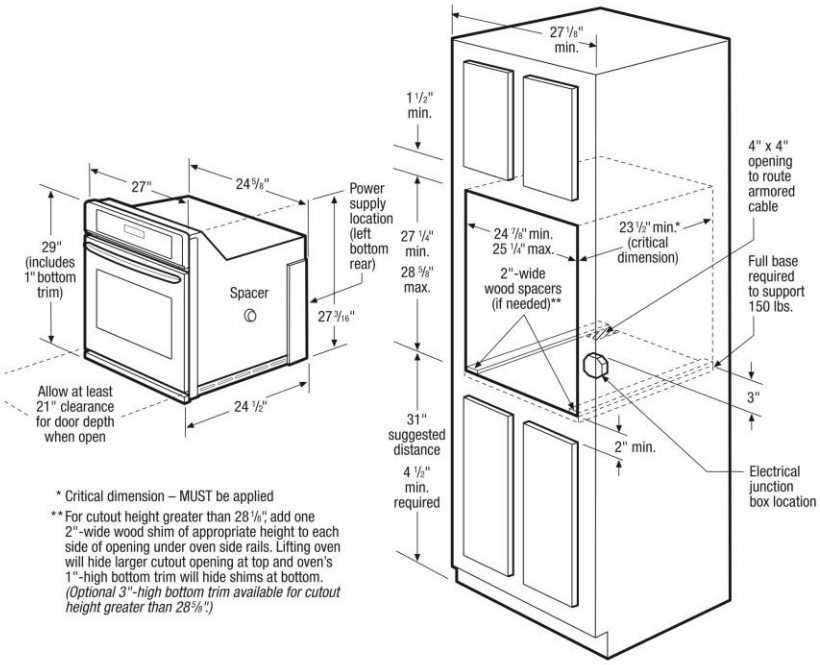
Specifications subject to change.

FFEW2725L 10/12

FRIGIDAIRE

Single Wall Ovens

FFEW2725L S/W/B **27" Electric**



* Critical dimension – MUST be applied

** For cutout height greater than 28 1/8", add one 2"-wide wood shim of appropriate height to each side of opening under oven side rails. Lifting oven will hide larger cutout opening at top and oven's 1"-high bottom trim will hide shims at bottom. *(Optional 3"-high bottom trim available for cutout height greater than 28 5/8".)*

Single Wall Oven Specifications

- Product Shipping Weight (approx.) – 155 Lbs.
- Single phase 3- or 4-wire cable, 120/240 or 120/208 Volt, 60 Hertz AC only electrical supply with ground required on separate circuit fused on both sides of line.
- Connected Load (kW Rating) @ 240/208 Volts = 3.4/2.6 kW
- Amps @ 240/208 Volts = 14.2/12.5 Amps
- Recommended Circuit Breaker – 20 Amps
- Always consult local and national electric codes.
- Minimum 21" clearance for oven door depth when open.
- Suggested distance from floor is 31". Minimum required distance is 4-1/2".
- Minimum 23-1/2" deep cutout dimension is critical for proper installation, to ensure that oven's faceplate will fit flush against cabinet front.
- To adapt oven to fit cutout height greater than 28-1/8", add one 2"-wide wood shim of appropriate height to each side of opening under oven side rails. Lifting oven will hide larger cutout opening at top and oven's 1"-high bottom trim will hide shims at bottom. *(Standard 1"-High Bottom Trim included.)*
- To adapt oven to fit cutout height greater than 28-5/8", optional 3"-High Bottom Trim available.
- Full oven base of solid plywood or similar material required, capable of supporting 150 Lbs.
- Base must be level and cabinet front must be square.
- Single Wall Oven is NOT approved to be used in stackable or side-by-side installation.
- Single Wall Oven is approved to be used alone in under-counter installation or beneath any approved Frigidaire® gas or electric cooktop. *(Refer to Gas or Electric Cooktop Installation Over 30"/27" Electric Single Wall Oven Specifications pages on web.)*
- Single Wall Oven is approved to be used in combination with any Frigidaire® Warmer Drawer. *(Refer to model-specific Warmer Drawer product page for Combination Installation Specifications.)*
- Single Wall Oven is approved to be used in combination with any Frigidaire® Built-In Microwave Oven.

Note: For planning purposes only. Refer to Product Installation Guide on the web at frigidaire.com for detailed instructions.

Optional Accessories

- 3"-High Stainless Steel Bottom Trim – (PN# 903114-901S).
- 3"-High White Bottom Trim – (PN# 903114-9011).
- 3"-High Black Bottom Trim – (PN# 903114-9010).

Accessories information available on the web at ***frigidaire.com***

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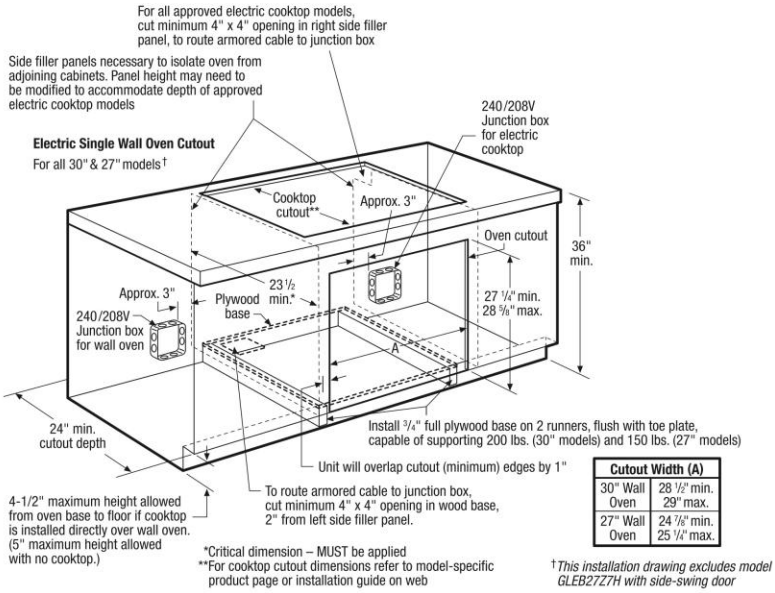
USA • 10200 David Taylor Drive • Charlotte, NC 28262 • 1-800-FRIGIDAIRE • **frigidaire.com**
CANADA • 5855 Terry Fox Way • Mississauga, ON L5V 3E4 • 1-800-265-8352 • **frigidaire.ca**

Specifications subject to change.

FFEW2725L 10/12

FRIGIDAIRE

Electric Cooktop Installation Over 30"/27" Electric Single Wall Oven



Cutout Width (A)	
30" Wall Oven	28 1/2" min. 29" max.
27" Wall Oven	24 7/8" min. 25 1/4" max.

30"/27" Electric Single Wall Oven Under-Counter Installation Specifications

- Single phase 3- or 4-wire cable, 120/240 or 120/208 Volt, 60 Hertz AC only electrical supply with ground required on separate circuit fused on both sides of line.
- For detailed electrical requirements, refer to model-specific product page and installation guide on web.
- Always consult local and national electric codes.
- Minimum 21" clearance for oven door depth when open.
- Minimum 23-1/2" deep cutout dimension is critical for proper installation, to ensure that oven's faceplate will fit flush against cabinet front.
- Side filler panels necessary to isolate oven from adjoining cabinets.
- Full oven base of solid plywood or similar material required, capable of supporting 200 Lbs. (30" models) or 150 Lbs. (27" models). Install over two runners and flush with toe plate.
- Base must be level and cabinet front must be square.
- Allow 5" maximum height from oven base to floor, if NO cooktop is installed directly over wall oven.

Electric Cooktop Installation Over 30"/27" Electric Single Wall Oven Specifications

All Frigidaire® Electric Single Wall Ovens are approved to be used beneath any approved Frigidaire® Electric Cooktop. *(This installation page excludes approved wall oven model GLEB27Z7H. For model-specific installation details, refer to Electric Cooktop Installation Over 27" Electric Single Wall Oven GLEB27Z7H Specifications pages on web.)*

For detailed Electric Cooktop installation, refer to model-specific product page and installation guide on web.

- Side filler panel height may need to be modified to accommodate the depth of approved electric cooktop models.
- To route armored cable to junction box, cut minimum 4" x 4" opening in right side filler panel.
- Allow 4-1/2" maximum height from oven base to floor, if cooktop is installed directly over wall oven.

Note: For planning purposes only. Refer to Product Installation Guide on the web at frigidaire.com for detailed instructions.

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EC_EW INST FR 02/12

Specifications subject to change.

FRIGIDAIRE
GALLERY

Built-In Cooktop

FGIC3067M B

30" Induction

Signature Features

More Responsive
Cooking with induction is more responsive than gas or electric so you can easily go from simmer to boil.

Versatile Induction Elements
With up to five powerfully efficient induction elements, the Induction Cooktop offers the superior cooking flexibility. And the 10" induction element offers up to 3,400 watts of power, so you can bring water to a boil quickly.

Exceptional Temperature Control
Adjust heat with greater accuracy than on gas or electric cooktops especially at lower settings.

More Energy-Efficient
Cooking with induction is 70% more efficient than gas and 20% more efficient than electric.

Product Dimensions

Width	30-3/4"
Depth	21-1/2"
Height	4-3/8"

More Easy-To-Use Features

Cooktop Stays Cooler
With induction cooking, heat is transferred directly to the cookware, so the cooktop stays cooler to the touch—making it easier to clean.

Power Assist Function
Generates rapid heat for a faster boil.

Cooking Versatility
Gentle enough to melt chocolate and powerful enough to boil water, so it's great for entertaining or getting dinner on the table quickly.

Express-Select® Controls
Easily go from warm to boil.

Smoothtop Ceramic Glass Cooking Surface

Hot Surface Indicators

A.D.A. Compliant[1]

Available in:

Black (B)

Elements	Size	Watts
Right Front	10"	2,500/3,400
Right Rear	6"	1,450/2,000
Left Front	7"	1,800/2,600
Left Rear	8"	2,300/3,200

[1]*When properly installed, meets the appliance standards in the Americans with Disabilities Act and the Architectural Barriers Act Accessibility Guidelines as published by the United States Access Board on June 23, 2004, as amended August 5, 2005.*

frigidaire.com

FRIGIDAIRE GALLERY

Built-In Cooktop

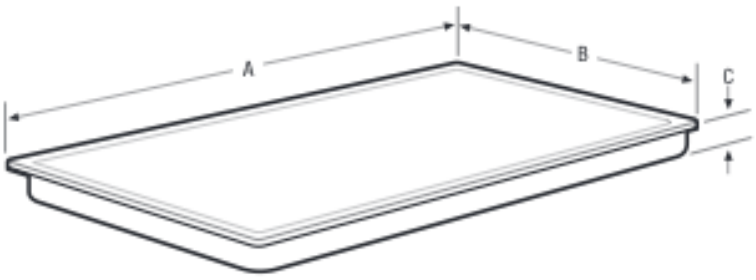
FGIC3067M B **30" Induction**

Features	
Controls	Express-Select®
Surface Type	Black Ceramic Glass
Right Front Element (Watts)	10" - 2,500/3,400
Right Rear Element (Watts)	6" - 1,450/2,000
Left Front Element (Watts)	7" - 1,800/2,600
Left Rear Element (Watts)	8" - 2,300/3,200
Hot Surface Indicators	Yes
Control Location	Center Front
Certifications	
A.D.A. Compliant[1]	Yes
Sabbath Mode (Star-K® Certified)	
Specifications	
Power Supply Connection Location	Right Rear
Voltage Rating	240V/208V/60Hz
Connected Load (kW Rating) @ 240/208 Volts[2]	8.4/7.3
Amps @ 240/208 Volts	35.1/35.0
Minimum Circuit Required (Amps)	40
Approved for Electric Single Wall Oven Combination Installation[3]	Yes
Shipping Weight (Approx.)	48 Lbs.

[1] *When properly installed, meets the appliance standards in the Americans with Disabilities Act and the Architectural Barriers Act Accessibility Guidelines as published by the United States Access Board on June 23, 2004, as amended August 5, 2005.*

[2] *Single phase 3- or 4-wire cable, 120/240 or 120/208 Volt, 60 Hertz AC only electrical supply with ground required on separate circuit fused on both sides of line.*

[3] *Cooktops are approved for installation above any of our Electric Single Wall Ovens.*



NOTE: For planning purposes only. Always consult local and national electric codes. Refer to Product Installation Guide for detailed installation instructions on the web at frigidaire.com.

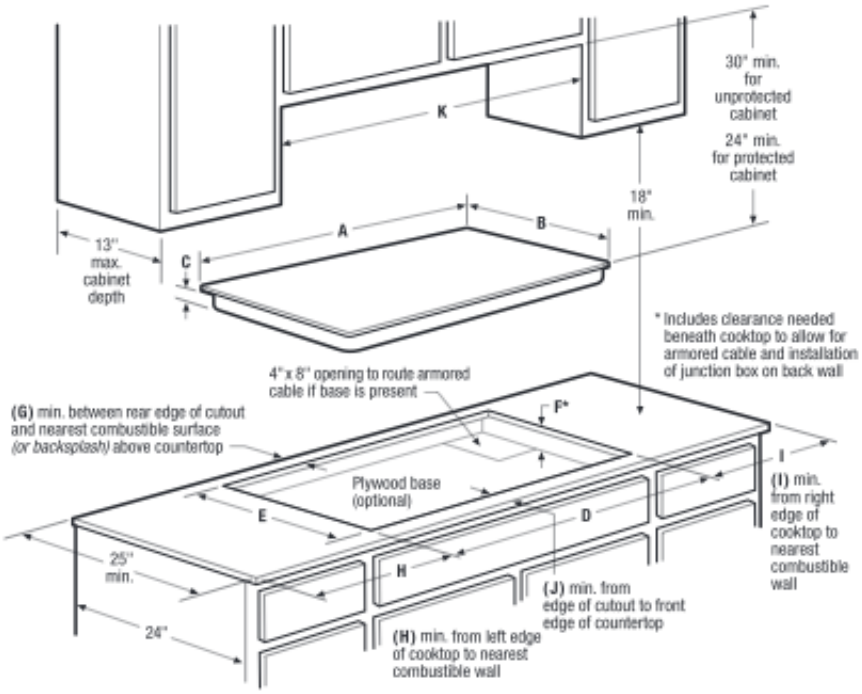
Product Dimensions		Cutout Dimensions	
A - Width	30-3/4"	Width (Min.)/(Max.)	29-5/8"/29-3/4"
B - Depth	21-1/2"	Depth (Min.)/(Max.)	20-3/8"/20-1/2"
C - Height	4-3/8"	Height	4-1/2"

Granite Countertop Installation Kit available.

FRIGIDAIRE GALLERY

Built-In Cooktop

FGIC3067M B **30" Induction**



Product Dimensions			Required Clearances			
A - Width	B - Depth	C - Height	G (min.)	H (min.)	I (min.)	J (min.)
30-3/4"	21-1/2"	4-3/8"	1-1/2"	2"	2"	2-1/2"
Product Cutout Dimensions			**K - Cabinet Opening Width (min.)**		**Utility Connection Locations**	
D - Width (min. - max.)	E - Depth (min. - max.)	F - Height (min.)*			Power Supply	
29-5/8" - 29-3/4"	20-3/8" - 20-1/2"	4-1/2"	30-3/4"		Right Rear	

Built-In Cooktop Specifications

- Product Shipping Weight (approx.) – 48 Lbs.
- Single phase 3- or 4-wire cable, 120/240 or 120/208 Volt, 60 Hertz AC only electrical supply with ground required on separate circuit fused on both sides of line.
- Connected Load (kW Rating) @ 240/208 Volts = 8.4/7.3kW
- Amps @ 240/208 Volts = 35.1/35.0 Amps
- Recommended Circuit Breaker – 40 Amps
- Always consult local and national electric codes.
- Cooktop cutout height includes clearance needed beneath cooktop to allow for armored cable and installation of junction box on back wall. Position center of junction box 10" inward from right side of cooktop cutout, and 12" down from underside of countertop.
- Overhead cabinetry should not exceed a 13" maximum depth.
- Absolute minimum horizontal distance between overhead cabinets installed to either side of appliance must be no less than 30-3/4".
- Allow 30" minimum clearance between top of cooktop platform and bottom of unprotected wood or metal overhead cabinet; or 24" minimum clearance when bottom of wood or metal overhead cabinet is protected by not less than 1/8" flame-retardant millboard covered with not less than No. 28 MSG sheet steel, 0.015" stainless steel, 0.024" aluminum or 0.020" copper.
- Allow 1-1/2" minimum clearance between rear edge of cutout and nearest combustible surface *(or backsplash)* above countertop.
- Allow 2" minimum required clearance from left edge of cooktop to nearest combustible wall and 2" minimum from right edge of cooktop to nearest combustible wall.
- Installation of drawer not recommended beneath cooktop.
- To reduce risk of fire when using overhead cabinetry, install range hood that projects horizontally a recommended minimum of 5" beyond bottom of cabinets.
- Electric Built-In Cooktop model FGIC3067M is approved to be used over any Frigidaire® Electric Single Wall Oven. *(Refer to Electric Cooktop Installation Over 30"/27" Electric Single Wall Oven Specifications page on web.)*
- Electric Built-In Cooktop model FGIC3067M is approved to be used in combination with Frigidaire® 30" Downdraft Vent E30DD75ESS or PL30DD50EC. *(Refer to model-specific Downdraft Vent product page on web for detailed countertop preparation specifications.)*

Note: For planning purposes only. Refer to Product Installation Guide on the web at frigidaire.com for detailed instructions.

Optional Accessories

- Granite Countertop Installation Kit – (PN # 903061-9010).

PART 3 - EXECUTION

A. See Above

3.01 INSTALLATION

A. Built-in Appliances: Securely anchor to supporting cabinetry or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

B. Freestanding Appliances: Place in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

C. Test each item of residential appliances to verify proper operation. Make necessary adjustments.

D. Verify that accessories required have been furnished and installed.

END OF SECTION

SECTION 12 93 00
SITE FURNISHINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Site furnishings will be both moveable and fixed units, consisting of custom and pre-made planters, benches, bike rack, table and chairs.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel and Iron:
   1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M, hot-dip galvanized.
   2. Steel Sheet: ASTM A 1011/A 1011M.

B. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated, with tongue and groove where indicated.
   1. Wood Species: White Cedar and Red Cedar

2.02 SITE FURNISHINGS

A. Planters
   1. Materials: White Cedar, Red Cedar, Steel, and Plastic.
      a. 3/4”x6” white cedar boards.
      b. 4”x 6” red cedar perlins.
      c. Steel collars, specified in detail sheet S-509.
      d. Generic plastic sheet lining box to retain moisture.
   2. Construction
      a. Planters shall be constructed by team members prior to transport to Irvine and installed on site. Team members shall comply with all construction specifications and safety requirements.
   3. Installation
      a. Planters will be fastened on the solar path at the locations specified in the plan. Soil and plants shall be installed before planters are placed.

A. Benches
   1. Materials
      a. Wood: 6"x 8” cedar perlins notched by hand to 4”x8”x3¾” at steel collar connections.
      b. Steel collars, specified in detail sheet S-509.
   2. Construction
      a. Benches shall be installed on site. Team members shall comply with all construction specifications and safety requirements.
   3. Installation

a. Benches will be fastened to the solar path at the locations specified in the plan.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All elements shall be placed on or adjacent to decking or solar path elements according the site plan. Where necessary, elements shall be temporarily secured. No element may be placed within 1.5” of the edge of the deck. All planters and benches near the edge of the deck shall be tested for stability and secured as needed.

END OF SECTION

SECTION 21 00 10
FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary
B. Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:
    1. Wet-pipe sprinkler systems.
B. Related Sections include the following:
    1. Division 2 Section "Water Distribution" for piping outside the building.
    2. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.
C. Fire protection system is to be designed to NFPA 13D and FM Global standards and requirements.

1.03 DEFINITIONS

A. Underground Service-Entrance Piping: Underground service piping below the building.
B. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13D for obtaining approval from authorities having jurisdiction.

1.04 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.05 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
B. Design Sprinklers and obtain approval from authorities having jurisdiction and FM Global.
C. Design sprinkle piping according to the following and obtain approval from authorities having jurisdiction and FM Global:
    1. Include 20 percent margin of safety for available water flow and pressure.
    2. Include losses through water-service piping, valves, and backflow preventers.
    3. Sprinkler Occupancy Hazard Classifications as follows:
        a. FM Global Requirements.
    4. Minimum Density for Automatic-Sprinkler Piping Design as follows:
        a. FM Global Requirements.
    5. Maximum Protection Area per Sprinkler as follows:
        a. FM Global Requirements.
D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13D and FM Global and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.06 SUBMITTALS

A. Product Data: For the following:
    1. Piping and fitting materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings. Along with methods of joining for sprinkler piping.
    2. Pipe hangers and supports, including seismic restraints.

3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
5. Fire Pump and Water Storage.
6. Hose connections, including size, type, and finish.
7. Hose stations, including size, type, and finish of hose connections; type and length of fire hoses; finish of fire hose couplings; type, material, and finish of nozzles; and finish of rack.
8. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
9. Alarm devices, including electrical data.

B. Shop Drawings: Diagram
C. Fire-hydrant flow test report.
D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13D, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13D and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping. "power, signal, and control wiring.
F. Welding certificates.
G. Field quality-control test reports.
H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.
I. Refer to Section 23 00 50 - Mechanical General Provisions for requirements regarding product substitutions.

1.07 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
C. Design Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent. Design engineer must possess a NICET level 3 certification in fire protection systems design at minimum.
D. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.
E. Sprinkler components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 Article 100, by a testing agency acceptable to authorities having jurisdiction.
G. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13D, "Standard for the Installation of Sprinkler Systems in One- and Two- Family Dwellings and Manufacturer Homes."

1.08 COORDINATION
A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. All equipment shall be FM Global approved. All non-FM Global approved equipment shall not be permitted.
B. Available Manufacturers: Subject to FM Global compliance with requirements, manufacturer's offering products that may be incorporated into the work include, but are not limited to, the following:
1. Specialty Valves and Devices:
a. Globe Fire Sprinkler Corps.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire Products
d. Viking Corp.
2. Sprinklers:
a. Globe Fire Sprinkler Corps.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire Products
d. Viking Corp.

2.02 PIPING MATERIALS
A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.03 STEEL PIPE AND FITTINGS
A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
a. Available Manufacturers:
1) Anvil International, Inc.

2) Victaulic Co. of America.
3) Ward Manufacturing.
4) Or Equal

C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

2.04 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.05 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed and FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum 300-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:
1. Available Manufacturers:
a. Anvil International, Inc.
b. Central Sprinkler Corp.
c. National Fittings, Inc.
d. Southwestern Pipe, Inc.
e. Star Pipe Products; Star Fittings Div.
f. Victaulic Co. of America.
g. Ward Manufacturing. h.Or Equal
2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
1. Available Manufacturers:
a. Central Sprinkler Corp.
b. Fire-End and Croker Corp.
c. Viking Corp.
d. Victaulic Co. of America.
e. Or Equal

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
1. Available Manufacturers:
a. Elkhart Brass Mfg. Co., Inc.
b. Fire-End and Croker Corp.
c. Potter-Roemer; Fire-Protection Div.
d. Or Equal

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
    1. Available Manufacturers:
        a. AGF Manufacturing Co.
        b. Central Sprinkler Corp.
        c. G/J Innovations, Inc.
        d. Triple R Specialty of Ajax, Inc.
        e. Or Equal
F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
    1. Available Manufacturers:
        a. CECA, LLC.
        b. Merit.
        c. Or Equal

2.06 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed and FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum 300-psig pressure rating if valves are components of high-pressure piping system.
B. Gate Valves with Wall Indicator Posts:
    1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
    2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
    3. Available Manufacturers:
        a. Grinnell Fire Protection.
        b. McWane, Inc.; Kennedy Valve Div.
        c. NIBCO.
        d. Stockham.
        e. Or Equal
C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
    1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
    2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
    3. NPS 3: Ductile-iron body with grooved ends.
    4. Available Manufacturers:
        a. NIBCO.
        b. Victaulic Co. of America.
        c. Or Equal
D. Butterfly Valves: UL 1091.
    1. NPS 2 and Smaller: Bronze body with threaded ends.
        a. Available Manufacturers:
            1) Global Safety Products, Inc.
            2) Milwaukee Valve Company.
            3) Or Equal
    2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
        a. Available Manufacturers:

1) Central Sprinkler Corp.
2) Global Safety Products, Inc.
3) McWane, Inc.; Kennedy Valve Div.
4) Mueller Company.
5) NIBCO.
6) Pratt, Henry Company.
7) Victaulic Co. of America.
8) Or Equal

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
   1. Available Manufacturers:
      a. Central Sprinkler Corp.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Globe Fire Sprinkler Corporation.
      d. Grinnell Fire Protection.
      e. Hammond Valve.
      f. Mueller Company.
      g. NIBCO.
      h. Reliable Automatic Sprinkler Co., Inc.
      i. Star Sprinkler Inc.
      j. United Brass Works, Inc.
      k. Victaulic Co. of America.
      l. Watts Industries, Inc.; Water Products Div.
      m. Or Equal

F. Gate Valves: UL 262, OS&Y type.
   1. NPS 2 and Smaller: Bronze body with threaded ends.
      a. Available Manufacturers:
         1) Crane Co.; Crane Valve Group; Crane Valves.
         2) Hammond Valve.
         3) NIBCO.
         4) United Brass Works, Inc.
         5) Or Equal
   2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
      a. Available Manufacturers:
         1) Clow Valve Co.
         2) Crane Co.; Crane Valve Group; Crane Valves.
         3) Crane Co.; Crane Valve Group; Jenkins Valves.
         4) Hammond Valve.
         5) Milwaukee Valve Company.
         6) Mueller Company.
         7) NIBCO.
         8) Red-White Valve Corp.
         9) United Brass Works, Inc.
         10) Or Equal

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
    a. Available Manufacturers:
        1) Milwaukee Valve Company.
        2) NIBCO.
        3) Victaulic Co. of America.
        4) Or Equal
3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
    a. Available Manufacturers:
        1) Central Sprinkler Corp.
        2) Grinnell Fire Protection.
        3) McWane, Inc.; Kennedy Valve Div.
        4) Milwaukee Valve Company.
        5) NIBCO.
        6) Victaulic Co. of America.
        7) Or Equal

2.07 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed and FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum 300-psig pressure rating if valves are components of high-pressure piping system.
    1. Available Manufacturers:
        a. Central Sprinkler Corp.
        b. Globe Fire Sprinkler Corporation.
        c. Grinnell Fire Protection.
        d. Reliable Automatic Sprinkler Co., Inc.
        e. Star Sprinkler Inc.
        f. Victaulic Co. of America.
        g. Viking Corp.
        h. Or Equal
    2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
        a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
        b. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
    1. Available Manufacturers:
        a. AFAC Inc.
        b. Grinnell Fire Protection.
        c. Or Equal

2.08 SPRINKLERS

A. Sprinklers shall be UL listed and FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum 300-psig pressure rating if sprinklers are components of high-pressure piping system.
B. Available Manufacturers:
C. Automatic Sprinklers: With heat-responsive element complying with the following:
    1. UL 1626, for residential applications.
    2. UL 1767, for early-suppression, fast-response applications.
D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
    1. Open Sprinklers: UL 199, without heat-responsive element.
        a. Orifice: 1/2 inch, with discharge coefficient K between 5.2 and 5.8.
        b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2. E. Sprinkler types, features, and options as follows:
    1. Extended-coverage sprinklers.
    2. Flush ceiling sprinklers, including escutcheon.
    3. Pendent sprinklers.
    4. Quick-response sprinklers.
    5. Recessed sprinklers, including escutcheon.
    6. Sidewall sprinklers.
    7. Upright sprinklers.
F. Sprinkler Finishes: Chrome plated, bronze, and painted.
G. Special Coatings: Wax, lead, and corrosion-resistant paint.
H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
    1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
    2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.09 HOSE CONNECTIONS

A. Available Manufacturers:
    1. Central Sprinkler Corp.
    2. Elkhart Brass Mfg. Co., Inc.
    3. Grinnell Fire Protection.
    4. Guardian Fire Equipment Incorporated.
    5. Mueller Company.
    6. United Brass Works, Inc.
    7. Or Equal
B. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle or gate pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include NPS 1-1/2 or NPS 2-1/2 as indicated, and hose valve threads according to NFPA 1963 and matching local fire department threads.
    1. Valve Operation: Nonadjustable type, unless pressure-regulating type is indicated.
    2. Finish: Rough metal or chrome-plated.

2.10 FIRE DEPARTMENT CONNECTIONS

A. Available Manufacturers:

1. AFAC Inc.
2. Central Sprinkler Corp.
3. Elkhart Brass Mfg. Co., Inc.
4. Fire-End and Croker Corp.
5. Fire Protection Products, Inc.
6. GMR International Equipment Corporation.
7. Guardian Fire Equipment Incorporated.
8. Potter-Roemer; Fire-Protection Div.
9. Reliable Automatic Sprinkler Co., Inc.
10. United Brass Works, Inc.
11. Or Equal

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
   1. Type: Coordinate with Authority Having Jurisdiction.

C. Exposed, Freestanding-Type, Fire Department Connection: UL 405, [175-psig (1200-kPa) minimum] [300-psig (2070-kPa)] pressure rating; with corrosion-resistant-metal body, brass inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, and bottom outlet with pipe threads. Include brass lugged caps, gaskets, and brass chains; brass lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high, brass sleeve; and round, floor, brass escutcheon plate with marking "AUTO SPKR & STANDPIPE."
   1. Finish Including Sleeve: Polished brass.

2.11 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm: UL 464, with 8-inch- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
   1. Available Manufacturers:
      a. Potter Electric Signal Company.
      b. System Sensor.
      c. Or Equal

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   1. Available Manufacturers:
      a. ADT Security Services, Inc.
      b. Grinnell Fire Protection.
      c. ITT McDonnell & Miller.
      d. Potter Electric Signal Company.
      e. System Sensor.

f. Viking Corp.
g. Watts Industries, Inc.; Water Products Div.
h. Or Equal

D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
1. Available Manufacturers:
a. Grinnell Fire Protection.
b. Potter Electric Signal Company.
c. System Sensor.
d. Viking Corp.
e. Or equal

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
1. Available Manufacturers:
a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.
d. Or Equal

2.12 PRESSURE GAUGES

A. Available Manufacturers:
1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. Marsh Bellofram.
6. WIKA Instrument Corporation.
7. Or Equal

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gauge with range of 0 to 250 psig minimum.
1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14 and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
B. Report test results promptly and in writing.

3.02 EARTHWORK

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.03 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.04 PIPING APPLICATIONS, GENERAL

A. Shop weld pipe joints where welded piping is indicated.
B. Do not use welded joints for galvanized-steel pipe.
C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings.
E. Underground Service-Entrance Piping: Ductile-iron, mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.

3.05 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
    1. NPS 1-1/2 and Smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
    2. NPS 2: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.

3.06 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13D and NFPA 14.
        a. Shutoff Duty: Use ball, butterfly, or gate valves.
    2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14.
        a. Shutoff Duty: Use ball, butterfly, or gate valves.
        b. Throttling Duty: Use ball or globe valves.

3.07 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Mechanical General Provisions" for basic piping joint construction.
B. Threaded Joints: Comply with NFPA 13D for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gauge and comply with ASME B1.20.1.
C. Twist-Locked Joints: Insert plain-end piping into locking-lug fitting and rotate retainer lug one-quarter turn.
D. Pressure-Sealed Joints: Use UL-listed tool and procedure. Include use of specific equipment, pressure-sealing tool, and accessories.
E. Mechanically Formed, Copper-Tube-Outlet Joints: Use UL-listed tool and procedure. Drill pilot hole in copper tube, form branch for collar, dimple tube to form seating stop, and braze branch tube into formed-collar outlet.
F. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
    1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.

2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.
4. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

G. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.08 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 2 Section "Water Distribution" for exterior piping.
B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping. Refer to Division 2 Section "Water Distribution" for backflow preventers.
C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.

3.09 WATER-SUPPLY CONNECTION

A. Connect fire-suppression piping to building's interior water distribution piping. Refer to Division 22 Section "Domestic Water Piping" for interior piping.
B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water distribution piping. Refer to Division 22 Section "Plumbing Specialties" for backflow preventers.
C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water supply.

3.10 PIPING INSTALLATION

A. Refer to Division 23 Section "Mechanical General Provisions" for basic piping installation.
B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints. Encase piping in corrosion-protective encasement.
D. Install underground copper service-entrance piping according to NFPA 24. Encase piping in corrosion-protective encasement.
E. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
F. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
G. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
I. Install sprinkler piping with drains for complete system drainage.

J. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
K. Install drain valves on standpipes.
L. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
M. Install alarm devices in piping systems.
N. Hangers and Supports: Comply with NFPA 13D for hanger materials.
    1. Install standpipe system piping according to NFPA 14.
    2. Install sprinkler system piping according to NFPA 13D.
O. Earthquake Protection: Install piping according to NFPA 13D to protect from earthquake damage.
P. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.
Q. Fill wet-standpipe system piping with water.
R. Fill wet-pipe sprinkler system piping with water.
S. Install flexible connectors on fire-pump and pressure-maintenance-pump supply and discharge connections and in fire-suppression piping where indicated.

3.11 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13D and NFPA 14 and authorities having jurisdiction.
B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
D. Specialty Valves:
    1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.12 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. All sprinklers and installations shall comply with FM Global requirements. Where specific types are not indicated, use the following sprinkler types:
    1. Rooms without Ceilings: Upright sprinklers.
    2. Rooms with Suspended Ceilings: Concealed sprinklers.
    3. Wall Mounting: Sidewall sprinklers.
    4. Spaces Subject to Freezing: Pendent, dry sprinklers.
    5. Sprinkler Finishes:
        a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
        b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

3.13 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.
C. All exposed sprinkler piping in public areas shall be painted to match finishes. To be coordinated with owner.

3.14 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes, unless otherwise indicated.
B. Install freestanding hose connections for access and minimum passage restriction.
C. Install NPS 1-1/2 hose-connection valves with flow-restricting device, unless otherwise indicated.
D. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device, unless otherwise indicated.
E. Install wall-mounting-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose.

3.15 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.
B. Install freestanding-type, fire department connections in level surface.
C. Install ball drip valve at each check valve for fire department connection.

3.16 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Plumbing Specialties" for backflow preventers.
D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
F. Electrical Connections: Power wiring is specified in Division 26.
G. Connect alarm devices to fire alarm.
H. Ground equipment according to Division 26 Section "Grounding and Bonding."
I. Connect wiring according to Division 26 Section "Conductors and Cables."
J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.17 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13D and NFPA 14 and in Division 23 Section "Mechanical Identification."

3.18 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
    1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    3. Energize circuits to electrical equipment and devices.

4. Flush, test, and inspect sprinkler systems according to NFPA 13D, "Systems Acceptance" Chapter.
5. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
6. Coordinate with fire alarm tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.19 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers with paint other than factory finish.
C. Protect sprinklers from damage until Substantial Completion.

3.20 DEMONSTRATION

A. Engauge a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

END OF SECTION

SECTION 22 05 00
PLUMBING GENERAL PROVISIONS

PART 1 GENERAL

1. 01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes Contract requirements and the following basic mechanical materials and methods to complement other Division 21, 22 and 23 Sections

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Concrete base construction requirements.
4. Escutcheons.
5. Dielectric fittings.
6. Flexible connectors.
7. Mechanical sleeve seals.
8. Nonshrink grout for equipment installations.
9. Field-fabricated metal and wood equipment supports.
10. Installation requirements common to equipment specification sections.
11. Cutting and patching.
12. Touchup painting and finishing.

B. Pipe and pipe fitting materials are specified in Division 21, 22, and 23 piping system Sections.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The use of the word “Provide”: Whenever the word “Provide” is used in the specifications and/or on the drawings, it shall mean “furnish and install”, “connect”, “apply”, “erect”, “construct”, or similar terms, unless otherwise indicated.

G. The use of the word “Piping”: “Piping” shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.

H. The use of the word “Material”: Whenever the word material is used in the specifications and/or on the drawings, it shall mean any “product”, “equipment”, “device”, “assembly”, or “item” required under the

contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.

I. The term "Mechanical Contractor", "HVAC Contractor", "Plumbing Contractor" or "Contractor" refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Mechanical, HVAC, and/or Plumbing drawings and in the Mechanical, HVAC, and/or Plumbing Specifications.

J. The term "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. "accessible ceiling" indicates acoustical tile type hung ceilings. Concealed spline or sheetrock ceilings with access panes shall not be considered accessible ceilings.

K. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

L. The following are industry abbreviations for rubber materials:
1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.04 CODES, STANDARDS, REFERENCES, AND PERMITS

A. All material and workmanship shall comply with all the latest editions of all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations.

B. In case of differences between the Building Codes, State Law, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the contractor shall promptly notify the Engineer in writing of any such difference.

C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary and bid purposes. However, no work will proceed until the Engineer determines the correct method of installation.

D. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Engineer.

E. All potable water installations shall meet the following requirements: maximum weighted average lead content to 0.25 percent for fixtures and 0.2 percent for solder or flux. This shall apply to pipes, fittings, fixtures, valves and other products that come in contact with drinking water

1.05 SUBMITTALS

A. Product Data: For the following:
1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

C. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.06 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.07 SYSTEM DESCRIPTION

A. Furnish and install all materials in order to provide functioning systems, upon completion, in compliance with all applicable codes, authorities having jurisdiction, manufacturer's requirements, performance requirements specified, and any modifications resulting from reviewed shop drawings and the field coordination drawings.

1.08 SCOPE OF WORK

A. The contractor is responsible for furnishing and installing all the devices and equipment shown indicated the Mechanical Drawings including materials and equipment required to create fully operational systems.

B. The contractor shall be responsible for reviewing the Architectural, Electrical, and Fire Protection Plans. In addition to all mechanical equipment, plumbing fixtures, and mechanical devices indicated on the Mechanical Plans, the contractor is responsible for mechanical installation of all the equipment and devices shown on the Architectural Plans and the Electrical Plans.

C. The contractor shall be responsible for reviewing the Architectural, Electrical, and Fire Protection Plans. Prior to bid, the contractor shall notify the Engineer of any discrepancies between the Architectural, Electrical, Mechanical, and Fire Protection Plans regarding equipment locations, equipment quantities, piping and duct work routing, device locations, light locations, chase locations, etc. otherwise it will be assumed the contractor is responsible for mechanical installation of all the equipment and devices shown on the Architectural Plans, Mechanical Plans, Plumbing Plans, Fire Protection Plans and the Electrical Plans regardless of whether they are indicated on the Mechanical Plans.

1.09 DRAWING INTERPRETATION

A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturer's product. In the event of a field verification or coordination issue, report issue to Owners construction supervisor.

B. Piping and air duct plans are intended to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The drawings do not necessarily indicate all required offsets, details and accessories and equipment to be connected or encountered in the way of new work.

C. Generally, layout pipelines requiring drainage first, followed by large pipe mains, air duct and electrical conduit. Follow this procedure for an orderly installation but not to establish precedence of one trade over another. It must be understood that pipe and duct hanger installations must comply with seismic bracing requirements. Minimizing hanger lengths (structure to equipment and crossbars) to 12" and under minimizes the requirement for seismic bracing.

D. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines, to avoid existing field conditions as wel as to maintain clearances to equipment whether or not indicated on the drawings. The contractor shall provide all drains, traps and accessories as required for his work to effect these offsets, transitions and changes in direction. Consult Design Professional before making changes that effect the function or appearance of systems.

E. Do not install equipment, air ducting or piping in a non-code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.

F. In some cases, drawings are based on products of one or several manufacturers, as listed on the contract documents. The contractor shall be held responsible for modifications made necessary by substitution of products or other manufacturers.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

A. Do not install any part of a system until all critical components of the systems and related systems have been approved. Coordinate individual parts of systems.

B. Coordinate contract work with other work specified in other sections. Relocate work if required for proper installation and functioning of other systems, at no extra cost to the Owner.

C. Install products in accordance with manufacturer's instructions. Notify Design Professional if Contract Documents conflict with manufacturer's instructions. Comply with Design Professional's interpretations,

D. In general, air duct, heating and sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The design professional will final decisions regarding the arrangement of work, which cannot be agreed upon by the contractors.

1.12 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.13 "AS-BUILT" RECORD DRAWINGS

A. Record daily progress on one set of construction documents. Utilize a permanent black or blue marking media. All progress of record drawings shall be provided in a neat and accurate fashion.

B. As-built drawing reviews will be completed on a monthly basis by the engineer of record. Release of requisitions will be based on the regular progress of As-built drawings. The latest As-built drawings shall be submitted for review with each requisition for payment.

C. Formal As-built drawings shall be submitted for review at the completion of each phase of the work. The as-built drawings shall be ¼" scale and created in electronic format utilizing both AUTOCAD Release 2000. At the completion of each phase of work, the mechanical contractor shall submit to the Engineer the original field progress as-built drawings, the electronic files of the formal as-built drawings, and four sets of final as-built drawings plotted on 24" x 36" 'D' sized sheets. Final payment for the phase of work and the start of the next phase shall be dependent of approval of the as-built drawings.

1.14 GUARANTEE

A. Provide written guarantee of all completed/installed work. Materials, equipment and workmanship shall be guaranteed for a minimum period of one year after Owners acceptance of work. Any failure due to defective material, equipment or workmanship shall be corrected at no additional cost to owner. This shall include damage completed to other areas of construction or facility resulting from this failure. Provide correction of any failure within an acceptable/reasonable time period.

B. Provide all equipment and material manufacturers guarantees and/or warranties to owner after acceptance of installation.

1.15 OPERATING AND MAINTENANCE MANUALS

A. Provide operating and maintenance information for all equipment, devices, systems, and materials. This shall include all maintenance and operations procedures, recommendations, and service requirements. All submitted data must include minimum equipment/device operations and maintenance requirements to fulfill manufacturers warrantees.

B. Submit all engineering selection and specification documentation with operating and maintenance information for all equipment, devices, systems, and materials.\

C. Submit all data media in a detailed, organized, and complete manner. Provide a minimum of three copies to Owners construction supervisor for engineer/architect review. Submit in 3 ring bound enclosure.

PART 2 PRODUCTS

2.01 PIPE AND PIPE FITTINGS

A. Refer to individual Division 21, 22, and 23 piping Sections for pipe and fitting materials and joining methods.

2.02 JOINING MATERIALS

A. Refer to individual Division 21, 22, and 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.03 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
3. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
   a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
   a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
1. Manufacturers:
   a. NIBCO INC.
   b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.

2.04 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
B. Dielectric unions: Dielectric unions are not acceptable.
C. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
D. Insulating Material: Suitable for system fluid, pressure, and temperature.
E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
    1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.
G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F

2.05 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 250-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
    1. 2-Inch NPS and Smaller: Threaded.
    2. 2-1/2-Inch NPS and Larger: Flanged.
    3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.
B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

2.06 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.
E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms. F. PVC Pipe: ASTM D 1785, Schedule 40.
F. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.07 PIPING SPECIALTIES

A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
   1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
   2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
   3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing. a. Underdeck Clamp: Clamping ring with set screws.
B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
   1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
   2. OD: Completely cover opening.
   3. Cast Brass: Split casting, with concealed hinge and set screw.
      a. Finish: Rough brass.
      b. Finish: Polished chrome-plate.

2.08 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
   1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psig, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    1. New Piping:
        a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
        c. Insulated Piping: One-piece, stamped-steel type with spring clips.
        d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
        e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
        f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
        g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
        h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type. M. Sleeves are not required for core-drilled holes with smooth concrete bore.
N. Permanent sleeves are not required for holes formed by removable PE sleeves.
O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
    1. Cut sleeves to length for mounting flush with both surfaces.
        a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
    2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
        a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
        b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
        c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
        d. Seal space outside of sleeve fittings with grout.
    4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.03 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

F. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

G. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.05 PAINTING AND FINISHING

A. Apply paint to exposed piping according to the following, unless otherwise indicated:

1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

B. Do not paint piping specialties with factory-applied finish.

C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Provide 2” chamfered edges on top of concrete pads. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psig, 28-day compressive-strength concrete and reinforcement as specified in Division Section "Cast-in-Place Concrete." Provide broom finish.

