



TENNESSEE
US DOE SOLAR DECATHLON 2011

UNIVERSITY OF TENNESSEE, KNOXVILLE
1715 VOLUNTEER BLVD, ROOM 313, KNOXVILLE, TN 37996
865.974.5211 | LIVLIGHT@UTK.EDU

PROJECT MANUAL

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON 2011

As-Built Document

August 11, 2011



UNIVERSITY OF TENNESSEE, KNOXVILLE

1715 Volunteer Blvd, Room 313

Knoxville, TN 37996

865.974.5211 | livlight@utk.edu

<http://www.livinglightutk.com>

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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.

February 4, 2011 - Revision

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

- The following sections have been updated

00 73 43	06 10 00	07 42 23	11 30 00	21 40 00	23 37 00	26 05 19	26 31 00
01 10 00	06 15 33	08 43 13	11 52 00	22 11 16	23 37 12	26 05 26	26 50 00
01 50 00	06 20 13	08 80 00	12 21 13	22 12 00	23 72 00	26 24 16	
01 53 00	06 41 00	08 91 00	12 36 00	22 14 00	23 81 00	26 27 13	
05 12 00	06 42 00	09 54 00	14 83 16	23 07 00	25 11 00	26 27 26	
05 40 00	07 13 00	11 28 13	21 13 00	23 31 00	26 05 00	26 28 13	

March 22, 2011 - Revision

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

- The Structural Calculations have been updated to reflect competition organizer comments from the 11/23/2010 submission.
- The following specification sections have been updated:

00 01 15	06 10 00	08 44 13	11 28 13	22 13 36 ADD	26 05 26	26 33 13	
05 12 00	06 60 00	09 64 00	11 30 00	22 13 53	26 24 16	26 50 00	
05 73 00	07 21 00	10 82 00 DEL	11 52 00	25 11 00	26 27 26		

May 03, 2011 - Revision

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

- The Structural Calculations have been updated to reflect competition organizer comments from the 02/22/2011 submission.
- The following specification sections have been updated:

01 50 00	06 15 22	06 42 00	09 54 00	21 40 00	22 14 00	26 05 26	
05 12 00	06 20 13	07 27 00	09 64 00	22 12 00	22 41 00	26 27 26	

06 14 13 06 41 00 07 42 23 12 21 13 22 13 53 26 05 00 26 50 00

August 11, 2011 - Revision

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

- Stamped Structural Sketches for Steel Cribbing Fabrication and Roof Tie Off Anchors
- Revision of the Living Light Energy Analysis and Discussion
- The following specification sections have been updated:

01 53 00 07 72 00 09 91 00 12 36 00 23 31 00 26 05 19 26 50 00

06 10 00 08 70 00 11 28 13 22 11 16 23 37 00 26 05 26

06 41 00 08 91 00 11 31 00 22 41 00 23 81 00 26 27 29

06 42 00 09 64 00 12 21 13 23 23 00 25 11 00 26 33 13

Rules Compliance Checklist

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	"O" Series
Rule 4-2	Construction Equipment	Specifications for heavy machinery	Section 14 83 16
Rule 4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	G-104 Section 26 05 26
Rule 4-4	Impact on the Turf	Drawing(s) showing the location, contact area, and soil-bearing pressure of every component resting directly on the turf	C102
Rule 4-5	Generators	Specifications for generators	Section 01 50 00
Rule 4-6	Spill Containment	Drawing(s) showing the locations of all equipment, containers, and pipes that will contain liquids at any point during the event	P101, M101, O Series
Rule 4-6	Spill Containment	Specifications for all equipment, containers, and pipes that will contain fluids at any point during the event	Section 07 63 23 Section 14 83 16 Section 21 13 00 Section 21 30 00 Section 21 40 00 Division 22 Section 23 00 00 Section 23 23 00
Rule 4-7	Lot Conditions	Calculations showing that the structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	See Structural Calculation Submittal 3/22/11
Rule 4-7	Lot Conditions	Drawing(s) showing shimming methods and materials to be used if 18 in. (45.7 cm) of vertical elevation change exists on the lot	G-501
Rule 5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	G-201
Rule 5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	N/A

Rule 6-1	Structural Design Approval	List of, or marking on, all drawing and project manual sheets that 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	00 01 15
Rule 6-2	Finished Square Footage	Drawing(s) showing all information needed by the rules officials to measure the finished square footage electronically	G101
Rule 6-2	Finished Square Footage	Drawing(s) showing all movable components that may increase the finished square footage if operated during contest week	N/A
Rule 6-3	Entrance and Exit Routes	Drawing(s) showing the accessible public tour route and the ground surface area that will be covered by organizer-provided walkway material	G103
Rule 7-1	Placement	Drawing(s) showing the location of all vegetation and, if applicable, the movement of vegetation designed as part of an integrated mobile system	L-101, L-104, L-105
Rule 7-2	Watering Restrictions	Drawing(s) showing the layout and operation of greywater irrigation systems	N/A
Rule 8-1	PV Technology Limitations	Specifications for photovoltaic components	Section 26 31 00
Rule 8-3	Batteries	Drawing(s) showing the location(s) and quantity of all primary and secondary batteries and stand-alone, PV-powered devices	L-101, E-101, A-402, T-501
Rule 8-3	Batteries	Specifications for all primary and secondary batteries and stand-alone, PV-powered devices	Section 26 33 13 Section 26 50 00
Rule 8-4	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	N/A
Rule 8-4	Desiccant Systems	Specifications for desiccant system components	N/A
Rule 8-5	Village Grid	Completed interconnection application form.	Project Manual Page 19
Rule 8-5	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	G-104; C-104; "E" Series
Rule 8-5	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	Division 26 Division 48
Rule 8-5	Village Grid	One-line electrical diagram	E-601
Rule 8-5	Village Grid	Calculation of service/feeder net computed load per NEC 220	E-603