B. The mechanical contractor shall fill each air handling unit fan inertia base with cast-in-place concrete. Use 3000-psig, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Refer to Division 5 Section "Metal Fabrications" for structural steel
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
C. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.08 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
C. Attach to substrates as required to support applied loads

3.09 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades.
B. Repair cut surfaces to match adjacent surfaces.
C. Mechanical Contractor shall be responsible for any patching of existing partitions after removal of duct work and HVAC piping.
D. The Plumbing Contractor Shall be responsible for any patching of existing partitions after removal of plumbing piping.

3.10 GROUTING

A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
B. Clean surfaces that will come into contact with grout. C. Provide forms as required for placement of grout.
C. Avoid air entrapment during placing of grout.
D. Place grout, completely filling equipment bases.
E. Place grout on concrete bases to provide smooth bearing surface for equipment. G.
Place grout around anchors.
F. Cure placed grout according to manufacturer's written instructions.

3.11 FIRESTOPPING

A. The mechanical contractor is responsible for providing proper U.L. Listed firestopping and smokestopping for all duct, pipe, controls conduit, and related electrical conduit installed by the mechanical contractor.
B. The mechanical contractor shall utilize the latest fire and smoke protection materials and installation methods. The mechanical contractor shall guarantee that all materials installed are fire and smoke stopped per U.L. Listing, NFPA, building code requirements.
C. The mechanical contractor shall utilize Architectural Life Safety Drawings to identify partition ratings. If the mechanical contractor is unsure of partition rating then he or she must inquire to Construction Manager.

END OF SECTION

SECTION 22 10 05
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for piping systems.
   1. Sanitary sewer.
   2. Domestic water.

1.02 RELATED REQUIREMENTS

A. Section 083100 - Access Doors and Panels.
B. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ANSI Z21.22 - American National Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems; 1999, and addenda A&B (R2004).
B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2010).
D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2011.
E. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; The American Society of Mechanical Engineers; 2011.
F. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2012.
G. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2011 (ANSI/ASME B31.9).
H. ASME (BPV IV) - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2010.
I. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2010.
J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
K. ASTM B32 - Standard Specification for Solder Metal; 2008.
L. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2010.
M. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed; 2011
N. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2011.
O. ASTM B75M - Standard Specification for Seamless Copper Tube (Metric); 1999 (Reapproved 2005)
P. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.
Q. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2008.
R. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2009.
S. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2010.
T. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl

Chloride) (CPVC) Plastic Pipe and Fittings; 2010.

U. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core; 2008.

V. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings; 2008.

W. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2010. X.ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems; 2011.

Y. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).

Z. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe; 2011.

AA. ASTM F1282 - Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe; 2010.

AB. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.

AC. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

AD. MSS SP-67 - Butterfly Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2011.

AE. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

AF. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2011.

AG. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; Manufacturer Standardization Society of the Valve and Fittings Industry, Inc.; 2011.

AH. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2011.

AI. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2008.

AJ. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2010.

AK. NSF 61 - Drinking Water System Components - Health Effects; 2012.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Project Record Documents: Record actual locations of valves.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with State of Vermont, standards.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME (BPV IX).
E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 REGULATORY REQUIREMENTS
A. Perform Work in accordance with State of Vermont plumbing code.
B. Conform to applicable code for installation of backflow prevention devices.
C. Complete potable water installation shall meet the following requirements: maximum weighted average lead content to 0.25 percent. This shall apply to pipes, fittings, fixtures, valves and other products that come in contact with drinking water.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. PVC PIPE AND FITTINGS
1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
2. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
3. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.
B. ABS PIPE AND FITTINGS
1. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
2. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
3. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. PVC PIPE AND FITTINGS
1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
2. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
3. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.
B. ABS PIPE AND FITTINGS
1. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
2. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

3. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.03 SANITARY SEWER PIPING, ABOVE GRADE

A. PVC PIPE AND FITTING
1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
2. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
3. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

B. ABS PIPE AND FITTINGS
1. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
2. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
3. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.04 WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn.
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
2. Joints: ASTM B 32, alloy Sn95 solder.

2.05 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn.
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
2. Joints: ASTM B 32, alloy Sn95 solder.

2.06 WATER PIPING, ABOVE GRADE

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.
1. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper crimp rings and matching PEX tube dimensions.
2. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877 and with plastic or corrosion-resistant-metal valve for each outlet.

2.07 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.
2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.08 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
a. Cold and Hot Pipe Sizes 6 Inches and Over: Double hangers.

3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment. B. Plumbing Piping - Drain, Waste, and Vent:
    1. Conform to ASME B31.9.
    2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
    3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
    4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
    5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
    6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp
    7. Vertical Support: Steel riser clamp.
    8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
    9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
7. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
8. Vertical Support: Steel riser clamp.
9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
11. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
6. Other Types: As required.

2.09 BALL VALVES

A. and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

2.10 PLUG VALVES

A. Construction 2-1/2 Inches and Larger: MSS SP-78, 175 psi CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.11 BUTTERFLY VALVES

A. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

B. and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.

2.12 FLOW CONTROLS

A. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi psi.

2.13 SWING CHECK VALVES

A. Up to 2 Inches:

1. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solderends.

B. Over 2 Inches:

1. MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

2.14 SPRING LOADED CHECK VALVES

A. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

2.15 WATER PRESSURE REDUCING VALVES

A. Up to 2 Inches:

1. MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.

B. Over 2 Inches:

1. MSS SP-85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.16 RELIEF VALVES

A. Pressure Relief:

1. AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

B. Temperature and Pressure Relief:

1. AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labelled.

2.17 STRAINERS

A. Size 2 inch and Under:

1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 1-1/2 inch to 4 inch:

1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 220516.
G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 220719.
H. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083100
I. Establish elevations of buried piping outside the building to ensure not less than 6 ft of cover.
J. Where pipe support members are welded to structural building framing, scrape, brush clean and apply one coat of zinc rich primer to welding.
K. Provide support for utility meters in accordance with requirements of utility companies.
L. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
M. Install bell and spigot pipe with bell end upstream.
N. Install valves with stems upright or horizontal, not inverted.
O. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
P. Install water piping to ASME B31.9.
Q. Sleeve pipes passing through partitions, walls and floors.
R. Pipe Hangers and Supports:
    1. Install in accordance with ASME B31.9.
    2. Support horizontal piping as scheduled.
    3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
    4. Place hangers within 12 inches of each horizontal elbow.
    5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengaugement of supported pipe.
    6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
    7. Provide copper plated hangers and supports for copper piping.
    8. Prime coat exposed steel hangers and supports. Refer to Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
    9. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 220548.

10. Support cast iron drainage piping at every joint.

3.04 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.
B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
C. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
D. Install globe valves for throttling, bypass, or manual flow control services.
E. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment. F. Provide spring loaded check valves on discharge of water pumps.

3.05 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Section 331300.
B. Prior to starting work, verify system is complete, flushed and clean.
C. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
F. Maintain disinfectant in system for 24 hours.
G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.
    1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
    2. Provide 18 gauge galvanized sheet metal sleeve around service main to 6 inch above floor and 6 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.
C. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 7 inch wg. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

3.08 SCHEDULES

A. Pipe Hanger Spacing:
    1. Metal Piping:
        a. Pipe size: 1/2 inches to 1-1/4 inches:

1) Maximum hanger spacing: 6.5 ft.
2) Hanger rod diameter: 3/8 inches. b. Pipe size: 1-1/2 inches to 2 inches:
3) Maximum hanger spacing: 10 ft.
4) Hanger rod diameter: 3/8 inch. c. Pipe size: 2-1/2 inches to 3 inches:
5) Maximum hanger spacing: 10 ft.
6) Hanger rod diameter: 1/2 inch. d. Pipe size: 4 inches to 6 inches:
7) Maximum hanger spacing: 10 ft.
8) Hanger rod diameter: 5/8 inch.

END OF SECTION

SECTION 22 10 06
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cleanouts.
B. Hose bibs.
C. Backflow preventers.
D. Thermostatic mixing valves.
E. Washing Machine Service Boxes

1.02 RELATED REQUIREMENTS

A. Section 016000 - Product Requirements: Procedures for [Owner]-supplied products.
B. Section 224000 - Plumbing Fixtures.
C. Section 223000 - Plumbing Equipment.
D. Section 232113 - Hydronic Piping

1.03 REFERENCE STANDARDS

A. ASSE 1011 - Hose Connection Vacuum Breakers; American Society of Sanitary Engineering; 2004 (ANSI/ASSE 1011).
B. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent; American Society of Sanitary Engineering; 2009 (ANSI/ASSE 1012).
C. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers; American Society of Sanitary Engineering; 2011.
D. ASSE 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type; American Society of Sanitary Engineering; 2011 (ANSI/ASSE 1019).

1.04 SUBMITTALS

A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes. B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
C. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 HYDRANTS

A. Manufacturers:
1. Woodford Manufacturing Company: http://www.woodfordmfg.com/woodford/definitions.html
2. Jay R. Smith Manufacturing Company; Model ___: www.jayrsmith.com.
3. Zurn Industries, Inc; Model ____: www.zurn.com.

B. Wall Hydrants:

1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

2.02 WASHING MACHINE BOXES AND VALVES

A. Box Manufacturers:
1. IPS Corporation/Water-Tite; Model ____: www.ipscorp.com.
2. Or approved equal.

B. Valve Manufacturers:
1. IPS Corporation/Water-Tite; Model ____: www.ipscorp.com.
2. Or approved equal.

C. Description: Plastic preformed rough-in box with brass long shank valves with wheel handles, socket for 2 inch waste, slip in finishing cover.

2.03 BACKFLOW PREVENTERS

A. Manufacturers:
1. Watts Regulator Company; Model _____: www.wattsregulator.com.
2. Zurn Industries, Inc; Model ____: www.zurn.com.
3. Or Equal

B. Reduced Pressure Backflow Preventers:
1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.04 MIXING VALVES

A. Pressure Balanced Thermostatic Mixing Valves:
1. Manufacturers:
a. Leonard Valve Company; Model _: www.leonardvalve.com.
b. Calleffi Hydronic Solutions; www.caleffi.us
2. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
3. Accessories:
a. Check valve on inlets.
b. Stem thermometer on outlet.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; fire sprinkler systems, irrigation systems, interior and exterior hose bibs.

F. Pipe relief from backflow preventer to nearest drain.

END OF SECTION

SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water heaters.
B. Water storage tanks.
C. Compression tanks.
D. Pumps.
   1. Circulators.
   2. Sump Pumps.
   3. Cooling Condensate Removal Pumps.
E. Water pressure booster system.

1.02 RELATED REQUIREMENTS

A. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
B. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2010.
B. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
C. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittals procedures.
B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Provide electrical characteristics and connection requirements.
C. Shop Drawings:
   1. Indicate heat exchanger dimensions, size of tappings, and performance data.
   2. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.
D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Identification: Provide equipment with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.06 CERTIFICATIONS

A. Water Heaters: NSF approved.

B. Electric Water Heaters: UL listed and labeled to UL 174 or UL 1453.

C. Pressure Vessels for Heat Exchangers: ASME labeled, to ASME (BPV VIII, 1). D. Water Tanks: ASME labeled, to ASME (BPV VIII, 1)

E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements. B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATER MANUFACTURERS

A. Bradford White 40 Gallon Electric Water Tank: www.bradfordwhite.com

B. EcoSmart Eco11 Electric Tankless Water Heater: www.ecosmartus.com

2.02 RESIDENTIAL ELECTRIC WATER HEATERS

BRADFORD WHITE®
WATER HEATERS

Residential Upright High Efficiency Energy Saver Electric Water Heater

Photo is of
M-2-HE40S6DS

Copper Screw Type Immersion Element
(Incoloy type immersion element available upon request)

The Upright High Efficiency Electric Models Feature:

- **DOE**—All residential storage models meet or exceed efficiency requirements of the Department of Energy, ASHRAE Standard 90.1 b (current standard) and the National Appliance Energy Conservation Act of 1987 recent amendment effective January 20, 2004 which supercedes all state and local efficiency requirements.
- **ETL & HUD**—Design evaluated by ETL in accordance with Part 280.707(d) of HUD Mobile Home Construction and Safety Standards for Energy Efficiency.
- **Fully Automatic Controls**—Fast acting surface-mount thermostats for automatic temperature control. Factory installed sensitive manual reset energy cutoff for safety to prevent overheating.
- **Direct Heat Transfer With Immersed Elements**—Transfers heat directly and efficiently to the water. Screw-in style.
- **Factory Installed Hydrojet® Total Performance System**—Cold water inlet sediment reducing device helps prevent sediment build up in tank. Increases first hour delivery of hot water while minimizing temperature build up at top of tank.
- **Vitraglas® Lining**—Bradford White tanks are lined with an exclusively engineered enamel formula that provides superior tank protection from the highly corrosive effects of hot water. This formula (Vitraglas®) is fused to the steel surface by firing at a temperature of over 1600°F (871°C).
- **2" Non-CFC Foam Insulation**—Covers the sides and top of the tank, reducing the amount of heat loss. This results in less energy consumption, improved operation efficiencies and jacket rigidity.
- **Water Connections**— 3/4" NPT factory installed true dielectric fittings extend water heater life and eases installation.
- **Factory Installed Heat Traps**—Design incorporates a flexible disk that reduces heat loss in piping and eliminates the potential for noise generation.
- **Protective Magnesium Anode Rod**—Provides added protection against corrosion for long trouble-free service.
- **Simultaneous and Non-Simultaneous Operation Available**—Simultaneous operation indicates when both elements (if equipped) are being heated at the same time. Non-Simultaneous operation indicates when one element is being heated at a time.
- **Voltages Available**—120V, 208V, 240V, 277V, 480V.
- **Single Phase or Three Phase Operation Available**—277V may only be wired for single phase operation.
- **T&P Relief Valve Included**—All models have special tapping on top of tank.
- **Low Restriction Brass Drain Valve**—Durable tamper proof design.
- **Minimum Energy Factor of 0.91**.

AHRI

Intertek Intertek

6 or 10-Year Limited Tank Warranties / 6 or 10-Year Limited Warranty on Component Parts.
For more information on warranty, please visit www.bradfordwhite.com
For products installed in USA, Canada and Puerto Rico. Some states do not allow limitations on warranties. See complete copy of the warranty included with the heater.

Residential Upright Electric Water Heater

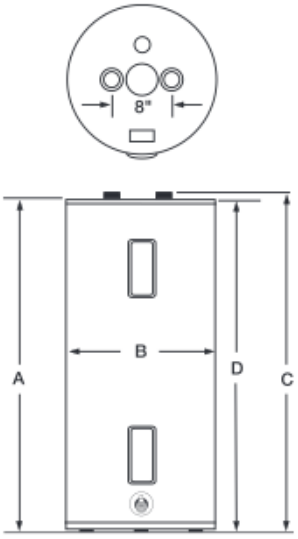
High Efficiency Energy Saver Models

C.E.C. Listed

Model Number	Capacity U.S. Gal.	Capacity Imp. Gal.	Recovery 90°F Rise U.S. GPH*	Recovery 90°F Rise Imp. GPH*	A Floor to Heater Top in.	B Jacket Dia. in.	C Floor to Water Conn. in.	D Floor to T&P Conn. in.	Approx. Shipping Weight lbs.
M-2-HE40S6DS	40	23	21	18	47 7/8	20	48 7/8	47 7/8	118
M-2-HE50S6DS	50	42	21	18	47 1/2	22	48 1/2	47 1/2	131
M-2-HE65R6DS	65	54	21	18	60 1/4	22	61 1/4	60 1/4	160
M-2-HE80R6DS	80	67	21	18	60 1/4	24	61 1/4	60 1/4	191

Model Number	Capacity Liters	Recovery 50°C Rise Liters/Hour*	A Floor to Heater Top mm.	B Jacket Dia. mm.	C Floor to Water Conn. mm.	D Floor to T&P Conn. mm.	Approx. Shipping Weight kg.
M-2-HE40S6DS	151	76	1216	508	1241	1216	54
M-2-HE50S6DS	189	76	1207	559	1232	1207	59
M-2-HE65R6DS	246	76	1530	559	1556	1530	73
M-2-HE80R6DS	303	76	1530	610	1556	1530	87

For 10 year models, change suffix "6" to "10".
For single element models change suffix "D" to "S"
*Based on 4500W/4500W, Non-Simultaneous operation.



Wattage	Recovery ▲ GPH Temperature Rise °F 60	80	90	100	120
1500W	10	8	7	6	5
2000W	14	10	9	8	7
2500W	17	13	11	10	9
3000W	21	15	14	12	10
3500W	24	18	16	14	12
4000W	28	21	18	16	14
4500W	31	23	21	19	15
5000W	34	26	23	21	17
5500W	38	29	25	23	19
6000W	41	31	28	25	21

▲(GPH based on Non-Simultaneous operation, when Simultaneous operation the GPH will approximately double.)

Wattage Limitations for Simultaneous Operation	Voltage 120V	208V	240V	277V	480V
1500W / 1500W	yes	yes	yes	yes	yes
2000W / 2000W	no	yes	yes	yes	yes
2500W / 2500W	no	yes	yes	yes	yes
3000W / 3000W	no	yes	yes	yes	yes
3500W / 3500W	no	yes	yes	no	no
4000W / 4000W	no	yes	yes	yes	yes
4500W / 4500W	no	yes	yes	yes	yes
5000W / 5000W	no	yes	yes	yes	yes
5500W / 5500W	no	no	yes	no	no
6000W / 6000W	no	no	no	yes	yes

Wattage Limitations for Non-Simultaneous Operation	Voltage 120V	208V	240V	277V	480V
1500W / 1500W	yes	yes	yes	yes	yes
2000W / 2000W	yes	yes	yes	yes	yes
2500W / 2500W	yes	yes	yes	yes	yes
3000W / 3000W	yes	yes	yes	yes	yes
3500W / 3500W	no	yes	yes	no	no
4000W / 4000W	no	yes	yes	yes	yes
4500W / 4500W	no	yes	yes	yes	yes
5000W / 5000W	no	yes	yes	yes	yes
5500W / 5500W	no	yes	yes	no	no
6000W / 6000W	no	yes	yes	yes	yes

General
All models ETL listed. These heaters are wired inter-locking (Non-Simultaneous, Single Phase) 240V with two 4500W elements, unless otherwise specified.
All water and electrical connections are 3/4" NPT (19mm).
All models certified at 300 psi test pressure (2068 kPa) and 150 psi working pressure (1034 kPa.)

Dimensions and specifications subject to change without notice in accordance with our policy of continuous product improvement.

BRADFORD WHITE
WATER HEATERS
Ambler, PA
For U.S. and Canada field service, contact your professional installer or local Bradford White sales representative.
Sales **800-523-2931** • Fax **215-641-1670** / Technical Support **800-334-3393** • Fax **269-795-1089** • Warranty **800-531-2111** • Fax **269-795-1089**
International: Telephone **215-641-9400** • Telefax **215-641-9750** / **www.bradfordwhite.com**
BRADFORD WHITE-CANADA® INC. Sales / Technical Support **866-690-0961** / **905-238-0100** • Fax **905-238-0105** / **www.bradfordwhite.com**

MODELS: Eco 8 & 11

Welcome to Ecosmart! Maker of the most efficient electric tankless water heaters on the market. Below please find specifications & sizing considerations to meet your hot water demand needs. **For any questions or special applications please contact our technical / engineering dept. Toll free at: 877-474-6473.**

Maximum Flow Rate Desired:
Consider the maximum flow rate you would like to use at a given time. The average shower temperatures are between 98°F and 105°F. The chart is based on 220V input voltage and maximum flow rates are listed for various incoming water temperatures.

INLET WATER TEMP	40°F	45°F	50°F	55°F	60°F	65°F	70°F	75°F	80°F
ECO 8	.75 GPM	.80 GPM	1.0 GPM	1.2 GPM	1.3 GPM	1.4 GPM	1.5 GPM	2.0 GPM	2.2 GPM
ECO 11	1.3 GPM	1.4 GPM	1.5 GPM	1.7 GPM	1.9 GPM	2.0 GPM	2.3 GPM	2.7 GPM	3.0 GPM

If you typically use about 2.5 gallons per minute (1 shower with water saver showerhead and a sink) at the same time, find the 2.5 GPM on the chart or the number closes to it. If the number is highlighted in **GREEN**, that means it's the correct model for you. If it's highlighted in **YELLOW**, that means you may fall short of your desired output temperature. If the inlet temperature is lower than usual or your flow rate is higher than normal. If it's highlighted in **RED**, you should consider a model with more capacity.

SPECIFICATIONS

MODELS	ECO 8	ECO 11
VOLTS / SINGLE PHASE	220/240	220/240
KW	7.3/8.0	11.8/13.5
ELEMENTS	1	2
AMPERAGE DRAW	37/40	54/57
REQUIRED BREAKER	40 DP	60 DP
REQUIRED WIRE	8 AWG	6 AWG
HZ	50/60	50/60
PIPE FITTINGS	1/2" NPT	1/2" CF
DIMENSIONS	12" x 9.5" x 4"	12" x 9.5" x 4"
WEIGHT LBS	4.75	6
EXCHANGER	STAINLESS/STEEL	STAINLESS/STEEL
PROTECTION	THERMAL AUTO	THERMAL AUTO
ACTIVATION FLOW	0.25	0.25
ENERGY EFFICIENCY	99.8	99.8
CERTIFICATIONS	UL/CSA	UL/CSA
WARRANTY	L/LIFETIME	L/LIFETIME

SPECIFICATIONS: Reflects variable voltage of 220-240. Lower voltage reduces the unit heating capacity.

APPLICATIONS

ECO 8	.80 GPM		2.0 GPM	
ECO 11	1.4 GPM		2.7 GPM	

WINTER INLET WATER 45° F SUMMER INLET WATER 75° F

Illustration above is based on water saver showerheads rated at 1.5 GPM and water saver aerators rated at 1.0 GPM. The number of showerheads/sinks next to each model reflects the units capacity of providing hot water simultaneously with the temperature control set to 105°F.

TEMPERATURE RISE CHART

FLOW RATE GPM	ECO 8 TEMP RISE	ECO 11 TEMP RISE
1.0 GPM	48.9	80.2
1.5 GPM	32.6	53.4
2.0 GPM	24.4	40.1
2.5 GPM	19.5	32.0
3.0 GPM	16.3	26.7

TEMPERATURE RISE CHART: Reflects temperature rise at different flow rates for different models.

ecosmartus.com

A. Type: Automatic, electric, vertical storage.
B. Performance:
1. Storage capacity: 40 gal.
2. First Hour Rating: 57 gal.
3. Heating element size: 4.5 kW.
4. Number of heating elements: 2.
5. Minimum recovery rate: 19 gph with 100 degrees F temperature rise.
6. Maximum working pressure: 150 psi.
C. Electrical Characteristics:
1. 240 volts, single phase.
2. 30 amperes maximum fuse size.
D. Tank: Enamel lined welded steel, thermally insulated with two inches of non CFC foam insulation; encased in corrosion-resistant steel jacket; baked-on enamel finish.
E. Controls: Automatic water thermostat with externally adjustable temperature range from 120 to 170 degrees F, flanged or screw-in nichrome elements, enclosed controls and electrical junction box . Unit to have (2) temperature sensors installed to be utilized by solar collector controller.
F. Accessories: Provide:
1. Water Connections: Brass.
2. Dip tube: Brass.
3. Drain Valve.
4. Anode: Magnesium
5. Temperature and Pressure Relief Valve: ASME labelled.
G. Solar Indirect Heat Exchanger: Double Walled, 1.5" glass coated steel coil. Minimum heat transfer area of 14 sq.ft. Maximum supply temperature of 250 degrees F.

2.03 DOMESTIC WATER STORAGE TANKS
A. Manufacturers:
1. Norwesco Water Tanks: www.watertanks.com.
2. Or Approved Equal..
B. Tank: Polyethylene storage tank for water only.
C. Openings: 1 1/2" top inlet, 2" lower inlet for simple connections. Tank to come with 16" manway and 2" vent.
D. Size: Two 1100 Gallon

2.04 DIAPHRAGM-TYPE COMPRESSION TANKS
A. Manufacturers:
1. Amtrol Inc; Model _____: www.amtrol.com.
2. Taco, Inc; Model _____: www.taco-hvac.com.
3. Or Equal
B. Construction: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.

2.05 DOMESTIC WATER SUPPLY PUMP
A. Manufacturers:
1. Grundfos; www.grundfos.com.

2. Or Approved Equal.

B. System shall consist of a self priming simplex pump with integral diaphram tank and larger external pressure tank and check valves.

C. Controls and Instruments: Pump shall have integral pressure and flow sensors and controller. The pump shall operate off of internal controls to maintain system pressure.

D. Over Heating Control: Pump shall stop when temperature levels are elevated. Pump will restart every 30 minutes.

E. Pump Switch: Permit on/off operation.

F. Performance:

1. Flow: 12 gpm, at 70 feet head.
2. Electrical Characteristics:
   a. 120 volts, single phase, 60 Hz, 7.2 minimum circuit ampacity.

2.06 SUMP PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc; Model __: www.armstrongpumps.com.
2. Goulds Pumps; Model __: www.goulds.com.
3. Zoeller Pump Company; Model _____: www.zoeller.com.
4. Liberty Pumps. www.libertypumps.com

B. Type: Vertical centrifugal, direct connected, simplex arrangement.

C. Controls (Simplex): Float switch with float rod, stops, and corrosion resistant float, and separate pressure switch high level alarm with transformer, alarm bell and stand-pipe.

D. Packaged system with pump, basin, controls, and electrical connections to plug in.

E. Performance:

1. Flow: 25 gal/min, at 15 feet lift.
2. Motor: 1/3-4/10 hp, 120 volt, single phase, 60 Hz.

2.07 COOLING CONDENSATE REMOVAL PUMPS

A. Safety: UL 778.

B. Performance:

1. Flow: 3 gpm, at 20 feet head.
2. Electrical Characteristics:
   a. 1/30 hp.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Domestic Water Heater/Solar Water Heat Exchanger:

1. Support unit on Pad. Provide seismic support strapping at the units 1/3 and 2/3 elevation to support the unit against a horizontal force in any direction equal to 1/3 of the units operating weight.
2. Pipe relief valves and drains to nearest drain location (can be waste line piped per code).

C. Domestic Water Storage Tanks:

1. Provide steel pipe support, independent of building structural framing members.
2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

D. Pumps:

1. Provide air cock and drain connection on horizontal pump casings.
2. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
3. Provide electrical interlocking from cooling condensate pump safety switch to associated HVAC unit(s) furnished under other Sections.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water closets.
B. Lavatories.
C. Sinks.
D. Showers.

1.02 RELATED REQUIREMENTS

A. Section 079005 - Joint Sealers: Seal fixtures to walls and floors.
B. Section 221006 - Plumbing Piping Specialties.
C. Section 223000 - Plumbing Equipment.
D. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).
B. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2011.
C. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures; The American Society of Mechanical Engineers; 2008 (R2011).
D. ASME A112.19.2 - Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals; The American Society of Mechanical Engineers; 2008.
E. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use); The American Society of Mechanical Engineers; 2008.
F. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures; The American Society of Mechanical Engineers; 1994 (R2004).
G. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 2011.
H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.
I. ISSFA-2 - Classification and Standards for Solid Surfacing Material; International Solid Surface Fabricators Association; 2001 (2007)

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
C. Manufacturer's Instructions: Indicate installation methods and procedures.
D. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 REGULATORY REQUIREMENTS

A. Complete potable water installation shall be in accordance with Vermont Act 193, which mandates a maximum weighted average lead content to 0.25 percent. This shall apply to pipes, fittings, fixtures, valves and other products that come in contact with drinking water

B. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water

F. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 TANK TYPE WATER CLOSETS

A. Tank Type Water Closet Manufacturers:

1. Niagara Conservation. http://www.niagaraconservation.com
2. Or Approved Equal.

B. Bowl: ASME A112.19.2; floor mounted, vitreous china reverse trap, close-coupled closet combination with regular rim, insulated vitreous china closet tank with fittings and lever flushing valve, bolt caps.

1. Water Cosumption: Maximum 0.8 Gallons per flush.

2.02 LAVATORIES

A. Lavatory Manufacturers:

1. American Standard, Inc: www.americanstandard-us.com.
2. Kohler Company; Model _____: www.kohler.com.

3. Or Approved Equal.

B. Vitreous China Counter Top Basin: ASME A112.19.2; vitreous china self-rimming counter top lavatory, [16.5 inch diameter] with front overflow, seal of putty, calking, or concealed vinyl gasket.

C. Supply Faucet Manufacturers:

1. American Standard, Inc; SERIN Monoblock Faucet: www.americanstandard-us.com.
2. Kohler Company; Model _____: www.kohler.com.
3. Moen. Moen.com
4. Or Approved Equal.

D. Supply Faucet: ASME A112.18.1; chrome plated brass construction with one piece self contained ceramic disc valve allowing for both volume and temperature control. Touch activated pop-up waste, drain with tail-piece and overflow. Water economy maximum flow of 1.5 GPM, single lever handle. E. Accessories:

1. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
2. Rigid supplies.

2.03 SINKS

A. Sink Manufacturers:

1. American Standard, Inc; Model _____: www.americanstandard-us.com.
2. Kohler Company; Model _____: www.kohler.com.
3. Or Approved Equal..

B. Single Compartment Bowl: ASME A112.19.3; 29 3/4 by 24 5/16 by 9 5/16 inch outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

KOHLER®

VAULT™

Features

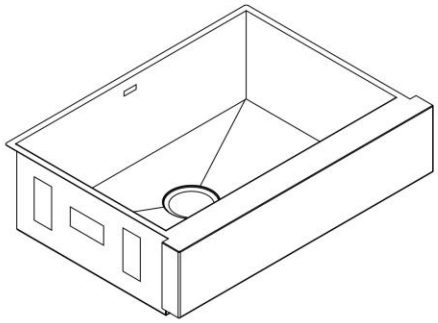
- *18-gauge stainless steel*
- *Under-mount*
- *Medium single bowl*
- *Includes bottom bowl rack*
- *Includes installation hardware*
- *Use for standard 30″ (762 mm) cabinet*
- *29-1/2″ (749 mm) x 21-1/4″ (540 mm)*

Codes/Standards Applicable

Specified model meets or exceeds the following:

- *ASME A112.19.3/CSA B45.4*

UNDER-MOUONT APRON FRONT KITCHEN SINK
K-3936



Colors/Finishes

- NA: None applicable

Accessories

- CP: Polished Chrome
- ST: Stainless Steel
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description		Colors/Finishes
K-3936	Under-mount apron front kitchen sink		❑ NA
Included Accessories			
K-6466	Bottom bowl rack		❑ ST
Optional Accessories			
K-8801	Duostrainer® sink strainer	❑ CP	❑ Other_____

Product Specification

The under-mount apron front sink shall be made of 18-gauge stainless steel. Sink shall have medium single bowl. Sink shall include bottom bowl rack and installation hardware. Sink shall be 29-1/2″ (749 mm) in length, 21-1/4″ (540 mm) in width. Sink shall be used for standard 30″ (762 mm) cabinet. Sink shall be Kohler Model K-3936-NA.

USA/Canada: 1-800-4KOHLER
(1-800-456-4537)
www.kohler.com

VAULT™

Technical Information

Fixture*:	
Bowl area	26-1/2″ (673 mm) x 17-3/16″ (437 mm)
Water depth	9″ (229 mm)
Drain hole	Ø 3-11/16″ (94 mm)
* Approximate measurements for comparison only.	

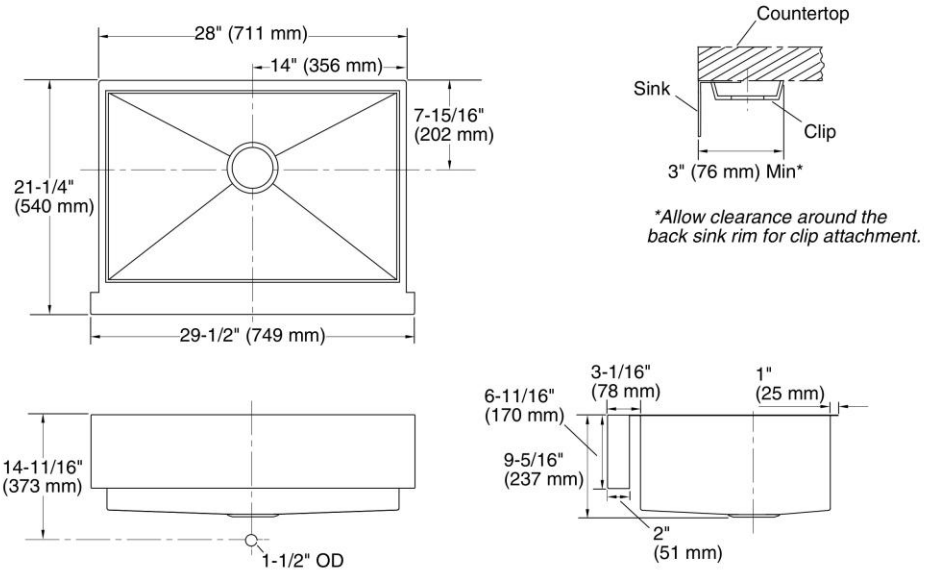
Included components:	
Hardware kit (4 required)	91915
Cut-out template	1166718-7

Installation Notes

Install this product according to the installation guide.

Allow a minimum of 3″ (76 mm) clearance for the back 1″ (25 mm) sink rim flange for clip attachment.

The 3/4″ (19 mm) side rim flanges are supported without using the clip attachment. See the installation guide for further instructions.



Product Diagram

VAULT™ UNDER-MOUONT APRON FRONT KITCHEN SINK
Page 2 of 2
1166713-4-**C**

THE BOLD LOOK OF KOHLER

1. Drain: 1-1/2 inch chromed brass drain with with strainer.

KOHLER FAUCETS

SIMPLICE®

Features

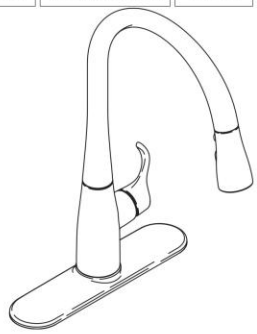
- *Metal construction*
- *One-piece, self-contained ceramic disc valve allows both volume and temperature control*
- *Temperature memory allows faucet to be turned on and off at any temperature setting*
- *Touch control for stream-to-spray water flow*
- *Promotion™ technology with nylon hose and ball joint for easy operation*
- *Flexible connections for easy installation*
- *Three-function sprayhead with spray, aerated stream, and pause settings*
- *360° spout rotation*
- *For single-hole or three-hole installation when included 10-1/2″ (267 mm) escutcheon plate is used*
- *Meets CalGreen requirements for kitchen faucets*
- *1.8 gallons (6.8 L) per minute maximum flow rate at 60 psi (4.1 bar)*

PULL-DOWN KITCHEN SINK FAUCET

K-596

ALSO K-597

ADA | **CSA B651** | **OBC**



Codes/Standards Applicable

Specified model meets or exceeds the following at date of manufacture:

- *ADA*
- *ICC/ANSI A117.1*
- *CSA B651*
- *OBC*
- *ASME A112.18.1/CSA B125.1*
- *NSF 61*
- *Energy Policy Act of 1992*
- *All applicable US Federal and State material regulations*

Colors/Finishes

- CP: Polished Chrome
- VS: Stainless Steel

Specified Model

Model	Description	Colors/Finishes	
K-596	Pull-down kitchen sink faucet – 9″ (229 mm) swing spout reach (shown)	❑ CP	❑ VS
K-597	Pull-down kitchen sink faucet – 8″ (203 mm) swing spout reach	❑ CP	❑ VS

Product Specification

The kitchen sink faucet shall be of metal construction with a one-piece, self-contained ceramic disc valve, which allows both volume and temperature control. Product shall feature temperature memory, allowing the faucet to be turned on and off at any temperature setting. Product shall feature a touch control for stream-to-spray water flow and Promotion technology with nylon hose and ball joint for easy operation. Product shall feature a 360° spout rotation and have flexible connections for easy installation. Product shall be available with a three-function sprayhead with spray, aerated stream, and pause settings. Product shall be for single-hole or three-hole installation when included 10-1/2″ (267 mm) escutcheon plate is used. Product shall be 1.8 gallon (6.8 L) per minute maximum flow rate. Product shall meet CalGreen requirements for kitchen faucets. Product shall be Kohler Model K-____-____.

USA/Canada: 1-800-4KOHLER
(1-800-456-4537)
www.kohler.com

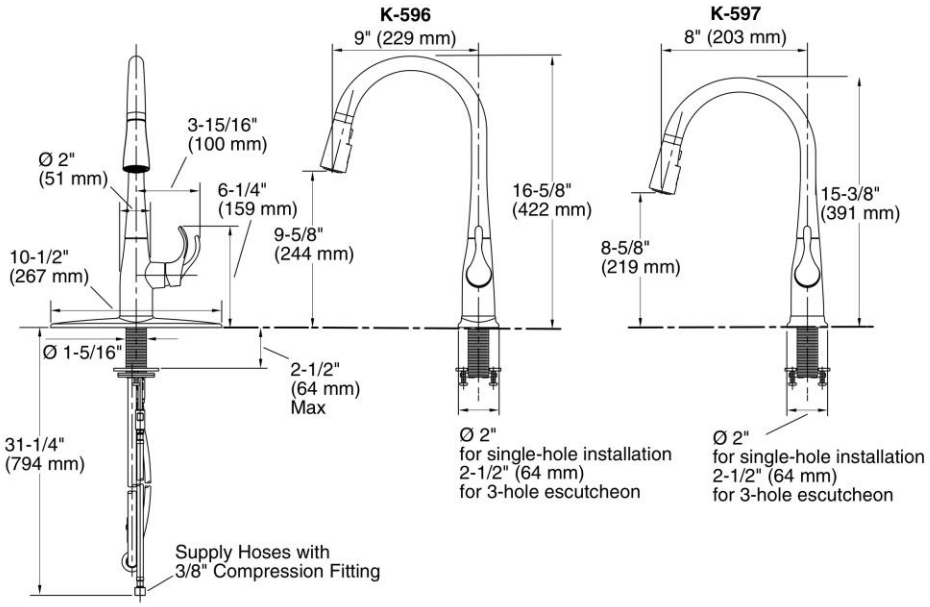
SIMPLICE®

Optional Accessories		
1012715	Deep roughing-in kit – provides an additional 2″ (51 mm) assembly depth	❑ NA
1167289	Low flow kit – reduces maximum flow to 1.5 gpm (5.7 L) at 60 psi (4.1 bar)	❑ NA
1167290	High flow kit – increases maximum flow to 2.2 gpm (8.3 L) at 60 psi (4.1 bar)	❑ NA

Installation Notes

Install this product according to the installation guide.

ADA, **CSA B651**, **OBC** compliant when installed to the specific requirements of these regulations.



Product Diagram

SIMPLICE® PULL-DOWN KITCHEN SINK FAUCET
Page 2 of 2
1086367-4-**F**

THE BOLD LOOK OF KOHLER®

2.04 SHOWERS

A. Tiled in Shower

KOHLER FAUCETS

AWAKEN™ G110

Features

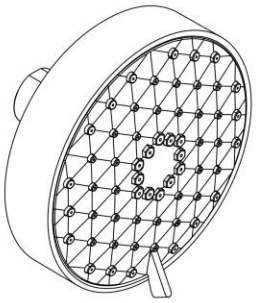
- *3-function showerhead with wide coverage, medium coverage, and forceful spray options*
- *MasterClean™ spray nozzles prohibit mineral buildup for easy cleaning*
- *2.0 gal/min (7.6 l/min) maximum flow rate*
- *4-5/16″ (110 mm) diameter sprayface*
- *1/2″-14 NPT connection*

Codes/Standards Applicable

Specified model meets or exceeds the following:

- *ASME A112.18.1/CSA B125.1*
- *EPA WaterSense®*

MULTIFUNCTION SHOWERHEAD
K-72419



Colors/Finishes

- CP: Polished Chrome
- Other: Refer to Price Book for additional colors/finishes

Accessories

- CP: Polished Chrome
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description	Colors/Finishes	
K-72419	Multifunction showerhead	❑ CP	❑ Other ____

Recommended Accessories			
K-7395	Shower arm and flange – 5-3/8″ (137 mm) length, 1/2″ NPT **OR**	❑ CP	❑ Other ____
K-7397	Shower arm and flange – 7-1/2″ (191 mm) length, 1/2″ NPT	❑ CP	❑ Other ____

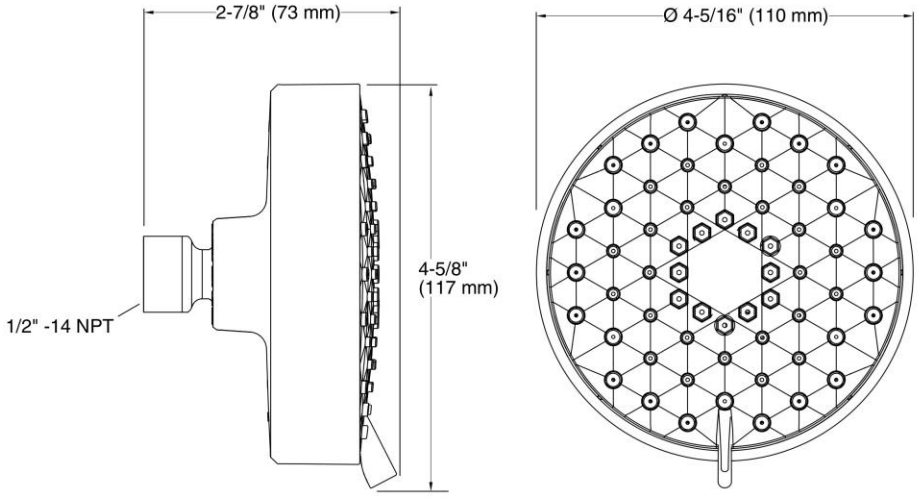
Product Specification

The multifunction showerhead shall feature three spray modes; wide coverage, medium coverage, and forceful spray. Showerhead shall feature MasterClean spray nozzles to prohibit mineral build-up for easy cleaning. Showerhead shall feature 2.0 gal/min (7.6 l/min) maximum flow rate. Showerhead shall have 4-5/16″ (110 mm) diameter sprayface and 1/2″-14 NPT connection. Multifunction showerhead shall be Kohler Model K-72419-____.

AWAKEN™ G110

Installation Notes

Install this product according to the installation guide.