Rule 8-5	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	G-103, G-104 C-103, L-101
Rule 8-5	Village Grid	Elevation(s) showing the meter housing, main utility disconnect, and other service equipment	L-201; E-201
Rule 9-1	Container Locations	Drawing(s) showing the location of all liquid containers relative to the finished square footage	P-101
Rule 9-1	Container Locations	Drawing(s) demonstrating that the primary supply water tank(s) is fully shaded from direct solar radiation between 9 a.m. and 5 p.m. EDT or between 8 a.m. and 4 p.m. solar time on October 1	G-901; L-201; L-507; P-101
Rule 9-2	Team-Provided Liquids	Quantity, specifications, and delivery date(s) of all team-provided liquids for irrigation, thermal mass, hydronic system pressure testing, and thermodynamic system operation	N/A
Rule 9-3	Greywater Reuse	Drawing(s) showing the layout and operation of greywater reuse systems	N/A
Rule 9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	P-101; P-903
Rule 9-6	Thermal Mass	Drawing(s) showing the locations of liquid-based thermal mass systems	N/A
Rule 9-6	Thermal Mass	Specifications for components of liquid-based thermal mass systems	N/A
Rule 9-7	Greywater Heat Recovery	Drawing(s) showing the layout and operation of greywater heat recovery systems	N/A
Rule 9-8	Water Delivery	Drawing(s) showing the complete sequence of water delivery and distribution events	"O" Series
Rule 9-8	Water Delivery	Specifications for the containers to which water will be delivered	Section 21 40 00 Section 22 12 00 Project Manual Appendix
Rule 9-9	Water Removal	Drawing(s) showing the complete sequence of water consolidation and removal events	"O" Series
Rule 9-9	Water Removal	Specifications for the containers from which water will be removed	Section 21 40 00 Section 22 12 00 Section 22 13 53 Section 22 14 00 Project Manual Appendix
Rule 11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	G-103

Structural Calculations

Load Data

The structural loads were developed in accordance with the 2006 International Building Code and the 2011 USDOE Solar Decathlon Building Code.

Dead Loads

Floors:	25 psf
Roof:	25 psf
Curtain Wall:	200 plf

Live Loads

Floors:	50 psf
Roof:	20 psf

Transportation Loads

Traveling speed (V):	65 mph (service wind load controls)
Acceleration and deceleration:	1 g

Snow Loads

Ground snow load (P_g):	15 psf
Flat roof snow load (P_f):	15 psf
Snow exposure factor (C_e):	0.9
Importance factor (I_s):	1
Thermal factor (C_t):	1

Wind Loads

Basic wind speed (V):	90 mph
Importance factor (I_w):	1
Exposure category:	C
Velocity pressure exposure coefficient (K_z):	0.9
Topographic factor (K_{zt}):	1.0
Wind directionality factor (K_d):	0.85
External pressure coefficient (GC_{pf}):	0.4 for zone 1 and 0.61 for zone 1E 0.43 for zone 4 and 0.29 for zone 4E 0.45 for zones 5 and 6
Internal pressure coefficient (GC_{pi}):	± 0.18
Force on MWFRS ($q_z = q_h$):	9.2 psf for zone 1 12.5 psf for zone 1E 9.7 psf for zone 4 7.5 psf for zone 4E 10 psf for zones 5 and 6

Seismic Loads

Maximum seismic spectral acceleration at 0.2 seconds (S_s):	1.0
Maximum seismic spectral acceleration at 1 second (S_1):	0.3
Design spectral response acceleration factor at short period (S_{ds}):	0.676
Design spectral response acceleration factor for 1-second period (S_{d1}):	0.3
Importance factor (I_e):	1.0
Site class:	C
Occupancy category:	II
Seismic design category:	D
Seismic response coefficient (C_s):	0.208
Design base shear (V):	17 kip
Response Modification Factor (R):	$3\frac{1}{4}$
System over strength factor (Ω_0):	2
Deflection amplification factor (C_d):	$3\frac{1}{4}$
Basic structural system:	Building Frame
Seismic resisting system:	Ordinary Steel Concentrically Braced Frame
Analysis by:	Equivalent Lateral Force

Re-evaluation required if located in the following 14 Tennessee Counties:

Carroll, Crockett, Dyer, Fayette, Gibson, Haywood, Henry, Lake, Lauderdale, Madison, Obion, Shelby, Tipton, and Weakley

Load Combinations (LRFD)

1.	1.4(D)
2.	1.2(D) + 1.6(L) + .5(L_r)
3.	1.2(D) + 1.6(L_r) + (L or W)
4.	1.2(D) + 1.6(W) + L + .5 (L_r)
5.	1.2(D) + 1(E) + L
6.	.9(D) + 1.6(W)
7.	(1.2 + 0.2 S_{ds})D + ρ E + L
8.	(.9 - 0.2 S_{ds})D + ρ E