Product Diagram

AWAKEN™ G110 MULTIFUNCTION SHOWERHEAD
Page 2 of 2
1207991-4-**A**

THE BOLD LOOK OF KOHLER

KOHLER. FAUCETS

Features

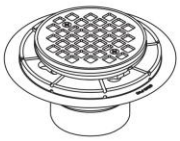
- *Brass and PVC construction*
- *Through-the-floor tile-in installation*
- *Removable grid plate*
- *Reversible collar to accommodate a variety of tile thicknesses*
- *2″ and 3″ PVC connection*

Codes/Standards Applicable

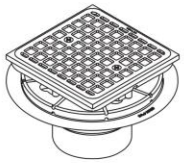
Specified model meets or exceeds the following:

- *ASME A112.18.2/CSA B125.2*

TILE-IN SHOWER DRAIN
K-9135
ALSO K-9136



K-9135



K-9136

Colors/Finishes

- CP: Polished Chrome
- Other: Refer to Price Book for additional colors/finishes

Specified Model

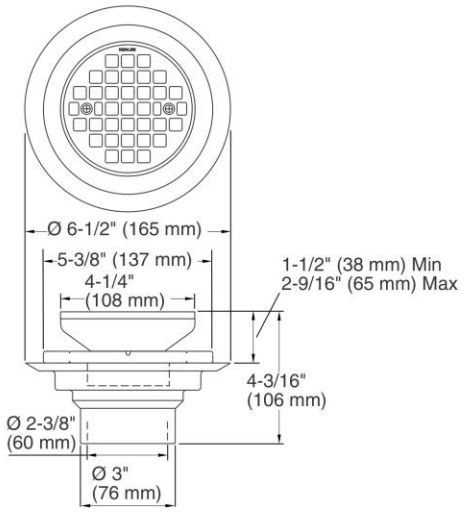
Model	Description	Colors/Finishes	
K-9135	Tile-in shower drain – round shaped grid plate	❑ CP	❑ Other ____
K-9136	Tile-in shower drain – square shaped grid plate	❑ CP	❑ Other ____

Product Specification

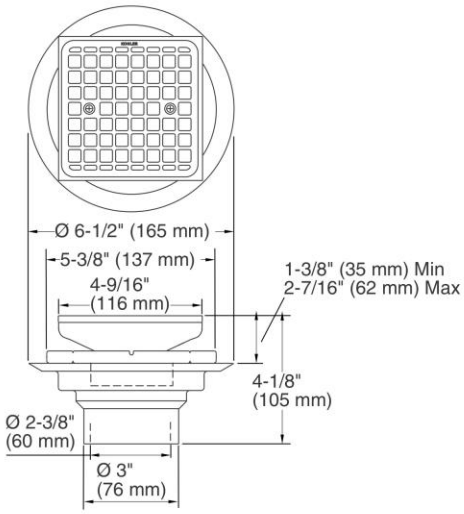
The tile-in shower drain shall be made of brass and PVC construction. Drain shall be for through-the-floor tile-in installation. Drain shall be for 2″ and 3″ PVC connection. Drain shall feature a removable grid plate and reversible collar to accommodate a variety of tile thicknesses. Drain shall be Kohler Model K-____-____.

Installation Notes

Install this product according to the installation guide.



K-9135
Collar with Threads Facing Down



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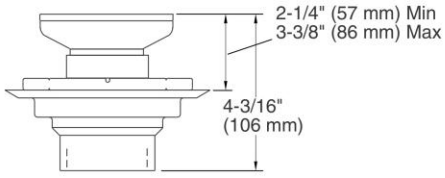
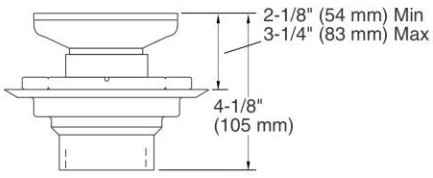
Collar with Threads Facing Down



Collar with Threads Facing Up



Collar with Threads Facing Up

Product Diagram

TILE-IN SHOWER DRAIN
Page 2 of 2
1090854-4-**C**

THE BOLD LOOK OF KOHLER.

KOHLER®

Features

- *Metal construction*
- *1/2"-14 NPT thread both ends*
- *Wall-mount flange*

Codes/Standards Applicable

Specified model meets or exceeds the following:

- *ASME A112.18.1/CSA B125.1*

SHOWER ARM AND FLANGE
K-7395
ALSO K-7397

K-7395

K-7397

Colors/Finishes

- CP: Polished Chrome
- PB: Vibrant® Polished Brass
- Other: Refer to Price Book for additional colors/finishes

Specified Model

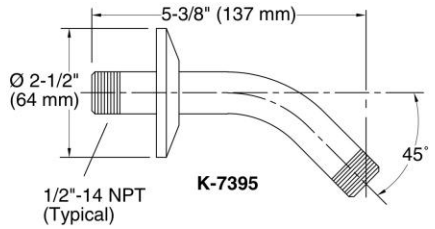
Model	Description	Colors/Finishes		
K-7395	Shower arm and flange - 5-3/8" (137 mm)	❑ CP	❑ PB	
K-7397	Shower arm and flange - 7-1/2" (191 mm)	❑ CP	❑ PB	❑ Other____

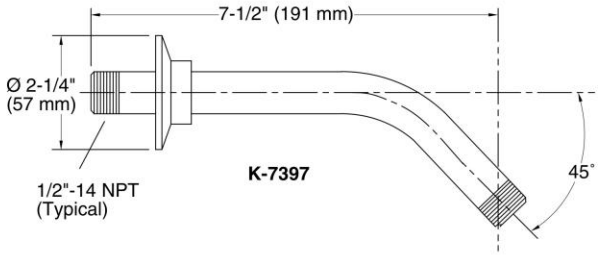
Product Specification

Shower arm and flange shall be of metal construction. Product shall have 1/2"-14 NPT thread both ends. Product shall have wall-mount flange. Shower arm shall be Kohler Model K-_____-_____.

USA/Canada: 1-800-4KOHLER
(1-800-456-4537)
www.kohler.com

[redacted]





Product Diagram

SHOWER ARM AND FLANGE
Page 2 of 2
113698-4-**D**

THE BOLD LOOK OF KOHLER.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports and bolts where applicable.

E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 079005, color to match fixture.

F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. Clean plumbing fixtures and equipment.

3.07 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Do not permit use of fixtures by construction personnel.

C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 23 05 00
MECHANICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes Contract requirements and the following basic mechanical materials and methods to complement other Division 21, 22 and 23 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Concrete base construction requirements.
4. Escutcheons.
5. Dielectric fittings.
6. Flexible connectors.
7. Mechanical sleeve seals.
8. Equipment nameplate data requirements.
9. Labeling and identifying mechanical systems and equipment is specified in Division 23 Section "Mechanical Identification."
10. Nonshrink grout for equipment installations.
11. Field-fabricated metal and wood equipment supports.
12. Installation requirements common to equipment specification sections.
13. Cutting and patching.
14. Touchup painting and finishing.

B. Pipe and pipe fitting materials are specified in Division 21, 22, and 23 piping system Sections.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop location

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The use of the word “Provide”: Whenever the word “Provide” is used in the specifications and/or on the drawings, it shall mean “furnish and install”, “connect”, “apply”, “erect”, “construct”, or similar terms, unless otherwise indicated.

G. The use of the word “Piping”: “Piping” shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.

H. The use of the word “Material”: Whenever the word material is used in the specifications and/or on the drawings, it shall mean any “product”, “equipment”, “device”, “assembly”, or “item” required under the contract, as indicated by trade or brand name, manufacturer’s name, standard specification reference or other description.

I. The term “Mechanical Contractor”, “HVAC Contractor”, “Plumbing Contractor” or “Contractor” refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Mechanical, HVAC, and/or Plumbing drawings and in the Mechanical, HVAC, and/or Plumbing Specifications.

J. The term “Accessible” indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. “accessible ceiling” indicates acoustical tile type hung ceilings. Concealed spline or sheetrock ceilings with access panes shall not be considered accessible ceilings.

K. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

L. The following are industry abbreviations for rubber materials:
1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.04 CODES, STANDARDS, REFERENCES, AND PERMITS

A. All material and workmanship shall comply with all the latest editions of all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations.

B. In case of differences between the Building Codes, State Law, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the contractor shall promptly notify the Engineer in writing of any such difference.

C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary and bid purposes. However, no work will proceed until the Engineer determines the correct method of installation.

D. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Engineer.

1.05 SUBMITTALS

A. Product Data: For the following:
1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

C. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

D. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.06 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.07 SYSTEM DESCRIPTION

A. Furnish and install all materials in order to provide functioning systems, upon completion, in compliance with all applicable codes, authorities having jurisdiction, manufacturer's requirements, performance requirements specified, and any modifications resulting from reviewed shop drawings and the field coordination drawings.

1.08 SCOPE OF WORK

A. The contractor is responsible for furnishing and installing all the devices and equipment shown indicated the Mechanical Drawings including materials and equipment required to create fully operational systems.

B. The contractor shall be responsible for reviewing the Architectural, Electrical, and Fire Protection Plans. In addition to all mechanical equipment, plumbing fixtures, and mechanical devices indicated on the Mechanical Plans, the contractor is responsible for mechanical installation of all the equipment and devices shown on the Architectural Plans and the Electrical Plans.

C. The contractor shall be responsible for reviewing the Architectural, Electrical, and Fire Protection Plans. Prior to bid, the contractor shall notify the Engineer of any discrepancies between the Architectural, Electrical, Mechanical, and Fire Protection Plans regarding equipment locations, equipment quantities, piping and duct work routing, device locations, light locations, chase locations, etc. otherwise it will be assumed the contractor is responsible for mechanical installation of all the equipment and devices shown on the Architectural Plans, Mechanical Plans, Plumbing Plans, Fire Protection Plans and the Electrical Plans regardless of whether they are indicated on the Mechanical Plans.

1.09 DRAWING INTERPRETATION

A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturer's product. In the event of a field verification or coordination issue, report issue to Owners construction supervisor.

B. Piping and air duct plans are intended to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The drawings do not necessarily indicate all required offsets, details and accessories and equipment to be connected or encountered in the way of new work.

C. Generally, layout pipelines requiring drainage first, followed by large pipe mains, air duct and electrical conduit. Follow this procedure for an orderly installation but not to establish precedence of one trade

over another. It must be understood that pipe and duct hanger installations must comply with seismic bracing requirements. Minimizing hanger lengths (structure to equipment and crossbars) to 12" and under minimizes the requirement for seismic bracing.

D. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines, to avoid existing field conditions as well as to maintain clearances to equipment whether or not indicated on the drawings. The contractor shall provide all drains, traps and accessories as required for his work to effect these offsets, transitions and changes in direction. Consult Design Professional before making changes that effect the function or appearance of systems.

E. Do not install equipment, air ducting or piping in a non-code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.

F. In some cases, drawings are based on products of one or several manufacturers, as listed on the contract documents. The contractor shall be held responsible for modifications made necessary by substitution of products or other manufacturers.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

A. Do not install any part of a system until all critical components of the systems and related systems have been approved. Coordinate individual parts of systems.

B. Coordinate contract work with other work specified in other sections. Relocate work if required for proper installation and functioning of other systems, at no extra cost to the Owner.

C. Install products in accordance with manufacturer's instructions. Notify Design Professional if Contract Documents conflict with manufacturer's instructions. Comply with Design Professional's interpretations,

D. In general, air duct, heating and sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The design professional will final decisions regarding the arrangement of work, which cannot be agreed upon by the contractors.

1.12 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.13 "AS-BUILT" RECORD DRAWINGS

A. Record daily progress on one set of construction documents. Utilize a permanent black or blue marking media. All progress of record drawings shall be provided in a neat and accurate fashion.

B. As-built drawing reviews will be completed on a monthly basis by the engineer of record. Release of requisitions will be based on the regular progress of As-built drawings. The latest As-built drawings shall be submitted for review with each requisition for payment.

C. Formal As-built drawings shall be submitted for review at the completion of each phase of the work. The as-built drawings shall be ¼" scale and created in electronic format utilizing both AUTOCAD Release 2004. At the completion of each phase of work, the mechanical contractor shall submit to the Engineer the original field progress as-built drawings, the electronic files of the formal as-built drawings, and four sets of final as-built drawings plotted on 24" x 36" 'D' sized sheets. Final payment for the phase of work and the start of the next phase shall be dependent of approval of the as-built drawings.

1.14 GUARANTEE

A. Provide written guarantee of all completed/installed work. Materials, equipment and workmanship shall be guaranteed for a minimum period of one year after Owners acceptance of work. Any failure due to defective material, equipment or workmanship shall be corrected at no additional cost to owner. This shall include damage completed to other areas of construction or facility resulting from this failure. Provide correction of any failure within an acceptable/reasonable time period.

B. Provide all equipment and material manufacturers guarantees and/or warranties to owner after acceptance of installation.

1.15 OPERATING AND MAINTENANCE MANUALS

A. Provide operating and maintenance information for all equipment, devices, systems, and materials. This shall include all maintenance and operations procedures, recommendations, and service requirements. All submitted data must include minimum equipment/device operations and maintenance requirements to fulfill manufacturers warrantees.

B. Submit all engineering selection and specification documentation with operating and maintenance information for all equipment, devices, systems, and materials.

C. Submit all data media in a detailed, organized, and complete manner. Provide a minimum of three copies to Owners construction supervisor for engineer/architect review. Submit in 3 ring bound enclosure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dielectric Flanges:

a. Capitol Manufacturing Co.

b. Central Plastics Co.
c. Epco Sales Inc.
d. Watts Industries, Inc.; Water Products Div.

2. Dielectric-Flange Insulating Kits:
   a. Calpico, Inc.
   b. Central Plastics Co.
3. Dielectric Couplings:
   a. Calpico, Inc.
   b. Lochinvar Corp.
4. Dielectric Nipples:
   a. Grinnell Corp.; Grinnell Supply Sales Co.
   b. Perfection Corp.
   c. Victaulic Co. of America.
5. Metal, Flexible Connectors:
   a. ANAMET Industrial, Inc.
   b. Flexicraft Industries.
   c. Mercer Rubber Co.
   d. Uniflex, Inc.
6. Rubber, Flexible Connectors:
   a. General Rubber Corp.
   b. Mercer Rubber Co.
   c. Proco Products, Inc. d. Uniflex, Inc.
7. Mechanical Sleeve Seals:
   a. Calpico, Inc.
   b. Metraflex Co.
   c. Thunderline/Link-Seal.

2.02 PIPE AND PIPE FITTINGS

A. Refer to individual Division 21, 22, and 23 piping Sections for pipe and fitting materials and joining methods.

2.03 JOINING MATERIALS

A. Refer to individual Division 21, 22, and 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
H. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.
I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 TRANSITION FITTINGS
A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
3. Aboveground Pressure Piping: Pipe fitting.
B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent cement-joint end.
1. Manufacturers:
a. Eslon Thermoplastics.
C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
a. Thompson Plastics, Inc.
D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
1. Manufacturers:
a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.
E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Manufacturers:
a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company. d. Plastic Oddities, Inc.

2.05 DIELECTRIC FITTINGS
A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F

2.06 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 250-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
   1. 2-Inch NPS and Smaller: Threaded.
   2. 2-1/2-Inch NPS and Larger: Flanged.
   3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.

B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

2.07 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms. F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.08 PIPING SPECIALTIES

A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
   1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.

2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
2. OD: Completely cover opening.
3. Cast Brass: Split casting, with concealed hinge and set screw.
   a. Finish: Rough brass.
   b. Finish: Polished chrome-plate.

2.09 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psig, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping exposed at ceiling level or below building as indicated on the drawings. Ensure access to fittings is provided.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes with smooth concrete bore.
N. Permanent sleeves are not required for holes formed by removable PE sleeves.
O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
d. Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Ha ndbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.03 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

F. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

G. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.05 PAINTING AND FINISHING

A. Apply paint to exposed piping according to the following, unless otherwise indicated:
   1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
   2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
   3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
   4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
   5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
   6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

B. Do not paint piping specialties with factory-applied finish.

C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Provide 2” chamfered edges on top of concrete pads. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psig, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete." Provide broom finish.

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.08 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.09 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.10 GROUTING

A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placing of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases to provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout according to manufacturer's written instructions.

3.11 FIRESTOPPING

A. The mechanical contractor is responsible for providing proper U.L. Listed firestopping and smokestopping for all duct, pipe, controls conduit, and related electrical conduit installed by the mechanical contractor.
B. The mechanical contractor shall utilize the latest fire and smoke protection materials and installation methods. The mechanical contractor shall guarantee that all materials installed are fire and smoke stopped per U.L. Listing, NFPA, building code requirements.
C. The mechanical contractor shall utilize Architectural Life Safety Drawings to identify partition ratings. If the mechanical contractor is unsure of partition rating then he or she must inquire to Construction Manager.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single phase electric motors.

1.02 RELATED REQUIREMENTS

A. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections.

B. Section 262913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.

C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for Single Phase motors larger than 1/2 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

E. Operation Data: Include instructions for safe operating procedures.

F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

A. Conform to NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lincoln Motors: www.lincolnmotors.com.

B. A. O. Smith Electrical Products Company: www.aosmithmotors.com.

C. Reliance Electric/Rockwell Automation: www.reliance.com.

D. Baldor Electric Co: www.baldor.com
E. Or Equal

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:
1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
2. Motors Larger than 1/2 Horsepower: 240 volts, single phase, 60 Hz.

B. Construction:
1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 40 degrees C environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Motors All Sizes : Single Phase

B. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not conform to these specifications.

C. Single phase motors for shaft mounted fans and centrifugal pumps: ECM type.

D. Single phase motors for fans and pumps: ECM type.

E. Motors located in exterior locations and air cooled condensers: Totally enclosed type weatherproof.

2.04 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.05 SINGLE PHASE POWER - ELECRONICALLY COMMUTATED MOTOR

A. Motors: Built-in inverter and a magnet rotor.

B. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve bearings.

C. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position. C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flexible pipe connectors.
B. Expansion joints and compensators.
C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS

A. Section 232113 - Hydronic Piping.
B. Section 232300 - Refrigerant Piping.

1.03 REFERENCE STANDARDS

A. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2010.
B. EJMA (STDS) - EJMA Standards; Expansion Joint Manufacturers Association; Ninth Edition.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures. B. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
C. Design Data: Indicate selection calculations.
D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
F. Maintenance Data: Include adjustment instructions.

1.05 REGULATORY REQUIREMENTS

A. Conform to UL requirements.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. Manufacturers:
   1. Mercer Rubber Company: www.mercer-rubber.com.
   2. Metraflex Company: www.metraflex.com.
   3. Or Equal
B. Inner Hose: Carbon Steel.
C. Exterior Sleeve: Single braided, stainless steel.
D. Pressure Rating: 125 psi and 450 degrees F.
E. Joint: As specified for pipe joints.
F. Size: Use pipe sized units.
G. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturer:
1. Mercer Rubber Company: www.mercer-rubber.com.
2. Metraflex Company: www.metraflex.com.
3. Or Equal

B. Inner Hose: Bronze.
C. Exterior Sleeve: Braided bronze.
D. Pressure Rating: 125 psi and 450 degrees F.
E. Joint: As specified for pipe joints.
F. Size: Use pipe sized units.
G. Maximum offset: 3/4 inch on each side of installed center line.
H. Application: Copper piping.

2.03 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE

A. Manufacturers:
1. Mercer Rubber Company: www.mercer-rubber.com.
2. Metraflex Company: www.metraflex.com.
3. Or Equal

B. Pressure Rating: 125 psi and 400 degrees F.
C. Maximum Compression: 1-3/4 inches.
D. Maximum Extension: 1/4 inch.
E. Joint: As specified for pipe joints.
F. Size: Use pipe sized units.
G. Application: Steel piping 3 inches and under.

2.04 EXPANSION JOINTS - TWO-PLY BRONZE BELLOWS TYPE

A. Manufacturers:
1. Mercer Rubber Company: www.mercer-rubber.com.
2. Metraflex Company: www.metraflex.com.
3. Or Equal

B. Construction: Bronze with anti-torque device, limit stops, internal guides.
C. Pressure Rating: 125 psi and 400 degrees F.
D. Maximum Compression: 1-3/4 inches.
E. Maximum Extension: 1/4 inch.
F. Joint: As specified for pipe joints.
G. Size: Use pipe sized units.
H. Application: Copper piping.

2.05 EXPANSION JOINTS - LOW PRESSURE COMPENSATOR WITH TWO-PLY BRONZE BELLOWS

A. Manufacturers:
1. Mercer Rubber Company; Model _____: www.mercer-rubber.com.
2. Metraflex Company; Model ___: www.metraflex.com.
3. Or Approved Equal..

B. Working Pressure: 75 psi.
C. Maximum Temperatures: 250 degrees F.
D. Maximum Compression: 1/2 inch.
E. Maximum Extension: 5/32 inch.

F. Joint: Soldered.
G. Size: Use pipe sized units.
H. Application: Copper or steel piping 3 inches and under.

2.06 ACCESSORIES

A. Stainless Steel Pipe: ASTM A269.
B. Pipe Alignment Guides:
1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
C. Swivel Joints:
1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION

SECTION 23 05 19
METERS AND GAUGES

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Flow meters.
- B. Pressure gauges and pressure gauge taps.
- C. Thermometers and thermometer wells.

1.02 RELATED REQUIREMENTS
- A. Section 232113 - Hydronic Piping.
- B. Section 25 00 00 - HVAC Instrumentation and Controls

1.03 REFERENCE STANDARDS
- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2005.
- B. ASTM E1 - Standard Specification for ASTM Thermometers; 2007.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2007.
- D. AWWA C700 - Cold Water Meters -- Displacement Type, Bronze Main Case; American Water Works Association; 2009 (ANSI/AWWA C700).
- E. AWWA C701 - Cold Water Meters -- Turbine Type, for Customer Service; American Water Works Association; 2012.
- F. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; American Water Works Association; 2012.
- G. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation. D. Maintenance Data: For meters and gauges to include in maintenance manuals specified in Division 1. Include data for the following:
  1. Retain or delete subparagraphs below as require
  2. Flow-measuring systems.
  3. Flowmeters.
  4. Thermal-energy flowmeters.
  5. Water meters.

1.05 FIELD CONDITIONS
- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- A. See Editing Instruction No. 1 in the Evaluations for cautions about naming products and manufacturers. Delete categories below not required.
- B. Liquid-in-Glass Thermometers:

1. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
2. Trerice: H. O. Trerice Co.
3. Weiss Instruments, Inc.

C. Direct-Mounting, Filled-System Dial Thermometers:
1. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
2. Trerice: H. O. Trerice Co.
3. Weiss Instruments, Inc.

D. Remote-Reading, Filled-System Dial Thermometers:
1. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
2. Trerice: H. O. Trerice Co.
3. Weiss Instruments, Inc.

E. Insertion Dial Thermometers:
1. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
2. Trerice: H. O. Trerice Co.
3. Weiss Instruments, Inc.

F. Pressure Gauges:
1. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
2. Trerice: H. O. Trerice Co.
3. Weiss Instruments, Inc.

G. Test Plugs:
1. Flow Design, Inc.
2. Trerice: H. O. Trerice Co.
3. Watts Industries, Inc.; Water Products Div.

2.02 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:
1. Other temperature ranges and units wiTh both Fahrenheit and Celsius scales are available.
2. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale
3. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale
4. Hot Water: 30 to 300 deg F, with 2-degree scale
5. Pumped Condensate: 30 to 300 deg F, with 2-degree scale

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.03 LIQUID-IN-GLASS THERMOMETERS

A. Description: ASTM E 1.
B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.
C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
D. Tube: Red or blue reading, organic-liquid filled with magnifying lens.
E. Retain paragraph above or below. Tube type above is recommended.
F. Tube: Red or blue reading, mercury filled with magnifying lens.
G. Scale: Satin-faced nonreflective aluminum with permanently etched markings.
H. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.04 DIRECT-MOUNTING, FILLED-SYSTEM DIAL THERMOMETERS

A. Description: Vapor-actuated, universal-angle dial type.

B. Cases are also constructed of molded brass, stainless steel, or phenolic plastic. Lenses are also made of clear acrylic plastic. Edit to suit Project.
C. Case: Drawn steel or cast aluminum, with 4-1/2-inch- diameter, glass lens.
D. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
E. Thermal Bulb: Copper with phosphor-bronze bourdon pressure tube. F. Movement: Brass, precision geared.
G. Scale: Progressive, satin-faced nonreflective aluminum with permanently etched markings.
H. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.05 REMOTE-READING, FILLED-SYSTEM DIAL THERMOMETERS
A. Description: Vapor-actuated, remote-reading dial type.
B. Case: Drawn steel or cast aluminum, with 4-1/2-inch diameter, glass lens.
C. Movement: Brass, precision geared.
D. Scale: Progressive, satin-faced nonreflective aluminum with permanently etched markings.
E. Tubing: Bronze, double-braided, armor-over-copper capillary; of length to suit installation.
F. Bulb: Copper with separable socket for liquids; averaging element for air.

2.06 INSERTION DIAL THERMOMETERS
A. Description: ASME B40.3, bimetal type.
B. Dial: 1-inch diameter.
C. Case: Stainless steel.
D. Stem: Dustproof and leakproof 1/8-inch diameter, tapered-end stem with nominal length of 5 inches.

2.07 SEPARABLE SOCKETS
A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
1. Retain first with second or third subparagraph below.
2. Material: Brass, for use in copper piping.
3. Material: Steel, for use in steel piping.
4. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
5. Retain one of three subparagraphs below.
6. Insertion Length: Pipe 6” and larger: To extend 2 inches into pipe.
7. Insertion Length: Pipe 4” to 6”: To extend to one-third of diameter of pipe.
8. Insertion Length: Pipe 3” and under: To extend to center of pipe.
9. Delete subparagraph below if not required or if all thermometers will be permanently installed.
10. Cap: Threaded, with chain permanently fastened to socket.
11. Heat-Transfer Fluid: Oil or graphite.

2.08 THERMOMETER WELLS
A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
1. Retain first with second or third subparagraph below.
2. Material: Brass, for use in copper piping.
3. Material: Steel, for use in steel piping.
4. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.

5. Retain one of three subparagraphs below.
6. Insertion Length: Pipe 6” and larger: To extend 2 inches into pipe.
7. Insertion Length: Pipe 4” to 6”: To extend to one-third of diameter of pipe.
8. Insertion Length: Pipe 3” and under: To extend to center of pipe.
9. Cap: Threaded, with chain permanently fastened to socket.
10. Heat-Transfer Fluid: Oil or graphite.

2.09 PRESSURE GAUGES

A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.
B. Cases are also constructed of molded aluminum and phenolic plastic. Lenses are also made of clear acrylic plastic. Edit to suit Project.
C. Case: Drawn steel, brass, or aluminum with 4-1/2-inch diameter, glass lens.
D. Connector: Brass, NPS 1/4.
E. Scale: White-coated aluminum with permanently etched markings.
F. Retain one of four paragraphs below.
G. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.
H. Range: Comply with the following:
1. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure
2. Fluids under Pressure: Two times the operating pressure.

2.10 PRESSURE-GAUGE FITTINGS

A. Valves: NPS 1/4 brass or stainless-steel needle type.
B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.11 TEST PLUGS

A. Edit paragraph below for NPS 1/4 (DN8) test plugs if required.
B. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.
C. Body: Length as required to extend beyond insulation.
D. Pressure Rating: 600 psig minimum. E. Retain one of three paragraphs below.
F. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gauge.
G. Core Inserts: Two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gauge.
H. Core Material for Air, Water, Oil, and Gas: 20 to 200 deg F, chlorosulfonated polyethylene synthetic rubber.
I. Core Material for Air and Water: Minus 30 to plus 275 deg F, ethylene-propylene-diene terpolymer rubber.
J. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

PART 3 EXECUTION

3.01 METER AND GAUGE INSTALLATION, GENERAL

A. Install meters, gauges, and accessories according to manufacturer's written instructions for applications where used.

3.02 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.
B. Install in the following locations, including locations indicated on drawings:
   1. Inlet and outlet of domestic water to each domestic water heater.
   3. At mixing valve.
C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.
   1. Retain one of first three subparagraphs below that matches subparagraph selected in "Separable Sockets" Article.
   2. Install with socket extending to center of pipe.
   3. Fill sockets with oil or graphite and secure caps.
D. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.
   1. Install with stem extending to center of pipe.
   2. Fill wells with oil or graphite and secure caps.

3.03 PRESSURE-GAUGE INSTALLATION

A. Install pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position.
B. Install dry-type pressure gauges in the following locations:
   1. Inlet and outlet of each side of each domestic water heater.
   2. Inlet to each expansion tank.
   3. Domestic cold water inlet.
   4. Fire Protection Entrance.
C. Install liquid-filled-type pressure gauges at suction and discharge of each pump.
D. Install pressure-gauge needle valve and snubber in piping to pressure gauges.
   1. Exception: Install syphon instead of snubber in piping to steam pressure gauges.

3.04 CONNECTIONS

A. Coordinate piping installation and specialty arrangement requirements with schematics on Drawings.
B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
   1. Install meters and gauges adjacent to machines and equipment to allow service and maintenance.
C. Delete paragraphs below if not required.
D. Ground electrically operated meters.
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
E. Electrical power, wiring, and connections are specified in Division 26 Sections.

3.05 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.
B. Adjust faces of meters and gauges to proper angle for best visibility.
C. Clean windows of meters and gauges and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Equipment support bases.
B. Vibration isolators.
C. Seismic restraints for suspended components and equipment..
D. Vibration isolators.
E. Seismic restraints.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2011.
B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2011.
C. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2002. D. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.
D. SMACNA (SRM) - Seismic Duct Restraint Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2008.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Provide manufacturer's product literature documenting compliance with PART 2
   2 Include seismic rating documentation for each isolator and restraint component accounting for horizontal, vertical, and combined loads.
C. Shop Drawings:
   1. Provide schedule of vibration isolator type with location and load on each.
   2 Fully dimensioned fabrication drawings and installation details for vibration isolation bases, member sizes, attachments to isolators, and supported equipment.
   3. Include auxiliary motor slide bases and rails, base weights, inertia bases, concrete weights, equipment static loads, support points, vibration isolators, and detailed layout of isolator location and orientation with static and dynamic load on each isolator
   4. Include selections from prescriptive design tables that indicate compliance with the applicable building code and the vibration isolator manufacturer's requirements.
   5. Clearly indicate the load and capacity assumptions selected. Include copies of any calculations.
   6. Include the calculations that indicate compliance with the applicable building code for seismic controls and the vibration isolator manufacturer's requirements.
   7. Include the seal of the Professional Structural Engineer registered in the State of Vermont in which the Project is located, on the drawings and calculations which at a minimum include the following:
      a. Seismic Restraint Details: Detailed drawings of seismic restraints and snubbers including anchorage details that indicate quantity, diameter, and depth of penetration, edge distance, and spacing of anchors.

b. Equipment Seismic Qualification Certification: Certification by the manufacturer or responsible party that each piece of equipment provided will withstand seismic force levels as specified in the applicable building code for seismic controls.
   1) Basis for Certification: Indicate whether the withstand certification is based on actual testing of assembled components, on calculations, or on historic data.
   2) Indicate equipment to be sufficiently durable to resist design forces and or remain functional after the seismic event.

D. Dimensioned outline drawings of equipment identifying center of gravity, locations, and provisions for mounting and anchorage.

E. Detailed description of the equipment anchorage devices on which the certifications are based.

F. Product Data:
   1. Provide schedule of vibration isolator type with location and load on each.
   2. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

G. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
      a. For each seismic restraint calculation, utilize appropriate component importance factor, component response modification factor, and component amplification factor. Where vibration pad isolators are utilized, recommend and provide appropriate pad thickness and quantity. Where vibration isolators are utilized, recommend appropriate minimum deflection, and provide vibration isolators meeting this recommendation.
      b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   2. Seismic- Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, OSHPD, an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

H. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.

I. Coordination Drawings: Show coordination of seismic bracing for Plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

J. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.05 QUALITY ASSURANCE

A. Perform design and installation in accordance with applicable codes.

B. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and registered and licensed in the State in which the Project is located.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.06 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the International Building Code unless requirements in this Section are more stringent

1.07 PERFORMANCE REQUIREMENTS

A. Seismic Restraint Loading:

1. Site Class as Defined in Internation Building Code: Site Class D
2. Importance Factor: 1.25
3. Assigned Seismic Use Group or Building Category as Defined in International Building Code: C
4. Design Spectral Response Acceleration at Short Periods (0.2 second): 0.405g.
5. Design Soectral Response Acceleration at 1-Second Period: 0.264g.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mason Industries: www.mason-ind.com.

B. Or Equal

2.02 PERFORMANCE REQUIREMENTS

A. General:

1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
2. Steel springs to function without undue stress or overloading.

2.03 EQUIPMENT SUPPORT BASES

A. Structural Bases:

1. Construction: Engineered, structural steel frames with welded brackets for side mounting of the isolators.
2. Frames: Square, rectangular or T-shaped.
3. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.

B. Concrete Inertia Bases:

1. Construction: Engineered, steel forms, with integrated isolator brackets and anchor bolts, welded or tied reinforcing bars running both ways in a single layer.
2. Size: 4 inches minimum depth and sized to accommodate elbow supports.
3. Mass: Minimum of 1.5 times weight of isolated equipment.
4. Connecting Point: Reinforced to connect isolators and snubbers to base including template and fastening devices for equipment.
5. Concrete: Filled on site with minimum 3000 psi concrete.

2.04 VIBRATION ISOLATORS

A. Non-Seismic Type:

1. All Elastomeric-Fiber Glass Pads:
   a. Configuration: Flat or molded.
   b. Thickness: 0.25 inch minimum.
   c. Assembly: Single or multiple layers using bonded, galvanized sheet metal separation plate between each layer with load plate providing evenly distributed load over pad surface.
2. Elastomeric Mounts:
   a. Material: Oil, ozone, and oxidant resistant compounds.
   b. Assembly: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
3. Steel Springs:
   a. Assembly: Freestanding, laterally stable without housing.
   b. Leveling Device: Rigidly connected to equipment or frame.
4. Restrained Steel Springs:
   a. Housing: Rigid blocking during rigging prevents equipment installed and operating height from changing during temporary weight reduction.
   b. Equipment Wind Loading: Adequate means for fastening isolator top to equipment and isolator base plate to supporting structure.
6. Elastomeric Hangers:
   a. Housing: Steel construction containing elastomeric isolation element to prevent rod contact with housing and short-circuiting of isolating function.
   b. Incorporate steel load distribution plate sandwiching elastomeric element to housing.
7. Spring Hanger:
   a. Housing: Steel construction containing stable steel spring and integral elastomeric element preventing metal to metal contact.
   b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.
8. Combination Elastomeric-Spring Hanger:
   a. Housing: Steel construction containing stable steel spring with elastomeric element in series isolating upper connection of hanger box to building structure.
   b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.

B. Seismic Type:

1. Coil Springs Consisting of Single Elements:
   a. Housing: Manufactured from cast iron material.

b. Ductile Material: Designed and rated for seismic applications.
c. Spring: Restrained by housing with out significant degradation of vibration isolation capabilities during normal equipment operating conditions.
d. Resilient Snubbing Grommet System: Incorporated and designed with clearances of no more than 0.25 inch in any direction preventing direct metal-to-metal contact between supported member and fixed restraint housing.
e. Resilient Pad: Located in series with spring.
f. Coil Springs: Color coded elements to have a lateral stiffness greater than 0.8 times the rated vertical stiffness with 50 percent overload capacity.
g. Finish: Suitable for the application.

2. All Directional Elastomeric:
a. Material: Molded from oil, ozone, and oxidant resistant compounds.
b. Operating Parameters: Designed to operate within the isolator strain limits providing maximum performance and service life.
c. Attachment Method: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
d. Rating: Cast iron and aluminum housings rated for seismic restraint applications.
e. Minimum Operating Static Deflections: Deflections indicated in project documents are not to exceed published load capacities.

2.05 SEISMIC RESTRAINTS FOR SUSPENDED COMPONENTS AND EQUIPMENT

A. Comply with:
1. ASHRAE Handbook - HVAC Applications
2. FEMA 412
3. FEMA 414
4. SMACNA - Seismic Duct Restraint Manual

B. Cable Restraints:
1. Wire Rope: Steel wire strand cables sized to resist seismic loads in all lateral directions.
2. Protective Thimbles: Eliminates potential for dynamic cable wear and strand breakage.
3. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
4. Connections:
a. Use overlapping wire rope U clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.
b. Internally brace clevis hanger bracket cross bolt to prevent deformation.
5. Vertical Suspension Rods: Attach required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

C. Rigid Restraints:
1. Structural Element: Sized to resist seismic loads in all lateral directions and carry both compressive and tensile loading.
2. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
3. Connections: Internally brace clevis hanger bracket cross bolt to prevent deformation.
4. Static Support System: Anchorage capable of carrying additional tension loads generated by the vertical component of the rigid brace compression which is additive to any static load requirements on the system.

5. Vertical Suspension Rods: Attached required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

2.06 VIBRATION ISOLATORS

A. Open Spring Isolators:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
   4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

B. Restrained Open Spring Isolators:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
   4. Restraint: Provide heavy mounting frame and limit stops.
   5. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

C. Spring Hangers:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
   3. Misalignment: Capable of 20 degree hanger rod misalignment.
   4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

D. Neoprene Pad Isolators:
   1. Configuration: Single layer.
   2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

E. Rubber Mount or Hanger: Molded rubber designed for 0.4 inch deflection with threaded insert.

F. Seismic Snubbers:
   1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
   2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
   3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
   4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.
B. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
C. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
D. Provide seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 0.05 inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.
E. Piping Restraints: Comply with requirements in MSS SP-127.
F. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for scheduled distance.
    1. Up to 4 Inches Pipe Size: First three points of support.
    2. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.02 INSTALLATION - SEISMIC

A. Comply with:
    1. ASHRAE Handbook - HVAC Applications
    2. FEMA 412
    3. FEMA 414
    4. SMACNA - Seismic Duct Restraint Manual
B. Seismic Snubbers:
    1. Snub equipment designated for post-disaster use to 0.05 inch maximum clearance.
    2. Snub all other equipment between 0.15 inch and 0.25 inch clearance.
C. Floor and Base-Mounted Equipment, Vibration Isolated Equipment and associated Vibration and Seismic Controls for Connections:
    1. Install equipment anchorage items designed to resist seismic design force in any direction.
    2. Provide flexible connections between equipment and interconnected piping.
    3. Provide isolators and restraints designed for amplified code forces per ASCE 7 and with demonstrated ability to resist required forces including gravity, operational and seismic forces.
    4. Where equipment is not designed to be point loaded, provide base capable of transferring gravity and seismic demands from equipment to isolator base plate anchorage.
    5. Where concrete floor thickness is less than required for expansion anchor installation, install through bolt in lieu of expansion anchor.
D. Suspended Mechanical Equipment:
    1. Provide supports and bracing to resist seismic design force in any direction.
    2. Provide flexible connections between equipment and interconnected piping.
    3. Brace equipment hung from spring mounts using cable or other bracing that will not transmit vibration to the structure.
E. Wall mounted Mechanical Equipment:
    1. Provide support and bracing to resist seismic design force in any direction.
    2. Install backing plates or blocking as required to deliver load to primary wall framing members.

3. Anchoring to gypsum wallboard, plaster or other wall finish that has not been engineered to resist imposed loads is not permitted.

F. Piping:

1. Provide seismic bracing in accordance with ASC 7.
2. Provide supports, braces, and anchors to resist gravity and seismic design forces.
3. Provide flexible connections between floor mounted equipment and suspended piping; between unbraced piping and restrained suspended items; as required for thermal movement; at building separations and seismic joints; and wherever relative differential movements could damage pipe in an earthquake.
4. Brace resiliently supported pipe with cable bracing or alternate means designed to prevent transmission of vibrations and noise to the structure.
5. Piping Explicitly Exempt from Seismic Bracing Requirements:
   a. Provide flexible connections between piping and connected equipment, including in-line devices such as VAV boxes and reheat coils.
   b. Install piping consistent with ASCE 7, such that swinging of the pipes will not cause damaging impact with adjacent components, finishes, or structural framing while maintaining clear horizontal distance of 67 percent of the hanger length between subject components.
   c. Provide swing restraints as required to control potential impact due to limited space between subject components.

G. Ductwork:

1. Provide seismic bracing for ducts with cross sectional area greater than 6 sq ft (independent of duct contents).
2. Provide supports, braces, and anchors to resist gravity and seismic design forces.
3. Install ducts and duct risers designed to accommodate interstory drift.
4. Independently support in-line devices weighing more than 20 pounds.
5. Independently support and brace all in-line devices weighing more than 75 pounds.
6. Provide unbraced piping attached to braced in-line equipment with adequate flexibility to accommodate differential displacements.
7. Positively attach dampers, louvers, diffusers and similar appurtenances to ductwork with mechanical fasteners.
8. Install duct supports designed to resist not less than 150 percent of the duct weight.
9. The use of power driven fasteners is prohibited in the hanging of ducts weighing over 10 pounds per lineal foot for seismic design categories D, E, and F.

H. Tanks:

1. Install tank anchorage, tank legs and/or supporting structure designed to resist design force.
2. Provide flexible connections between tank and interconnected piping.

I. Install cables so they do not bend across edges of adjacent equipment or building structure.

J. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction providing required submittals for component.

K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engauged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.03 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 15 Section "Hydronic Piping" for piping flexible connections.

3.04 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections. B. Test and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC AND PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.02 RELATED REQUIREMENTS
- A. Section 099000 - Painting and Coating: Identification painting.

1.03 REFERENCE STANDARDS
- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2001 (Reapproved 2007).

1.04 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation. F. Project Record Documents: Record actual locations of tagged valves.
- G. Valve numbering scheme.
- H. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
- A. Air Handling Units (Heat Pumps): Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Nameplates.
- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Pipe markers.
- K. Pumps: Nameplates.
- L. Relays: Tags.
- M. Small-sized Equipment: Tags.
- N. Tanks: Nameplates.
- O. Thermostats: Nameplates.

P. Valves: Tags and ceiling tacks where located above lay-in ceiling.
Q. Water Treatment Devices: Nameplates.

2.02 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
   1. Terminology: Match schedules as closely as possible.
   2. Data:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
   3. Size: 2-1/2 by 4 inches (64 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Data: Instructions for operation of equipment and for safety procedures.
   2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
   3. Thickness: 1/8 inch (3.2 mm), unless otherwise indicated.
   4. Retain and edit subparagraph above or first subparagraph below.
   5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch- (1.6-mm-) thick, engraved laminated plastic with white letters on a red background, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch (3.2-mm) center hole for attachment. Letters shall be no less than ¾ inches in height.
   1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.03 PIPING IDENTIFICATION DEVICES

A. Do not use pipe markers or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.

B. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
   1. Colors: Comply with ASME A13.1, unless otherwise indicated.
   2. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
   3. Arrows: Separate unit on each pipe marker to indicate direction of flow.

C. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

2.04 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.05 VALVE TAGS

A. Valve Tags: Stamped or engraved with 3/4-inch letters for piping system abbreviation and 1-inch (13-mm) numbers, with numbering scheme approved by owner. Provide 5/32-inch (4-mm) hole for fastener.
   1. Retain one of first three subparagraphs below.
   2. Material: 0.032-inch- (0.8-mm-) thick brass.
   3. Valve-Tag Fasteners: Brass S-hook.

2.06 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
   2. Frame: Extruded aluminum.
   3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.07 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches (100 by 178 mm).
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
   4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.03 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Pumps, condensers, and similar motor-driven units.
   2. Heat exchangers, coils, evaporators, heat (energy) recovery units, and similar equipment.
   3. Fans, blowers, primary balancing dampers, and mixing boxes.
   4. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. Letter Size: Minimum 3/4 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Main control and operating valves, including safety devices.
      b. Fire department hose valves and hose stations.
      c. Meters, gauges, thermometers, and similar units.
      d. Pumps, condensers, and similar motor-driven units.
      e. Heat exchangers, coils, evaporators, heat (energy) recovery units, and similar equipment.
      f. Fans, blowers, primary balancing dampers, and mixing boxes. g. Packaged HVAC central-station and zone-type units.
      h. Tanks and pressure vessels.
      i. Strainers, filters, water-treatment systems, and similar equipment.

C. Delete paragraph below if stenciled markers are prohibited.

D. Install access panel markers with screws on equipment access panels.

E. Equipment located above ceiling system shall be clearly marked on the ceiling tile or access panel directly below the mechanical equipment.

3.04 PIPING IDENTIFICATION

A. Do not use pipe markers and tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.

B. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes without insulation: Pretensioned pipe markers. Use size to ensure a tight fit. C. Retain subparagraph above or first subparagraph below.

3.05 Retain subparagraph above or below.

A. Delete paragraph and subparagraphs below if stenciled markers are prohibited.

3.06 Edit paragraph and subparagraphs below to suit Project.

A. Locate pipe markers and color bands where piping is exposed in finished spaces; above removable acoustical ceiling systems; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 20 feet along each run and on each side of a wall or deck penetration.
7. On piping above removable acoustical ceilings.