Specifications
Deflection Criteria

Floor and roof:	L/240
Exterior beams at glass:	L/600

Member Analysis

W12 x 19 - Beam

Governing load case is during transportation

Critical Loads:

$$P_u = 0.1 \text{ kip, Compression}$$

$$M_{u,y} = 7.5 \text{ k-ft}$$

$$M_{u,x} = 20.8 \text{ k-ft}$$

Design Strength:

$$\phi P_n = 218 \text{ kip, Compression}$$

$$\phi M_{n,y} = 10.7 \text{ k-ft}$$

$$\phi M_{n,x} = 92.6 \text{ k-ft}$$

Critical Equation: H1-1b

$$(P_u / 2\phi P_n) + (M_{u,y} / \phi M_{n,y}) + (M_{u,x} / \phi M_{n,y}) = .924$$

W12 x 26 - Beam

Governing load case is during transportation

Critical Loads:

$$P_u = 119 \text{ kip, Compression}$$

$$M_{u,y} = 3.3 \text{ k-ft}$$

$$M_{u,x} = 66.5 \text{ k-ft}$$

Design Strength:

$$\phi P_n = 257 \text{ kip, Compression}$$

$$\phi M_{n,y} = 30 \text{ k-ft}$$

$$\phi M_{n,x} = 133 \text{ k-ft}$$

Critical Equation: H1-1a

$$(P_u / \phi P_n) + (8/9)[(M_{u,y} / \phi M_{n,y}) + (M_{u,x} / \phi M_{n,y})] = 1.0$$

Deflection (Δ): L/1700

W14 x 22 - Beam

Governing load case is during transportation

Critical Loads:

$$P_u = 26 \text{ kip, Compression}$$

$$M_{u,y} = 10.3 \text{ k-ft}$$

$$M_{u,x} = 3.2 \text{ k-ft}$$

Design Strength:

$$\phi P_n = 235 \text{ kip, Compression}$$

$$\phi M_{n,y} = 15.8 \text{ k-ft}$$

$$\phi M_{n,x} = 124.5 \text{ k-ft}$$

Critical Equation: H1-1b

$$(P_u / 2\phi P_n) + (M_{u,y} / \phi M_{n,y}) + (M_{u,x} / \phi M_{n,y}) = .924$$

Deflection (Δ): L/1700

HSS 12 x 6 x 5/16 - Beam

Governing load case is during transportation

Critical Loads:

$$\begin{aligned}
 P_u &= 0.26 \text{ kip, Compression} \\
 T_u &= 5.8 \text{ k-ft} \\
 V_u &= 33 \text{ kip} \\
 M_{u,y} &= 10.3 \text{ k-ft} \\
 M_{u,x} &= 3.2 \text{ k-ft}
 \end{aligned}$$

Design Strength:

$$\begin{aligned}
 \phi P_n &= 235 \text{ kip, Compression} \\
 \phi T_n &= 80.3 \text{ k-ft} \\
 \phi V_n &= 81.9 \text{ kip} \\
 \phi M_{n,y} &= 15.8 \text{ k-ft} \\
 \phi M_{n,x} &= 124.5 \text{ k-ft}
 \end{aligned}$$

Critical Equation: H3-6

$$[(P_u/\phi P_n) + (M_{u,y}/\phi M_{n,y}) + (M_{u,x}/\phi M_{n,x})] + [(T_u/\phi T_n) + (V_u/\phi V_n)]^2 = .71$$

HSS 12 x 8 x 5/8 - Beam

Governing load case is during transportation

Critical Loads:

$$\begin{aligned}
 P_u &= 0.86 \text{ kip, Compression} \\
 T_u &= 6.1 \text{ k-ft} \\
 V_u &= 4.8 \text{ kip} \\
 M_{u,y} &= 12.6 \text{ k-ft} \\
 M_{u,x} &= 153 \text{ k-ft}
 \end{aligned}$$

Design Strength:

$$\begin{aligned}
 \phi P_n &= 794 \text{ kip, Compression} \\
 \phi T_n &= 147 \text{ k-ft} \\
 \phi V_n &= 491 \text{ kip} \\
 \phi M_{n,y} &= 181 \text{ k-ft} \\
 \phi M_{n,x} &= 228 \text{ k-ft}
 \end{aligned}$$

Critical Equation: H3-6

$$[(P_u/\phi P_n) + (M_{u,y}/\phi M_{n,y}) + (M_{u,x}/\phi M_{n,x})] + [(T_u/\phi T_n) + (V_u/\phi V_n)]^2 = .74$$

HSS 4 x 0.220 – Diagonal Brace

Governing load case is during transportation

Critical Loads:

$$P_u = 33.4 \text{ kip, Compression}$$

Design Strength:

$$\phi P_n = 33.5 \text{ kip, Compression}$$

Critical Equation: HSS Compression

$$P_u/\phi P_n = .99$$

W12 x 19 - Column

Governing load case is during transportation

Critical Loads:

$$P_u = 11.4 \text{ kip, Compression}$$

$$M_{u,y} = 0.03 \text{ k-ft}$$

$$M_{u,x} = 24.3 \text{ k-ft}$$

Design Strength:

$$\phi P_n = 51 \text{ kip, Compression}$$

$$\phi M_{n,y} = 10.7 \text{ k-ft}$$

$$\phi M_{n,x} = 41.2 \text{ k-ft}$$

Critical Equation: H1-1a

$$(P_u / \phi P_n) + (8/9)[(M_{u,y} / \phi M_{n,y}) + (M_{u,x} / \phi M_{n,y})] = .78$$

HSS 12 x 8 x 5/8 - Column

Governing load case is during transportation

Critical Loads:

$$P_u = 31 \text{ kip, Compression}$$

$$T_u = 10.6 \text{ k-ft}$$

$$V_u = 123 \text{ kip}$$

$$M_{u,y} = 97 \text{ k-ft}$$

$$M_{u,x} = 22.7 \text{ k-ft}$$

Design Strength:

$$\phi P_n = 819.7 \text{ kip, Compression}$$

$$\phi T_n = 147 \text{ k-ft}$$

$$\phi V_n = 491 \text{ kip}$$

$$\phi M_{n,y} = 181.1 \text{ k-ft}$$

$$\phi M_{n,x} = 228.3 \text{ k-ft}$$

Critical Equation: H3-6

$$[(P_u / \phi P_n) + (M_{u,y} / \phi M_{n,y}) + (M_{u,x} / \phi M_{n,y})] + [(T_u / \phi T_n) + (V_u / \phi V_n)]^2 = .8$$

HSS 4 x 0.220 - Column

Governing load case:

$$(0.9 - 0.2S_{ds})D + \rho E$$

Critical Loads:

$$P_u = 0.39 \text{ kip, Compression}$$

$$V_u = 1.2 \text{ kip}$$

$$M_{u,y} = 0 \text{ k-ft}$$

$$M_{u,x} = 6.4 \text{ k-ft}$$

Design Strength:

$$\phi P_n = 50.8 \text{ kip, Compression}$$

$$\phi V_n = 33.7 \text{ kip}$$

$$\phi M_{n,y} = 6.95 \text{ k-ft}$$

$$\phi M_{n,x} = 6.95 \text{ k-ft}$$

Critical Equation: H3-6

$$[(P_u / \phi P_n) + (M_{u,x} / \phi M_{n,y})] + (V_u / \phi V_n)^2 = .93$$

Support Reactions

Wind controls lateral loads at Washington DC site

Coefficient of friction (μ) = .4 (steel to wood, wood to wood, and wood to ground)

Resistance against sliding provided by connections in same framing bay. The short direction governs along Grid Lines C, G, J, M, and Q.

End Bays (Grid Lines C & Q):

$$P_{\text{leeward}} = 6.6 \text{ kips} \quad P_{\text{windward}} = 3.9 \text{ kips} \quad P_{\text{total}} = 10.5 \text{ kips}$$

$$V_{\text{leeward}} = 1.97 \text{ kips} \quad V_{\text{windward}} = 0.45 \text{ kips} \quad V_{\text{total}} = 2.42 \text{ kips}$$

$$\text{Resistance against sliding } F = P_{\text{total}} * \mu = 10.5 * 0.4 = 4.2 \text{ kips}$$

$$\text{Factor of safety against sliding } (F/V_{\text{total}}) = 4.2 / 2.42 = 1.7 > 1.5 \text{ OK}$$

Interior Bays (Grid Lines G, J, & M):

$$P_{\text{leeward}} = 6.9 \text{ kips} \quad P_{\text{windward}} = 6.2 \text{ kips} \quad P_{\text{total}} = 13.1 \text{ kips}$$

$$V_{\text{leeward}} = 1.57 \text{ kips} \quad V_{\text{windward}} = 1.42 \text{ kips} \quad V_{\text{total}} = 2.99 \text{ kips}$$

$$\text{Resistance against sliding } F = P_{\text{total}} * \mu = 13.1 * 0.4 = 5.24 \text{ kips}$$

$$\text{Factor of safety against sliding } = (F/V_{\text{total}}) = 5.24 / 2.99 = 1.75 > 1.5 \text{ OK}$$

Overturning

Wind controls for Washington DC site

Governing load case for resistance to overturning is .6D + 1.0W

$M_r = 184 \text{ k-ft}$ (note: no support reactions experience uplift)

Maximum and minimum elevations calculated for 18" variation in elevations

Elevation from Bottom of Frame to Ground 33" (Maximum elevation)

$M_{ot} = 121 \text{ k-ft}$

Factor of safety against overturning (M_r / M_{ot}) = $184 / 121 = 1.52$

Elevation from Bottom of Frame to Ground 15" (Minimum elevation)

$M_{ot} = 102 \text{ k-ft}$

Factor of safety against overturning (M_r / M_{ot}) = $184 / 102 = 1.80$

Foundations

Maximum allowable soil bearing pressure: 1500 psf

Minimum load (National Mall surface damage mitigation): 1000 psf

At 6 Interior Support Locations

Maximum service load at support locations: 16,600 lbs

Cribbing bearing area at support locations: 12.25 sq. ft.

Maximum soil bearing pressure: 1355 psf

At Exterior Support Locations (4 Corners)

Maximum service load at support locations: 12,800 lbs

Cribbing bearing area at support locations: 8.51 sq. ft.