3.07 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
2. Green: For return-air supply ducts.
3. Yellow: For exhaust-, outside-, relief-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
5. Letter Size: Minimum 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Delete first paragraph below if stenciled markers are prohibited.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.08 VALVE-TAG INSTALLATION

A. Edit this Article as required to delete an entire piping system from tagging or otherchanges. A schedule is helpful for complex projects. Retain and edit first paragraph below if a schedule is prepared.

B. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
1. Other valve-tag sizes, shapes, colors, and letter colors may be available if required.
2. Valve-Tag Size and Shape:
a. Cold Water: 2 inches (50 mm), round.
b. Hot Water: 2 inches (50 mm), round.
c. Fire Protection: 2 inches (50 mm), round.
d. Sanitary: 2 inches (50 mm), round.
3. Select contrasting valve-tag color and letter color for each service in two subparagraphs and associated subparagraphs below.
4. Valve-Tag Color:
a. Cold Water: Natural.
b. Hot Water: Natural.
c. Fire Protection: Natural.
d. Sanitary: Natural.
5. Letter Color:
a. Cold Water: Black.
b. Hot Water: Black.
c. Fire Protection: White.
d. Sanitary: Black.

3.09 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.10 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.11 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic systems.

C. Measurement of final operating condition of HVAC systems.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.

B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau; 2005, Seventh Edition.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

1. Submit to Owner.
2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Owner and other installers to sufficiently understand the design intent for each system.
4. Include at least the following in the plan:
   a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
   b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
   c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
   d. Final test report forms to be used.
   e. Detailed step-by-step procedures for TAB work for each system and issue, including:
      1) Terminal flow calibration (for each terminal type).
      2) Diffuser proportioning.
      3) Branch/submain proportioning.
      4) Total flow calculations.
      5) Rechecking.

6) Diversity issues.
f. Expected problems and solutions, etc.
g. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
h. Details of how TOTAL flow will be determined; for example:
1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
i. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
j. Confirmation of understanding of the outside air ventilation criteria under all conditions.
k. Method of checking building static and exhaust fan and/or relief damper capacity. l. Time schedule for TAB work to be done in phases (by system, etc.)
m. Time schedule for deferred or seasonal TAB work, if specified.
n. False loading of systems to complete TAB work, if specified.
o. Fan balancing and capacity verifications, including any required room pressure differentials.
p. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
q. Procedures for formal progress reports, including scope and frequency.
r. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least once a week to Construction Manager and /or Owner.
E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
F. Progress Reports.
G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
1. Submit under provisions of Section 014000.
2. Revise TAB plan to reflect actual procedures and submit as part of final report.
3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
6. Units of Measure: Report data in I-P (inch-pound) units only. PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
1. AABC MN-1, AABC National Standards for Total System Balance.

2. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
3. SMACNA HVAC Systems Testing, Adjusting, and Balancing.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction

D. TAB Agency Qualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of three years documented experience.
3. Certified by one of the following:
a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.
b. NEBB, National Environmental Balancing Bureau: www.nebb.org.
c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Owner to facilitate spot checks during testing.

C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.07 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 TEMPERATURE CONTROL VERIFICATION

A. A. Verify that controllers are calibrated and commissioned

B. B. Check transmitter and controller locations and note conditions that would adversely affect control functions

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.

F. G. Confirm interaction of electrically operated switch transducers

G. H. Confirm interaction of interlock and lockout systems

H. K. Note operation of electric actuators using spring return for proper fail-safe operations

3.09 ADDITIONAL TESTS

A. A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions

B. B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions

3.10 SCOPE

A. Test, adjust, and balance the following:

1. Fire Pumps
2. Plumbing Pumps
3. HVAC Pumps
4. Packaged Terminal Air Conditioning Units (Heat Pump System)
5. Fans

6. Air Terminal Units
7. Air Inlets and Outlets

END OF SECTION

SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Duct insulation
- B. Duct Liner.
- C. Insulation jackets.

1.02 RELATED REQUIREMENTS
- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 230553 - Identification for HVAC Piping and Equipment
- C. Section 233100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS
- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- B. ASTM C553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2011.
- C. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 1985 (Reapproved 2007).
- D. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings; 2008.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2012
- F. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2010.
- G. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- H. SMACNA (DCS) - HVAC Duct Construction Standards; Sheet Metal and Air Conditionin Contractors' National Association; 2005.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING
- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

A. Adhesive: As recommended by insulation material manufacturer.
B. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.03 FIELD-APPLIED JACKETS

A. Insulation jackets below are for field applications. Ignore below if jackets are factory applied. ASTM C 921, Type 1, is for use over insulation on ducts operating below ambient temperatures at least part of the time or for where a vapor retarder is required. ASTM C 921, Type II, is for use over insulation on ducts operating above ambient temperatures or for where a vapor retarder is not required.
B. General: ASTM C 921, Type 1, unless otherwise indicated.
C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
    1. Adhesive: As recommended by insulation material manufacturer.
    2. PVC jackets are available in several colors. Colored jackets may be used to replace field painting. PVC Jackets to be White or Gray.
D. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209, and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.
    1. Select finish from subparagraphs below. Verify with manufacturer.
    2. Finish: Smooth finish.
    3. Verify that moisture barrier in subparagraph below is adequate for corrosive atmospheres.
    4. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and kraft paper.
E. Stainless-Steel Jacket: Deep corrugated sheets of stainless steel complying with ASTM A 666, Type 304 or 316; 0.10 inch thick; and roll stock ready for shop or field cutting and forming to indicated sizes.
    1. Select from two moisture barriers below. Features are from Pabco jackets. The first moisture barrier is standard and is for corrosive atmospheres; the second moisture barrier is optional and produces lower flame-spread and smoke-developed ratings.
    2. Moisture Barrier: 3-mi thick, heat-bonded polyethylene and kraft paper.
    3. Jacket Bands: Stainless steel, Type 304, 3/4 inch wide.
F. Fiberglass Jacket: ASTM C1258 - 08, UL-214 and UL-723; 0.035” thick, 18 oz./sq. yard; flame spread rating 0; smoke spread rating 0.

2.04 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.
    1. Tape Width: 4 inches.
B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Aluminum: 0.007 inch thick.
3. Brass: 0.010 inch thick.
4. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

D. Select from three paragraphs below.

E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

2.05 ADHESIVES

A. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 VAPOR RETARDERS

A. Products with a perm rating of 1.0 are considered vapor retarders. Ambient conditions and operating temperatures must be considered when selecting a vapor retarder.

B. Mastics: Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.07 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.08 SEALANTS

A. Joint Sealants

1. Joint Sealants for Polystyrene Products: For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants

1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants

1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.09 DUCT LINER

A. Flexible Elastomeric Duct Liner: Comply with NFPA 90A or NFPA 90B.

1. Manufacturers:
   a. Armacell
   b. KFlex USA
2. Materials: Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
   a. Thickness: 3/8 inch (9 mm) or 1/2 inch (13 mm
   b. Thermal Conductivity (k-Value): 0.25 at 75 deg F mean temperature. C Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
   d. Liner Adhesive: As recommended by insulation manufacturer and complying wit NFPA 90A or NFPA 90B.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Apply multiple layers of insulation with longitudinal and end seams staggered.
E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
F. Keep insulation materials dry during application and finishing.
G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
H. Apply insulation with the least number of joints practical.
I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
L. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.

2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

Q. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.03 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to ducts and plenums as follows:
1. Follow the manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the duct and plenum surface.

3.04 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.05 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.06 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

C. Insulate the following plenums and duct systems:
1. Indoor concealed supply, and outside-air ductwork.
2. Indoor exposed supply, and outside-air ductwork.
3. Indoor exposed range-hood exhaust ductwork.

4. Indoor concealed range-hood exhaust ductwork.
5. ERV exhaust ductwork.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Fibrous-glass ducts.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
4. Flexible connectors.
5. Vibration-control devices.
6. Testing agency labels and stamps.
7. Nameplates and data plates.
8. Insulated access panels and doors in air-distribution systems.

END OF SECTION

SECTION 23 07 16
HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Equipment insulation.
- B. Covering.

1.02 RELATED REQUIREMENTS
- A. Section 230553 - Identification for HVAC Piping and Equipment.
- B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 232114 - Hydronic Specialties.
- D. Section 232300 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS
- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2010.
- C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2011.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2012.
- E. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.05 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS
- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 MANUFACTURERS

A. Retain above for nonproprietary or below for semiproprietary Specification. Refer to Division 1 Section "Materials and Equipment."
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. See Editing Instruction No. 1 in the Evaluations for cautions about naming products and manufacturers.
2. Flexible Elastomeric Thermal Insulation:
a. Armstrong World Industries, Inc.
b. Rubatex Corp.

2.03 INSULATION MATERIALS
A. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.04 FIELD-APPLIED JACKETS
A. Insulation jackets below are for field applications. Ignore below if jackets are factory applied. ASTM C 921, Type 1, is for use over insulation on pipes operating below ambient temperatures at least part of the time or for where a vapor retarder is required. ASTM C 921Type II, is for use over insulation on pipes operating above ambient temperatures or for where a vapor retarder is not required.
B. General: ASTM C 921, Type 1, unless otherwise indicated.
C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
1. PVC jackets are available in several colors. Colored jackets may be used to replace field painting. Ultraviolet rays fade colors in exterior applications. Some colors (black, gray, and white) do not fade as quickly as other colors (red, orange, and green).
D. PVC Jacket Color: White or gray.
E. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from .015” thick, high-impact, ultraviolet-resistant PVC.
1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
F. Aluminum Jacket: Factory cut and rolled to indicated sizes. Comply with ASTM B 209, 3003 alloy, H-14 temper.
G. Stainless-Steel Jacket: ASTM A 666, Type 304 or 316; 0.10 inch thick; and factory cut and rolled to indicated sizes.
H. Fiberglass Jacket: ASTM C1258 - 08, UL-214 and UL-723; 0.035” thick, 18 oz./sq. yard; flame spread rating 0; smoke spread rating 0.

2.05 ACCESSORIES AND ATTACHMENTS
A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
1. Tape Width: 4 inches.
B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.

4. Brass: 0.010 inch thick.
5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.06 ADHESIVES

A. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I. 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. PVC Jacket Adhesive: Compatible with PVC jacket.
1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.07 VAPOR RETARDERS

A. Products with a perm rating of 1.0 are considered vapor retarders. Ambient conditions and operating temperatures must be considered when selecting a vapor retarder.

B. Mastics: Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.08 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.09 SEALANTS

A. Joint Sealants
1. Joint Sealants for Polystyrene Products: For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants
1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants
1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.10 REMOVEABLE COVERS

A. Products with a perm rating of 1.0 are considered vapor retarders. Ambient conditions and operating temperatures must be considered when selecting a vapor retarder.

B. Provide preformed, rigid foam, self locking and re-sealable insulation fitting covers at all balance valve locations.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

3.02 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.04 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each equipment system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either the wet or dry state.

D. Apply multiple layers of insulation with longitudinal and end seams staggered.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges and fittings.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on equipment scheduled to receive vapor retarders. Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.

O. Insulate the following indoor equipment:

1. Domestic hot-water tanks, not factory insulated.
2. Heating hot-water air separators.
3. Pump casings and fittings.

P. Omit insulation from the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.05 INDOOR TANK AND VESSEL INSULATION APPLICATION

A. Flexible Elastomeric Thermal Insulation Applications for Tanks and Vessels: Apply insulation over entire surface of tanks and vessels according to the manufacturer's written instructions.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.06 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket where indicated, directly over bare insulation or insulation with factory-applied jackets.
1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.
1. Draw jacket material smooth and tight.
2. Apply lap or joint strips with the same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Aluminum Jackets: Secure jackets according to jacket manufacturer's written instructions.

D. Stainless-Steel Jackets: Secure jackets according to jacket manufacturer's written instructions.

3.07 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation
B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 078400 - Firestopping.
C. Section 099000 - Painting and Coating: Painting insulation jacket.
D. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.
E. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
F. Section 232300 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2010.
D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellula Thermal Insulation in Sheet and Tubular Form; 2011.
F. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 2010.
G. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2007.
H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2012.
I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexible Elastomeric Thermal Insulation:

a. Armstrong World Industries, Inc.

b. Rubatex Corp.

2.03 INSULATION MATERIALS

A. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I.

1. Adhesive: As recommended by insulation material manufacturer.

2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.04 FIELD-APPLIED JACKETS

A. Insulation jackets below are for field applications. Ignore below if jackets are factory applied. ASTM C 921, Type 1, is for use over insulation on ducts operating below ambient temperatures at least part of the time or for where a vapor retarder is required. ASTM C 921, Type II, is for use over insulation on ducts operating above ambient temperatures or for where a vapor retarder is not required.

B. General: ASTM C 921, Type 1, unless otherwise indicated.

C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.

2. PVC jackets are available in several colors. Colored jackets may be used to replace field painting. Color to be white or gray.

D. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209, and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.

1. Select finish from subparagraphs below. Verify with manufacturer.

2. Finish: Smooth finish.

3. Verify that moisture barrier in subparagraph below is adequate for corrosive atmospheres.

4. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and kraft paper.

E. Stainless-Steel Jacket: Deep corrugated sheets of stainless steel complying with ASTM A 666, Type 304 or 316; 0.10 inch thick; and roll stock ready for shop or field cutting and forming to indicated sizes.

1. Select from two moisture barriers below. Features are from Pabco jackets. The first moisture barrier is standard and is for corrosive atmospheres; the second moisture barrier is optional and produces lower flame-spread and smoke-developed ratings.

2. Moisture Barrier: 3-mi thick, heat-bonded polyethylene and kraft paper.

3. Jacket Bands: Stainless steel, Type 304, 3/4 inch wide.

F. Fiberglass Jacket: ASTM C1258 - 08, UL-214 and UL-723; 0.035" thick, 18 oz./sq. yard; flame spread rating 0; smoke spread rating 0.

2.05 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.
   1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
   1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
   2. Aluminum: 0.007 inch thick.
   3. Brass: 0.010 inch thick.
   4. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

D. Select from three paragraphs below.

E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

F. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

2.06 ADHESIVES

A. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.07 VAPOR RETARDERS

A. Products with a perm rating of 1.0 are considered vapor retarders. Ambient conditions and operating temperatures must be considered when selecting a vapor retarder.

B. Mastics: Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.08 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.09 SEALANTS

A. Joint Sealants
   1. Joint Sealants for Polystyrene Products: For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. FSK and Metal Jacket Flashing Sealants
   1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants
   1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 EXECUTION

3.01 EXAMINATION
- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PREPARATION
- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.03 GENERAL APPLICATION REQUIREMENTS
- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
  1. Apply insulation continuously through hangers and around anchor attachments.
  2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:
1. Pull jacket tight and smooth.
2. Circumferential Joints: Cover with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with vapor-retarder mastic.

P. Select one of two paragraphs below.

Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic

R. Coordinate requirements in two paragraphs below with Division 7 Section "Joint Sealants." S. Interior Wall and Partition Penetrations: Apply insulation continuously through walls anD floors.

T. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."

U. Floor Penetrations: Apply insulation continuously through floor assembly.
1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.04 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.
1. Draw jacket material smooth and tight.
2. Apply lap or joint strips with the same material as jacket.

3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

D. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.05 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect or Owner. Vary first and second coats to allow visual inspection of the completed Work.

3.06 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Below-grade piping, (to be pre-insulated piping, see Hydronic Piping).
5. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.07 FIELD QUALITY CONTROL

A. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

B. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.08 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping.
B. Refrigerant.
C. Moisture and liquid indicators.
D. Valves.
E. Strainers.
F. Filter-driers.

1.02 RELATED REQUIREMENTS

A. Section 083100 - Access Doors and Panels.
B. Section 099000 - Painting and Coating.
C. Section 220719 - Plumbing Piping Insulation.
D. Section 220716 - Plumbing Equipment Insulation.
E. Section 230716 - HVAC Equipment Insulation.
F. Section 230719 - HVAC Piping Insulation.
G. Section 23 6320 - Packaged Air-Cooled Heat Pump Unit
H. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 710 - Performance Rating of Liquid-Line Driers; Air-Conditioning, Heating, and Refrigeration Institute; 2009.
B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE Std 15).
C. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.
D. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2010.
E. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2010.
F. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2010).
G. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes; The American Society of Mechanical Engineers; 2011.
H. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2010.
I. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2011 (ANSI/ASME B31.9).
J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2008.
K. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
L. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.
N. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturer Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
O. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
C. Liquid Indicators:
D. Filter-Driers:
1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic e xpansion valves, solenoid valves, and moisture indicators.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general assembly of specialties, including manufacturer's catalogue information. Provide manufacturers catalog data including load capacity.
C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes by Manufacturer.
D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
E. Test Reports: Indicate results of leak test, acid test.
F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
G. Submit welders certification of compliance with ASME (BPV IX).
H. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
I. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.
B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
C. Welders Certification: In accordance with ASME (BPV IX).
D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.
B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 PIPING

A. Copper Tube: ASTM B 280, 1/2H hard drawn Type O annealed copper pipe.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.

B. Pipe Supports and Anchors:
   1. Conform to ASME B31.5.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
   3. Vertical Support: Steel riser clamp.
   4. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   5. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   6. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.02 REFRIGERANT

A. Refrigerant: R410A as defined in ASHRAE Std 34.

2.03 VALVES

A. Diaphragm Packless Valves:
   1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

B. Packed Angle Valves:
   1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

C. Ball Valves:
   1. Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

D. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.04 STRAINERS

A. Straight Line or Angle Line Type:
   1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.05 CHECK VALVES

A. Globe Type:

1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, Teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.

B. Straight Through Type:
1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.06 FILTER-DRIERS
A. Performance:
1. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
2. Design Working Pressure: 350 psi, minimum.
B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
C. Construction: UL listed.
1. Connections: As specified for applicable pipe type.

PART 3 EXECUTION
3.01 PREPARATION
A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.
3.02 INSTALLATION
A. Install refrigeration specialties in accordance with manufacturer's instructions.
B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient. Piping sizing and routing per manufacturer's requirements.
C. Install piping to conserve building space and avoid interference with use of space.
D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
F. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.5.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Provide copper plated hangers and supports for copper piping.
G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 083100.
J. Flood piping system with nitrogen when brazing.
K. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
L. Insulate piping and equipment; refer to Section and Section 230716.
M. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
N. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
O. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
P. Fully charge completed system with refrigerant after testing.
Q. Provide electrical connection to solenoid valves. Refer to Section 262717.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.
B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.
B. Casing and plenums.
C. Kitchen hood ductwork.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 099000 - Painting and Coating: Weld priming, weather resistant, paint or coating.
C. Section 230713 - Duct Insulation: External insulation and duct liner.
D. Section 233300 - Air Duct Accessories.
E. Section 233700 - Air Outlets and Inlets.
F. Section 230593 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE STANDARDS

A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2009.
B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2008.
C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.
E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2012.
F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.
G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2012. H. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2012.
I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
J. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.
K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.
L. SMACNA (DCS) - HVAC Duct Construction Standards; 2005
M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for duct materials
C. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot (1:48) scale. Show fabrication and installation details for metal ducts.
    1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
    2. Duct layout indicating sizes and pressure classes.
    3. Elevations of top and bottom of ducts.
    4. Fittings.

5. Reinforcement and spacing.
6. Seam and joint construction.
7. Penetrations through fire-rated and other partitions.
8. Equipment installation based on equipment being used on Project.
9. Duct accessories, including access doors and panels.
10. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

C. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

D. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

1.06 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A standards.

1.07 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

A. All Ducts: Galvanized steel, unless otherwise indicated.

B. Ventilation Air Supply: 4 inch w.g. pressure class, galvanized steel.

C. Ventilation Air Return: 4 inch w.g. pressure class, galvanized steel.

D. Ventilation Air Exhaust: 4 inch w.g. pressure class, galvanized steel.

E. Ventilation Air Outdoor Air: 4 inch w.g. pressure class, galvanized steel.

F. Terminal Unit Supply: 4 inch w.g. pressure class, galvanized steel.

G. Terminal Unit Return: 4 inch w.g. pressure class, galvanized steel.

H. Kitchen Exhaust: 4 inch w.g. pressure class, galvanized steel.

I. Outside Air Intake: 4 inch w.g. pressure class, galvanized steel.

2.02 SHEET METAL MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating; ; ducts shall have mill-phosphatized finish for surfaces exposed to view.

B. A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet

metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. B. Sheet Metal shall have a certificate indicating that 50% min. of material is recycled.

D. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

E. See Evaluations for discussion on attachment of galvanized-steel hangers, specified in first paragraph below, to aluminum ducts.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.03 DUCT JOINING AND HANGING MATERIALS

A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
2. VOC Content: Not more than 250 g/L, excluding water.
3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
4. For Use With Flexible Ducts: UL labeled.

B. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

C. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
6. Other Types: As required.

2.04 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE Handbook - Fundamentals.

C. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

D. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.

G. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.05 MANUFACTURED DUCTWORK AND FITTINGS

A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
   1. Manufacture in accordance with SMACNA HVAC Duct Construction Standards.
   2. Insulation:
      a. Thickness: 1 inch.
      b. Material: Cotton Denim.

2.06 CASINGS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards and construct for operating pressures indicated.
B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gauge galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.
B. Install in accordance with manufacturer's instructions.
C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
D. Flexible Ducts: Connect to metal ducts with adhesive
E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
H. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
I. Use double nuts and lock washers on threaded rod supports.
J. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
K. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

3.02 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
   1. Instruction in subparagraph below exceeds requirements in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," which does not require sealing of ducts in pressure classes lower than 2-inch wg (500 Pa). If sealing ducts is required, revise below.
   2. For pressure classes lower than 5-inch wg (500 Pa), seal transverse joints.
B. Seal ducts before external insulation is applied.

3.03 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
B. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.
C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
D. Retain two paragraphs and associated subparagraph below for installations in concrete structures.
E. Install concrete inserts before placing concrete.
F. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
    1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

3.04 CONNECTIONS

A. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified. If Drawings are explicit enough, these requirements may be reduced or omitted.
B. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."
C. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.05 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
    1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
    2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
    3. Edit limits of tests to be performed and total leakage acceptable.
    4. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
        a. Allowable Leakage, Supply Duct Systems: 1 percent of design airflow.
        b. Allowable Leakage, Return Duct Systems: 2 percent of design airflow.
        c. Allowable Leakage, Exhaust Supply Duct Systems: 2 percent of design airflow.
        d. Allowable Leakage, Supply Duct Systems, Terminals to Air Outlets: 2 percent of design airflow.
    5. Retain subparagraph and associated subparagraphs above or first subparagraph below.
    6. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (500 Pa) (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg (500 to 2500 Pa).
    7. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.07 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
B. Use service openings, as required, for physical and mechanical entry and for inspection.
   1. Create other openings to comply with duct standards.
   2. Disconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling sections to gain access during the cleaning process.
C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
D. Clean the following metal duct systems by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Energy Recovery Unit internal surfaces and components including coil section, air wash systems, energy recovery wheel, condensate drain pans, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
E. Mechanical Cleaning Methodology:
   1. Seal Air Duct at Fabrication Shop for Delivery and Storage. Seal Open ends after installation. No Debris shall enter duct.
F. Retain first paragraph and subparagraphs below if required for Project.
G. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

3.08 SPIRAL DUCT APPLICATION:
A. Spiral Double Walled ducts are to be installed as supply branches in Kitchen/Living room.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Duct access doors.
- D. Duct test holes.
- E. Flexible duct connections.
- F. Volume control dampers.

1.02 RELATED REQUIREMENTS
- A. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Section 233100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS
- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- B. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.

1.04 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- E. Project Record Drawings: Record actual locations of access doors and test holes.

1.05 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS
- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL
- A. Manufacturers:
  1. Nailor Industries Inc; Model ___: www.nailor.com.
  2. Ruskin Company; Model _____: www.ruskin.com.
  3. Or Approved Equal.
- B. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

2.03 DUCT ACCESS DOORS
- A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.

1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.

B. Access doors with sheet metal screw fasteners are not acceptable.

2.04 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.05 VOLUME CONTROL DAMPERS

A. Splitter Dampers:
1. Material: Same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .

B. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
1. Fabricate for duct sizes up to 6 x 30 inch.
2. Blade: 24 gauge, minimum.

C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
1. Blade: 18 gauge, minimum.

D. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards. Refer to Section 233100 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

F. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment; see Section 220548.

G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
H. Use splitter dampers only where indicated.
I. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 23 33 19
DUCT SILENCERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Acoustic Louvers.

1.02 RELATED REQUIREMENTS

A. Section 233100 - HVAC Ducts and Casings: Connections to silencers.

B. Section 233300 - Air Duct Accessories: Flexible duct connections.

1.03 REFERENCE STANDARDS

A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.

B. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 1990.

C. ANSI S1.4 - American National Standard Specification for Sound Level Meters; 1983 (R2006) with Amd.S1.4A-1985.

D. ANSI S1.8 - American National Standard Reference Quantities for Acoustical Levels; 1989 (R2006).

E. ANSI S1.13 - American National Standard Measurement of Sound Pressure Levels in Air; 2005.

F. AHRI 575 - Method of Measuring Machinery Sound Within an Equipment Space; Air-Conditioning, Heating, and Refrigeration Institute; 2008.

G. ASHRAE Std 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 1997.

H. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2011.

I. NEBB (STDS) - Procedural Standards for the Measurement and Assessment of Sound and Vibration; National Environmental Balancing Bureau; 2006.

J. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.

1.04 PERFORMANCE REQUIREMENTS

A. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook - HVAC Applications

1. Private Residences Maximum: 25

1.05 SUBMITTALS

A. Product Data: Provide catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance.

B. Shop Drawings: Indicate assembly, materials, thicknesses, dimensional data, pressure losses, acoustical performance, layout, and connection details.

C. Design Data: Provide engineering calculations, referenced to specifications and AMCA 301 standards indicating that maximum room sound levels are not exceeded.

D. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.

E. Manufacturer's Installation Instructions: Indicate installation procedures necessary to maintain integrity of sound isolation.

F. Manufacturer's Field Reports: Indicate installation is complete and in accordance with instructions.

1.06 QUALITY ASSURANC

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Perform Work in accordance with AMCA 300 standards and recommendations of ASHRAE Std 68.

PART 2 PRODUCTS

2.01 ACOUSTIC DAMPER LOUVERS

A. Manufacturers:
1. Greenheck; Model ____: www.greenheck.com.
2. Ruskin; www.ruskin.com
3. Industrial Acoustics ; http://www.industrialacoustics.com
4. Or Approved Equal.

B. Configuration: 4 inch deep louvers with blades on 45 degree slope; sound absorbing fill material, and inner surface of perforated sheet metal, heavy channel frame.

C. Materials:
1. Louver outer casings and splitter blades shall be of 22 gauge galvanized steel.
2. Louvers shall be packed with inert, vermin and moisture proof mineral fiber.

D. Rating:
1. Insertion loss:
a. 2nd Octave: 4 dB.
b. 3rd Octave: 5 dB.
c. 4th Octave: 6 dB.
d. 5th Octave: 9 dB.
e. 6th Octave: 13 dB.
f. 7th Octave: 14 dB.
g. 8th Octave: 13 dB.

2. Static Pressure Drop at 300 fpm Face Velocity: .05 inches wg.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Attach control damper to acoustic louver with ductwork. Refer to Section 233300.

3.02 FIELD QUALITY CONTROL

A. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed.

B. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.

C. Submit complete report of test results including sound curves.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Diffusers
- B. Registers/grilles.
- C. Louvers.

1.02 RELATED REQUIREMENTS
- A. Section 23 41 00 - Air Filters

1.03 REFERENCE STANDARDS
- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2012.
- B. ASHRAE Std 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; 2006.
- C. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.

1.04 SUBMITTALS
- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE
- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70. B.
- B. Test and rate louver performance in accordance with AMCA 500-L.

PART 2 PRODUCTS

2.01 MANUFACTURERS
- A. Carnes Company HVAC: www.carnes.com.
- B. Nailor Industries Inc; www.nailor.com
- C. Metal Industries Inc; http://www.metalindustriesinc.com/metalaire/

2.02 ROUND SIDEWALL DIFFUSERS
- A. Type: Round, 2-way adjustable pattern, stamped or spun, multi-core diffuser, with sectorizing baffles where indicated.
- B. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 WALL SUPPLY REGISTERS/GRILLES
- A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Steel with 20 gauge minimum frames and 22 gauge minimum blades, steel and aluminum with 20 gauge minimum frame, or aluminum extrusions, with factory baked enamel finish.

2.04 WALL EXHAUST AND RETURN REGISTERS/GRILLES
- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.

C. Fabrication: Aluminum extrusions, with factory baked enamel finish.

2.05 LINEAR FLOOR SUPPLY REGISTERS/GRILLES

A. Type: Streamlined blades with 0 degree deflection, 1/8 x 3/4 inch on 1/4 inch centers, assembled on expanded tubes mandrel construction.

B. Frame: 1-1/4 inch heavy margin frame with countersunk screw mounting, and mounting frame.

C. Fabrication: Aluminum extrusions with factory baked enamel finish.

D. Damper: Integral gang-operated opposed blade damper with removable key operator, operable from face.

2.06 LOUVERS

A. Type: 4 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake. Coordinate Louver Depth with wall (or masonry wall).

B. Fabrication: 16 gauge thick galvanized steel welded assembly, with factory prime coat finish.

C. Mounting: Furnish with interior flat flange for installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

END OF SECTION

SECTION 23 41 00
AIR FILTERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes factory fabricated air filter devices and media used to remove particulate matter from air for HVAC applications.

1.03 DEFINITIONS

A. HEPA: High efficiency particulate air.

1.04 SUBMITTALS

A. Product Data: Include dimensions; shipping, installed, and operating weights; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
3. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturers installed and field installed wiring.

C. Maintenance Data: For each type of filter and rack to include in maintenance manuals specified in Division 1.

1.05 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Other manufacturers systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

B. Electronic Air Cleaners and Electrical Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to authorities having jurisdiction.

C. Comply with NFPA 90A and NFPA 90B.

D. ASHRAE Compliance: Comply with provisions of ASHRAE 52.1 and 52.2 for method of testing and rating air filter units.

E. Comply with NFPA 70 for installing electrical components.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete set of filters for each filter bank. If system includes pre-filters, provide one sets of pre-filters.
2. Provide two complete sets of filters for each fan coil unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Air Filters, Electrostatic Air Cleaners, and Filter Holding Systems:
   a. AAF International.
   b. Farr Co.
   c. Flanders Filters, Inc.
2. Filter Gauges:
   a. Airguard Industries, Inc.
   b. Dwyer Instruments Inc.

2.02 FILTER GAUGE REQUIREMENTS

A. Furnish and install an air filter gauge to indicate the pressure drop across each filter section. Each gauge shall be installed in an easily accessible and readable location. Locate the static pressure tips at least 1'-0" upstream and 1'-0" down stream from the filters. The static heads shall be placed in a zone of minimum turbulance. Properly level inclined manometers and calibrate all filter gauges.

B. Provide Magnehelic differential pressure gauges complete with static pressure tips, aluminum tubing and vent valves for filters mounted above the ceiling. Remote mount gauge for filters installed above ceiling system. Coordinate gauge location with FAHC Facilities prior to installation.

2.03 DISPOSABLE PLEATED AIR FILTERS

A. Disposable pleated filter, cotton polyester media with wire back-ing. Filter bonded to heavy paperboard or internal metal frame on front, back and sides. Average filter efficiency of 25-30% as measured by ASHRAE 52-76. Provide permanent holding frame of sizes scheduled on drawings. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Arrestance (ASHRAE 52.1): 90.
2. MERV (ASHRAE 52.2): 7.

2.04 FILTER GAUGES

A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: 4-1/2 inches
2. Range: 0- to 3.0-inch wg.

B. Manometer-Type Filter Gauge: Molded plastic with epoxy-coated aluminum scale, logarithmic-curve tube gauge with integral leveling gauge, graduated to read from 0- to 3.0-inch wg, and accurate within 3 percent of full scale range.

C. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install filter frames according to manufacturer's written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Install filter gauge for each filter bank.

E. Install filter gauge static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

F. Coordinate filter installations with duct and air-handling unit installations. G. Electrical wiring and connections are specified in Division 26 Sections.

H. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.02 APPLICATIONS

A. Install MERV 7 filter to be installed in Heat Pump (HP-1) return in factory installed filter "rack".

B. ERV to be supplied with washable aluminum pre-filter and 95% efficient MERV 1 replaceable filter.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engauge a factory-authorized service representative to inspect field-assembled components, filter and filter-frame installation, and electrical wiring. Report results in writing.

3.04 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 23 72 27
AIR TO AIR HEAT RECOVERY UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 RELATED REQUIREMENTS

A. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
B. Section 230513 - Common Motor Requirements for HVAC Equipment.
C. Section 233416 - Centrifugal HVAC Fans: Supply Fans and Exhaust Fans.
D. Section 23 41 00 - Air Filters
E. Section 23 82 16 - Air Coils
F. Section 23 62 13 - Packaged Air-Cooled Refrigerant Compressor and Condenser Units
G. Section 25 00 00 - HVAC Instrumentation and Controls.
H. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 SUMMARY

A. This Section includes Packaged Air to Air Heat Recovery Units.

1.04 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
D. ASHRAE Std 23 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2005.
E. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2007, Including All Addenda (ANSI/ASHRAE/
F. ASHRAE Std 90.2 - Energy Efficient Design of New Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2007.
G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.
H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2009.
J. UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
D. Commissioning Reports: Indicate results of startup and testing commissioning requirements.
E. Maintenance Data: Maintenance manuals specified in Division 1.
F. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
1. The air handling unit(s) shall be certified in accordance with UL Standard 1995 and CSA-C22.2 No. 236
2. The air handling unit(s) shall be safety certified by an accredited testing laboratory and the nameplate shall carry the label of the certification agency.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver air handling units as factory-assembled (ship unassembled) as recommended by the manufacturer.
B. Coordinate delivery of units in sufficient time to allow movement into building.
C. Handle air handling units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.08 COORDINATION

A. Coordinate installation of air handling units including, but not limited to, structural support of unit, piping size and connection location, and electrical power and control wiring.

1.09 REGULATORY REQUIREMENTS

A. Conform to NFPA 70.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.10 WARRANTY

A. General Warranty
B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to strict compliance with the requirements of this specification, provide products by one of the following:
1. Energy Recovery Units:
a. Ultimate Air.
b. Or Equal

2.02 AIR HANDLING UNITS

A. Description: Factory assembled (shipped unassembled) air handling units designed to the performance scheduled and including components as shown on the drawings.

B. Construction:
   1. Unit specific color-coded wiring diagrams shall match the unit color-coded wiring and will be provided in both point-to-point and ladder form.
   2. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.
   3. Access to filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with quarter turn latches or removable access panel.
   4. Hinged access doors shall have stainless steel hinges with removable pin and full perimeter gasketing and open against air pressure.
   5. Unit shall have decals and tags to indicate service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.

C. Fan Module:
   1. Fan motors shall be premium efficiency – Motors for use with integral speed controller.
   2. Variable speed drive shall be factory mounted and wired to the fan motor.
   3. Unit shall be provided with a factory installed and wired internal disconnect.
   4. Unit shall be provided with a factory installed and field wired 115 volt, 15 amp ground fault service receptacle.

D. Control Module:
   1. The control panel module size shall be required as necessary or optionally selected, and shall be selected to provide adequate space for power and control options.
      a. Unit shall be provided with a factory installed and wired speed controller.
      b. Control module shall accept inputs from CO2 and Bathroom timer for airflow Boost Function.
      c. Unit shall be provided with a factory installed and field wired 115 volt, 15 amp ground fault service receptacle.

E. Energy Recovery Module:
   1. The heat recovery module shall be factory mounted and tested heat recovery flat-plate heat exchanger. The heat recovery module shall be mounted in a rigid frame.
   2. The heat recovery cassette shall be rated in accordance with ARI Standard 1060 and shall bear the ARI certification symbol.
   3. Heat Exchanger: 95% efficient media.
   4. Heat recovery wheel cassette shall carry a 5 year non-prorated warranty.

F. Filter Modules:
   1. The filter module(s) shall be provided and shall include filters as specified. The filter rack shall be constructed of galvanized steel and shall be an integral part of the module.
   2. Filter options:
      a. Outdoor Air Stream (upstream of Heat Recovery Core): washable aluminum pre-filters with 95% (MERV 12) final filters.
      b. Clogged filter indicator.

G. Controls:
   1. Factory installed field controller. See Controls drawing and Mechanical Schedule for options.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete pad is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available within maximum length of power supply cord.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Ceiling mounts per manufacturer's recommendations.

3.03 SYSTEM STARTUP

A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

A. Demonstrate operation to Owner's maintenance personnel.

3.05 MAINTENANCE

A. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.

END OF SECTION

SECTION 23 81 27
SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Air-source heat pumps.
- B. Air cooled condensing units.
- C. Indoor air handler (fan & coil) units for duct connection.
- D. Controls.

1.02 RELATED REQUIREMENTS
- A. Section 233100 - HVAC Ducts and Casings.
- B. Section 232300 - Refrigerant Piping.
- C. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS
- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
- D. AHRI 610 - Performance Rating of Central System Humidifiers for Residential Applications; Air Conditioning, Heating, and Refrigeration Institute; 2004.
- E. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE Std 15).
- F. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.
- G. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010, Including All Addenda (ANSI/AHSRAE/
- H. ASHRAE Std 90.2 - Energy-Efficient Design of New Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2007.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- J. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.
- K. UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS
- A. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- B. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- C. Design Data: Indicate refrigerant pipe sizing.
- D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Project Record Documents: Record actual locations of components and connections
F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
G. Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Daikin; www.daikinac.com
B. Mitsubishi Electric; www.mitsubishipro.com

2.02 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator located in the mechanical room.
   2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line. Install and size per manufacturer's recommendations.
B. Performance Requirements: .
   1. Efficiency:
      a. Seasonal Energy Efficiency Ratio: 20, minimum.
      b. Heating COP: 4.0, minimum.
   2. Air Handling:
      a. Air Flow: 600 cfm.
      b. External Static Pressure Resistance: 0.5 inch wg.
   3. Heating Performance Requirements:
      a. Heating Output: 20,000 Btuh.
   4. Cooling Performance Requirements:
      a. Evaporator Cooling Output: 18,000 Btuh.
      b. Air Temperature Entering Evaporator:
         1) Dry Bulb: 80 degrees F.
         2) Wet Bulb: 67 degrees F.
      c. Condenser Cooling Rated Ambient Air Temperature: 95 degrees F.
      d. Condenser Heating Rated Ambient Air Temperature: 47 degrees F.
C. Electrical Characteristics:
   1. 1.47 kW.
   2. 240 volts, single phase, 60 Hz.
   3. 20 amperes maximum fuse size.
   4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 262717.

2.03 INDOOR UNITS FOR DUCTED SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.

1. Air Flow Configuration: Upflow.
2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.
1. Motor: NEMA MG 1; 1750 rpm single speed, permanently lubricated, hinge mounted.
2. Motor Electrical Characteristics:

C. Air Filters: Replaceable type arranged for easy replacement in return air stream. Unit to provide special slot for filter.

D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL listed.
2. Manufacturers: System manufacturer.

2.04 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
1. Refrigerant: R-410A.
2. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL listed.
3. Sound Rating: 69 dBA, when measured in accordance with AHRI 270.

B. Air Cooled Condenser: ARI 520; Aluminum fin and copper tube coil, with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.

D. Operating Controls:
1. Control by factory supplied room thermostat to maintain room temperature setting.

E. Unit to be provided with low ambient kit to allow cold weather operation. Daikin unit requires optional wind baffle.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that proper power supply is available and in correct location.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.

B. Install in accordance with NFPA 90A and NFPA 90B.

C. Install refrigeration systems in accordance with ASHRAE Std 15.

D. Pipe drain from heat pump to lavatory drain. If slope will not allow connection, provide external condensate pump to provide adequate system drainage.

END OF SECTION

SECTION 25 00 00
HVAC INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 262717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.02 SUMMARY
- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.03 REFERENCE STANDARDS
- A. A.NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements

1.04 SYSTEM DESCRIPTION
- A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories.
- B. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- C. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.05 SEQUENCE OF OPERATION
- A. As specified in the drawings

1.06 SUBMITTALS
- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  1. Each control device labeled with setting or adjustable range of control.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  3. Written description of sequence of operation.
  4. Schedule of dampers including size, leakage, and flow characteristics.
  5. Schedule of valves including leakage and flow characteristics.
- C. Samples: For each color required, of each type of thermostat cover.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- F. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.07 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Perform work in accordance with NFPA 70.
C. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.08 DRAWINGS USE AND INTERPRETATION

A. It is not the intention of the drawings to show every item, piece of equipment, and detail related to the project.
B. The drawings are diagrammatical and indicate the general arrangement of systems and equipment, unless indicated otherwise by dimension or Detail Drawings. For exact locations of building elements, refer to dimensioned Architectural/Structural Drawings. However, field measurements take precedence over dimensioned drawings. The installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawing requirements specified in Division 1 – General Requirements, and the General Conditions.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

1.11 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
B. Provide two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

PART 2 PRODUCTS

2.01 SENSORS

A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
    1. Thermistor temperature sensors as follows:
        a. Accuracy: Plus or minus 0.36 deg F at calibration point.
        b. Wire: Twisted, shielded-pair cable.
    2. Resistance Temperature Detectors: Platinum.
        a. Accuracy: Plus or minus 0.2 percent at calibration point.
        b. Wire: Twisted, shielded-pair cable.
        c. Room Sensors: Match room thermostats, locking cover.
        d. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
B. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment, for flush mounting.

2.02 THERMOSTATS

A. Room Thermostats: Electronic, microcomputer-based room thermostat with digital readout.
    1. 10K ohm thermistor w/ 0.36°F standard accuracy and 0.18°F drift over a ten year space.
    2. Concealed communications port for laptop access.
    3. Multiple units can be daisy chained to one controller.

4. LCD display capable of indicating zone temperature, heating set point, cooling set point and outdoor air temperature.
5. Mounting: On wall per manufacturer's recommendations.

B. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

2.03 HUMIDISTATS

A. Room Humidistat (Same unit at Heat Pump room thermostat):
1. Wall mounted, proportioning type.
2. Throttling range: Adjustable 2 percent relative humidity.
3. Operating range: 30 to 80 percent.
4. Maximum temperature: 110 degrees F.
5. Cover: Set point indication.

2.04 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
3. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Damper and Large-Valve Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:
a. Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
6. Power Requirements Two-Position Spring Return: 120-V ac.
7. Temperature Rating: Minus 22 to plus 122 deg F.
8. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
9. Run Time: 12 seconds open, 5 seconds closed.

2.05 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Globe Valves NPS 2 and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

C. Globe Valves NPS 2-1/2 and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

D. Hydronic system globe valves shall have the following characteristics:
   1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
   2. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
   3. Sizing: 3-psig maximum pressure drop at design flow rate.
   4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

E. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable Buna N sleeve and stem seals.
   1. Body Style: Wafer.
   2. Disc Type: 316 Stainless Steel.
   3. Sizing: 1-psig maximum pressure drop at design flow rate.

F. Terminal Unit Control Valves: Bronze body, bronze trim, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends.
   1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
   2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
   3. Flow Characteristics: Two-way valves shall have equal percentage characteristics;t hree-way valves shall have linear characteristics.

2.06 DAMPERS

A. Dampers: AMCA-rated, opposed blade design; 0.1084-inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635-inch galvanized steel with maximum blade width of 8 inches.
   1. Blades shall be secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   2. Operating Temperature Range: From minus 40 to plus 200 deg F.
   3. For standard applications, include optional closed-cell neoprene edging.
   4. For low-leakage applications, use opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. lbf; when tested according to AMCA 500D.