Maximum soil bearing pressure: 1500 psf

Detailed Water Budget

FUNCTION	WATER USE (GALLONS)	CALCULATIONS		NOTES
		GAL	EVENTS	
HOT WATER DRAWS	264	16.5	16	10% above 15 gallon limit for wastage and spillage
WATER VAPORIZATION	3	0.75	4	Must vaporize 5lbs but must begin with 6lbs
DISHWASHER	17.5	3.5	5	3.5 gallons/use per manufacturer's specifications
CLOTHES WASHER	112	14	8	14 gallons/use per manufacturer's specifications
VEGETATION	45	4	17	Estimated at 4 gallons per day and 17 days between grid-tie assembly and disassembly
FIRE PROTECTION	400	400	1	2 sprinklers for 7 minutes at 26 GPM
TESTING	40	5	8	5 gallons per day during 8 days of assembly
INITIAL SYSTEMS FILL	50	50	1	50 gallon hot water tank
SAFETY FACTOR	468.5			33% of all water required.
WATER REQUIRED	1400	GALLONS		For fill and removal locations see "O" series drawings and Project Manual Appendix.



TENNESSEE
US DOE SOLAR DECATHLON 2011

UNIVERSITY OF TENNESSEE, KNOXVILLE
1715 VOLUNTEER BLVD, ROOM 313, KNOXVILLE, TN 37996
865.974.5211 | LIVLIGHT@UTK.EDU

Summary of Unlisted Electrical Components

All electrical components carry an approved testing agency's listing per Section 6-7 of the SD2011 Building Code.

Summary of Reconfigurable Features

The Living Light House is equipped with several reconfigurable features affecting Rule 6-2.

Demonstration of Reconfigurable Features for Jury Tours

Mechanically Operated Blinds

The Living Light House is equipped with mechanically operated blinds installed within the north and south façade assemblies. The blinds are controlled through the home automation system to control light, heat gain, and privacy. The location of the blinds can be seen in the wall section A4 on A311. Specification information can be found in Section 12 21 13 Horizontal Louver Blinds.

Zoom Room Bed

The bed unit is mechanically controlled to change positions for different home furniture configurations. The operation of the bed will be demonstrated during jury walkthroughs. The location of the bed can be seen A1/A101 and A404. The various configurations can be seen on I-101. Specification information can be found in Section 12 58 00 Residential Furniture.

Interconnection Application Form

University of Tennessee – Lot 202

Team Name and Lot Number

PV Systems

Module Manufacturer	Short Description of Array	DC Rating of Array (sum of the DC ratings)
Solyndra SL-001-182	5 panels in series is one string & 6 strings in parallel are connected to one inverter. Two arrays make up complete house photovoltaic system.	5.46 kW (per array)

Total DC power of all arrays is 10.9 kW (in tenths)

INVERTERS

Inverter Manufacturer	Model Number	Voltage	Rating (kVA or KW)	Quantity
Xantrex	GT 5.0	240 V	4.5 kW	2

Total AC power of all inverters is 9 kW kVA or kW (in whole numbers)

The following information must be included in the project manual or construction documents. If located in the construction documents, list the drawing locations in this section of the project manual. (Example: B3/E-201)

1. One-Line Electrical schematic – the loads do not have to be detailed. **Located on E-601 of drawing set.**
2. Calculations of service/feeder net computer load and neutral load (NCE 220). **Located on E-603 of drawing set.**
3. Plan view of the lot showing the house, decks, ramps, tour paths, the service point and the distribution panel or load center. **Located on G-103, G104, C-103, and L-101.**

Provide the Team’s “Electrical Engineer” contact in the “Team Officer Contact Info” database on the Yahoo Group as required per Rule 3-2.

Please see the “SD2011_Microgrid_Interconnection_Process_v1” file located the Files/Rules/Team Interconnection Process section of the Yahoo Group for more details on the interconnection process.

Living Light Energy Analysis Report and Discussions

1.0 Introduction

This report details key energy related design features of the Living Light house and describes our approach to analyzing its energy performance for both the Solar Decathlon competition week in Washington D.C. and throughout the year in a Tennessee climate. The Living Light house resulted from a collaborative effort between students in Architecture, Mechanical Engineering, Electrical Engineering, Interior Design, Landscape Design, and Business. Through this integrated design approach, the University of Tennessee’s Solar Decathlon Team developed six concepts which exemplified Living Light and focused design decisions around maximizing transparency and view, living compactly, harvesting the sun’s energy, having user control of light, view, and ventilation, leaving a small footprint, and having a space which transforms in service of function. What resulted is a high performance house which connects the occupant to the outdoors, consumes less than half the energy of the Building America Benchmark house, is expected to produce twice the energy it consumes over the course of a year, and is expected to meet and exceed the Solar Decathlon competition criteria.

Many different energy modeling programs and techniques were used in the energy analysis of the Living Light house. The building information model (BIM) has served as the foundation of these analysis’s as the same information presented in the BIM model was replicated with as much accuracy as each program and tool allowed.

Table 1: Modeling Tools Used

Category	Modeling Tool(s)
Envelope/Heating and Cooling Loads	EnergyPlus
Double Glass Façade	Analytical Computer Code, EnergyPlus, Field Study
Photovoltaic Power Production	Solyndra Energy Yield Forecast Tool
Appliance and Misc. Electric Load Consumption	Building America Analysis Excel Spreadsheet

2.0 Double Façade

One of the most distinguishing features of the Living Light house is the use of a double glass façade along the majority of the north and south walls. Not your traditional envelope, the double facade integrates many features of the house such as maximizing transparency to connect the occupants to the outdoors and giving the occupant control of lighting, views, and ventilation through the use of operable blinds and windows. The south-facing façade contains a single pane of glass on its exterior, a 12-in air space to capture heat and on the interior, an R-11 (hr·ft² ·oF/Btu) double pane window with two layers of film between the panes. Operable windows within the inner façade are composed of a translucent version of this suspended film glass. A blind system in between the cavity will reduce glare while enhancing heat gains in the cavity during the winter and will reduce heat gains in the living space during the summer. The north-facing façade is constructed in the same method except the operable windows are R-11 transparent glass and the fixed windows are

translucent. The double glass façade offers advantages for thermal comfort, reduced drafts and infiltration, and a reduction in transmitted noise as compared to conventional single or double pane windows.