PART 3 EXECUTION

3.01 ARANGEMENT OF WORK

A. Install work as closely as possible to layouts shown on contract drawings. Modify work as necessary to provide maximum possible headroom and space clearance on each side. Provide adequate clearance and ready access to all parts of the work, for inspection operation, safe maintenance and repair, and code conformance. Coordinate and arrange work to avoid conflicts with other trades and as needed for

satisfactory space conditions shown on coordination drawing submittals. Where space appears to be inadequate consult Design Professional before proceeding with installation.

3.02 COORDINATION

A. Examine Contract Documents and coordinate with contractor and other trades as necessary to facilitate the progress of work.

B. Furnish services of experienced electrical superintendent who shall be constantly in charge of electrical work, together with skilled laborers required to unload, transfere, erect, connect, adjust, start, operate, and test each system.

C. Do not install a system until critical components of systems and related systems have been coordinated and applicable shop drawings have been approved.

3.03 PROTECTION

A. The Controls Contractor shall be responsible for work and equipment until fully inspected, tested and accepted. Carefully store materials and equipment, which is not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material or damaging water.

3.04 LUBRICATION

A. Equipment shall be furnished and installed so that lubrication points are conveniently and readily accessible for maintenance. Make these provisions by whatever means is appropriate: extended fittings, access doors, equipment location, etc. Provide lube sites for grease fittings.

3.05 TESTING AND BALANCING

A. Provide controls systems operations during the mechanical systems adjustment period at the completion of each phase of the project, and during the final testing and balancing procedures. Document all issues encountered during the mechanical systems adjustment period. Submit three copies of issues to Owner's Construction Supervisor.

3.06 INSTALLATION

A. Install equipment level and plumb.

B. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Coordinate location with owner.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

C. Install automatic dampers according to Division 23 Section "Duct Accessories."

D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

E. Install labels and nameplates to identify control components according to Division 23 Section "Mechanical Identification."

F. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

G. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

H. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

3.07 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Controls Contractor is responsible for all controls wiring and conduit.

B. All controls conductors shall be installed in conduit.

1. Minimum conduit size shall be ½" EMT.

C. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."

D. Install building wire and cable according to Division 26 Section "Conductors and Cables."
   1. Install controls conductors in minimum ½" EMT
   2. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

3.08 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Install piping adjacent to machine to allow service and maintenance.

B. Ground equipment.
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.09 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
   4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.
   5. Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.
   6. Calibration test pneumatic and electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

B. Replace damaged or malfunctioning controls and equipment.
   1. Start, test, and adjust control systems.
   2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
   3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.
B. Nonmetallic-sheathed cable.
C. Service entrance cable.
D. Metal-clad cable.
E. Wiring connectors.
F. Electrical tape.
G. Oxide inhibiting compound.
H. Wire pulling lubricant.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.
B. Section 260501 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
C. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
E. Section 263100 - Photovoltaic Collectors: Additional wiring requirements for photovoltaic systems.
F. Section 283100 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2001 (Reapproved 2007).
B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010.
D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2009).
E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2011).
F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2007
G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2008.
I. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); Federal Specification; Revision A, 2008.
J. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

K. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; National Electrical Contractors Association; 2006 (NECA/AA 104).
L. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association; 2006.
M. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); National Electrical Contractors Association; 2007.
N. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).
O. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
P. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
Q. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
R. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
S. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
T. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
U. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
V. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
W. UL 719 - Nonmetallic-Sheathed Cables; Current Edition, Including All Revisions.
X. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

Southwire 100 ft. 12-2 Romex NM-B W/G Yellow Cable

Model # 56753923 Internet # 100684025

★★★★★ (8) | Write a Review

$50.76 / each

This item cannot be shipped to the following state(s): AK,GU,HI,PR,VI

Free Shipping

Select a Store for more info on inventory and pick up options.

Zoom

Product Overview | Specifications | Customer Reviews | Shipping Options

PRODUCT OVERVIEW

This Southwire Romex SIMpull 100 ft. 12-2 NM-B Cable is used for both exposed and concealed work. The cable features 2 annealed copper conductors and is primarily used in residential wiring as branch circuits for outlets, switches and other loads. NM is for indoor use only.

- May be run in air voids of masonry block or tile walls not subject to excessive moisture
- 600 volts maximum
- SlikQuik Infused Membrane Jacket reduces pulling force by up to 50% for easy installation
- UL Listed and CSA Certified
- MFG Model # : 56753923
- MFG Part # : 56753923

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SPECIFICATIONS

Allowable Ampacities	20	Approximate Cable Dimensions (mils)	410 MIL
Assembled Depth (in.)	10 in	Assembled Height (in.)	2.375 in
Assembled Width (in.)	10 in	Cable/Wire Type	NM-B
Certifications and Listings	1-UL Listed	Conductor Gauge	12
Conductor Material	Copper	Direct Burial	No
Electrical Product Type	Indoor Residential Electrical Wire	Flame Retardant	No
Government/Mil Spec Number	na	Indoor/Outdoor	Indoor
Insulation Material	PVC	Insulation Thickness (mils)	19.0
Jacket Material	Nylon	Manufacturer Warranty	na
Number of Conductors	2	Oil and Gas Resistant	No
Outer Color	Yellow	Product Length (ft.)	100 ft
Product Weight per Foot (lb.)	0.0818	Returnable	90-Day
Stranded or Solid	Solid	Sunlight / UV Resistant	No
Voltage (volts)	600 V	Wet Location Use	No

Zoom

Southwire 250 ft. Yellow 12-3 Romex NM-B W/G Wire

Model # 63947655 Internet # 202316276 Store SKU # 268917

★★★★★ (2) | Write a Review

$118.00 / each

This item cannot be shipped to the following state(s): AK,GU,HI,PR,VI

Free Shipping

Buy Online, Pick Up In Store Today
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Product Length (ft.)
250 ft

PRODUCT OVERVIEW

Install the Southwire Romex SIMpull 250 ft. Yellow 12/3 NM-B Cable in masonry block or tile wall spaces where there is not excessive moisture. This non-metallic sheathed cable features an easy-pull nylon jacket. UL listed.

- For use in residential wiring as branch circuits for outlets, switches and other loads
- Rated at 600 volts
- Designed for exposed and concealed applications in normally dry locations at temperatures not to exceed 194 degrees Fahrenheit (with amperage limited to that for 140 degrees Fahrenheit conductors), as specified in the National Electrical Code 1
- Suitable for use in air voids of masonry block or tile walls where excessive moisture or dampness is not present
- 250 ft. long
- Romex SIMpull SlikQuik-infused membrane jacket allows for reduction in pulling force
- Annealed soft copper conductors
- Note: Product may vary by store.
- MFG Model # : 63947655
- MFG Part # : 63947655

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SPECIFICATIONS

Allowable Ampacities	20	Approximate Cable Dimensions (mils)	347.0 MIL
Assembled Depth (in.)	13.50 in	Assembled Height (in.)	3.2 in
Assembled Width (in.)	13.5 in	Cable/Wire Type	NM-B
Certifications and Listings	1-UL Listed	Conductor Gauge	12
Conductor Material	Copper	Direct Burial	No
Electrical Product Type	Indoor Residential Electrical Wire	Flame Retardant	No
Government/Mil Spec Number	NA	Ground Material	Copper
Ground Wire Gauge	12	Indoor/Outdoor	Indoor
Insulation Material	PVC	Insulation Thickness (mils)	19.0
Jacket Material	Nylon	Manufacturer Warranty	NA
Number of Conductor Strands	1.0	Number of Conductors	3
Oil and Gas Resistant	No	Outer Color	Yellow
Packaging	Coil	Product Length (ft.)	250 ft
Product Weight per Foot (lb.)	0.1071	Returnable	90-Day
Stranded or Solid	Solid	Sunlight / UV Resistant	No
Voltage (volts)	600 V	Wet Location Use	No
Wire/Cable Length (ft.)	250		

AL SEU/SER

Type SE, Style R and Type SE, Style U

Service Entrance Cable 600 Volt

AlumaFlex™ Aluminum Alloy (AA-8176) Conductors

Individual Conductors Rated XHHW-2 or TYPE THWN

AlumaFlex™ Aluminum Alloy Neutral

Sunlight Resistant Jacket and Individual Conductors

APPLICATIONS

Suitable for use as follows:

- Southwire Type SE, service entrance cable is used to convey power from the service drop to the meter base and from the meter base to the distribution panelboard; however, it may be used in all applications where Type SE cable is permitted
- SE cable may be used in wet or dry locations at temperatures not to exceed 90°C
- Voltage rating is 600 volts

STANDARDS & REFERENCES

Southwire Type SE cable meets or exceeds UL Standard 44 for Type XHHW-2 conductors or UL Standard 83 for Type THHN/THWN, UL Standard 854, Federal Specification A-A-59544, and requirements of the NEC.

CONSTRUCTION

Southwire Type SE cable is constructed with sunlight resistant Type XHHW-2 conductors or Type THWN conductors. Aluminum conductors are AlumaFlex™ AA-8000 series aluminum alloy, compact stranded. Southwire Type SE, Style R Cable assembly plus reinforcement tape are jacketed with gray sunlight resistant polyvinyl chloride (PVC). Available as 2 conductor (2 insulated phase conductors, bare ground), 3 conductor (2 insulated phase conductors, insulated neutral, bare equipment ground), or 4 conductor (3 insulated phase conductors, insulated neutral, bare equipment ground). Southwire Type SE, Style U Cable assembly plus an overall concentrically applied neutral and reinforcement tape are jacketed with gray sunlight resistant polyvinyl chloride (PVC).

SPECIFICATIONS

- SER Sample Specification: Cable shall be UL-listed Type SE, Style R, suitable for operation at 600 volts or less as specified in the NEC. Conductors shall be AlumaFlex™ aluminum alloy, weather resistant PVC jacketed, as manufactured by Southwire Company or approved equal.
- SEU Sample Specification: Cable shall be UL-listed Type SE, Style U, suitable for operation at 600 volts or less as specified in the NEC. Conductors shall be AlumaFlex™ aluminum alloy, weather resistant PVC jacketed, as manufactured by Southwire Company or approved equal.

Southwire OEM Division

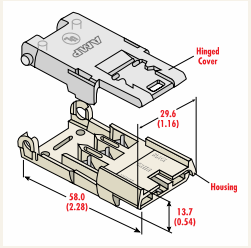
UL LISTED MADE IN USA

WEIGHTS, MEASUREMENTS AND PACKAGING						
CONDUCTOR SIZE/CONST. (AWG or kcmil)	NOMINAL O.D. (mils)	ALLOWABLE AMPACITIES*				APPROX. NET WEIGHT PER 1000 FT. (lbs)
		60°C	75°C	90°C	DWELLING	
SER THREE CONDUCTOR WITH BARE GROUND (FORMERLY REFERRED TO AS "FOUR CONDUCTOR")						
8-8-8-8	612	30	40	45	—	136
6-6-6-6	717	40	50	60	—	196
4-4-4-6	823	55	65	75	—	252
2-2-2-4	956	75	90	100	100	359
1-1-1-3	1079	85	100	115	110	449
1/0-1/0-1/0-2	1168	100	120	135	125	540
2/0-2/0-2/0-1	1264	115	135	150	150	653
3/0-3/0-3/0-1/0	1378	130	155	175	175	793
4/0-4/0-4/0-2/0	1503	150	180	205	200	968
250-250-250-3/0	1576	170	205	230	225	—

NM Splice & Tap

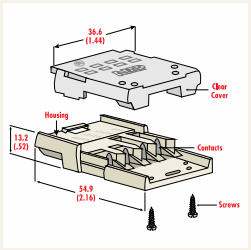
NON-METALLIC CABLE SPLICES AND TAPS

NMS-2 (SPLICE)



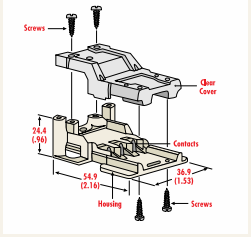
For splicing 12 or 14 awg solid conductor, 2-conductor cable with ground. Hinged cover makes termination fast and easy. The NMS-2 kit includes everything required to make a two conductor splice.

NMS-3 (SPLICE)



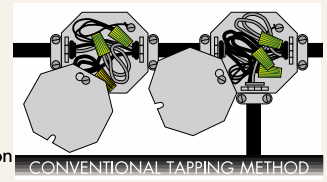
For splicing 12 or 14 awg solid conductor, 3-conductor cable with ground. The NMS-3 kit includes everything required to make a three conductor splice.

NMT-2 (TAP)



For tapping into 12 or 14 awg solid conductor 2-conductor cable with ground. The NMT-2 kit includes everything required to complete a two conductor tap.

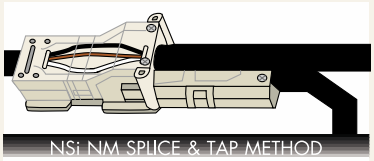
ELIMINATE COSTLY AND TIME-CONSUMING JUNCTION BOXES


CONVENTIONAL TAPPING METHOD

The NSi NM Splice & Tap method provides a fast and reliable way to connect 12 and 14 AWG circuits using non-metallic (NM) cable. It eliminates the need for junction boxes, covers, fittings, connectors – and is approved for use in a variety of applications including: residential branch circuits, manufactured housing and pre-fabricated building structures. When adding new circuits in residential applications, NM connectors eliminate both the need to cut into the existing wiring and the extra junction boxes and associated hardware required for the tap connection.

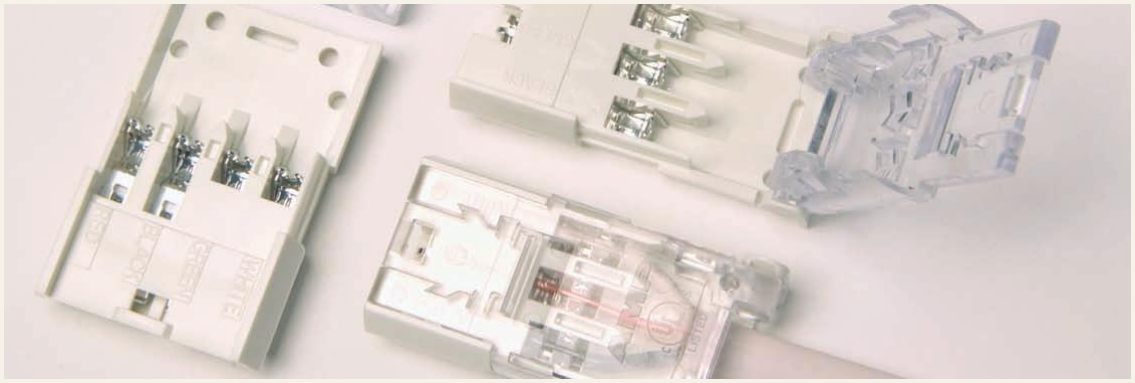
In factory installations within pre-fabricated structures, the NM connectors eliminate costly time-consuming on-site wiring. As individual modules are joined, splices and taps are simply snapped together easily by assembly crews with no special training or tools.

Termination is easy. Split the cable, remove the sheathing and cut the splice conductors to length (if necessary). With the tap, individual conductors do not need to be stripped, only exposed. Clear cover installation is done with slip-joint pliers. The installation displacement contacts eliminate the need to strip individual conductors. Simply plug the connectors together and the installation is complete.


NSi NM SPLICE & TAP METHOD

NON-METALLIC CABLE SPLICES AND TAPS

CATALOG NO.	UPC CODE	WIRE RANGE	KIT DESCRIPTION	CARTON QUANTITY
NMS-2	00320	12 – 14 AWG	splice for 2-conductor cable with ground	25
NMS-3	00321	12 – 14 AWG	splice for 3-conductor cable with ground	25
NMT-2	00322	12 – 14 AWG	splice and tap kit for 2-conductor cable	12



2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is permitted only as follows:

1. Where not otherwise restricted, may be used:

a. For branch circuit wiring in dry locations within one- and two-family dwellings and their attached or detached garages, and their storage buildings.

b. For branch circuit wiring in dry locations within multifamily dwellings permitted to be of Types III, IV, and V construction.

2. In addition to other applicable restrictions, may not be used:

a. Where exposed to view.

b. Where exposed to damage.

c. For damp, wet, or corrosive locations.

D. Service entrance cable is permitted only as follows:

1. Where not otherwise restricted, may be used:

a. For overhead service drop, installed in raceway to service head.

2. In addition to other applicable restrictions, may not be used:

a. Where exposed to damage.

2.02 ALL CONDUCTORS AND CABLES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 260526.

H. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.

I. Conductor Material:

1. Provide copper conductors except where aluminum conductors are specifically indicated. Substitution of aluminum conductors for copper is not permitted. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.

2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.

3. Tinned Copper Conductors: Comply with ASTM B33.

4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

J. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.
    a. Exceptions:
        1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
        2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
2. Control Circuits: 14 AWG.

K. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
    a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
    a. 240/120 V, 1 Phase, 3 Wire System:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Neutral/Grounded: White.
    b. Equipment Ground, All Systems: Green.
    c. Travelers for 3-Way and 4-Way Switching: Pink.
    d. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.
B. Conductor Stranding:
1. Feeders and Branch Circuits:
    a. Size 10 AWG and Smaller: Solid.
    b. Size 8 AWG and Larger: Stranded.
2. Control Circuits: Stranded.
C. Insulation Voltage Rating: 600 V.
D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
    a. Size 4 AWG and Larger: Type XHHW-2.
    b. Installed Underground: Type XHHW-2.
    c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.
2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

2.04 NONMETALLIC-SHEATHED CABLE

A. Description: NFPA 70, Type NM multiple-conductor cable listed and labeled as complying with UL 719, Type NM-B.
B. Conductor Stranding:
1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.
C. Insulation Voltage Rating: 600 V.

2.05 SERVICE ENTRANCE CABLE

A. Service Entrance Cable for Above-Ground Use: NFPA 70, Type SE multiple-conductor cable listed and labeled as complying with UL 854, Style R.

B. Conductor Stranding: Stranded.

C. Insulation Voltage Rating: 600 V.

2.06 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Wiring Connectors for Splices and Taps:

1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
3. Connectors for Aluminum Conductors: Use compression connectors.

C. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Aluminum Conductors: Use compression connectors for all connections.
7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
8. Conductors for Control Circuits: Use crimped terminals for all connections.

D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

G. Mechanical Connectors: Provide bolted type or set-screw type.

H. Compression Connectors: Provide circumferential type or hex type crimp configuration.

I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.07 WIRING ACCESSORIES

A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as shown on the drawings.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated and routing is not shown, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft of location shown.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.
7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.
C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1. D.install aluminum conductors in accordance with NECA 104.
E. Install nonmetallic-sheathed cable (Type NM-B) in accordance with NECA 121.
F. Exposed Cable Installation (only where specifically permitted):
    1. Route cables parallel or perpendicular to building structural members and surfaces.
    2. Protect cables from physical damage.
G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
I. Terminate cables using suitable fittings.
J. Install conductors with a minimum of 2 inches of slack at each outlet.
K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
L. Make wiring connections using specified wiring connectors.
    1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
    2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
    3. Do not remove conductor strands to facilitate insertion into connector.
    4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
    5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
    6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
    7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
M. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
N. Insulate ends of spare conductors using vinyl insulating electrical tape.
O. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
P. Color Code Legend: Provide identification label identifying color code for ungrounded conductors at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.
B. Inspect and test in accordance with NETA STD ATS, except Section 4.
C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.
D. Grounding and bonding components.
E. Provide all components necessary to complete the grounding system(s) consisting of:
1. Existing metal underground water pipe.
2. Metal frame of the building.

1.02 REFERENCE STANDARDS

A. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. For signal reference grids, coordinate the work with access flooring furnished in accordance with Section 096900.
4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.
B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
C. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Metal Underground Water Pipe(s):
      a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
      b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
   3. Metal Building or Structure Frame:
      a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
   4. Concrete-Encased Electrode:
   a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

E. Service-Supplied System Grounding:
   1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
   2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

F. Separately Derived System Grounding:
   1. Separately derived systems include, but are not limited to:
      a. Transformers (except autotransformers such as buck-boost transformers).
      b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
   2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
   3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
   4. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor

connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.

5. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

G. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

H. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.

I. Pole-Mounted Luminaires: Also comply with Section 265600.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 260519:

1. Use insulated copper conductors unless otherwise indicated.
   a. Exceptions:
      1) Use bare copper conductors where installed underground in direct contact with earth.
      2) Use bare copper conductors where directly encased in concrete (not in raceway).
      3) Use 6AWG bare copper in free air on Solar Path

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

2.3 CONNECTORS AND ACCESSORIES

A. Mechanical Connectors: Bronze.
B. Wire: Stranded copper.
C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions prior to beginning work.

3.02 INSTALLATION

A. Provide bonding to meet requirements described in Quality Assurance.
B. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260534 - Conduit: Additional support and attachment requirements for conduits.

C. Section 260537 - Boxes: Additional support and attachment requirements for boxes.

D. Section 263100 - Photovoltaic Collectors: Photovoltaic module mounting systems.

E. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

F. Section 265600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2011.

D. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.

E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2009.

F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2006

G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2010

H. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2009.

I. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

J. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's catalog data for fastening systems.
C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Comply with MFMA-4.
   2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
   3. Channel Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   4. Minimum Channel Thickness: 12 gauge.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch diameter.
      b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
      c. Outlet Boxes: 1/4 inch diameter.
      d. Luminaires: 1/4 inch diameter.

F. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

2.02 MATERIALS

A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

B. Supports: Fabricated of structural steel or formed steel members; galvanized. C.Anchors and Fasteners:
   1. Do not use powder-actuated anchors, spring clips, or beam clamps.
   2. Concrete Structural Elements: Use precast inserts, expansion anchors, powder-actuated anchors, or preset inserts.
   3. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
   4. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
   5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
   6. Solid Masonry Walls: Use expansion anchors or preset inserts.
   7. Sheet Metal: Use sheet metal screws.
   8. Wood Elements: Use wood screws.

D. Fastener Types:
   1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
   2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
   3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
   4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
   5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
   6. Other Types: As required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive support and attachment components.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
C. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
2. Obtain permission from Architect before drilling or cutting structural members.
D. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
E. Install surface-mounted cabinets and panelboards with minimum of four anchors.
F. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
G. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.
B. Inspect support and attachment components for damage and defects.
C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 34
CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flexible metal conduit (FMC).
B. Liquidtight flexible metal conduit (LFMC).
C. Electrical metallic tubing (EMT).
D. Rigid polyvinyl chloride (PVC) conduit.
E. Conduit fittings.
F. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.
B. Section 260526 - Grounding and Bonding for Electrical Systems.
C. Section 260529 - Hangers and Supports for Electrical Systems.
D. Section 260553 - Identification for Electrical Systems.
E. Section 260537 - Boxes.
F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
G. Section 262701 - Electrical Service Entrance: Additional requirements for electrical service conduits.
H. Section 271005 - Structured Cabling for Voice and Data - Inside-Plant: Additional requirements for communications systems conduits.
I. Section 312316 - Excavation.
J. Section 312323 - Fill: Bedding and backfilling.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.
E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.
F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).
G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.
H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.
I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
K. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
L. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions. M. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

N. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
O. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.
B. Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, flexible nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
B. Accept conduit on site. Inspect for damage.
C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
C. Underground:
1. Under Slab on Grade: Use rigid PVC conduit.
2. Exterior, Direct-Buried: Use rigid PVC conduit.

3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.

D. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

E. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

F. Interior, Damp or Wet Locations: Use electrical metallic tubing (EMT).

G. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

H. Exposed, Exterior, Possibility of Physical Damage: Use liquidtight flexible metal conduit (LFMC).

2.02 CONDUIT REQUIREMENTS

A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

C. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 1/2 inch (16 mm) trade size.
2. Control Circuits: 1/2 inch (16 mm) trade size.
3. Underground, Interior: 3/4 inch (21 mm) trade size.
4. Underground, Exterior: 1 inch (27 mm) trade size.

D. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 METAL CONDUIT

A. Wheatland Tube Company; RMC. www.w

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

C. Description: Interlocked steel construction.

D. Fittings: NEMA FB 1.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

C. Description: Interlocked steel construction with PVC jacket.

2.07 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use compression (gland) or set-screw type. a. Do not use indenter type connectors and couplings.
4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

D. Description: NEMA TC 2.

E. Fittings and Conduit Bodies: NEMA TC 3.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

D. Verify routing and termination locations of conduit prior to rough-in.

E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

D. Install electrical nonmetallic tubing (ENT) in accordance with NECA 111.

E. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.

2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
a. Electrical rooms.
b. Mechanical equipment rooms.
c. Within joists in areas with no ceiling.
5. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
6. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
7. Route conduits above water and drain piping where possible.
8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
9. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
10. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
11. Group parallel conduits in the same area together on a common rack.

F. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.

G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

I. Underground Installation:
1. Provide trenching and backfilling in accordance with Sections 312316 and 312323.
2. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 24 inches.
3. Provide underground warning tape in accordance with Section 260553 along entire conduit length for service entrance where not concrete-encased.

J. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

K. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

L. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

M. Provide grounding and bonding in accordance with Section 260526.

N. Identify conduits in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer.

C. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.
B. Install steel conduit as specified in NECA 101.
C. Install nonmetallic conduit in accordance with manufacturer's instructions. D. Arrange supports to prevent misalignment during wiring installation.
E. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
F. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
G. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.
H. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
I. Do not attach conduit to ceiling support wires.
J. Arrange conduit to maintain headroom and present neat appearance.
K. Route exposed conduit parallel and perpendicular to walls.
L. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
M. Route conduit in and under slab from point-to-point.
N. Do not cross conduits in slab.
O. Maintain adequate clearance between conduit and piping.
P. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.
Q. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
R. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.
S. Ground and bond conduit under provisions of Section 260526.
T. Identify conduit under provisions of Section 260553.

3.06 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

END OF SECTION

SECTION 26 05 37
BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.

1.02 RELATED REQUIREMENTS
- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260534 - Conduit:
  - 1. Conduit bodies and other fittings.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 262726 - Wiring Devices: Wall plates in finished areas.

1.03 REFERENCE STANDARDS
- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010) (ANSI/NEMA OS 1).
- E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010) (ANSI/NEMA OS 2).
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
- A. Coordination:
  - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
  - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.

4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use suitable concrete type boxes where flush-mounted in concrete.
4. Use suitable masonry type boxes where flush-mounted in masonry walls.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.

12. Wall Plates: Comply with Section 262726.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
a. Indoor Clean, Dry Locations: Type 1, painted steel.
b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
4. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

2.02 OUTLET BOXES
A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
B. Nonmetallic Outlet Boxes: NEMA OS 2.
C. Wall Plates for Finished Areas: As specified in Section 262726.

2.03 PULL AND JUNCTION BOXES
A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
1. Material: Galvanized cast iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as shown on drawings.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
C. Box Locations:
1. Locate boxes as required for devices installed under other sections or by others.
2. Locate boxes so that wall plates do not span different building finishes.
3. Locate boxes so that wall plates do not cross masonry joints.
4. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
5. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
D. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.

2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

E. Close unused box openings.

F. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

G. Provide grounding and bonding in accordance with Section 260526.

H. Identify boxes in accordance with Section 260553.

I. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.

J. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.

K. Orient boxes to accommodate wiring devices oriented as specified in Section 262726.

L. Maintain headroom and present neat mechanical appearance.

M. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

N. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

O. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

P. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

Q. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

R. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

S. Use flush mounting outlet box in finished areas.

T. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

U. Locate outlet boxes so that wall plates do not span different building finishes.

V. Locate outlet boxes so that wall plates do not cross masonry joints.

W. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation.

1. Provide minimum 24 inches separation in fire rated walls.

X. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

Y. Use stamped steel bridges to fasten flush mounting outlet box between studs.

Z. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

AA. Use adjustable steel channel fasteners for hung ceiling outlet box.

AB. Do not fasten boxes to ceiling support wires.

AC. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

AD. Use gang box where more than one device is mounted together. Do not use sectional box.

AE. Use gang box with plaster ring for single device outlets.

AF. Use cast outlet box in exterior locations exposed to the weather and wet locations.

3.03 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused box openings.

3.04 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

B. Clean exposed surfaces and restore finish.

3.05 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Underground warning tape.
- E. Warning signs and labels.
- F. Field-painted identification of conduit.

1.02 RELATED REQUIREMENTS
- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 263100 - Photovoltaic Collectors: Additional identification requirements for photovoltaic systems.

1.03 REFERENCE STANDARDS
- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2007.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2007.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
- A. Coordination:
  1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
  1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
  2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS
- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.06 QUALITY ASSURANCE
- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS
- A. Identification for Equipment:
  1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
     a. Panelboards:

1) Identify power source and circuit number. Include location when not within sight of equipment.
2) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
3) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
4) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
b. Enclosed switches, circuit breakers, and motor controllers:
1) Identify power source and circuit number. Include location when not within sight of equipment.
c. Time Switches:
d. Enclosed Contactors:
1) Identify load(s) and associated circuits controlled. Include location.
2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.
b. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.
3. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
B. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 271005.
2. Use identification label to identify fire alarm system devices.
C. Buried Electrical Lines: Underground warning tapes.
D. Communication Cabinets: Nameplates.
E. Control Device Station: Labels.
F. Electrical Distribution and Control Equipment Enclosures: Nameplates.
G. Junction Box Load Connections: Wire markers.
H. Outlet Box Load Connections: Wire markers.
I. Panel Gutter Load Connections: Wire markers.
J. Pull Box Load Connections: Wire markers.

2.02 IDENTIFICATION NAMEPLATES AND LABELS A. Identification Nameplates:

1. Materials:
a. Indoor Clean, Dry Locations: Use plastic nameplates.
b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
B. Identification Labels:
1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
C. Plastic: Conform to ASTM D 709. D. Letter Size:

1. Use 1/8 inch letters for identifying individual equipment and loads.
2. Use 1/4 inch letters for identifying grouped equipment and loads.

2.03 WIRE AND CABLE MARKERS

A. Legend: Power source and circuit number or other designation indicated.
B. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
C. Minimum Text Height: 1/8 inch.
D. Color: Black text on white background unless otherwise indicated.
E. Color: Black on white.
F. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings.

2.04 UNDERGROUND WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
C. Legend: Type of service, continuously repeated over full length of tape.
D. Color:

2.05 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
B. Warning Signs:
1. Materials:
2. Minimum Size: 7 by 10 inches unless otherwise indicated.
C. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.
B. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.

5 Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conductors and Cables: Legible from the point of access.
8. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.
D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.
B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.
C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Lighting and appliance panelboards.
- B. Load centers.
- C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS
- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 264300 - Surge Protective Devices.

1.03 REFERENCE STANDARDS
- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- E. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.
- G. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 67 - Panelboards; Current Edition, Including All Revisions.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- M. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- N. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions. O. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
   3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   4. Include documentation of listed series ratings upon request.
D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.
E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
   1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Siemens Industry, Inc. www.siemans.com
   B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
   C. General Electric Company: www.geindustrial.com.
   D. Schneider Electric; Square D Products: www.schneider-electric.us.
   E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ALL PANELBOARDS
   A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
   B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
      1. Altitude: Less than 6,600 feet.
      2. Ambient Temperature:
         a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
   C. Short Circuit Current Rating:
      1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
   E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
   F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
   G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
      1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
      2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   H. Conductor Terminations: Suitable for use with the conductors to be installed.
   I. Enclosures: Comply with NEMA 250, list and label as complying with UL 50 and UL 50E.
      1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
         a. Indoor Clean, Dry Locations: Type 1.
      2. Boxes: Galvanized steel unless otherwise indicated.
         a. Provide wiring gutters sized to accommodate the conductors to be installed.
         b. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
      3. Fronts:
         a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Aluminum.
3. Ground Bus Material: Aluminum.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
1. Provide flush-mounted enclosures as indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LOAD CENTERS

A. Description: Circuit breaker type load centers listed and labeled as complying with UL 67; ratings, configurations, and features as indicated on the drawings.

B. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Bus Material: Aluminum or copper.

C. Circuit Breakers: Thermal magnetic plug-in type.

D. Enclosures:
1. Provide flush-mounted enclosures unless otherwise indicated.
2. Fronts: Provide hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide circuit directory label on inside of door or individual circuit labels adjacent to circuit breakers.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   b. Provide interchangeable trip units.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
9. Do not use tandem circuit breakers.
10. Do not use handle ties in lieu of multi-pole circuit breakers.
11. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

2.06 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive panelboards.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide required supports in accordance with Section 260529.
E. Install panelboards plumb.
F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
H. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
J. Provide grounding and bonding in accordance with Section 260526.
K. Install all field-installed branch devices, components, and accessories.
L. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
M. Provide filler plates to cover unused spaces in panelboards.
N. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
1. Fire detection and alarm circuits.
O. Identify panelboards in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.
B. Inspect and test in accordance with NETA STD ATS, except Section 4.
C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.
D. Test GFCI circuit breakers to verify proper operation.
E. Test AFCI circuit breakers to verify proper operation.
F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
B. Adjust alignment of panelboard fronts.
C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 01
ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Meter bases.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SYSTEM DESCRIPTION

A. System Characteristics: 120/240 volts, single phase, three-wire, 60 Hertz.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work of this section. Review service entrance requirements and details with Utility Company representative.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.

1.06 QUALITY ASSURANCE

A. Utility Company:

B. Perform work in accordance with utility company written requirements and NFPA 70.

1. Maintain one copy of each document on site.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Milbank Manufacturing: www.milbankmfg.com.

2.02 COMPONENTS

A. Meter Base: Furnished by utility company.

B. Other Components: As required by utility company.

PART 3 EXECUTION

3.01 PREPARATION

A. Arrange with utility company to obtain permanent electric service to the Project.

B. Verify that field measurements are as indicated on utility company drawings.

3.02 INSTALLATION

A. Install meter base as required by utility company.

B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

END OF SECTION

SECTION 26 27 16
ELECTRICAL CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Hinged cover enclosures.
- B. Terminal blocks.
- C. Accessories.

1.02 RELATED REQUIREMENTS
- A. Section 260529 - Hangers and Supports for Electrical Systems.

1.03 REFERENCE STANDARDS
- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- C. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks; National Electrical Manufacturers Association; 2005.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- C. Cabinet Keys: Deliver to Owner in accordance with Section 016000 for maintenance materials.

1.05 QUALITY ASSURANCE
- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 HINGED COVER ENCLOSURES
- A. Construction: NEMA 250, Type 1 steel enclosure.
- B. Covers: Continuous hinge, held closed by flush latch operable by screwdriver.
- C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with white enamel.
- D. Enclosure Finish: Manufacturer's standard enamel.

2.02 CABINETS
- A. Boxes: Galvanized steel.
- B. Backboard: Provide 3/4 inch thick plywood backboard for mounting terminal blocks. Paint matte white.
- C. Fronts: Steel, flush type with concealed trim clamps, door with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
- D. Provide metal barriers to form separate compartments wiring of different systems and voltages.
- E. Keys: Provide two of each different key.

2.03 TERMINAL BLOCKS
- A. Terminal Blocks: NEMA ICS 4.

B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.04 ACCESSORIES

A. Plastic Raceway: Plastic channel with hinged or snap-on cover.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner under the provisions of Section 260529.
C. Install cabinet fronts plumb.

3.02 CLEANING

A. Clean electrical parts to remove conductive and harmful materials.
B. Remove dirt and debris from enclosure.
C. Clean finishes and touch up damage.

END OF SECTION

SECTION 26 27 17
EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

A. Section 260534 - Conduit.

B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).

C. Section 260537 - Boxes.

D. Section 262726 - Wiring Devices.

E. Section 262818 - Enclosed Switches.

1.03 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).

B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
2. Determine connection locations and requirements.

B. Sequencing:

1. Install rough-in of electrical connections before installation of equipment is required.
2. Make electrical connections before required start-up of equipment.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disconnect Switches: As specified in Section 262818 .

B. Wiring Devices: As specified in Section 262726.

C. Flexible Conduit: As specified in Section 260534.

D. Wire and Cable: As specified in Section 260519.

E. Boxes: As specified in Section 260537.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.
B. Wall dimmers.
C. Fan speed controllers.
D. Receptacles.
E. Wall plates.
F. Floor box service fittings.
G. Poke-through assemblies.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.
B. Section 260537 - Boxes.
C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
D. Section 260923 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.
E. Section 271005 - Structured Telecommunications Cabling and Enclosures: Voice and data jacks.

1.03 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
E. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
K. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
L. UL 1917 - Solid-State Fan Speed Controls; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS
A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
1. Wall Dimmers: Include derating information for ganged multiple devices.
C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
D. Operation and Maintenance Data:
1. Wall Dimmers: Include information on operation and setting of presets.
2. GFI Receptacles: Include information on status indicators and testing procedures and intervals.
3. Surge Protection Receptacles: Include information on status indicators.
E. Project Record Documents: Record actual installed locations of wiring devices.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Keys for Locking Switches: Two of each type.
3. Extra Wall Plates: One of each style, size, and finish.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Hubbell Incorporated; : www.hubbell-wiring.com.
B. Leviton Manufacturing Company, Inc; : www.leviton.com.
C. Lutron Electronics Company, Inc: www.lutron.com.
D. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us

E. Substitutions: See Section 016000 - Product Requirements.
F. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 APPLICATIONS
A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
D. Provide tamper resistant receptacles for all receptacles installed in dwelling units.
E. Provide GFI protection for all receptacles installed within 6 feet of sinks.
F. Provide GFI protection for all receptacles installed in kitchens.
G. Provide GFI protection for all receptacles serving electric drinking fountains. H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.03 ALL WIRING DEVICES
A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
B. Finishes:
1. All Wiring Devices: White with white nylon wall plate unless otherwise indicated.

2.04 WALL SWITCHES
A. Manufacturers:
1. Hubbell Incorporated; : www.hubbell-wiring.com.
2. Leviton Manufacturing Company, Inc; : www.leviton.com.
3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
4. Substitutions: See Section 016000 - Product Requirements.
B. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
C. Standard Wall Switches: Residential grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.05 WALLDIMMERS
A. Manufacturers:
1. Leviton Manufacturing Company, Inc; : www.leviton.com.
2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com.
3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
4. Substitutions: See Section 016000 - Product Requirements.
B. All Wall Dimmers: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

C. Control: Slide control type with separate on/off switch.
D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
E. Provide locator light, illuminated with load off.
F. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.06 FAN SPEED CONTROLLERS

A. Description: 120 V AC, solid-state, full-range variable speed, slide control type with separate on/off switch, with integral radio frequency interference filtering, fan hum elimination circuitry, field-adjustable trim, power failure preset memory, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1917.
   1. Current Rating: 1.5 A unless otherwise indicated or required to control the load indicated on the drawings.

2.07 RECEPTACLES

A. Manufacturers:
   1. Hubbell Incorporated; : www.hubbell-wiring.com.
   2. Leviton Manufacturing Company, Inc; : www.leviton.com.
   3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com.
   4. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
   5. Substitutions: See Section 016000 - Product Requirements.
B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
   2. NEMA configurations specified are according to NEMA WD 6.
C. Convenience Receptacles:
   1. Standard Convenience Receptacles: Residential grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
   2. Weather Resistant Convenience Receptacles: Residential grade, 20A, 125V, NEMA 5-20R, , listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
   3. Tamper Resistant Convenience Receptacles: Residential grade, 20A, 125V, NEMA 5-20R, , listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
   4. Tamper Resistant and Weather Resistant Convenience Receptacles: Residential grade, 20A, 125V, NEMA 5-20R, , listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
D. GFI Receptacles:
   1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
   2. Standard GFI Receptacles: Residential grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. Weather Resistant GFI Receptacles: Residential grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.08 WALL PLATES

A. All Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard; .
   3. Screws: Metal with slotted heads finished to match wall plate finish.
B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
C. Weatherproof Covers for Wet or Damp Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected.

2.09 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:
   1. Hubbell Incorporated; : www.hubbell-wiring.com.
B. Description: Service fittings compatible with floor boxes provided under Section 260537 with all components, adapters, and trims required for complete installation.
C. Flush Floor Service Fittings:
   1. Single Service Flush Convenience Receptacles:
      a. Cover: Round.
      b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
   2. Dual Service Flush Combination Outlets:
      a. Cover: Round.
      b. Configuration:
         1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
         2) Voice and Data Jacks: As specified in Section 271005.

2.10 POKE-THROUGH ASSEMBLIES

A. Manufacturers:
1 . Hubbell Incorporated; : www.hubbell-wiring.com.
B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.
C. Flush Floor Service Fittings:
   1. Single Service Flush Convenience Receptacles:
      a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
   2. Dual Service Flush Combination Outlets:
      a. Cover: Hinged door(s).
      b. Configuration:
         1) Power: One standard convenienceduplex receptacle(s).

2) Voice and Data Jacks: As specified in Section 271005.

3. Accessories:
   a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
D. Verify that final surface finishes are complete, including painting.
E. Verify that floor boxes are adjusted properly.
F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface. B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switches: 48 inches above finished floor.
      b. Wall Dimmers: 48 inches above finished floor.
      c. Fan Speed Controllers: 48 inches above finished floor.
      d. Receptacles: 18 inches above finished floor or 6 inches above counter.
   2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   4 Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
C. Install wiring devices in accordance with manufacturer's instructions.
D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
H. Provide GFI receptacles with integral GFI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
J. Install wall switches with OFF position down.
K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
P. Provide wiring device label in accordance with Section 260553 for wall-mounted controls controlling loads that are not visible from the control location or multiple wall-mounted controls installed at one location identifying load controlled.
Q. Provide wiring device label in accordance with Section 260553 for all receptacles identifying serving branch circuit.
R. Install poke-through closure plugs in all unused core holes to maintain fire rating of floor.

3.04 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 014000.
B. Inspect each wiring device for damage and defects.
C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
D. Test each receptacle to verify operation and proper polarity.
E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.
B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Fuses.
- B. Spare fuse cabinet.

1.02 RELATED REQUIREMENTS
- A. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 262818 - Enclosed Switches: Fusible switches.
- C. Section 262913 - Enclosed Controllers: Fusible switches.

1.03 REFERENCE STANDARDS
- A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R2007).
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
- A. Coordination:
- 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
  - a. Fusible Enclosed Switches: See Section 262818.
  - b. Fusible Switches for Enclosed Motor Controllers: See Section 262913.
- 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
- 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
  - 1. Spare Fuse Cabinet: Include dimensions.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 016000 - Product Requirements, for additional provisions.
  - 2. Extra Fuses: One set(s) of three for each type and size installed.
  - 3. Fuse Pullers: One set(s) compatible with each type and size installed.
  - 4. Spare Fuse Cabinet Keys: Two.

1.06 QUALITY ASSURANCE
- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 APPLICATIONS
- A. Individual Motor Branch Circuits: Class RK1, time-delay.
- B. Primary Protection for Control Transformers: Class CC, time-delay.

2.02 FUSES
- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class CC Fuses: Comply with UL 248-4.

2.03 SPARE FUSE CABINET
- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.

PART 3 EXECUTION

3.01 EXAMINATION
- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where indicated.

END OF SECTION

SECTION 26 28 17
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS
- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS
- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
- A. Coordination:
  1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
  2 Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
  4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Siemens Industry, Inc: www.sea.siemens.com.
B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
C. General Electric Company: www.geindustrial.com.
D. Schneider Electric; Square D Products: www.schneider-electric.us.
E. Substitutions: See Section 016000 - Product Requirements.
F. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS
A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
D. Short Circuit Current Rating:
1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
E. Conductor Terminations: Suitable for use with the conductors to be installed.
F. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
H. Provide externally operable handle with means for locking in the OFF position.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:

1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:

1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 260529.

E. Install enclosed circuit breakers plumb.

F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

H. Provide grounding and bonding in accordance with Section 260526.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.

B. Inspect and test in accordance with manufacturer's instructions and NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for circuit breakers used for service entrance.

D. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 28 18
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.
B. Section 260529 - Hangers and Supports for Electrical Systems.
C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
D. Section 262813 - Fuses.
E. Section 262913 - Enclosed Controllers: Manual motor controllers.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).
D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections. D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Siemens Industry, Inc: www.sea.siemens.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. Substitutions: See Section 016000 - Product Requirements.

F. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break, enclosed safety switches complying with NEMA KS 1, type HD (heavy duty), and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
D. Horsepower Rating: Suitable for connected load.
E. Voltage Rating: Suitable for circuit voltage.
F. Short Circuit Current Rating:
   1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   2. Minimum Ratings:
      a. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
G. Provide with switch blade contact position that is visible when the cover is open.
H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
   1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
I. Conductor Terminations: Suitable for use with the conductors to be installed.
J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
L. Enclosures: Comply with NEMA KS 1 and NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
N. Heavy Duty Switches:
   1. Conductor Terminations:
      a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive enclosed safety switches.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install enclosed switches in accordance with manufacturer's instructions.
B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide required supports in accordance with Section 260529.
E. Install enclosed switches plumb.
F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
G. Provide grounding and bonding in accordance with Section 260526.
H. Provide fuses complying with Section 262813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 014000.
B. Inspect and test in accordance with NETA STD ATS, except Section 4.
C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.1.1.
D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 31 00
PHOTOVOLTAIC COLLECTORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Photovoltaic system requirements.
B. Photovoltaic modules.
C. Photovoltaic module mounting system.
D. Photovoltaic combiner boxes.
E. Photovoltaic inverters. F. Monitoring system.

1.02 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.
B. Section 260526 - Grounding and Bonding for Electrical Systems.
C. Section 260529 - Hangers and Supports for Electrical Systems.
D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
E. Section 262701 - Electrical Service Entrance.
F. Section 262813 - Fuses.
G. Section 262818 - Enclosed Switches.
H. Section 264300 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

A. IEC 61215 - Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval; 2005.
B. IEEE 1547 - Standard for Interconnecting Distributed Resources with Electric Power Systems; 2003 (Reaff 2008).
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
G. UL 1703 - Flat Plate Photovoltaic Modules and Panels; Current Edition, Including All Revisions.
H. UL 1741 - Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources; Current Edition, Including All Revisions.
I. UL 2579 - Low-Voltage Fuses - Fuses for Photovoltaic Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for photovoltaic system components.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of all affected installers. Include adequate instruction on the electrical hazards associated with photovoltaic systems and appropriate safety procedures to be followed.

C. Rebates and Incentives: Prepare and submit documentation as required for Owner to secure funds from available federal, state, and utility company rebate and incentive programs. Notify Owner of any time constraints affecting program qualification.

D. Utility Interconnection:
   1. See Section 262701 for Utility Company contact information and additional requirements.
   2. Prepare and submit documentation as required for securing utility interconnection agreement between Owner and Utility Company.
   3. Preinstallation Meeting: Convene one week prior to commencing work of this section to review interconnection requirements and details with Utility Company representative.
   4. Coordinate with Utility Company to provide utility metering suitable for system requirements.
   5. Arrange for inspections and secure permits necessary to obtain Utility Company approval of system.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, attachment locations and details, and proposed size, type, and routing of conduits and cables. Include system interconnection schematic diagrams showing all factory and field connections.

D. Design Data:
   1. Include structural calculations, certified by structural engineer, for equipment and mounting system.
   2. Include electrical calculations for array and associated equipment other than the basis of design products and configuration.

E. Certify that products of this section meet or exceed specified requirements.

F. Installer's Qualifications: Include evidence of compliance with specified requirements.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

H. Manufacturer’s detailed field testing procedures.

I. Manufacturer's detailed startup procedures.

J. Rebate and incentive documentation.

K. Utility interconnection documentation.

L. Source quality control test reports.

M. Field quality control test reports.

N. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

O. Maintenance contracts.
P. Software: One copy of software provided under this section.

1.06 QUALITY ASSURANCE
A. Comply with NFPA 70.
B. Comply with Utility Company requirements for interconnection.
C. Structural Designer Qualifications: Registered structural engineer licensed in the State in which the Project is located.
D. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience with photovoltaic systems of similar size, type, and complexity.
1. Licensed in the State in which the Project is located to install photovoltaic systems.
2. Manufacturer's authorized installer.
3. Supervisor: North American Board of Certified Energy Practitioners (NABCEP) certified PV Installer or three years experience supervising the installation of photovoltaic systems.
4. Installer Personnel: At least 2 years of experience installing photovoltaic systems.
E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.08 WARRANTY
A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
B. Specified warranties indicate minimum requirements. Provide additional warranties or extended warranty periods where required to qualify for rebate and incentive programs.
C. Photovoltaic Modules:
1. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
2. Provide manufacturer warranty guaranteeing minimum 90 percent of rated power output for 10 years and minimum 80 percent of rated power output for 20 years.
D. Photovoltaic Module Mounting System: Provide minimum 10 year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
E. Photovoltaic Combiner Boxes: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
F. Photovoltaic Inverters: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 PHOTOVOLTAIC SYSTEM REQUIREMENTS
A. Provide complete photovoltaic system consisting of photovoltaic modules and associated balance of system components necessary for connection to facility electrical system.
B. System Description:
1. Photovoltaic array is ground-mounted in location indicated on the drawings.
2. Orientation of array is as indicated on the drawings.
3. Photovoltaic DC system is negative grounded.
4. System includes interconnection with utility grid (grid-tied system).

a. Utility metering configuration: Net metering.

5. System does not include battery storage system.
6. System does not include engine generator.
7. System includes DC system surge protection.
8. System includes monitoring system.
9. Owner intends to secure funds from available federal, state, and utility company rebate and incentive programs.

C. Capacity:
1. Total Nominal Rated Power Output of Array: Equal to or greater than the rated output of the basis of design array.

D. Provide photovoltaic system and associated components suitable for wind loads, snow loads, seismic loads, and other structural design considerations of the installed location.

E. Provide photovoltaic system and associated components suitable for continuous operation under the service conditions at the installed location.

F. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or Intertek (ETL) as suitable for the purpose indicated.

G. Provide photovoltaic system and associated components that qualify for available federal, state, and utility company rebate and incentive programs.

H. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system.

I. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

J. Arrange array to minimize shading during peak production periods.

2.2 PHOTOVOLTAIC MODULES

LUMOS

LSX250 Series

A true systems approach to photovoltaic module and racking integration

Features	Benefits
Frameless Module	No aluminum = lower embodied energy Lower profile
No Module Grounding	No ground lugs No continuous module equipment ground
Constrained Module Positioning	Perfect alignment Speeds install time
Integrated Wireway	UV and rodent protection Speeds installation time
Tamper Resistant Stainless Fasteners	Keeps your investment working for you
Available with black, clear or white back sheet	Aesthetic options for different applications

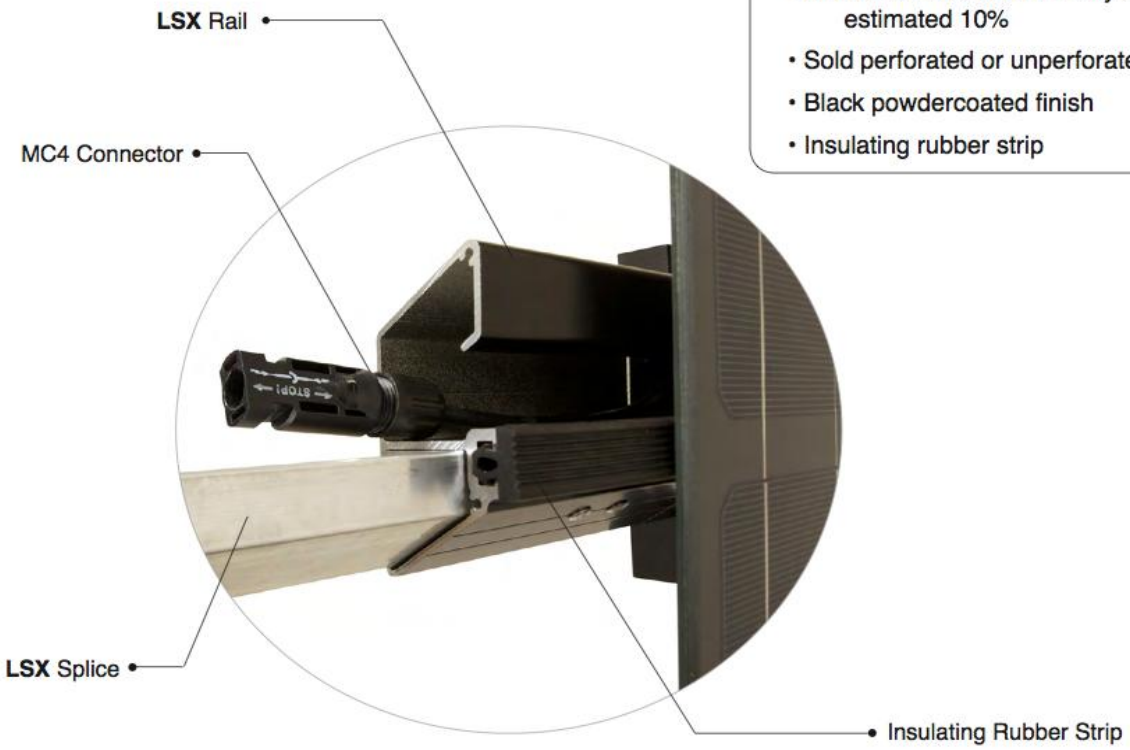
LSX Racking System

Our **LSX** Rail is the proprietary racking solution for the **LSX Module System**.

LSX Rail is sold with the insulating rubber strip and pre-installed, pre-positioned fasteners.

Features:

- Integrated wireway provides rodent and UV protection
- Shortens installation time by an estimated 10%
- Sold perforated or unperforated
- Black powdercoated finish
- Insulating rubber strip



LSX Rail

- Perforated or Unperforated
- Integrated Wireway
- Black Powdercoated Finish

X Flash

- Compatible with all racking systems
- Low profile and easily adjustable
- IRC and IBC Code Compliant

LSX Bolt and Tool

- Tamper Resistant Stainless Steel Bolt
- Custom Installation Tool

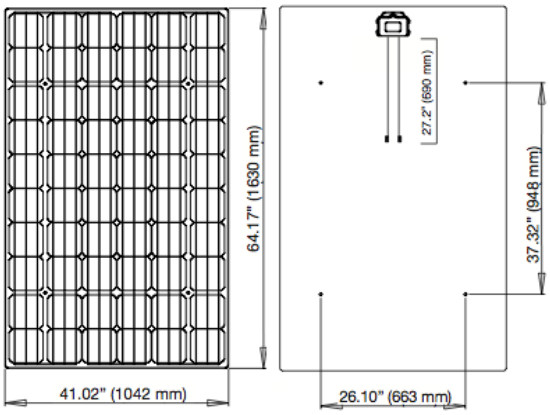
3550 Frontier Ave Ste C-2
Boulder, Colorado 80301
877-301-3582
www.lumossolar.com

LUMOS

LSX250 Series

Mechanical Specifications

Solar Cell	Monocrystalline 6" x 6" (156mm x 156mm)
Number of Cells	60 (6 x 10)
Internal Bypass Diodes	6
Module Dimensions	64.17" x 41.02" x 1.38" (1630 mm x 1042 mm x 35 mm)
Module Area	18.28 ft² (1.70 m²)
Module Weight	62.6 lbs (28.4 kg)
Front Glass	.24" (6mm) Tempered Glass
Backsheet	Black, White, and Clear
LSX Rail Assembly Options	3-4 Portrait Module Lengths (Black Powdercoated Finish) 3 Landscape Module Lengths (Black Powdercoated Finish)
Output Cables	12 Awg. (690 mm) PV Wire with MC4 Connectors
Static Load	50 PSF (2400 Pa) Portrait
Hail	Maximum Diameter 1" (25 mm) at 52 mph (23 m/s)
Warranty	12 years at 90% of the rated power output 25 years at 80% of the rated power output
Certifications	ETL per UL-1703 & CEC listed



Temperature Coefficients

Nominal Operating Cell Temperature (NOCT)	48± 2 °C
Power Temperature Coefficient	-0.49 % / °C
Voltage Temperature Coefficient (Voc)	-0.35 % / °C
Current Temperature Coefficient (Isc)	+0.05 % / °C

Electrical Specifications

Model	LSX 235-60M-B/W/C*	LSX 240-60M-B/W/C*	LSX 245-60M-B/W/C*	LSX 250-60M-B/W/C*
Rated Power @ STC	235 W	240 W	245 W	250 W
Black/Clear PTC	208.8 W	213.3 W	217.9 W	222.5 W
White PTC	208.9 W	213.5 W	218.1 W	222.6 W
Nominal Voltage	24 V	24 V	24 V	24 V
Peak Power Voltage (Vmp)	29.6 V	29.8 V	30.0 V	30.1 V
Maximum Power Current (Imp)	7.94 A	8.06 A	8.17 A	8.31 A
Open Circuit Voltage (Voc)	36.8 V	37.0 V	37.20 V	37.3 V
Short Circuit Current (Isc)	8.54 A	8.62 A	8.69 A	8.78 A
Operating Temperature	-40 °C to 85 °C	-40 °C to 85 °C	-40 °C to 85 °C	-40 °C to 85 °C
Max System Voltage (UL / IEC)	600 V / 1000 V	600 V / 1000 V	600 V / 1000 V	600 V / 1000 V
Max Series Fuse Rating	15 A	15 A	15 A	15 A
Power Tolerance	±3%	±3%	±3%	±3%
Module Efficiency	13.80%	14.10%	14.39%	14.68%

*B-Black Backsheet
*W-White Backsheet
*C-Clear Backsheet

PATENTS PENDING

3550 Frontier Ave Ste C-2
Boulder, Colorado 80301
877-301-3582
www.lumossolar.com

LUMOS

A. Acceptable Module Types: Only crystalline silicon modules are acceptable. Thin film modules will not be considered for this project.

B. General Requirements:

1. Photovoltaic Modules: Factory assembled; consisting of photovoltaic cells, frame, junction box, cables for series connection, and bypass diodes for shade tolerance; rated for 600 V DC; listed as complying with UL 1703.
2. Crystalline Silicon Photovoltaic Modules: Comply with IEC 61215.
3. Frame: Frameless
4. Factory-Installed Junction Box: Weatherproof, with factory-installed terminals and bypass diodes.
5. Factory-Installed Cables: Type USE-2 or listed photovoltaic (PV) wire with polarized locking connectors.
6. Unless otherwise indicated, specified module performance characteristics are rated under Standard Test Conditions (STC).
7. Power Rating Tolerance: Plus or minus 3 percent

2.03 BALANCE OF SYSTEM COMPONENTS

A. Photovoltaic Module Mounting System:

1. Provide complete mounting system compatible with modules to be installed and suitable to properly install them in the location indicated, including all necessary hardware and accessories.
2. Support Structure and Associated Hardware Materials: Use aluminum, galvanized steel, or stainless steel.
3. Ground-Mounted Arrays:
   a. Module Tilt Angle: As required to provide maximum energy production for installed location.
   b. Foundation Type: As required for soil conditions at installed location.

B. Photovoltaic Combiner Boxes:

1. Provide combiner box(es) for termination of strings as indicated or as required for the array configuration installed.
2. Combiner Boxes: Rated for 600 V DC; current ratings suitable for connected strings; equipped with terminal blocks; listed as complying with UL 1741.
3. Terminal blocks: Suitable to receive wires indicated.
4. Number of Input Circuits: As indicated or as required for termination of strings, with minimum of 25 percent spare capacity for future expansion.
5. Enclosure: NEMA 250, Type 3R, unless otherwise indicated.

C. Photovoltaic Inverters:

power-one®
Renewable Energy Solutions

AURORA UNO

PVI-5000-TL
PVI-6000-TL

GENERAL SPECIFICATIONS

Designed for residential and small commercial PV installations, this inverter fills a specific niche in the Aurora product line to cater for those installations producing between 5kW and 20kW.

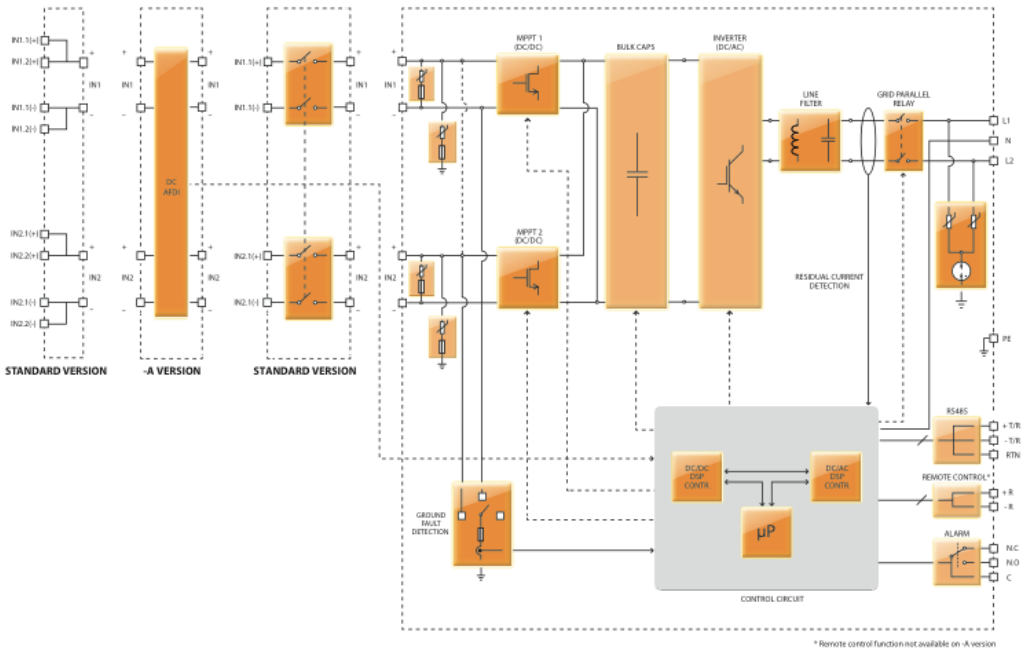
This inverter has all the usual Aurora benefits, including dual input section to process two strings with independent MPPT, high speed and precise MPPT algorithm for real-time power tracking and energy harvesting, as well as transformerless operation for high performance efficiencies of up to 97.1%.

The wide input voltage range makes the inverter suitable to low power installations with reduced string size. This outdoor inverter has been designed as a completely sealed unit to withstand the harshest environmental conditions.

Features

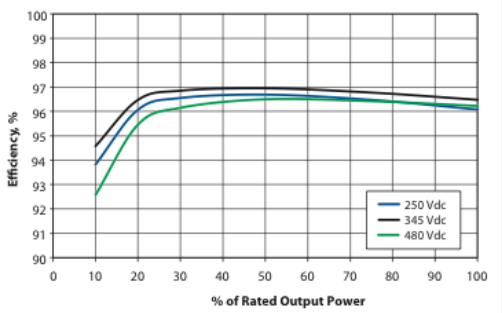
- Each inverter is set on specific grid codes which can be selected in the field
- Single phase output
- Dual input sections with independent MPPT, allows optimal energy harvesting from two sub-arrays oriented in different directions
- Wide input range
- High speed and precise MPPT algorithm for real time power tracking and improved energy harvesting
- Flat efficiency curves ensure high efficiency at all output levels ensuring consistent and stable performance across the entire input voltage and output power range
- Outdoor NEMA 4X rated enclosure for unrestricted use under any environmental conditions
- RS-485 communication interface (for connection to laptop or datalogger)
- Compatible with PVI-RADIOMODULE for wireless communication with Aurora PVI-DESKTOP
- Integrated Arc Fault Detection and Interruption (-A Version)

BLOCK DIAGRAM OF PVI-5000-OUTD AND PVI-6000-OUTD FOR NORTH AMERICA

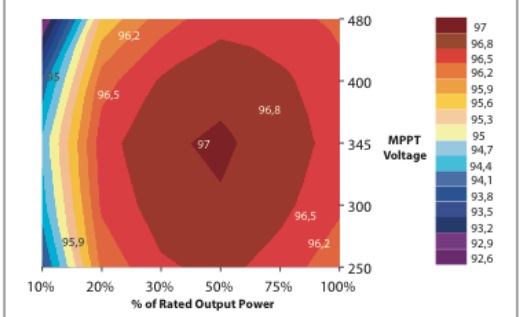


Block Diagram and Efficiency Curves

PVI-5000/6000-OUTD-US



PVI-5000/6000-OUTD-US



TECHNICAL DATA	VALUES	PVI-5000-OUTD-US			PVI-6000-OUTD-US		
Nominal Output Power	W	5000			6000		
Maximum Output Power	W	5000			6000		
Rated Grid AC Voltage	V	208	240	277	208	240	277
Input Side (DC)							
Number of Independent MPPT Channels		2			2		
Maximum Usable Power for Each Channel	W	4000			4000		
Absolute Maximum Voltage (Vmax)	V	600			600		
Start- Up Voltage (Vstart)	V	200 (adj. 120-350)			200 (adj. 120-350)		
Full Power MPPT Voltage Range	V	200-530			200-530		
Operating MPPT Voltage Range	V	0.7xVstart-580			0.7xVstart-580		
Maximum Current (Idcmax) for both MPPT in Parallel	A	36			36		
Maximum Usable Current per Channel	A	18			18		
Maximum Short Circuit Current Limit per Channel	A	22			22		
Number of Wire Landing Terminals Per Channel		2 Pairs			2 Pairs		
Array Wiring Termination		Terminal block, Pressure Clamp, AWG8-AWG4					
Output Side (AC)							
Grid Connection Type		1Ø/2W	Split-Ø/3W	1Ø/2W	1Ø/2W	Split-Ø/3W	1Ø/2W
AdjustableVoltage Range (Vmin-Vmax)	V	183-228	211-264	244-304	183-228	211-264	244-304
Grid Frequency	Hz	60			60		
Adjustable Grid Frequency Range	Hz	57-60.5			57-60.5		
Maximum Current (Iacmax)	A_{RMS}	27	23	20	30	28	24
Power Factor		> 0.995			> 0.995		
Total Harmonic Distortion At Rated Power	%	< 2			< 2		
Contributory Fault Current**	A_{pk}/A_{RMS}	36.25/25.63	36.5/25.81	31.75/22.45	36.25/25.63	36.5/25.81	31.75/22.45
Grid Wiring Termination Type		Terminal block, Pressure Clamp, AWG8 - AWG4					
Protection Devices							
Input							
Reverse Polarity Protection		Yes			Yes		
Over-Voltage Protection Type		Varistor, 2 for each channel			Varistor, 2 for each channel		
PV Array Ground Fault Detection		Pre start-up Riso and dynamic GFDI (Requires Floating Arrays)			Pre start-up Riso and dynamic GFDI (Requires Floating Arrays)		
Output							
Anti-Islanding Protection		Meets UL 1741/IEE1547 requirements			Meets UL 1741/IEE1547 requirements		
Over-Voltage Protection Type		Varistor, 2 (L_1 - L_2 / L_1 - G)			Varistor, 2 (L_1 - L_2 / L_1 - G)		
Maximum AC OCPD Rating	A	35	30	25	40	35	30
Efficiency							
Maximum Efficiency	%	97.1			97.1		
CEC Efficiency	%	96	96.5	96.5	96	96.5	96.5
Operating Performance							
Stand-by Consumption	W_{RMS}	< 8			< 8		
Night time consumption	W_{RMS}	< 0.6			< 0.6		
Communication							
User-Interface		16 characters x 2 lines LCD display					
Remote Monitoring (1xRS485 incl.)		AURORA-UNIVERSAL (opt.)					
Wired Local Monitoring (1xRS485 incl.)		PVI-USB-RS485_232 (opt.), PVI-DESKTOP (opt.)					
Wireless Local Monitoring		PVI-DESKTOP (opt.) with PVI-RADIOMODULE (opt.)					
Environmental							
Ambient Air Operating Temperature Range	°F (°C)	-13 to +140 (-25 to +60)			-13 to +140 (-25 to +60) with derating above 122 (50)		
Ambient Air Storage Temperature Range	°F (°C)	-40 to 176 (-40 to +80)			-40 to 176 (-40 to +80)		
Relative Humidity	% RH	0-100 condensing			0-100 condensing		
Acoustic Noise Emission Level	db (A) @1m	< 50			< 50		
Maximum Operating Altitude without Derating	ft(m)	6560 (2000)			6560 (2000)		
Mechanical Specifications							
Enclosure rating		NEMA 4X			NEMA 4X		
Cooling		Natural Convection			Natural Convection		
Dimensions (H x W x D)	in (mm)	41.4 x 12.8 x 8.6 (1052 x 325 x 218)					
Weight	lb (kg)	< 59.5 (27.0)			< 59.5 (27.0)		
Shipping Weight	lb (kg)	< 78 (35.4)			< 78 (35.4)		
Mounting System		Wall bracket			Wall bracket		
Conduit Connections		Trade Size Kos: (2ea x 1/2") and (2ea x 1-1/4", 3 places side, front, rear)			Trade Size Kos: (2ea x 1/2") and (2ea x 1-1/4", 3 places side, front, rear)		
DC Switch Rating (Per Contact)	A/V	25 / 600			25 / 600		
Safety							
Isolation Level		Transformerless (Floating Array)			Transformerless (Floating Array)		
Safety and EMC Standard		UL 1741, CSA - C22.2 N. 107.1-01 , UL1998 UL1699B, FCC Part 15 Class B					
Safety Approval		cCSA$_{US}$			cCSA$_{US}$		
Warranty							
Standard Warranty	years	10			10		
Extended Warranty	years	15 & 20			15 & 20		
Available Models							
Standard - With DC Switch - Floating Array		PVI-5000-OUTD-US			PVI-6000-OUTD-US		
With DC Switch, Wiring box and Arc Fault Detector and Interrupter		PVI-5000-OUTD-US-A			PVI-6000-OUTD-US-A		

*All data is subject to change without notice
** Inverter can apply that much current - Breaker will open

AURORA UNO 3

1. Provide inverter(s) as indicated or as required for connection of the photovoltaic array DC system to the AC system indicated.
2. Inverters: Suitable for the requirements of the connected array; output configuration compatible with connected system; listed as complying with UL 1741; furnished with the following features:
   a. Two independent maximum power point tracking (MPPT).
   b. LCD display.
   c. Integral DC disconnect.
   d. Integral DC ground fault detection and interruption (GFDI).
3. Grid-Tied Inverters: Comply with IEEE 1547, including over/under grid voltage and frequency protection, and anti-islanding protection to automatically disconnect upon loss of utility power and to remain disconnected until utility power restoration has been maintained for five minutes.
4. Total Harmonic Distortion: Less than two percent.
5. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

D. Enclosed Switches: In addition to requirements of Section 262818, comply with the following:
   1. Switches for DC System: Rated for 600 V DC.

E. Surge Protective Devices: In addition to requirements of Section 264300, comply with the following:
   1. Surge Protective Devices for DC System:
      a. Rated for 600 V DC.
      b. Listed and labeled as complying with UL 1449, Type 1.
      c. Surge Current Rating: Not less than 50 kA per mode.
      d. UL 1449 Nominal Discharge Current (I-n): 20 kA.

F. Fuses: In addition to requirements of Section 262818, comply with the following:
   1. Fuses for DC System: Rated for 600 V DC.
   2. Fuses for Protection of Photovoltaic Strings and Arrays: Use photovoltaic fuses listed as complying with UL 2579.

G. Monitoring System
   1. Provide a system to monitor photovoltaic system performance including all sensors, dataloggers, connections, software, equipment and accessories necessary for a complete operating system.
   2. System communications interfaces to be wired or wireless, with compatible interconnected components.
      a. Provide suitable raceway, minimum 3/4 inch trade size, for all required wired connections.
   3. System to monitor and record, in 15 minute intervals:
      a. Inverter status.
      b. Instantaneous power (kW).
      c. Cumulative energy production (kWh).
   4. System real-time and historical data to be accessible from the following locations:
      a. Personal computer(s), via internet connection.

2.04 SOURCE QUALITY CONTROL

A. Factory test the following products to verify operation and performance characteristics. Include test reports with submittals.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Use open circuiting, short circuiting, or opaque covering to disable modules, array or portions of array prior to installation and service.

3.03 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install products in accordance with manufacturer's instructions.

C. Provide required supports in accordance with Section 260529.

D. Mount equipment such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor, ground, or working platform.

E. Provide cast-in-place concrete foundations for ground-mounted arrays as required.

F. Circuiting Requirements, in Addition to Requirements of Section 260519:

1. Wiring Methods:

a. Unless otherwise indicated, use exposed module factory-installed cables (not routed inside building) for module interconnections.

b. Unless otherwise indicated, use type THHN/THWN-2 single-conductor building wire in suitable raceway for wiring between combiner box(es) and point of interconnection.

c. Secure exposed cables in accordance with NFPA 70. Where possible, conceal behind array.

d. Install cables in suitable raceway where readily accessible or where required by authority having jurisdiction.

e. Use suitable twist-on insulated spring connectors, mechanical connectors, or compression connectors for photovoltaic circuit splices and taps.

2. Photovoltaic DC System Conductor Color Code:

a. Negative Grounded System:

1) Positive: Red.

2) Negative/Grounded: White.

3. Maintain separation of photovoltaic and non-photovoltaic circuits in accordance with NFPA 70.

G. Grounding and Bonding Requirements, in Addition to Requirements of Section 260526:

1. Ensure that there is only one AC System bonding connection between grounding system and grounded/neutral conductor, including external connections and connections internal to equipment.

2. Grounded DC Systems: Ensure that there is only one point of system grounding connection to the grounded conductor, including external connections and connections internal to equipment.

H. Identification Requirements, in Addition to Those Specified in Section 260553:

1. Use identification nameplate or means of identification acceptable to authority having jurisdiction to identify the presence of multiple power sources and the location of main service disconnecting means and each photovoltaic system disconnecting means. Locate at main service disconnecting means and each photovoltaic system disconnecting means. Verify format and descriptions with authority having jurisdiction.
2. Use identification nameplate to identify each photovoltaic system disconnecting means with text "PHOTOVOLTAIC SYSTEM DC DISCONNECT" or "PHOTOVOLTAIC SYSTEM AC DISCONNECT" as applicable.
3. Use identification nameplate or identification label to identify each photovoltaic system; DC disconnecting means with the following information:
    a. Rated maximum power-point current (operating current).
    b. Rated maximum power-point voltage (operating voltage).
    c. Maximum system voltage.
    d. Short-circuit current.
4. Use identification nameplate or identification label to identify the interactive system point of interconnection at the disconnecting means as a power source and with the rated AC output current and the nominal operating AC voltage.
5. Where the inverter output connection is located in a panelboard on the opposite (load) end from the input feeder location or main circuit location in order to meet requirements of NFPA 70, use identification nameplate or identification label to identify the overcurrent device with the word message "Warning; Inverter output connection; Do not relocate this overcurrent device".
6. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for photovoltaic system disconnecting means. Include the word message "Warning - Electric Shock Hazard; Do not touch terminals; Terminals on both the line and load sides may be energized in the open position" or approved equivalent.
7. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for photovoltaic systems equipped with DC ground-fault protection in accordance with NFPA 70. Include the word message "Warning - Electric Shock Hazard; If a ground fault is indicated, normally grounded conductors may be ungrounded and energized".
8. Use wire and cable markers to identify photovoltaic system source, output, and inverter circuit conductors at all points of termination, connection, and splices.
9. Use voltage markers, identification labels, stenciled text, or suitable permanent marking approved by authority having jurisdiction to identify exposed raceways, cable trays, pull boxes, junction boxes, and conduit bodies with the text "Photovoltaic Power Source" at maximum intervals of 10 feet in accordance with NFPA 70.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.
B. See article "SYSTEM STARTUP" below for additional requirements related to testing and inspection.
C. Inspection and testing to include, at a minimum
    1. Inspect each system component for damage and defects.
    2. Verify that equipment enclosures, boxes, and associated connections installed outdoors are weatherproof.
    3. Verify proper wiring connections have been made and check for conductor continuity.

4. Verify proper polarity.
5. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
6. Measure and record voltages at the inverter AC and DC inputs.
7. Measure and record AC output power.
8. Perform inverter functional test.
   a. Grid-Tied Inverters: Include simulation of loss of utility power and subsequent power restoration.
9. Verify proper operation of monitoring system.

D. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

E. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
   1. Record all system operations and malfunctions.
   2. If a malfunction occurs, start diagnostic period over after correction of malfunction.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.05 SYSTEM STARTUP

A. Provide services of a manufacturer's authorized representative to assist in performing system startup. Include manufacturer's detailed startup procedures with submittals.

B. Obtain Owner's approval prior to performing system startup.

C. Grid-Tied Systems: Obtain Utility Company's approval prior to performing system startup. D. Prepare and start system in accordance with manufacturer's instructions.

3.06 CLEANING

A. Clean modules using only methods recommended by manufacturer to avoid scratches and other damage. Clean exposed surfaces on other components to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of photovoltaic system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

3.08 PROTECTION

A. Protect installed products from subsequent construction operations.

3.09 MAINTENANCE

A. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of photovoltaic system for two years from date of Substantial Completion, to include the work described below; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Surge protective devices for service entrance locations.

1.02 RELATED REQUIREMENTS
- A. Section 260526 - Grounding and Bonding.
- B. Section 262416 - Panelboards.

1.03 ABBREVIATIONS AND ACRONYMS
- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS
- A. MIL-STD-220 - Method of Insertion Loss Measurement; Revision C, 2009.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
- G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS
- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.06 SUBMITTAL
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
  1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
- D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
  1. UL 1449.
  2. UL 1283 (for Type 2 SPDs).
- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

G. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
H. Project Record Documents: Record actual connections and locations of surge protective devices.

1.07 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND PROTECTION
A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS
A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY
A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Field-installed, Externally Mounted Surge Protective Devices:
1. Advanced Protection Technologies, Inc (APT); : www.aptspd.com.
2. Current Technology; a brand of Thomas & Betts Power Solutions; www.tnbpowersolutions.com.
3. General Electric Company; : www.geindustrial.com.
4. Substitutions: See Section 016000 - Product Requirements.
B. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 ALL SURGE PROTECTIVE DEVICES
A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service, listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated; system voltage as indicated on the drawings.
B. Protected Modes:
1. Wye Systems: L-N, L-G, N-G, L-L.
2. Single Split Phase Systems: L-N, L-G, N-G, L-L.
C. UL 1449 Voltage Protection Ratings (VPRs):
1. 240/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
E. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
1. Indoor clean, dry locations: Type 1.
F. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
1. Provide surface-mounted SPD where mounted adjacent to surface-mounted equipment.
2. Provide flush-mounted SPD where mounted adjacent to flush-mounted equipment.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Unless otherwise indicated, provide field-installed, externally mounted SPDs

B. List and label as complying with UL 1283 and UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 125 kA per mode/250 kA per phase.

E. UL 1449 Nominal Discharge Current (I-n): 20 kA.

F. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

G. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).

1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

H. Diagnostics:

1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
3. Remote Status Monitoring: Provide two Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

I. Provide surge rated integral disconnect switch for SPDs not direct bus connected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of the drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 260526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install SPD in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be

reasonably be rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 260526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES
- A. Interior luminaires.
- B. Ballasts.
- C. Lamps.
- D. Luminaire accessories.

1.02 RELATED REQUIREMENTS
- A. Section 260537 - Boxes.
- B. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.

1.03 REFERENCE STANDARDS
- A. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.
- B. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (R2008).
- C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.
- F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.
- G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.
- H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2006.
- I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- K. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
- A. Coordination:
  1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Provide photometric calculations where luminaires are proposed for substitution upon request.
C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
   2. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
   3. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
   4. Fluorescent Emergency Power Supply Unit: Include list of compatible lamp configurations and associated lumen output.
D. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.
E. Field Quality Control Reports.
F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
   3. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.
   4. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. Provide two year manufacturer warranty for all linear fluorescent ballasts.

PART 2 PRODUCTS

elemental LED

Elemental LED, LLC
www.elementalled.com
1195 Park Ave., Suite 211
Emeryville, CA 94608
toll free 877.564.5051
fax 510.740.4457

CORONIS™ 240 High Output LED Strip Light

EL-12V-COR-240
UL #E348280
Weight per ft.: 0.4 oz.
Width: 0.3 in.
Depth: 0.1 in.
Chip Spacing: 0.3 in. (between centers)
0.2 in. (between edges)
Cuttable: every 3 chips / 1 in.
Max. Length on one run: 16.4 ft.
Spool Length: 16.4 ft.
UV/IR Radiation: None
Lifespan: 50,000 hours
Warranty: 5 years

RoHS compliant

Our CORONIS™ 240 High Output LED Strip Light (formerly called High Density Flexible LED Strip Light) is super bright LED strip lighting that has twice as many LED chips as our AURIS™ 115 LED Strip Light. This UL Listed high output LED strip makes a brighter, cheaper and warmer light than any fluorescent or incandescent fixture.

The energy efficiency, flexible design, and high intensity of LED strip lighting make it optimal for these indoor home and commercial lighting situations:

- Kitchen cabinet, under cabinet, shelf, and case lighting
- Exhibit, presentation, and project lighting
- Close application task lighting
- Cove and interior accent lighting
- Shop windows, window displays, and display case lights
- Light boxes, interior sign and signage light

Some of the features of CORONIS 240 LED Light include:

- RoHS certified
- Dimmable
- Can be dimmed with our 12V Dimmable Driver and a 120V AC dimmer
- Can be dimmed with our REIGN™ Dimmer and our standard 12V Driver
- Energy-efficient, using only 2.88 Watts of electricity per foot
- Low voltage LEDs diminish the chances of electrical shock and fire danger
- Estimated life of 50,000 hours, which is 8 years if left constantly on
- Easy to install, with 3M sticky back adhesive

color	color temp.	voltage	lumens	IP rating	beam angle	chip type	power consumption	CRI	chips / ft.
warm white	2700k	12V DC	240	40	120°	3528 SMD	2.88W / 240mA	75	36
neutral white	4200k	12V DC	240	40	120°	3528 SMD	2.88W / 240mA	72	36
cool white	5000k	12V DC	240	40	120°	3528 SMD	2.88W / 240mA	80	36
red	626nm	12V DC	77	40	120°	3528 SMD	2.88W / 240mA	n/a	36
green	525nm	12V DC	126	40	120°	3528 SMD	2.88W / 240mA	n/a	36
blue	470nm	12V DC	36	40	120°	3528 SMD	2.88W / 240mA	n/a	36

Emeryville, CA 94608
toll free 877.564.5051
fax 510.740.4457

CORONIS™ 240 Waterproof High Output LED Strip Light

EL-12V-COR-240-WP
UL #E348280
Weight per ft.: 1 oz.
Width: 0.4 in.
Depth: 0.2 in.
Chip Spacing: 0.3 in. (between centers)
0.2 in. (between edges)
Cuttable: every 3 chips / 1 in.
Ambient Operating Temp.: -4°F ~176°F (-20°C ~ 80°C)
Fixture Surface Temp.: -4°F ~ 122°F (-20°C ~ 50°C)
Max. length of one run: 20 ft.
UV/IR Radiation: None
Lifespan: 50,000 hours
Warranty: 5 years

CORONIS™ 240 Waterproof High Output LED Strip Light (formerly called High Density Waterproof Flexible LED Strip Light) is a super bright LED strip light with twice as many LED chips as our AURIS™ 115 LED Strip Light, and is ideal for indoor and outdoor use. This UL Listed bulk strip light is sold by the 9.5 foot spool at a discount, and is packed with high power SMD LEDs that make a brighter, cheaper and warmer light than any fluorescent fixture. This LED light provides an adequate level of brightness for most business and home task lighting applications, and is one of our most popular strips.

This energy-efficient outdoor LED strip light is optimal for high traffic indoor home and commercial lighting situations. Its polymer housing protects the strip against liquids, humidity and dust, and can be wiped clean with a sponge. Common applications include:

- Kitchen and bathroom lighting
- Restaurant and bar workspace lighting
- Workshop, garage, and basement lighting
- Decks, patios, greenhouses, and landscaping
- Close application task lighting in high traffic areas
- Interior and exterior sign and signage light

Some of the features of wet location high density CORONIS 240 LED light include:

- UL #E348280
- Rated for use outdoors and in wet locations
- Dimmable with our 12V Dimmable Driver and a 120V AC dimmer
- Dimmable with our REIGN™ Dimmer and our standard 12V Driver
- Energy-efficient, using only 2.88 Watts of electricity per foot
- Low voltage LEDs diminish the chances of electrical shock and fire danger
- Estimated life of 50,000 hours, which is 8 continuous years
- Easy to install, with included mounting clips
- RoHS certified

color	color temp.	voltage	lumens	IP rating	beam angle	chip type	power consumption	CRI	chips / ft.
warm white	2700k	12V DC	240	68	120°	3528 SMD	2.88W / 240mA	75	36
cool white	5000k	12V DC	240	68	120°	3528 SMD	2.88W / 240mA	80	36

MOON_18 scraplights

$485.00

hardwired cord-set, black, 8'

add to cart

[download a MOON_18 spec sheet]

scrap light shades are made entirely from repurposed cardboard boxes. all of our lampshades are handmade and therefore can vary slightly in shape + size. the moon_18 shades are approximately 17.5" in diameter and are spherical in shape. lead time for scrap light orders varies, and is about 4 weeks.

two types of cords are available, both of which are available in black and white colors. hardwired cord-sets are ready to wire and include a 5" diameter ceiling canopy kit in the matching color. plug/switch swag-sets are 15' in length and plug into standard US electrical outlets. they also have a switch integrated into the cord about mid-length.

if you are located outside of the united states or canada, please [contact the nearest distributor] for order inquiries.

The Lighting House
3002 Shelburne Road
Shelburne, VT 05482
Website: www.thelightinghouse.net

Phone: 800-649-2204
Fax: 802-985-8931
Email: vermontlighting@aol.com

6`` cord mount cylinder

Item ID:	**865238**
Finish:	**Antique Bronze**
Height:	**7.38"**
Width/Dia.:	**7.88"**
Price:	**Call for Price**

Features

Additional Information
Weight: **3lb**

Please be advised that all prices and information shown here are subject to verification by ourshowroom personnel. In the event of a discrepancy, we reserve the right to make any correctionsnecessary.

Color: Bronze

SLIM18Y

Full cutoff, fully shielded LED wallpack
Can be used as a downlight or uplight
Contractor friendly features for easy installation
100,000-Hour LED Life
5-Year Warranty

LED Info

Watts:	18W
Color Temp:	3000K (Warm)
Color Accuracy:	82
L70 Lifespan:	100,000
LM79 Lumens:	1,423
Efficacy:	67 LPW

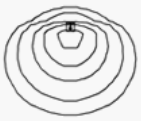
Driver Info

Type:	Constant Current
120V:	0.18A
208V:	0.11A
240V:	0.09A
277V:	0.08A
Input Watts:	21W
Efficiency:	85%

Dimensions

Weight: 4.5 lbs

EZ Layout



Design a custom lighting layout

Technical Specifications

UL Listing:
Suitable for wet locations. Suitable for mounting within 1.2m (4ft) of the ground.

IP Rating:
Ingress Protection rating of IP66 for dust and water.

LED:
Multi-chip, long-life LED.

Lifespan:
100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

Driver:
Constant Current, Class 2, 100-277V, 50/60 Hz., 4KV surge protection, 500mA, 100-240VAC 0.3-0.15 Amps, 277VAC 0.15 Amps, THD<20%, Power Factor 99%.

Input Watts:
21W.

Output Lumens:
1,423.

Color Accuracy (CRI):
82 CRI.

Correlated Color Temp. (Nominal CCT):
3000K.

Cold Weather Starting:
The minimum starting temperature is -40°F/-40°C.

Ambient Temperature:
Suitable for use in 40°C (104°F) ambient temperatures.

Thermal Management:
Superior heat sinking with internal Air-Flow fins.

Housing:
Precision die-cast aluminum housing.

Mounting:
Heavy-duty mounting bracket with hinged housing for easy installation.

Recommended Mounting Height:
Up to 14 ft.