From a thermal comfort perspective, the double glass façade allows blinds to be placed outside of the conditioned space while still being protected during harsh weather. Having exterior blinds greatly reduces the cooling load by blocking solar radiation before it penetrates into the conditioned space. Figures 2.1 and 2.2 as well as Table 2 show the results from parametric EnergyPlus simulations to study this affect.

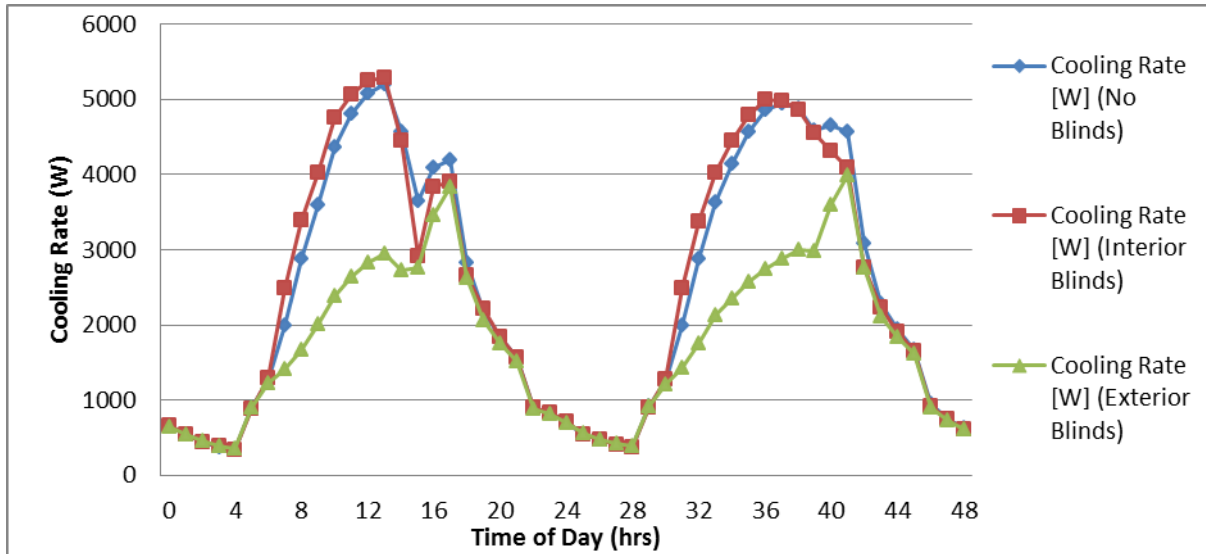


Figure 2.1: Living Light Blind Analysis, Summer Condition1

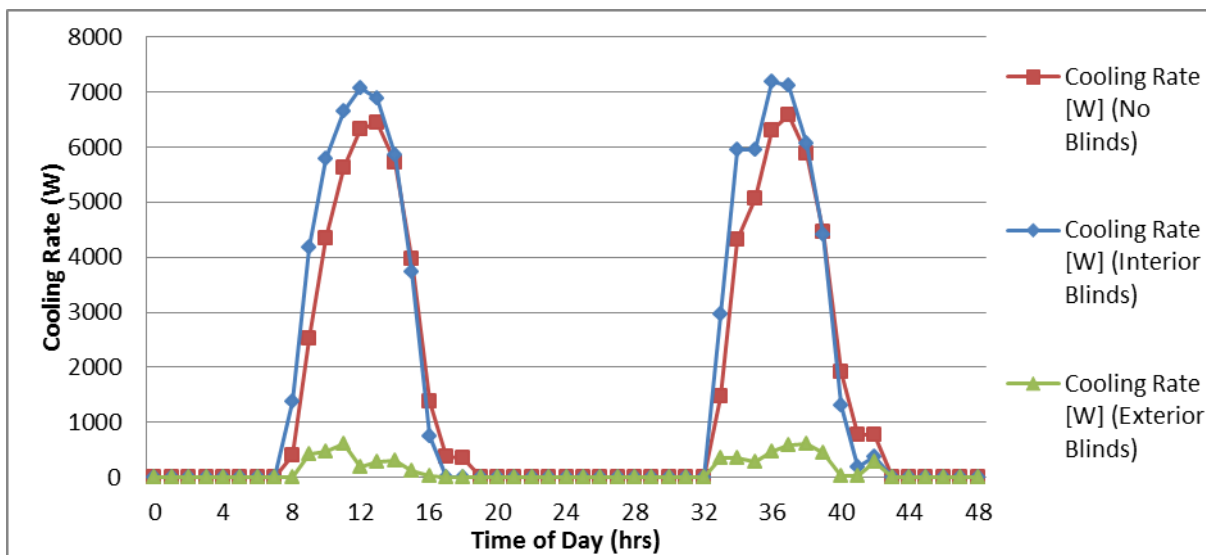


Figure 2.2: Living Light Blind Analysis, Winter Condition

¹ Blinds were modeled to be down at night and down when cooling and 100W/m² solar radiation was incident on the window