HID Replacement Range:
The SLIM18 can be used to replace 100W MH based on delivered lumens.

Lens:
Tempered glass lens.

Reflector:
Specular thermoplastic.

Gaskets:
High-temperature silicone.

Finish:
Chip and fade resistant polyester powder coat finish.

DLC Listed:
This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.

Dark Sky Approved:
The International Dark Sky Association has approved this product as a full cutoff, fully shielded luminaire.

Color Consistency:
3-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Color Stability:
LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:
RAB's range of CCT (Correlated Color Temperature) follows the guidelines for the American National Standard for Specifications for the Chromaticity of Solid State Lighting (SSL) Products, ANSI C78.377-2011.

Green Technology:
Mercury and UV free, and RoHS compliant.

IESNA LM-79 & LM-80 Testing:
RAB LED luminaires have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have received the Department of Energy "Lighting Facts" label.

Patents:
The design of the SLIM™ is protected by patents pending in US, Canada, China, Taiwan and Mexico.

Country of Origin:
Designed by RAB in New Jersey and assembled in the USA by RAB's IBEW Local 3 workers.

Buy American Act Compliant:
This product is a COTS item manufactured in the United States, and is compliant with the Buy American Act.

Recovery Act (ARRA) Compliant:
This product complies with the 52.225-21 "Required Use of American Iron, Steel, and Manufactured Goods-- Buy American Act-- Construction Materials (October 2010).

Trade Agreements Act Compliant:
This product is a COTS item manufactured in the United States, and is compliant with the Trade Agreements Act.

GSA Schedule:
Suitable in accordance with FAR Subpart 25.4.

ET2 Contemporary Lighting™

Product Specifications for E20263-10

Job Name:	Job Type:
Quantity:	Comments

E20263-10
Hagen LED Pendant

Finish	*Glass/Shade*	*Product Category*
Polished Chrome	Clear	Mini Pendant

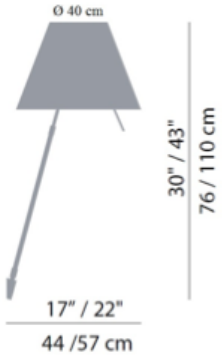
Lamping		*Measurements*		*Shipping*	
Number of Bulb(s)	3	Width	7.00"	Carton Weight	5.06 lb(s)
Light Type	LED	Height	5.50"	Carton Width	6.69"
Bulb Type	LED	Length	N/A	Carton Height	9.65"
Max Bulb Wattage	1	Extension	N/A	Carton Length	9.45"
Max Fixture Wattage	3	Back Plate Width	N/A	Carton Cubic Feet	N/A
Rated Life	±50,000 Hours	Back Plate Height	N/A	Master Pack	6
Rated Lumens	±240	HCO	N/A	Master Pack Weight	34.16 lb(s)
Color Temp	±3,000 K	Min Overall Height	N/A	Master Pack Width	10.24"
Bulb(s) Included	Integrated	Max Overall Height	124.00"	Master Pack Height	20.67"
Light Up/Down	N/A	Hanging Weight	4.30 lb(s)	Master Pack Length	21.50"
Beam Spread	N/A	Height Adjustable	Yes	Master Cubic Feet	N/A
CRI	N/A	Slope	120°	UPS Shippable	Yes
Photo Cell Included	N/A	Chain Length	N/A		
Ballast/Driver/Transformer	Yes	Wire Length	120.00"		
Dimmable	No	Canopy Width	N/A		
		Canopy Height	N/A		
		Canopy Length	N/A		

Certification		*Other*		*Equivalents*	
Safety Rating	Dry	UPC Code	845094018070	Incandescent Watts	21.82
Energy Star	No	Material	N/A	Fluorescent Watts	4.8
CA Title 24	No				
CA Title 20	No				
ADA	No				

253 North Vineland Avenue | City of Industry, California 91746 | 800.486.2946p 800.486.7337f | www.et2online.com

http://www.lightingdeluxe.com/costanza-d13-a-wall-sconce

LightingDeluxe



Costanza D13 a. Wall sconce

The wall sconce Costanza a D13 by Luceplan creates an enchanting light which can be controlled in four steps with a sensor dimmer. The translucent polycarbonate lampshade is combined with an aluminum structure. When touching the shade it elegantly swings back and forth. It is available in many colors and can easily be replaced. Thanks to the telescopic pole, the lamp can also be adjusted in height. This fascinating design was developed by Paolo Rizzatto. A wall mounting box is available upon request and at additional cost. You can beautifully combine this lamp with other lights of the Costanza lighting series.

SKU: 33082

Manufacturer: Luceplan
Designer: Paolo Rizzatto
Country of Origin: Italy
Design: 1986
Delivery scope: excl. bulb
Adjustable: Yes
Security: IP20
Light Emission: uniform
Color structure: aluminium
Special Options: Touch dimmer
Dimensions in cm (WxHxD): Ø 40 cm x 76 cm - 110 cm
Dimensions in inch (WxHxD): Ø 15,75" x 29,92" - 43,31"
Illuminant: 1x150W Medium base incandescent

Price: $494.40

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings. B. Substitutions: See Section 016000 - Product Requirements.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

D. Provide products complying with Federal Energy Management Program (FEMP) requirements.

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

H. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.

2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.

3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

I. Fluorescent Luminaires:

1. Where applicable, luminaires shall be HPT8 with Super T8 lamps.

2. Provide ballast disconnecting means complying with NFPA 70 where required.

3. Fluorescent Luminaires Controlled by Occupancy Sensors: Provide programmed start ballasts.

J. LED Luminaires: Listed and labeled as complying with UL 8750.

1. Provide LED luminaires that meet Premium requirements of Efficiency Vermont.

2.03 BALLASTS

A. All Ballasts:

1. Provide ballasts containing no polychlorinated biphenyls (PCBs).

2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

3. Ballasts shall be Nema premium per Efficiency Vermont.

B. Fluorescent Ballasts:

1. All Fluorescent Ballasts: Unless otherwise indicated, provide high frequency electronic ballasts complying with ANSI C82.11 and listed and labeled as complying with UL 935.

a. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 10 percent.

b. Total Harmonic Distortion: Not greater than 10 percent.

c. Power Factor: Not less than 0.98.

d. Ballast Factor: Low ballast factor between 0.75 and 0.85, unless otherwise indicated.

e. Thermal Protection: Listed and labeled as UL Class P, with automatic reset for integral thermal protectors.

f. Sound Rating: Class A, suitable for average ambient noise level of 20 to 24 decibels.
g. Lamp Compatibility: Specifically designed for use with the specified lamp, with no visible flicker.
h. Lamp Operating Frequency: Greater than 20 kHz, except as specified below.
i. Lamp Current Crest Factor: Not greater than 1.7.
j. Provide automatic restart capability to restart replaced lamp(s) without requiring resetting of power.
k. Provide end of lamp life automatic shut down circuitry for T5 and smaller diameter lamp ballasts.
l. Surge Tolerance: Capable of withstanding characteristic surges according to IEEE C62.41.2, location category A.
m. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 18, for Class B, consumer application.
n. Ballast Marking: Include wiring diagrams with lamp connections.

2. Non-Dimming Fluorescent Ballasts:
a. Lamp Starting Method:
1) T8 Lamp Ballasts: Instant start unless otherwise indicated.
2) T5 Lamp Ballasts: Programmed start unless otherwise indicated.
3) Compact Fluorescent Lamp Ballasts: Programmed start unless otherwise indicated.
b. Lamp Starting Temperature: Capable of starting standard lamp(s) at a minimum of 0 degrees F, and energy saving lamp(s) at a minimum of 60 degrees F unless otherwise indicated.

2.04 LAMPS

A. All Lamps:
1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards. Fluorescent lamps shall be "super T8" with premium ballasts per Efficiency Vermont requirements.
4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

2.05 ACCESSORIES

A. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of luminaires provided under this section.
B. Install products according to manufacturer's instructions.
C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
E. Suspended Ceiling Mounted Luminaires:
    1. Do not use ceiling tiles to bear weight of luminaires.
    2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
    3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
    4. Secure pendant-mounted luminaires to building structure.
    5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
    6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
    7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
F. Recessed Luminaires:
    1. Install trims tight to mounting surface with no visible light leakage.
G. Suspended Luminaires:
    1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
    2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
    3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
I. Install accessories furnished with each luminaire.
J. Bond products and metal accessories to branch circuit equipment grounding conductor.
K. Exit Signs:
    1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
    2. Install lock-on device on branch circuit breaker serving units.
L. Fluorescent Emergency Power Supply Units:
    1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install on top of luminaire.

2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
3. Install lock-on device on branch circuit breaker serving units.

M. Remote Ballasts: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.

N. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.06 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 00 00
TELE/DATA SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following types of control and signal transmission media:
   1. Coaxial cable.
   2. Twisted-pair cable.

B. Related Sections include the following:
   1. Division 26 Section "Electrical General Provisions" for building wire used for control or signal circuits.
   2. Division 26 Section "Conductors and Cables" for building wire used for control or signal circuits.

1.03 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.04 SUBMITTALS

A. Product Data: For control/signal transmission media.

B. Product Certificates: Signed by manufacturers of transmission media certifying that the products furnished comply with requirements and that they are have been coordinated with and accepted by manufacturer of connected equipment.

C. Samples of each of the following cable types for approval:
   1. Optical fiber riser cables.
   2. Composite copper and optical fiber cables.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Maintenance Data: For transmission media to include in the maintenance manuals specified in Division 1.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain all cable of each type through one source from a single manufacturer.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

C. Comply with NFPA 70.

1.06 COORDINATION

A. Coordinate with and obtain review of cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.

PART 2 PRODUCTS

2.01 CAT5e Cable

GigaBase 350 CAT5e, 350-MHz Solid Bulk Cable (UTP)

The backbone of your CAT5e channel

- This cable is part of our ETL Verified GigaBase® CAT5e channel solution.
- Sweep tested and characterized to 350 MHz.
- Guaranteed to meet or exceed ANSI/TIA/EIA-568-C.2 CAT5e specs.
- Every master pull box is tested for electrical performance.
- Easy-to-use pull box features Accu-Pull Measuring System.
- Cable is marked in descending two-foot increments so you always know how much cable is in the box.
- Low attenuation and power-sum crosstalk characteristics over an extended frequency range.
- ✦✦WARRANTY — Lifetime

Construction facts

- PVC cable has polyolefin insulation and a flame-retardant jacket.
- The plenum cable has FEP insulation and features a compound jacket that's rated to 32° F (0° C) for low-temperature handling.
- Both have a longitudinal rip cord for easy jacket opening.

Guaranteed for life

- You're covered. We guarantee—for life—this cable and all the products in our GigaBase line.

Proven performance

- InterTek Testing Services/ETL Semko, Inc. conducts quarterly tests on the this cable. (For test results, see **page 3**.)

Applications

- 10/100/1000BASE-T
- 100BASE-VG
- 155-Mbps and 622-Mbps ATM
- T1
- Other high-performance cable applications
  - Backbone
  - Floor-to-floor backbone
  - Horizontal cabling to desktop

Compliance

- TIA/EIA-568-C.2 Category 5e
- EN50173
- EN71-3
- EPA 3050B
- UL® 444; E196163-P, C; Safety Vol.1 Sec. 13; Plenum: also EN71-3
- ETL Verified
- RoHS: 2002/95 EC
- PVC: CMR; CSA, CMG, FT4; Plenum: CMP, FT6

TECH SPECS

AC Leakage Current Throughout Overall Jacket — AC 1500V ≤ 10 mA
ACR (Minimum at 100 m) — 13.3 dB at 100 MHz
Attenuation (Minimum at 100 m) — 22.0 dB at 100 MHz;
32.4 dB at 200 MHz;
44.9 dB at 350 MHz
Cable Type — 4-pair UTP, 300 V
Capacitance Unbalance (Maximum) — 330 pF/100 m (pair to ground)
Capacitance, Mutual (Maximum) — 56 pF/km
Characteristic Impedance — 1–350 MHz: 100 ± 15 ohms
Cold Bend Test — -4° F (-20° C) at 4 hrs; no crack
Conductor — 24 AWG, solid, bare copper
Conductor Resistance (Maximum) — 93.8 ohm/67° F
Dielectric Strength — AC: 1.5 KV/2 sec)
DC Resistance Unbalance (Maximum) — 5%
Delay Skew (Maximum) — 1–350 MHz: 40 nS/100 m
EL-FEXT (Minimum at 100 m) — 23.8 dB at 100 MHz;
17.7 dB at 200 MHz;
12.9 dB at 350 MHz
Input Impedance — 1–100 MHz: 100 ± 15 ohms
Insulation Material —
PVC: HDPE; Thickness" Average and minimum: 0.007";
Diameter: .035" ± 0.0007" (0.89 ± 0.02 mm);
Plenum: FEP; Thickness: average: 0.007", minimum: 0.006"; Diameter: 0.0342"
Insulation Shrinkback — 150 m/m; 249.8° F (121° C) at 1 hr. at 9.5m/m
Jacket — PVC: 0.188" OD; Plenum: FR PVC (low smoke), 0.177" OD
NEXT (Minimum at 100 m) —
35.3 dB at 100 MHz;
30.8 dB at 200 MHz;
27.1 dB at 350 MHz
Outside Diameter — PVC: 0.18" ± 0.007" (.48 ±0.02 cm);
Plenum: 0.17" (0.073 cm)
Propagation Delay — 536 nS/100 m at 350 MHz
PS-ACR (Minimum at 100 m) — PVC: 10.3 dB at 100 MHz
PS-ELFEXT (Minimum at 100 m) — PVC: 20.8 dB at 100 MHz;
14.7 dB at 200 MHz;
9.9 dB at 350 MHz
PS-NEXT (Minimum at 100 m) —
32.3 dB at 100 MHz;
27.8 dB at 200 MHz;
24.1 dB at 350 MHz
Rating Temperature Voltage — 167° F (75° C); 300V
Return Loss — 20.1 dB at 100 MHz
RoHS — Yes
Spark Test — 2.5 KV
Velocity of Propagation (Minimum) — 62.1% at 350 MHz
Weight — 20.9 lb./1000 ft. (9.5 kg/304.8 m)

Item		Blue	Yellow	White	Gray	Violet
GigaBase 350 CAT5e 350-MHz Solid Bulk Cable (UTP), 24 AWG, 4-Pair, Pull Box						
1000-ft. (304.8-m)	PVC	EYN851A-PB-1000	EYN855A-PB-1000	EYN853A-PB-1000	EYN857A-PB-1000	EYN845A-PB-1000
	Plenum	EYN850A-PB-1000	EYN854A-PB-1000	EYN852A-PB-1000	EYN856A-PB-1000	EYN844A-PB-1000

Item		Green	Red	Orange	Black
GigaBase 350 CAT5e 350-MHz Solid Bulk Cable (UTP), 24 AWG, 4-Pair, Pull Box (Continued)					
1000-ft. (304.8-m)	PVC	EYN859A-PB-1000	EYN849A-PB-1000	EYN847A-PB-1000	EYN861A-PB-1000
	Plenum	EYN858A-PB-1000	EYN848A-PB-1000	EYN846A-PB-1000	EYN860A-PB-1000

2.02 Linksys Router

Model:	Linksys E900
Technology:	Wireless-N
Bands:	2.4 GHz
Transmit / receive:	2 x 2
Antennas:	2 internal
USB Port:	No
Ethernet ports x speed:	4 x 10/100
Cisco Connect software:	Yes, but does not include Parental Controls or Guest Access Software
Setup:	Cisco Connect CD Install
Warranty:	2 year hardware limited warranty
OS compatibility:	Windows, Mac
Minimum system requirements:	• **PC:** Wi-Fi enabled PC with CD or DVD drive, running Windows XP SP3, Windows Vista SP1 or later, Windows 7, or Windows 8 • **Mac:** Wi-Fi enabled Mac with CD or DVD drive, running OS X Leopard 10.5 or Snow Leopard 10.6
Internet browser requirements:	• Internet Explorer 7, Safari 4, or Firefox 3 or higher for optional browser-based configuration
Package Contents:	• Linksys E900 Wireless-N300 Router • Quick start guide • CD-ROM with setup software and resources • Ethernet cable • Power adapter

*Maximum performance derived from IEEE Standard 802.11 specifications. Actual performance can vary, including lower wireless network capacity, data throughput rate, range and coverage. Performance depends on many factors, conditions and variables, including distance from the access point, volume of network traffic, building materials and construction, operating system used, mix of wireless products used, interference and other adverse conditions.

This website provides information based on geographic region. This information may contain references or links to products, services or promotions that are not currently available in your country.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine raceways and other elements to receive cables for compliance with requirements for installation tolerances and other conditions affecting performance of transmission media. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 SUMMARY

A. In the specifications below, "horizontal" distribution refers to the cabling which links the individual data jacks with the nearest wire closet.

3.03 CABLES FOR HORIZONTAL DISTRIBUTIONS

A. Each data jack location will be served with (2) Category-6, 4 pair 24 AWG solid BC, UTP cables.

B. All runs from jack to termination panels in the wire closets shall be of length 90 meters or less. This is an absolute requirement. If this length constraint cannot be met, additional wire closets must be provided.Pull cables without exceeding cable manufacturer's recommended pulling tensions. Data UTP cabling shall conform to the following electromagnetic transmission characteristics:

1. Mutual Capacitance, nominal 4.4 nF/100m;
2. DC resistance, 9.4 Ohms/100m;
3. Nominal velocity of propagation, .70c;
4. At 100MHz: attenuation 22dB/100m maximum
   a At 200MHz: attenuation 33dB/100m maximum
   b. At 100MHz: worst pair NEXT 38dB minimum
   c. Maximum Skew: 25ns at 100 meters
5. Input impedance shall be swept out to 350MHz and meet:
   a. 1MHz to 100MHz is 100 ohms +/- 15
   b. 100MHz to 200MHz is 100 ohms +/- 22

C. All runs from jack to termination panels in the wire closets shall be of length 90 meters or less. This is an absolute requirement. If this length constraint cannot be met, additional wire closets must be provided.Pull cables without exceeding cable manufacturer's recommended pulling tensions. Data UTP cabling shall conform to the following electromagnetic transmission characteristics:

1. Mutual Capacitance, nominal 4.4 nF/100m;
2. DC resistance, 9.4 Ohms/100m;
3. Nominal velocity of propagation, .70c;
4. At 100MHz: attenuation 22dB/100m maximum
   a. At 200MHz: attenuation 33dB/100m maximum
   b. At 100MHz: worst pair NEXT 38dB minimum
   c. Maximum Skew: 25ns at 100 meters
5. Input impedance shall be swept out to 350MHz and meet:
   a. 1MHz to 100MHz is 100 ohms +/- 15
   b. 100MHz to 200MHz is 100 ohms +/- 22

D. In addition, Data UTP cabling shall conform to all requirements of the following standards Where transmission requirements in these standards differ from those specified above, cable shall conform to the more stringent requirement:

1. ANSI/TIA/EIA 568-A “Commercial Building Telecommunications Cabling Standard”
2. ANSI/TIA/EIA-569 “Commercial Building Standard for Telecommunications Pathways and Spaces”
3. ANSI/TIA/EIA-607 “Commercial Building Grounding/Bonding Requirements”
4. TIA/EIA-568-A-1 “Propagation and Delay Skew Specification for 100 ohm 4-pair Cabling”
5. ISO/IEC 11801

E. Cable is not required to be plenum-grade flame rating, except where this may be required to conform to fire codes (discretion of builder). If plenum cable is required in any locations, cable must not deviate from above performance specifications
F. Data cable outer jacket Color: Blue.
G. Handling and installation of UTP cabling must be done with care, to preserve its performance characteristics. In particular:
    1. Minimum allowed bend radius is 6 inches
    2. Pulling tension must not exceed manufacturer's recommendations;
    3. Any cable-ties, etc., must not compress the cable sufficiently to visibly deform the outer jacket, or alter the cable's cross-section shape. (Electrical characteristics depend on the geometry of internal cable components.)

3.04 TERMINATIONS FOR HORIZONTAL DISTRIBUTION
A. At each voice/data jack location, each cable shall terminate in an RJ45 standard jack. (Thus each data location will have two RJ45 jacks.)
B. Termination of cable pairs shall conform to TIA/EIA 568-A specifications
C. All termination components shall be certified conformant to Category 6 electrical characteristics, and meet the electrical and mechanical performance requirements of:
    1. ANSI/TIA/EIA-568A
    2. ISO/IEC 11801
    3. IEC 603-7
    4. FCC Part 68 Subpart F
D. Cables shall terminate on a patch panel.
E. There shall be no more than 48 jacks on each patch panel.
F. Final selection of patch panels and jacks (brands and types) is subject to approval by the Owner.

3.05 LABELING AND IDENTIFICATION OF CABLES
A. Jacks within each patch panel are numbered 1 through 48 on each panel.

3.06 FIELD QUALITY CONTROL
A. Testing Agency: Owner will engage a qualified independent testing agency to perform field quality-control testing.
B. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.
C. Copper Cable Testing Procedures: Inspect for physical damage and test cable for continuity and shorts. Use time-domain reflectometer with strip-chart recording capability and anomaly resolution to within 12 inches in runs up to 1000 feet in length. Test cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts.
D. Optical Fiber Cable Testing Procedures: Perform each visual and mechanical inspection and field test, including optional procedures, stated in NETA ATS, Section 7.25. Certify compliance with test parameters and manufacturer's written instructions.
E. Replace malfunctioning cables at Project site, where possible, and retest to demonstrate compliance.

END OF SECTION

SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire alarm system design and installation, including all components, wiring, and conduit.

B. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.

C. Maintenance of fire alarm system under contract for specified warranty period.

1.02 RELATED REQUIREMENTS

A. Section 211300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.

B. Refer to drawings for additional information regarding fire alarm system installations at Middlebury College, including carbon monoxide monitoring.

1.03 REFERENCE STANDARDS

A. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits; 2002 (R2008).

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 72 - National Fire Alarm Code and Signaling Code; 2010.

D. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; 2009.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures. B. Proposal Documents: Submit the following with cost/time proposal:

1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
3. Certification by Contractor that the system design will comply with the contract documents.
4. Proposed maintenance contract.

C. Drawings must be prepared using AutoCAD Release 2004.

1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.

D. Evidence of designer qualifications.

E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:

1. Copy (if any) of list of data required by authority having jurisdiction.
2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
4. System zone boundaries and interfaces to fire safety systems.
5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.

7. List of all devices on each signaling line circuit, with spare capacity indicated.
8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
10. Certification by Contractor that the system design complies with the contract documents.

F. Evidence of installer qualifications.

G. Evidence of instructor qualifications; training lesson plan outline.

H. Evidence of maintenance contractor qualifications, if different from installer. I. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
2. Submit documentation of satisfactory inspections and tests.
3. Submit NFPA 72 "Inspection and Test Form," filled out.

J. Operating and Maintenance Data: demonstration:; have one set available during closeout
1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.
2. Complete set of specified design documents, as approved by authority having jurisdiction.
3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
4. Contact information for firm that will be providing contract maintenance and trouble call-back service.
5. List of recommended spare parts, tools, and instruments for testing.
6. Replacement parts list with current prices, and source of supply.
7. Detailed troubleshooting guide and large scale input/output matrix.
8. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
9. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

K. Project Record Documents: :
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

L. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
3. Certificate of Occupancy.
4. Maintenance contract.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
   1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification
   2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
   3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
   4. Contract maintenance office located within 50 miles of project site.
   5. Certified in the State in which the Project is located as fire alarm installer.

C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.06 WARRANTY

A. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

SMOKE & CO COMBO ALARM

CAT. SC9120B

SEPARATE SMOKE & CO
Combination alarm detects both dangers and eliminates the need for two electrical boxes.

ELECTROCHEMICAL CO SENSOR
Most accurate technology available for detecting carbon monoxide as compared to other sensing technologies.

LATCHING ALARM INDICATOR
Remembers which unit initiated an alarm.

INTELLIGENT SENSING TECHNOLOGY
Microprocessor controlled to reduce the number nuisance alarms.

TWO LOCKING FEATURES
Pins lock battery drawer and/or alarm to base. Perfect for apartment, dormitory or hotel applications.

LIMITED 5 YEAR WARRANTY

IONIZATION

Listed to UL 217 & UL 2034 Standards

BRK®

THE PROFESSIONAL STANDARD

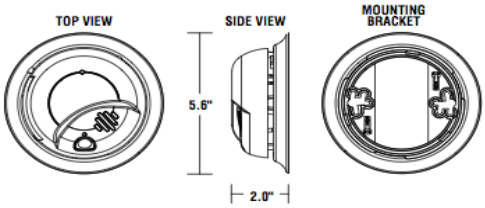
120VAC, 60Hz Wire-in with 9V Battery Backup

Description:

The BRK Brands, Inc. Cat. No SC9120B is a wire-in, 120 VAC 60Hz single and / or multiple station combination smoke and carbon monoxide alarm specifically designed for residential and institutional applications including sleeping rooms of hospitals, hotels, motels, dormitories and other multi-family dwellings as defined in standard NFPA 101 Model SC9120B complies with UL217, UL2034, CSFM, NFPA 72, NFPA 720, HUD, FHA and other agencies that model their codes after the above agencies. They meet building codes where AC/DC smoke and carbon monoxide alarms are required either separately or in combination. The alarms are interconnectable up to 18 devices, of which 12 can be smoke alarms.

The BRK SC9120B features a dual ionization smoke sensing chamber and an electrochemical carbon monoxide sensor, an 85dB horn, 9V battery back-up and a silence feature. "Intelligent Sensing Technology" is designed to reduce nuisance alarms. "Latching Alarm Indicator" remembers which unit initiated an alarm. When interconnected in a series, the unit that triggered the alarm will store in memory or "latch" the information and begin to flash the LED indicator 2 seconds on, 2 seconds off. The "Perfect Mount" system features a gasketless base and a mounting bracket that keeps the alarm secure over a wide rotation range to allow for true alignment. A single button test/silence button eliminates confusion. Battery installation and removal can occur while the unit is mounted to the ceiling or wall via the side load battery compartment. Other Contractor Preferred features include a dust cover to keep alarm clean during construction, keyhole slots in the mounting bracket eliminate the need to remove the electrical box screws for installation. Two locking features are provided to prevent battery theft and/or theft of the unit. Connection to AC power is made with a "Quick-Connect" wiring harness. Installation is quick, easy and cost effective.

CAT. SC9120B



ARCHITECTURAL AND ENGINEERING SPEC

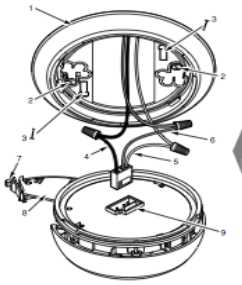
The combination smoke and carbon monoxide alarm shall be a BRK Model SC9120B and shall provide at a minimum the following features and functions:

1. An ionization smoke sensing chamber and an electrochemical CO sensor.
2. Powered by 120V AC, 60Hz and have a monitored 9V battery backup and a solid state piezo horn rated at 85dB at 10 ft. and shall be capable of self restoring.
3. The unit shall perform self diagnostic tests and issue a malfunction warning (three chirps) if the unit malfunctions.
4. A visual power-on indicator to confirm unit is receiving AC power or has switched to battery backup mode. Separate LED 's to indicate a smoke or CO alarm.
5. The CO sensor is adjusted not to detect CO levels below 30 PPM and will not alarm when exposed to constant levels of 30 PPM for 30 days. It will alarm at the following levels: 400 PPM CO between 4 and 15 minutes, 150 PPM CO between 10 and 50 minutes and 70 PPM CO between 60 and 240 minutes.
6. A test/silence button to check all alarm functions and to silence any nuisance alarms. In addition, the unit shall have a low battery silence feature to quiet the low battery chirp for up to eight hours.
7. Two Locking features - tamper resistant locking pins that lock battery drawer and/or alarm to mounting bracket.
8. The unit shall be capable of operating between 40°F (4°C) and 100°F (38°C) and relative humidity between 10% and 95%.
9. The unit shall have a plug in connector and be capable of interconnection of up to 18 alarms, 12 of which can be smoke alarms.
10. The unit shall at a minimum meet the requirements of UL217 and UL2034, CSFM, NFPA 72 and 720 and the ICC.

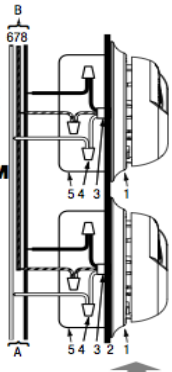
INSTALLATION OF ALARM

Installation of this smoke alarm must conform to all local electrical codes and Article 760 of the National Electrical Code (NFPA 70) and NFPA 72. Interconnected units must meet the following requirements: Total length of wire interconnecting units should be less than 1000 feet, be #18 gauge or larger and be rated at least 300V. It is recommended that all units be on the same fuse or circuit breaker. If local codes do not permit, be sure the neutral wire is common to both phases.

THE PARTS OF THIS SMOKE/CO ALARM



1. Mounting bracket
2. Mounting Slots
3. Locking Pins
4. Hot (Black) AC Wire
5. Nuetral (White) AC Wire
6. Interconnect (Orange) Wire
7. Battery Drawer Latch
8. Battery Drawer - Install 9V battery here
9. Quick-Connect Plug



A. Unswitched 120VAC 60 Hz source
B. To additional units; Maximum = 18 total (Maximum 12 Smoke Alarms)

1. Smoke/CO Alarm
2. Ceiling or Wall
3. Power Connector
4. Wire Nut
5. Junction Box
6. Neutral Wire (White)
7. Interconnect Wire (Orange)
8. Hot Wire (Black)

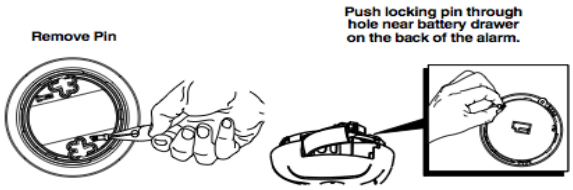
TECHNICAL SPECS

Alarm Dimensions:	5.6" dia x 2.0"H
Weight:	8.5 oz
Operating Voltage:	120V AC 60Hz w/ 9V battery backup
Operating Current:	.09 amps (standby/alarm)
Temperature Range:	40°F (4°C) to 100°F (38°C)
Humidity Range:	10% to 95% relative humidity (RH)
Audio Alarm:	85dB at 10 feet
Test/Silence:	Electronically simulates smoke condition or carbon monoxide condition, causing the unit to alarm Press and hold test/silence button
Alarm Reset:	Automatic when smoke and/or CO clears
Interconnections:	Up to 18 units of First Alert or BRK Smoke, CO and Heat Alarms. Maximum of 12 smoke alarms. See user's manual for details.
Smoke Sensor:	Dual chamber ionization
CO Sensor:	Electrochemical
Indicator Lights/Sounds:	
AC Power:	Constant Green LED
DC Power:	Intermittent Green LED
Local Alarm:	Red LED flashes rapidly
Remote Alarm:	Red LED out.
Alarm Latch:	Red LED flashes every 5 seconds after local alarm stops
Listing:	Listed to UL217 and UL2034 Standards

SHIPPING SPECS:

Individual Carton Dimensions	5.69"L x 2.25"W x 5.59"H
Weight	0.63 lbs.
Cube	0.041 ft3
UPC	0 29054 51306 9
Master Carton Dimensions	14.43"L x 6.19"W x 12.63"H
Master Pack	12
Weight	8.1 lbs.
Cube:	0.65 ft3
I2of5:	100 29054 51306 6
Pallet Information	
Cases per Layer	19
Number of Layers:	3
Cases per Pallet:	57
Units per pallet:	684
Cube:	42.2 ft3
Weight:	464 lbs.

BATTERY DRAWER LOCK



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brkelectronics.com

2.01 MANUFACTURERS

A. Fire Alarm Control Units: BRK Electronics.

B. Initiating Devices, and Notification Appliances:

1. Provide all initiating devices and notification appliances made by the same manufacturer.

C. Substitutions: See Section 016000 - Product Requirements.

1. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with contract documents.

2.02 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new, adressable, automatic fire detection and alarm system:

1. Provide all components necessary, regardless of whether shown in the contract documents or not.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
   a. The Americans With Disabilities Act (ADA).
   b. The requirements of NFPA and the Vermont Fire Code.
   c. The requirements of the local authority having jurisdiction .
   d. Applicable local codes.
   e. The contract documents (drawings and specifications).
   f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Residential Units:
   a. For smoke detector/carbon monoxide operation within the room or suite, initiate sounder base of smoke detector, any strobes, and send signal to main FACP.

B. Supervising Stations and Fire Department Connections:

1. Public Fire Department Notification: Verify requirements with local authorities having jurisdiction..

C. Circuits:

1. Initiating Device Circuits (IDC): Class A, Style D.
2. Signaling Line Circuits (SLC) Within Single Building: Class A, Style 5.
3. Notification Appliance Circuits (NAC): Class A, Style Z.

D. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:

1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
4. Each Computer System: Provide uninterruptible power supply (UPS).

2.03 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
   1. Sprinkler water control valves.
   2. Dry-pipe sprinkler system pressure.
   3. Dry-pipe sprinkler valve room low temperature.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
   1. Sprinkler water flow.

2.04 COMPONENTS

A. General:
   1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
   2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed by Underwriters Laboratories as suitable for the purpose intended.

C. Master Control Unit: As specified for Basis of Design above, or equivalent.

D. Initiating Devices:
   1. Smoke Detectors: 3 .
      a. Provide 1 extra.
   2. Addressable Interface Devices: 0 .

E. Notification Appliances:
   1. Horns: 0 .
      a. Provide 1 extra.
   2. Strobes: 0 .
      a. Provide 1 extra.

F. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

H. Locks and Keys: Deliver keys to Owner.
   1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type

I. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
   1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
   2. Provide one for each control unit where operations are to be performed.
   3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
   4. Provide extra copy with operation and maintenance data submittal.

J. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
   1. Padlock eye and hasp for lock furnished by Owner.
   2. Locate as directed by Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
C. Obtain Owner's approval of locations of devices, before installation. D. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.
B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
E. Provide all tools, software, and supplies required to accomplish inspection and testing. F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
    1. Record all system operations and malfunctions.
    2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
    3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
    4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 Owner PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
    1. Hands-On Instruction: On-site, using operational system.
    2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
    1. Initial Training: 1 session pre-closeout.
C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
    1. Initial Training: 1 session pre-closeout.
D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
    1. Be prepared to conduct any of the required tests.

2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.

B. Occupancy of the project will not occur prior to Substantial Completion.

C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
1. Specified diagnostic period without malfunction has been completed.
2. Approved operating and maintenance data has been delivered.
3. All aspects of operation have been demonstrated to Owner.
4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
5. Occupancy permit has been granted.
6. Specified pre-closeout instruction is complete.

3.05 MAINTENANCE

A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

END OF SECTION

SECTION 32 92 00
EXTERIOR PLANTS

Part 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1, as listed in the table on sheet L-101.

B. Planting Restrictions: All vegetation is potted or in standing planters

C. Maintain trees and shrubs during competition, per plant loan requirements determined by Tree of Life Nursery, San Juan Capistrano, CA.

D. Maintain flower, vegetable, and herb plants up to and during competition, but not less than growing period necessary for healthy, mature plant.

Part 2 - PRODUCTS

2.01 PLANTING MATERIALS

A. Shrub Material: Nursery grown, with healthy root systems, well shaped, fully branched, healthy, and free of insects, eggs, larvae, defects, and disfigurement.

B. Plants: Established and well rooted in pots or similar containers.

2.02 SOIL AND AMENDMENTS

A. Topsoil: ASTM D 5268, with pH range of 5.5 to 7, free of stones 1 inch (25 mm) or larger and other extraneous materials harmful to plant growth.

B. Compost: Well-composted, stable, and weed-free organic matter; pH range of 5.5 to 8.

C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

D. Organic Mulch: shredded hardwood, ground or shredded bark, or pine straw.

2.03 PLANTING SOIL MIX

A. To be used in growing pots for plants. Mix topsoil with the following soil amendments in the following quantities:

B. Ratio of Loose Compost to Topsoil by Volume: 1:4.

C. Ratio of Loose Wood Derivatives to Topsoil by Volume: 1:4.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Planting Bed Establishment (within deck planters): Loosen subgrade to a depth of 4 inches (100 mm) to 14 inches (355 mm), depending on need of plant. Remove stones sticks, roots, and rubbish. Spread planting soil mixture to a depth of 4 inches (100 mm) to 14 inches (355 mm), but not less than required to meet finish grades. Work first layer into top of loosened subgrade. Top with mulch.

B. Shrubs (All potted): Set trees and shrubs along edges of deck structure, in specific locations to be determined. All vegetation will remain in pots/planters at all times. Place according to height and type. Make sure shrubs are on level ground, using wooden props if necessary. Maintain less than 1500 pounds per square foot pressure on ground below. Manage water and drain holes.

C. Set plants into liners according to spacing determined on site. Water after planting. Do not cover plant crowns with wet soil.

D. Mulching: Place newspaper, hay and/or mulch around potted shrubs and plants in their designated spots, and finish level with adjacent finish grades. Do not place mulch against trunks or stems.

3.02 MAINTENANCE

A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, restoring planting saucers, adjusting and repairing, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings.

B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, mulching, and other operations as required to establish healthy, viable plantings.

C. General Irrigation: Vegetation will be irrigated by hand using a watering can filled at the sink. Irrigation requirements will depend on the demand of the plants, and will avoid over-watering to avoid the necessity of draining excess water.

END OF SECTION

SECTION 41 22 00
CRANE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Crane and forklift specifications for assembly and disassembly for heavy lifting.

1.02 RELATED REQUIREMENTS

A. Refer to construction drawings and health and safety plan for additional information regarding crane location and lifting diagrams.

B. See structural calculations that reference the lifting points of panels

1.03 REFERENCE STANDARDS

A. ANSI B30.11 – Rated Load Test

PART 2 PRODUCTS

2.01 Crane: Grove TMS 9000E

A. 110 USt (90 t) capacity

B. 36-142 ft (11.2 - 43.3 m) 5 section full power boom

C. Patented TWIN-LOCK boom pinning system

D. 33 - 56 ft (10 - 17 m) bifold lattice swingaway extension

E. Optional 33 - 56 ft (10 - 17 m) hydraulically offsettable bifold swingaway

F. Optional lattice insert extensions for a 237 ft (72.2 m) maximum tip height

G. Tiltable superstructure cab

H. Up to 48,500 lb (21 300 kg) counterweight with hydraulic removal system

I. Cummins ISM 450 07, 6-cylinder turbocharged aftercooled 450 hp (336 kW) engine

2.02 Superstructure Details of Crane

* Offsettable Lattice Extension

33 ft - 56 ft (10 m - 17 m) bifold lattice swingaway extension hydraulically offset from 5° - 40°. Controlled from the crane cab. Maximum tip height: 207 ft (63.1 m).

* Lattice Jib Extensions

Two 16 ft (5 m) inserts for use with lattice swingaway extension to increase length up to 72 ft (21.9 m) or 88 ft (26.8 m).
Maximum tip height: 237 ft (72.2 m)

Load Moment & Anti-Two Block System

Load moment and anti-two block system with audio/visual warning and control lever lockout provides electronic display of boom angle, length, radius, tip height, relative load moment, maximum permissible load, load indication and warning of impending two-block condition.

Cab

All aluminum construction cab with acoustical lining is hydraulically tiltable to +20° and includes tinted safety glass, adjustable operator's seat with hydraulic suspension, sliding windows in side and cab rear, hinged front window with wiper, sun visor and window shade. Other features include diesel heater/defroster, armrest integrated crane controls, and ergonomically arranged instrumentation.

Crane Control System

Full control of all crane movements using electrical control levers with automatic reset to zero. Controls are integrated with the LMI and engine management system by CAN-BUS. ECOS system with graphic display.

Superstructure

Boom

37 ft. - 142 ft. (11.2 m - 43.2 m) five section, full power boom with TWIN-LOCK™ boom pinning system. Maximum tip height: 150 ft (45.8 m).

Boom Nose

Five nylatron sheaves, mounted on heavy duty tapered roller bearings with removable pin-type rope guards. Quick reeve boom nose. Removable auxiliary boom nose with removable pin type rope guard.

Boom Elevation

Single lift cylinder with safety valve provides boom angle from -3° to +82°.

Offsettable Lattice Extension

33 ft. - 56 ft. (10 m - 17 m) bifold lattice swingaway extension manual offset at 0°, 20°, and 40°.
Maximum tip height: 207 ft (63.1 m).

2 separate circuits, 1 axial piston variable displacement pump (load sensing) with electronic power limiting control and 1 gear pump for swing.
2 thermostatically controlled oil coolers keep oil at optimum operating temperature.
Tank capacity: 134 gallons. (508 l)

Hoist

Main and auxiliary hoists are powered by axial piston motor with planetary gear and brake. "Thumb-thumper" hoist drum rotation indicator alerts operator of hoist movement.

Hoist Line Pull:
1st Layer: 22,122 lb (10034 kg)
3rd Layer: 18,665 lb (8466 kg)
5th Layer: 16,142 lb (7322 kg)

Maximum Line Speed:
365 fpm (111 m/min)

Maximum Permissible Line Pull:
15,700 lb (7621 kg.) Casar Eurolift
Optional 17,160 lb (7784 kg.) 35X7 Flex-x

Rope Diameter:
3/4" (19 mm)

Rope Length:
738 ft (225 m) Casar Eurolift
702 ft (214 m) 35X7 Flex-x

Maximum Rope Storage:
984 ft (300 m)

Denotes optional equipment

Swing

Two planetary gear boxes with axial piston fixed displacement motors. Infinitely variable to 1.7 rpm. Holding brake and service brake.

Counterweight

16,000 lb (7258 kg) consisting of various sections with hydraulic installation/removal system operated from the cab.

*Optional "Heavy Lift" counterweight package consisting of (2) 10,000 lb (4636 kg) sections in addition to standard, for a total of 36,000 lb (16329 kg).

*Optional "XL" counterweight package consisting of (2) 4,000 lb (1814 kg) and (2) 2,250 lb (1021 kg) wing sections in addition to standard and "Heavy Lift" package, for a total of 48,500 lb (21300 kg).