Table 2: Living Light Blind Analysis Results

Energy Plus Results	Max Heating Load (Btu/hr)	Total Heating Energy (kBtu)	Max Cooling Load (tons)	% Difference in Max Cooling Load	Total Cooling Energy (ton-hrs)	% Difference in Cooling Energy
No Shading	15,656	16,003	2.24	0	3,231	0
Interior Shading	16,662	17,399	2.39	+6.7%	3,365	+3.8%
Exterior Shading	15,419	16,185	1.26	-43.8%	1,700	-47.4%

As the figures and table show, having exterior blinds will reduce the maximum cooling load by 43.8% and the total cooling energy by 47.4%. This is a direct result of blocking solar radiation before it enters the conditioned space. The increase in maximum cooling rate and total cooling energy due to the addition of interior blinds vs. no blinds is a result of the way in which EnergyPlus models the transmittance of solar energy. With no blinds, direct beam solar radiation can be transmitted all the way through the house, depending on angle of incident. By adding an interior blind, a majority of the direct beam radiation is absorbed by the blind and trapped in the living space which increases the cooling load. Ultimately it is shown that exterior blinds offer superior performance when large amounts of glass are used. These results were the first step in developing the double façade system as the blinds within the cavity are outside of the conditioned space yet protected from the elements and therefore can be deployed under all weather conditions. Section 3.3 explains in further detail full benefits of the double façade system.

3.0 Modeling of the Dynamic Double Facade

In summer, makeup air will be introduced into the home on a prescribed cycle through the north façade cavity. The moderately cool air will exchange heat in an Energy Recovery Ventilator (ERV) while stale air from the home will be exhausted through the south facing façade cavity to improve fenestration performance. In winter, the inlet and exhaust airstreams are reversed. The blind assembly within the south façade cavity will be deployed to reduce glare and will also act as a solar collector to preheat the fresh airstream before exchanging heat with the exhaust airstream in the ERV. The stale exhaust air from the ERV will be exhausted out through the north façade to help buffer heat loss. Therefore, the envelope will have a dynamic design to help enhance the thermal performance of the glass walls. The complexity of the dynamic envelope approach requires that a combined experimental and analytic approach be used to establish operating criteria.

3.1 Field Study

A south-facing prototype double façade² was studied to assess temperatures, heat flows, and the potential for condensate on the inner surface of the exterior window of the assembly. A control composed of a double pane of window is adjacent the façade to experimentally judge the benefits of the double façade against conventional design. This process involves placing Type T copper/constantan thermocouples at various locations of interest and observing the diurnal effects of solar irradiance followed by the effects of night-sky radiation losses on the glass temperatures.

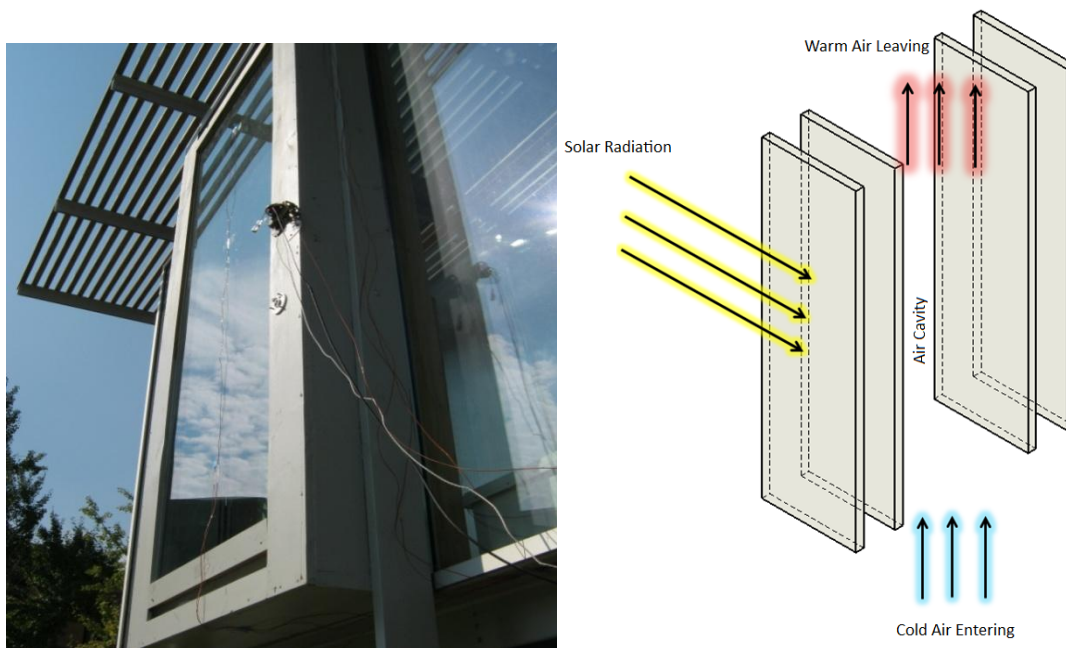


Figure 3.1: Double Façade Experimental Setup on UTZero Prototype

The exterior and interior glass temperatures of the double façade and adjacent single pane window are shown in Figure 3.2. Here the exterior glass temperature of the double façade exceeds the measured exterior temperature of the single pane. The interior pane of the double façade is the lowest of all interior pane temperatures, which indicates the double façade has a higher resistance to heat transfer than the single pane facade.