Hydraulic System

TEREX

ROUGH TERRAIN CRANE
RT 780

DATASHEET - IMPERIAL

RT 780

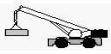
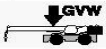
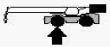
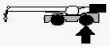
Features:

- Rated capacity:
  80 ton @ 10 ft working radius
- Maximum boom length:
  126 ft
- Maximum tip height:
  190 ft

WORKS FOR YOU.™

KEY

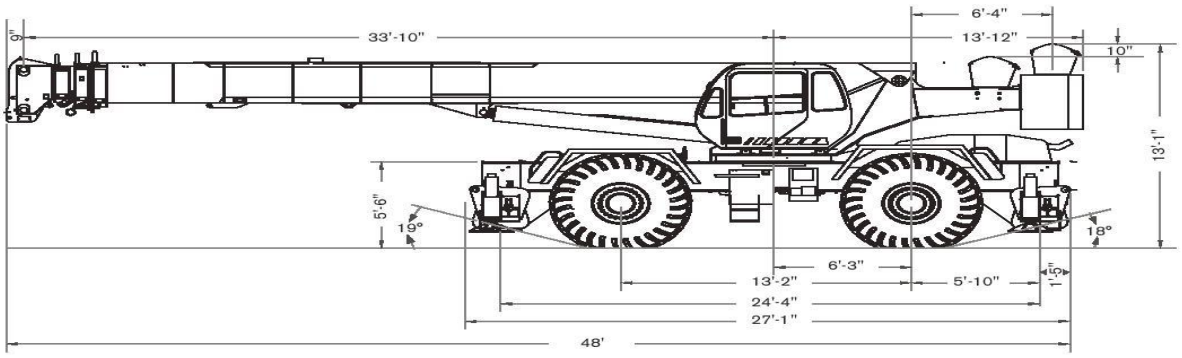
RT 780

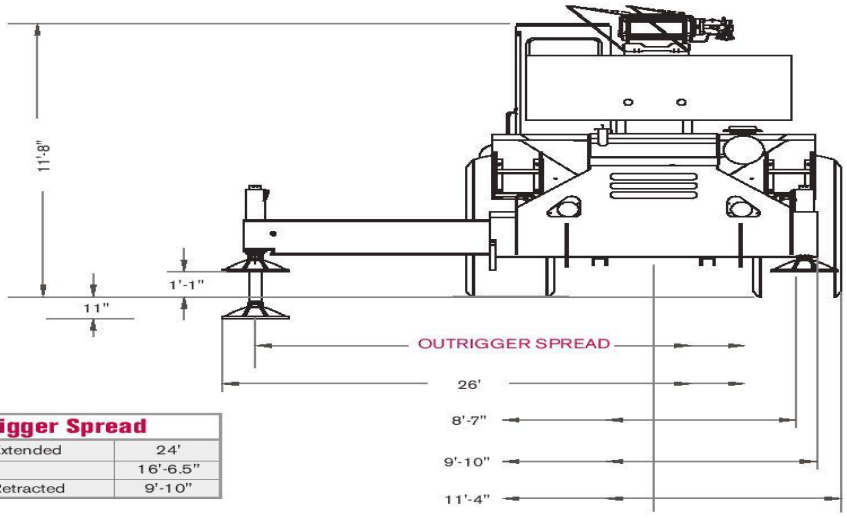
	Counterweight		General performance
	Main boom		Telescoping mode
	Boom length		Boom luffing angle
	Tip height		Working radius
	Boom with extension		Max. boom length with extension
	Main boom with aux head		Distance from the hook to the head sheave pin
	Slewing / Allowable slewing range		Slewing locked / Slewing locked at specified position
	Slewing brake		Slewing gears
	Outriggers / Lifting on outriggers (100/50/0% extended)		Lifting on wheels / Pick & Carry
	Main hoist		Auxiliary hoist
	Hoist speed		Rope length
	Rope – Standard / Optional		Max. line pull
	Rope diameter		Tire
	Hook block		Controls
	Cab		Engine
	Operator aids / Load limiter / Load indicator		Steering
	Mechanical transmission		Speed
	Hydraulics		Heating / Air conditioning
	Working temperature		Gradeability
	Lights		Gross vehicle weight
	Crane / Crane in standard configuration		Weight on front axle
	Crane without counterweight		Weight on rear axle

3

CRANE DIMENSIONS

RT 780





Outrigger Spread	
Fully Extended	24'
Half	16'-6.5"
Fully Retracted	9'-10"

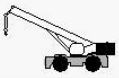
TEREX

4

CRANE WEIGHTS

RT 780

Approximate Weights

		GVW		
	STD	91,216 lb	47,047 lb	44,169 lb
	Add / Subtract for main optional equipment			
	33 ft to 57 ft swing on jib stowed	+ 2,170 lb	+ 3,992 lb	- 1,822 lb
	Auxiliary boom head	+ 125 lb	+ 406 lb	- 281 lb
	Auxiliary hoist*	+ 134 lb	- 35 lb	+ 159 lb
	5 sheaves, 75T	+ 1,608 lb	+ 3,447 lb	- 1,839 lb
	5 sheaves, 60T	+ 1,204 lb	+ 2,581 lb	- 1,377 lb

NOTE: Values are subject to 2% variation

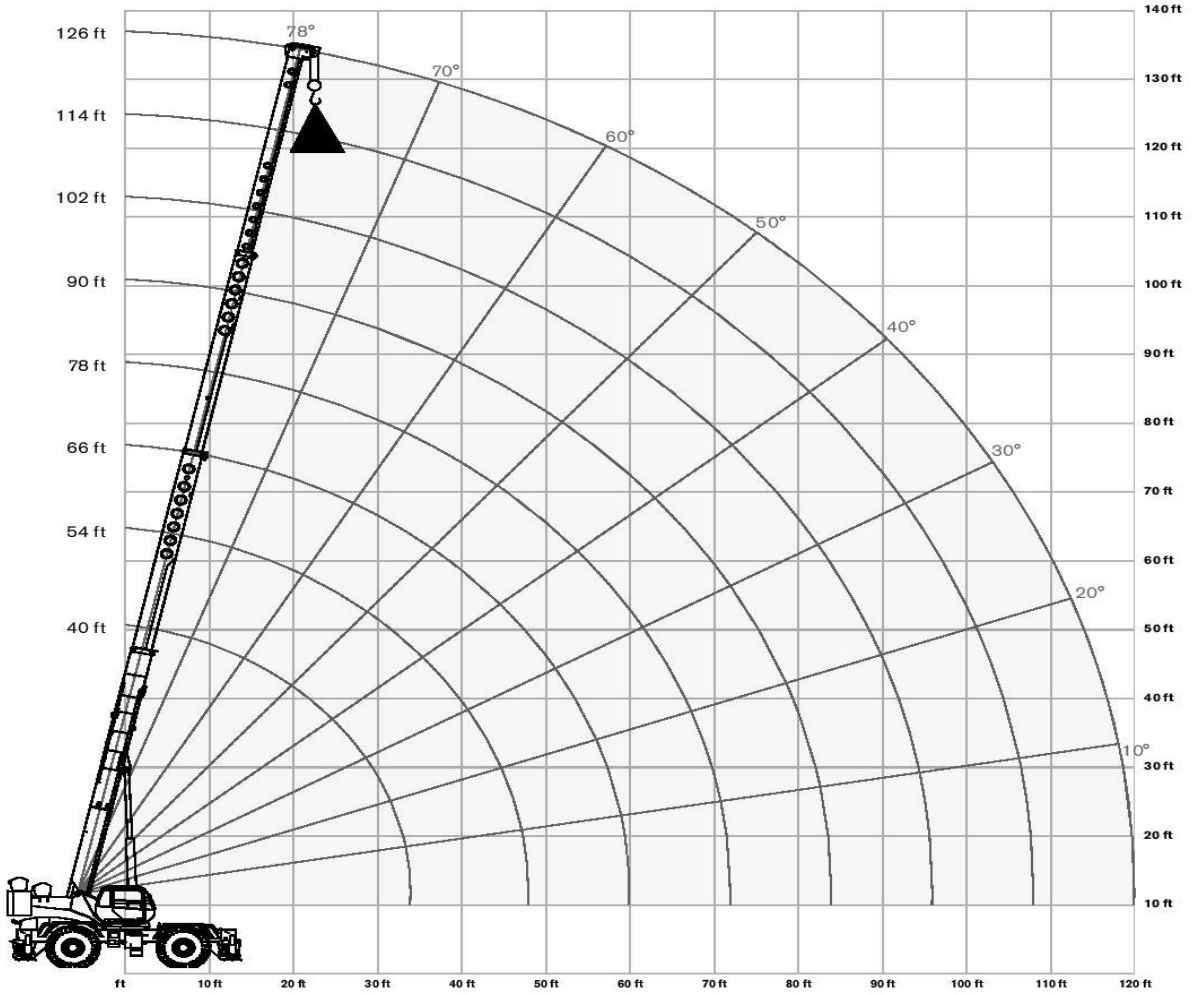
* Weight includes rope

RANGE DIAGRAM - MAIN BOOM

RT 780

Outriggers Fully Extended (100%)

with hook block:
6 ft 9 in



TEREX

6

LOAD CHART - MAIN BOOM

RT 780

Outriggers Fully Extended (100%)

15,200 lbs counterweight | Outriggers extended 24 ft (100%) | 360 degree rotation | Standard ASME B30.5

	Boom Length								
	40 ft	54 ft	66 ft	78 ft	90 ft	102 ft	114 ft	126 ft	
ft	lb	lb	lb	lb	lb	lb	lb	lb	ft
10	160,000	102,500							10
12	125,600	102,500							12
15	108,800	100,500	80,600						15
20	84,700	85,300	71,900	62,200	56,200				20
25	65,600	66,700	64,800	55,700	48,000	41,900			25
30	49,200	50,500	51,000	49,700	41,700	36,400	31,500		30
35		37,700	38,200	38,500	36,600	32,100	29,500	24,700	35
40		29,400	29,900	30,200	30,400	28,600	26,200	24,600	40
45		23,500	24,100	24,400	24,600	24,700	23,500	22,100	45
50			19,800	20,200	20,300	20,500	20,600	20,000	50
55			16,400	16,900	17,100	17,200	17,300	17,400	55
60				14,200	14,500	14,600	14,700	14,800	60
65				12,100	12,300	12,500	12,600	12,700	65
70				10,300		10,800	10,900	10,900	70
75						9,200	9,400	9,400	75
80						7,900	8,100	8,200	80
85						6,800	6,900	7,100	85
90						5,800	6,000	6,100	90
95						4,900	5,100	5,200	95
100							4,300	4,400	100
105							3,600	3,700	105
110								3,100	110
115								2,500	115

Notes to lifting capacity

Lifting capacities do not exceed 85% of tipping load. Weight of hook blocks and slings is part of the load, and is to be deducted from the capacity ratings. Consult operation manual for further details.

Note: Data published herein is intended as a guide only and shall not be construed to warrant applicability for lifting purposes. Crane operation is subject to the computer charts and operation manual both supplied with the crane.

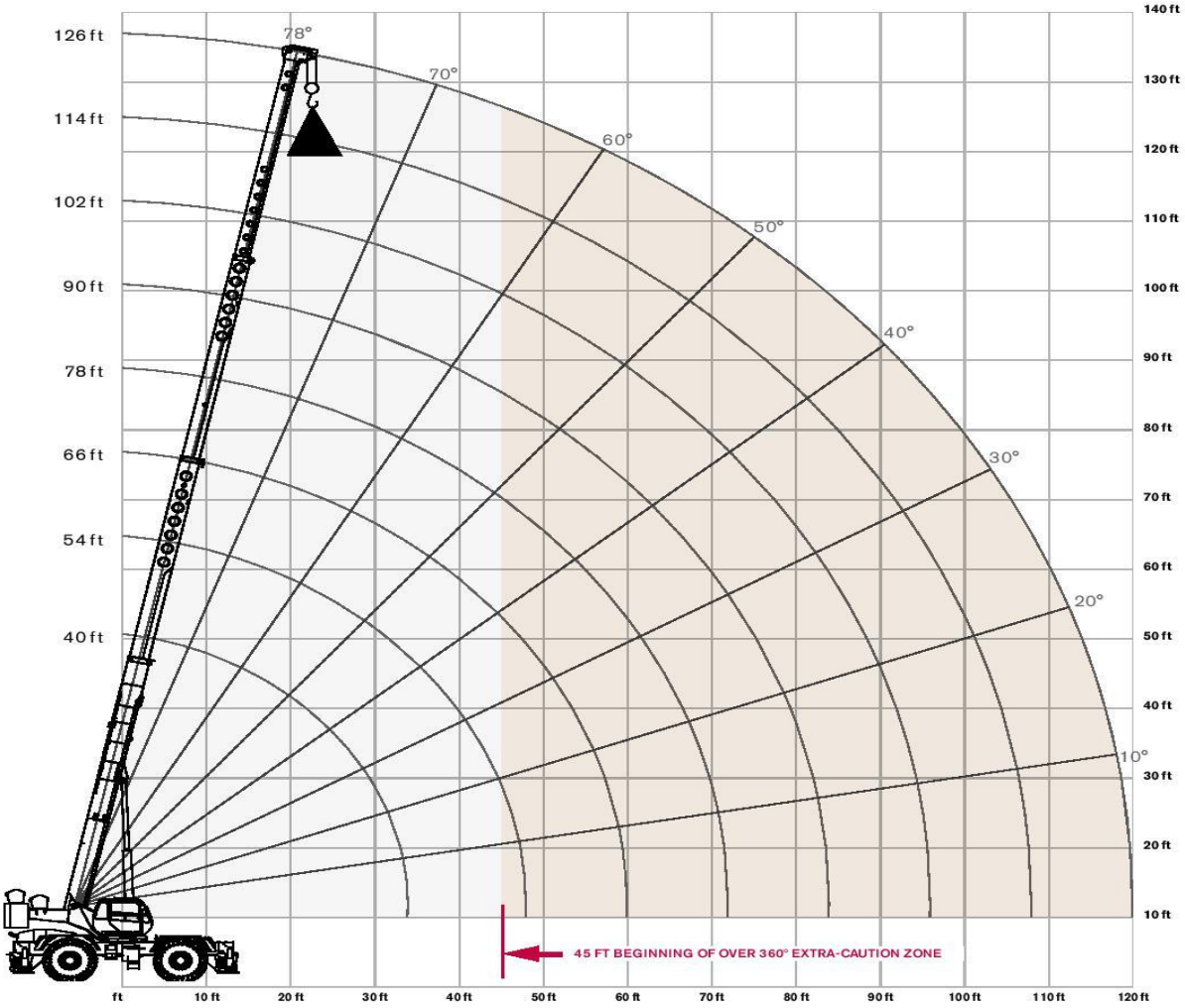
7

RANGE DIAGRAM - MAIN BOOM

RT 780

Outriggers Fully Retracted (0%)

with hook block:
6 ft 9 in



TEREX

8

LOAD CHART - MAIN BOOM

RT 780

Outriggers Fully Retracted (0%)

15,200 lbs counterweight

Outriggers retracted 9 ft 10 in (0%)

360 degree rotation

Standard ASME B30.5

	Boom Length								
	40 ft	54 ft	66 ft	78 ft	90 ft	102 ft	114 ft	126 ft	
ft	lb	lb	lb	lb	lb	lb	lb	lb	ft
10	84,500	85,600							10
12	59,300	60,300							12
15	39,300	40,400	40,800						15
20	23,200	24,300	24,800	25,000	25,200				20
25	14,900	16,000	16,500	16,800	17,000	17,000			25
30	9,800	10,900	11,400	11,800	12,000	12,000	12,100		30
35		7,500	8,000	8,400	8,600	8,600	8,800	8,900	35
40		5,000	5,600	5,900	6,100	6,100	6,300	6,500	40
45		3,200	3,700	4,000	4,300	4,300	4,500	4,700	45
50							3,000	3,300	50

Notes to lifting capacity

Lifting capacities do not exceed 85% of tipping load. Weight of hook blocks and slings is part of the load, and is to be deducted from the capacity ratings. Consult operation manual for further details.

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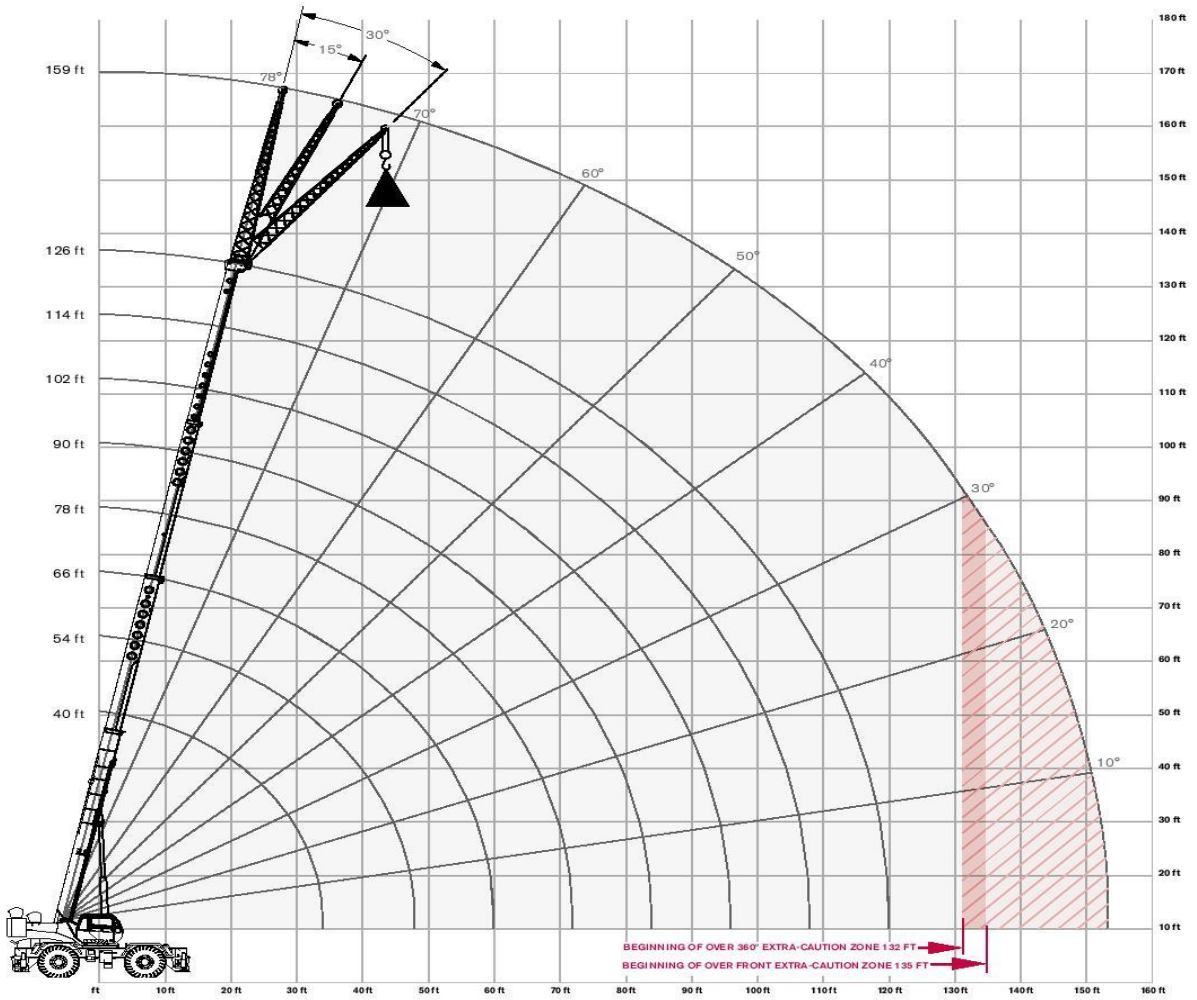
9

RANGE DIAGRAM - MAIN BOOM

RT 780

With Jib, 33 ft offset

with hook block:
6 ft 9 in



TEREX

10

LOAD CHART - MAIN BOOM

RT 780

With Jib, 33 ft offset

15,200 lbs counterweight | Outriggers extended 24 ft (100%) | 360 degree rotation | Standard ASME B30.5

33 ft Offsettable Jib					
0° Offset		15° Offset		30° Offset	
Radius (ft)	lbs	Radius (ft)	lbs	Radius (ft)	lbs
41	12,500	50	8,500	57	6,400
47	12,000	56	8,100	62	6,200
52	11,500	61	7,800	67	6,100
58	10,900	67	7,500	72	5,900
66	9,900	74	7,100	79	5,900
74	9,200	81	6,700	86	5,600
81	8,600	88	6,400	93	5,400
88	7,300	95	6,200	99	5,300
97	5,700	103	5,200	107	5,200
105	4,500	111	4,200	114	4,300
113	3,600	117	3,400	120	3,500
120	2,900	124	2,700	126	2,800
127	2,200	131	2,000	132	1,900
135	1,600	138	1,400	138	1,100

Notes to lifting capacity

Lifting capacities do not exceed 85% of tipping load. Weight of hook blocks and slings is part of the load, and is to be deducted from the capacity ratings. Consult operation manual for further details.

Note: Data published herein is intended as a guide only and shall not be construed to warrant applicability for lifting purposes. Crane operation is subject to the computer charts and operation manual both supplied with the crane.

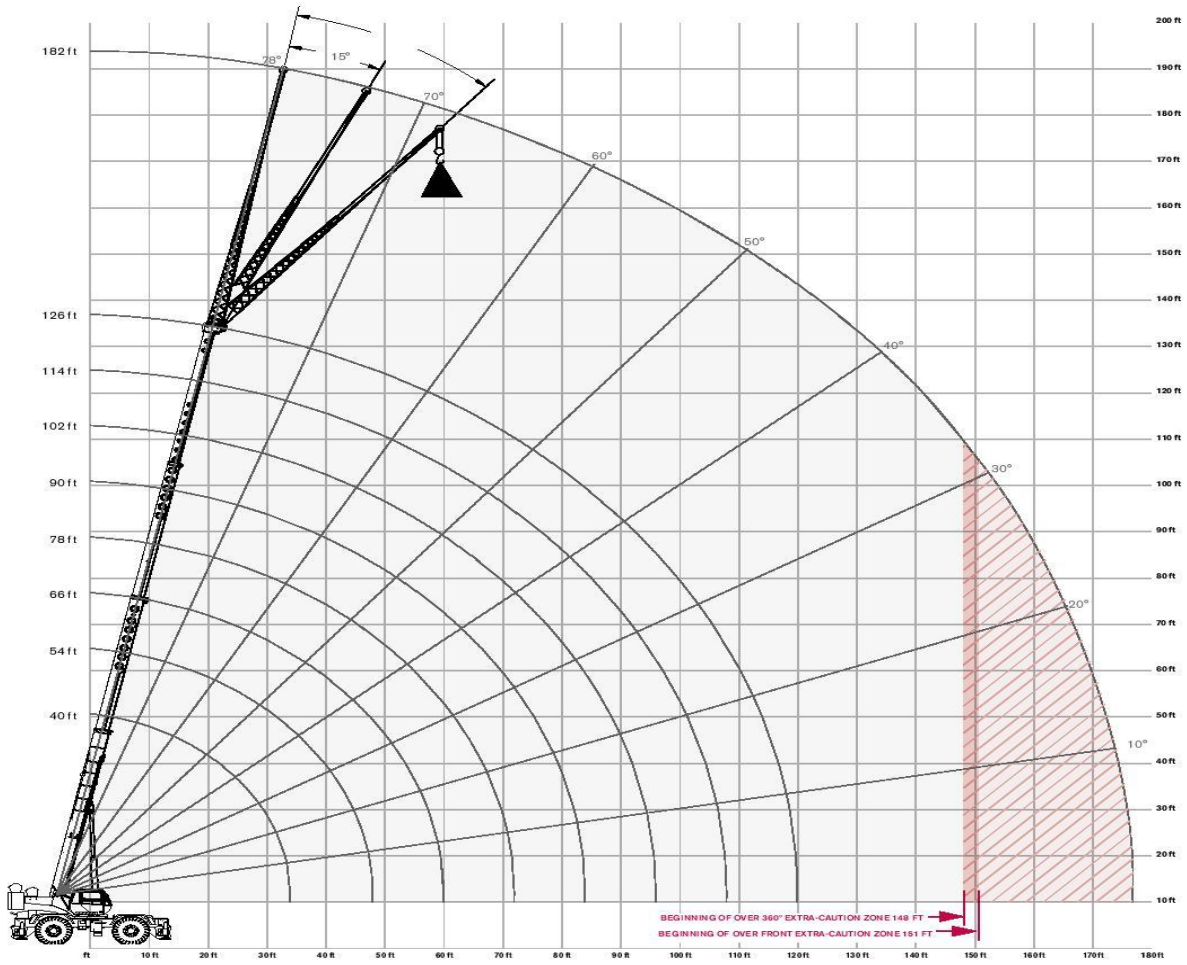
11

RANGE DIAGRAM - MAIN BOOM

RT 780

With Jib, 57 ft offset

with hook block:
6 ft 9 in



TEREX

12

LOAD CHART - MAIN BOOM

RT 780

With Jib, 57 ft offset

15,200 lbs counterweight | Outriggers extended 24 ft (100%) | 360 degree rotation | Standard ASME B30.5

57 ft Offsettable Jib					
0° Offset		15° Offset		30° Offset	
Radius (ft)	lbs	Radius (ft)	lbs	Radius (ft)	lbs
48	6,500	66	4,500	75	3,300
56	6,400	72	4,300	81	3,200
63	6,200	77	4,100	87	3,100
70	6,000	83	3,900	92	3,000
80	5,400	91	3,700	100	2,900
90	4,900	99	3,500	108	2,800
98	4,500	106	3,300	115	2,700
106	4,200	114	3,100	121	2,600
116	3,800	123	2,900	129	2,500
125	3,500	132	2,800	137	2,500
133	2,800	140	2,600	143	2,400
140	2,200	147	2,100	149	2,000
148	1,600	154	1,500	155	1,500
157	1,000	161	1,000	162	1,000

Notes to lifting capacity

Lifting capacities do not exceed 85% of tipping load. Weight of hook blocks and slings is part of the load, and is to be deducted from the capacity ratings. Consult operation manual for further details.

Note: Data published herein is intended as a guide only and shall not be construed to warrant applicability for lifting purposes. Crane operation is subject to the computer charts and operation manual both supplied with the crane.

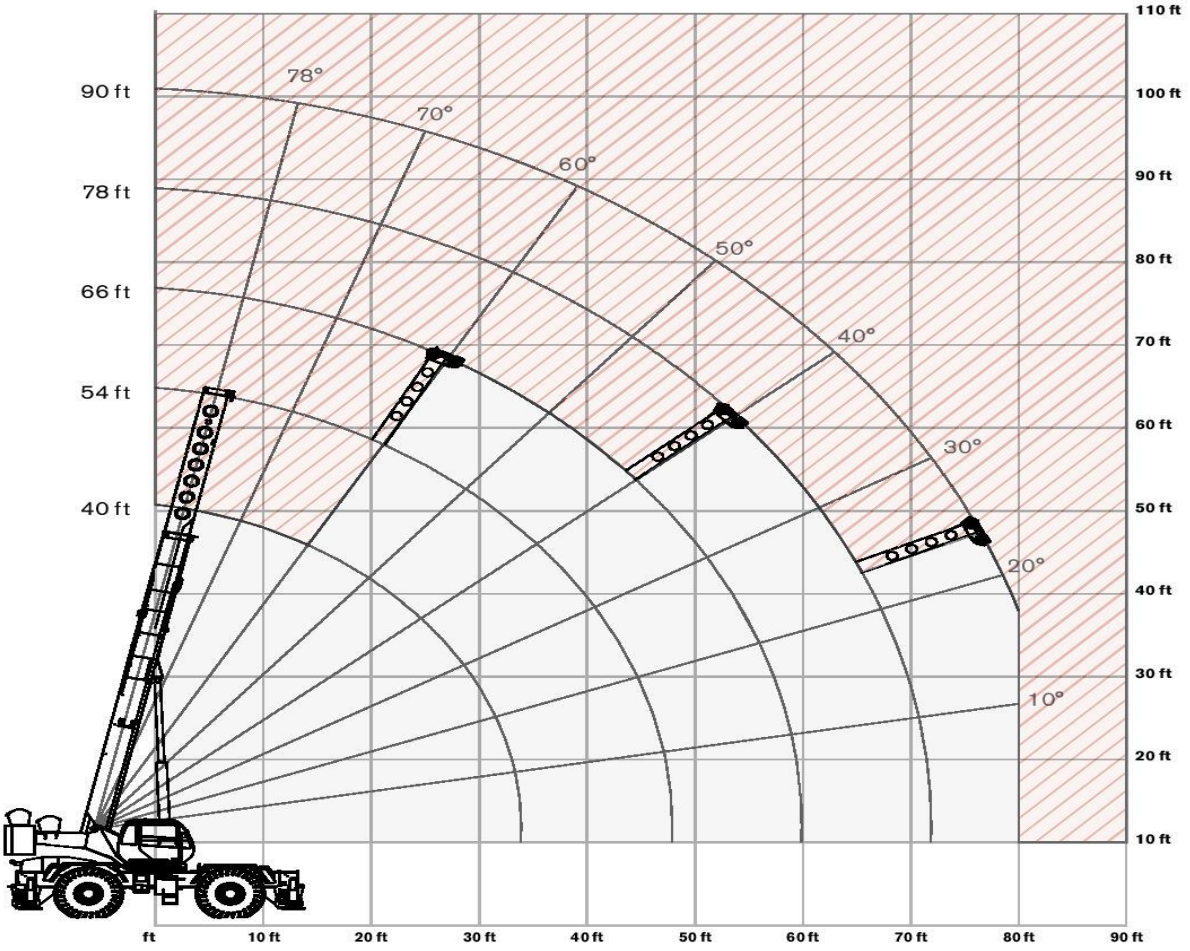
13

RANGE DIAGRAM - MAIN BOOM

RT 780

On Tires

with hook block:
6 ft 9 in



TEREX

14

LOAD CHART - MAIN BOOM

RT 780

On Tires

15,200 lbs counterweight

360 degree rotation

On tires 29.5 X 25-28PR

Standard ASME B30.5

Boom		Travel Speed Boom straight over front		
Radius	Length	0 mph	Creep	2.5 mph
ft	ft	lb	lb	lb
10	40	82,700	68,700	51,800
12	40	69,800	60,400	45,300
15	40	54,200	50,700	37,600
20	40	36,000	36,000	28,700
25	54	24,900	24,700	22,500
30	54	18,200	18,200	17,800
35	54	14,200	14,200	14,200
40	66	11,600	11,600	11,100
45	66	9,600	9,600	9,000
50	66	7,900	7,900	7,900
55	78	6,300	6,300	6,300
60	78	4,900	4,900	4,900
65	78	3,300	3,300	3,300
70	90	3,100	3,100	3,100
75	90	2,700	2,700	2,700
80	90	2,200	2,200	2,200

Notes to lifting capacity

Lifting capacities do not exceed 75% of tipping load. Weight of hook blocks and slings is part of the load, and is to be deducted from the capacity ratings. Consult operation manual for further details.

Note: Data published herein is intended as a guide only and shall not be construed to warrant applicability for lifting purposes. Crane operation is subject to the computer charts and operation manual both supplied with the crane.

TECHNICAL DESCRIPTION

RT 780

Boom

Standard configuration:	
4 sections hydraulic actuated boom	
Full power mechanically synchronized	
Min. / Max.	40 ft / 126 ft
Boom elevation angle range (min. / max.)	-4° / 78°
Optional configuration:	
Single sheave	
One section, side stowable, with pull out insert Angular offsets	33 ft / 57 ft 0, 15 and 30 degrees
Jib with pull out extended	190 ft

Hoist, Rope and Hook

Standard configuration:	
Grooved drum Storage capacity	 561 ft
Two speed ratios Without load in 5th layer (low range / high range) Without load in 1st layer (low range / high range)	 275 ft/min / 489 ft/min 191 ft/min / 341 ft/min
6 x 19 IWRC XIPS, right regular lay, preformed	
	3/4 in
	600 ft
Max. line pull; 1st layer low-range Max. line pull permissible	18,450 lb 13,800 lb

TEREX

16

TECHNICAL DESCRIPTION

RT 780

Optional configuration:	
5 sheaves	60 ton
5 sheaves	80 ton
Grooved drum	
Storage capacity	591 ft
Without load in 5th layer (maximum)	489 ft/min
Rotation resistant compacted strand 34X7	
	3/4 in
	600 ft
Minimum breaking strength	69,000 lbs
Permissible line pull	13,800 lbs

Superstructure

Standard configuration:	
Non stop	360°
Maximum rotation speed without load	2.2 rpm
Hydraulic motor	
Planetary reducer	
Manually actuated by foot pedal	
360° house lock	

Cab, Controls, Operator aids and Load limiter / Load indicator

Standard configuration:
Sliding door
Hinged, tinted all glass skylight
Six way adjustable seat
Armrest mounted dual axis electro-proportional joysticks
Steering wheel column with gear selector on the left and directional light selector on the right
Dashboard mounted switches for outrigger operation
Graphic interface for load indicator

17

TECHNICAL DESCRIPTION

RT 780

Optional configuration:

Hydraulic powered air conditioner
Hydraulic powered heater
Work lights
Rotating beacon

Carrier, Engine, Drive-line and Hydraulic system

Standard configuration:

Hydraulic, independent extension:

Diameter of outrigger pads	24 in
Area of outrigger pads	452 in²

Cummins QSB6.7 6 cylinders

Rated power	275 hp @ 2500 rpm
Maximum gross torque	750 ft·lb @ 1,500 rpm
Intake: turbocharger with intercooler	
Fuel type	
Diesel	
Fuel tank capacity	80 gallons

6 x 6 powershift transmission with torque converter
Selectable 4WD (Four-Wheel Drive)
Rigid mounted front axle
Oscillating rear axle
Differential lock on front and rear axles
Rear axle oscillation lock - manual or automatic actuation
Air-over-hydraulic disc brakes
Front axle parking brake
Hydraulic oil cooler

Hydraulic power steering
Front wheel steering
Four wheel steering concentric
Four wheel steering crab

Hydraulic Pumps:

Tandem pumps:	
Boom lift / Telescope	57.8 gal/min @ 4,500 psi
Power steering / Outriggers and swing	42.1 gal/min @ 4,500 psi
Single pump:	
Main and auxiliary hoist pump	52.7 gal/min @ 4,500 psi

Hydraulic oil reservoir capacity	178 gallons
Hydraulic oil suction filter	250 microns
Hydraulic oil return filter	5 microns

TEREX

TECHNICAL DESCRIPTION

RT 780

Vehicle performance

	Standard configuration:	
	Max. in 1st gear Max. in 6th gear	98.9% 3%
	Max. (6th gear)	25 mph

Tires

	Standard configuration:	
	Wide tread - Earth mover pattern	29.5 X 25-28PR

19

2.03 Carrier Details of Crane

Carrier

Chassis
Triple box section, four-axle carrier, fabricated from high strength, low alloy steel with towing and tie-down lugs.

Outrigger System
Four hydraulic telescoping, two-stage, double box beam outriggers with inverted jack and integral holding valves. Quick release type outrigger floats 24 in. (610 mm) diameter. Three position setting with fully extended, intermediate (50%) extended and fully retracted capacities. Maximum outrigger pad load: 109,000 lbs. (49 442 kg).

Outrigger Controls
Located in the superstructure cab and on either side of carrier. Crane level indicators located at all stations. Auto leveling standard.

Engine
Cummins ISM450 07 six cylinder, turbo-charged and after cooled diesel engine, 661 cu. in. (10.8 L), 450 bhp (336 kW) (gross) @ 2000 RPM. Maximum torque 1,440 ft. lbs. (1952 Nm) @ 1400 RPM.
Equipped with engine compression brake, audio-visual engine distress system and ether cold start aid.

Fuel Tank Capacity
100 gallons (376 L).

Transmission
Roadranger 11 speeds forward, 3 reverse.

Steering
Front axle, single circuit, mechanical steering with hydraulic power assist. Turning radius: 45.1 ft.

Axles
Front: (2) beam-type steering axles, 83.4 in. (2.12 m) track.
Rear: (2) single reduction drive axles, 74.5 in. (1.89 m) track. Inter-axle differential locks.
Drive: 8 x 4 x 4.

Brakes
S-cam, dual air split system operating on all wheels. Spring-applied, air released parking brake acting on rear axles. Air dryer. ABS with traction control.

Suspension
Front: Walking beam with air bags and shock absorbers.
Rear: Walking beam with air bags and shock absorbers.

Tires
Front: 445/65R 22.5 tubeless, mounted on aluminum disc wheels.
Rear: 315/80R 22.5 tubeless, mounted on aluminum disc outer wheels, inner wheels steel.

Lights
Full lighting package including turn indicators, head, tail, brake, and hazard warning lights.
Meets FMVSS and CMVSS standards.

Cab
One man design, aluminum fabricated with acoustical lining and tinted safety glass throughout. Deluxe fabric covered seat with air adjustment . Complete driving controls and engine instrumentation including tilt telescope steering wheel, tachometer, speedometer, voltmeter, water temp., oil pressure, fuel level, air pressure gauge, engine high temp./low oil pressure A/V warning. Other standard items include hot heater, heater/defroster, electric windshield wash/wipe, fire extinguisher, seat belt and door lock.

Electrical System
Four maintenance-free batteries provide 24 V electrical system. Standard battery disconnect.

Maximum Speed
65 MPH (105 kph).

Gradeability (Theoretical)
70%.

Miscellaneous Standard Equipment
Aluminum fenders with rear storage compartments; dual rear view mirrors; electronic back-up alarm; sling/tool box; tire inflation kit; air cleaner restriction indicator; headache ball stowage; aluminum wheels;

* Optional Equipment
*Flashing Light Package (Includes amber strobe for superstructure and carrier cab)
*Air conditioning
*Dual boom base mounted floodlights
*Aircraft warning light
*Hookblocks
*Pintle hook (rear)
*Trailing Boom Package
*Aluminum outrigger pads
*Air horn
*Counterweight packages
*Tow cable
*Wind speed indicator
*Winterfront radiator cover
*Additional storage
*Counterweight slings

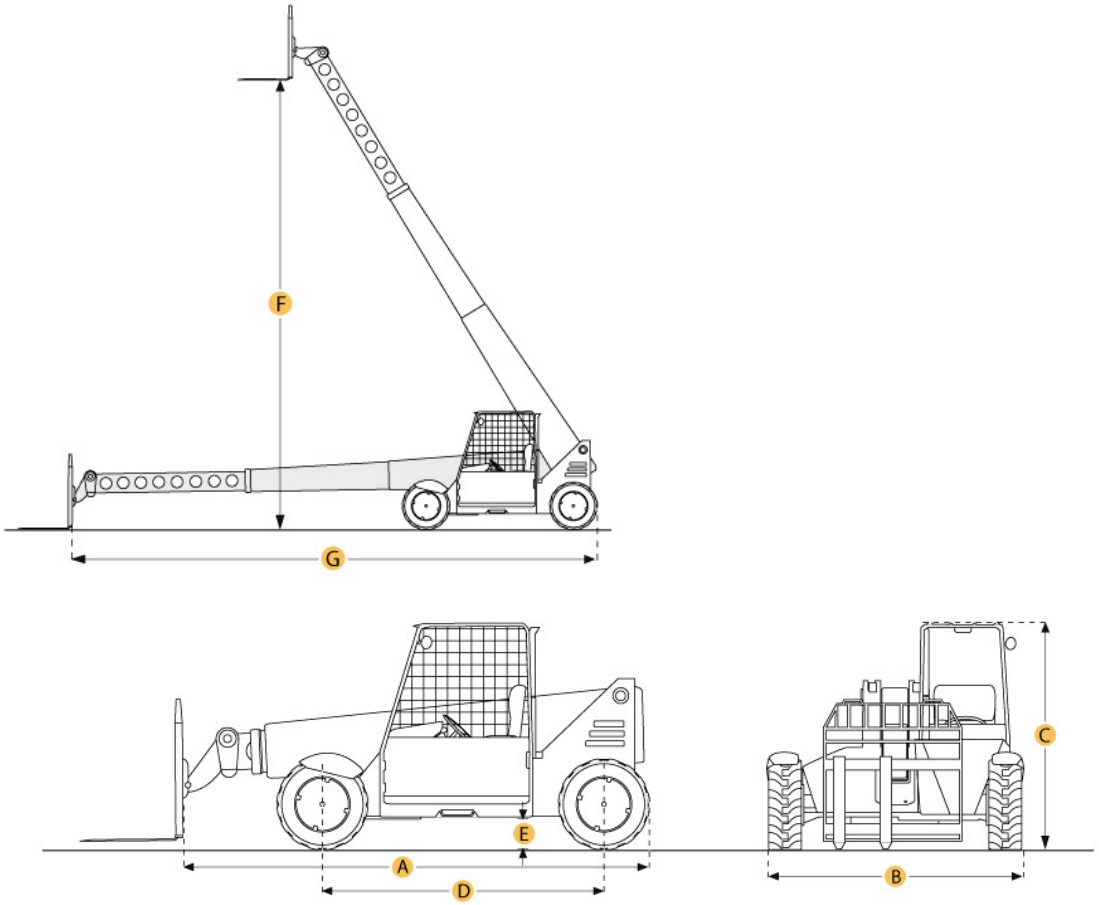
*Denotes optional equipment

2.04 Telescope Forklift - Model: John Deere e 4045TF275

Specification		
Engine		
MAKE	John Deere	
MODEL	e 4045TF275	
GROSS POWER	114 hp	85 kw
MAX TORQUE	2500 lb ft	3389.5 Nm
DISPLACEMENT	274.6 cu in	4.5 L
NUMBER OF CYLINDERS	4	
Operational		
OPERATING WEIGHT	31349.7 lb	14220 kg
FUEL CAPACITY	38 gal	144 L
HYDRAULIC SYSTEM FLUID CAPACITY	33.5 gal	127 L
OPERATING VOLTAGE	12 V	
ALTERNATOR SUPPLIED AMPERAGE	95 amps	
DRAWBAR PULL	21700 lb	9843 kg
TIRE SIZE	14.00x24	
Transmission		
TYPE	modulated powershift	
NUMBER OF FORWARD GEARS	4	
NUMBER OF REVERSE GEARS	3	
MAX SPEED - FORWARD	21.7 mph	35 km/h
Hydraulic		
PUMP TYPE	load sensing dual gear	
Lift		
MAX LIFT CAPACITY	10000 lb	4535.9 kg
MAX LIFT HEIGHT	54.1 ft in	16500 mm
MAX LOAD AT MAX HEIGHT	4000 lb	1814.4 kg
MAX FORWARD REACH	44.9 ft in	13700 mm
MAX LOAD AT MAX REACH	1500 lb	680.4 kg
Dimensions		
LENGTH TO FORK FACE	20.5 ft in	6240 mm
WIDTH OVER TIRES	8.4 ft in	2570 mm
OVERALL HEIGHT	8.1 ft in	2460 mm
WHEELBASE	10.3 ft in	3140 mm
GROUND CLEARANCE	16 ft in	406 mm
TURNING RADIUS OUTSIDE TIRES	14.2 ft in	4320 mm

Selected Dimensions		
Dimensions		
A. LENGTH TO FORK FACE	20.5 ft in	6240 mm
B. WIDTH OVER TIRES	8.4 ft in	2570 mm
C. OVERALL HEIGHT	8.1 ft in	2460 mm
D. WHEELBASE	10.3 ft in	3140 mm
E. GROUND CLEARANCE	16 ft in	406 mm
Lift		
F. MAX LIFT HEIGHT	54.1 ft in	16500 mm
G. MAX FORWARD REACH	44.9 ft in	13700 mm

2.5 Forklift Images



PART 3 - EXECUTION

3.01 Installation

A. Ensure and assess safety of construction workers on site before beginning operation.

END OF SECTION

SECTION 48 10 00
ELECTRICAL POWER GENERATION EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Generator Specifications

PART 2 - PRODUCTS

2.01 Generator/Light Tower Model: GNRK10/ GNRL 6000

A. 4kW Light Tower Diesel Generator

B. Rated Voltage: 220V (1phase)

C. Noise Level at 7m: 70dB(A)

D. Parameters

	Model	GNRL5000	GNRL6000	GNRL20000
Mast & Lamp	Max. extension of mast	4.8m	9m	9m
	Stages	2	3	3
	Total power of lamps	4*400W	4*1000W	4*1000W
	Light capacity	4*250000 lumen	4*110000lumen	4*110000lumen
	Lifetime of lamp	2000 hours	5000 hours	5000 hours
Generator	Model	GNRD6500I	GNRK10	GNRP20
	Rated Power	50Hz 4.2kw	50Hz 6.0kw	50Hz 20kw
		60Hz 5.0kw	60Hz 8.0kw	60Hz 23kw
	Standby Power	50Hz 4.5kw	50Hz 7.0kw	50Hz 22kw
		60Hz 5.5kw	60Hz 9.0kw	60Hz 25kw
	Engine model	RP186FA	Kubota D1105-BG	Perkins 1003G
	Fuel tank capacity	16L	100L	120L
	Prime fuel consumption	≤1.65L/h	≤2.0L/h	≤5.25L/h
Trailer	Stabilizer Support	4*manual	5*manual	5*manual
	Tire Size	Diameter=25cm	Diameter=25cm	Diameter=25cm
	Anti-wind capacity	≤6	≤10	≤10
Dimension	Dimension(mm)	1300*840*2600	4400*1200*1930	4400*1450*2100
	Net Weight	350kg	870kg	1950kg

PART 3 - EXECUTION

3.01 Operation

A. Operate generator according to instruction manual and rental agreement.

END OF SECTION