Figure 3.2 clearly show that the heat gain into the double façade is directly proportional to the amount of incident solar irradiance. For the 3 consecutive days shown in Figure 3.2, the temperature stratification from bottom to top of the air space was as high as 15°C at solar noon. This temperature gain within the south façade cavity is useful for supplemental heating of the north-facing façade cavity through the dynamic ventilation scheme of double façade system. This will help boost the overall thermal resistance of the envelope. See section 5.2 for additional information regarding the dynamic ventilation scheme.

² The experimental setup on the UTZero Prototype which was a joint effort between The College of Architecture and the College of Engineering, MABE department.

The double façade also causes its interior glass temperature to be lower than that of a conventional single pane window (Figure 3.2). This occurs because of the higher thermal resistance and the reduced amount of irradiance absorbed by the interior pane.

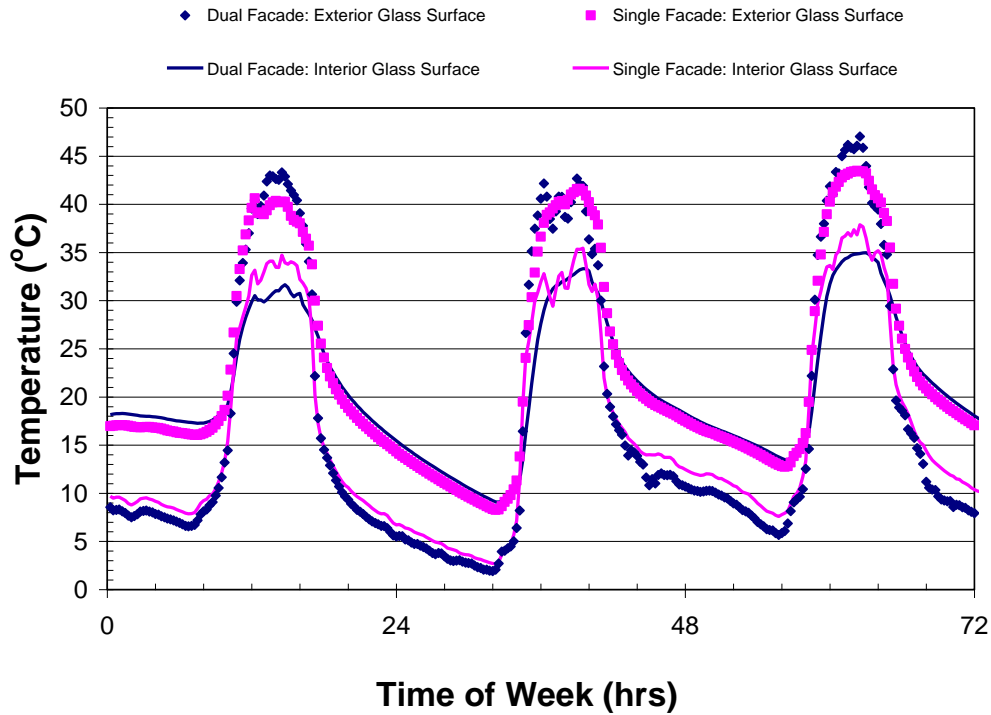


Figure 3.2: Exterior and interior temperatures of the glass prototypes under field study.

A lower interior glass temperature has several benefits regarding heat transfer. It lowers the amount of heat radiation emitting into the room while also reducing heat transfer due to conduction and convection. Thus the data proves that for summer conditions, a dual façade structure is superior to a single façade.

3.2 Analytical Study

An analytical model based on 1st principals has been developed to predict the overall heat transfer coefficient (U_o) of the façade, its solar heat gain coefficient (SHGC) and the façade's optimal airflow to benefit the fenestration and overall R-value of the envelope. ASHRAE 2009 lists metrics for several different IGUs with and without low-e coatings and with and without Nobel gas fills. A student team has benchmarked their codes for predicting U_o against these data in the ASHRAE Fundamentals 2009. The code was also benchmarked for temperature prediction against LBNL's Windows program. Results are provided in Table 3.1 and 3.2.

Table 3.1: The computed overall heat transfer coefficient (Uo) for multiple-pane IGUs is benchmarked against data from ASHRAE Fundamentals (2009), Table 4, Section 15.8

	ID 28	ID 29	ID 47	ID 48
	Triple Glazing	Triple Glazing	Quadruple Glazing	Quadruple Glazing
	6.4 mm air space	12.7 mm air space	12.7 mm Air space	6.4 mm Kr space
ASHRAE	2.16	1.76	0.68	0.68
Team Algorithm	2.13	1.77	0.66	0.67
Error	1.39 %	-0.57 %	2.94 %	1.47 %

Table 3.2 Benchmarks of the UTK code against the quad window in the Living Light house.

										Irradiance	0	W/m ²
										Wind	5.5	m/s
	T _{OD}	T(1)	T(2)	T(3)	T(4)	T(5)	T(6)	T(7)	T(8)	T _{ID}		
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C		
LBNL Windows 6.3	-18	-17.3	-17.2	-3.8	-3.8	7.3	7.3	17.8	17.9	21		
UTK Energy Balance		-17.3	-17.2	-3.8	-3.8	7.3	7.3	17.9	18.1			
										Irradiance	783	W/m ²
										Wind	2.75	m/s
	T _{OD}	T(1)	T(2)	T(3)	T(4)	T(5)	T(6)	T(7)	T(8)	T _{ID}		
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C		
LBNL Windows 6.3	35	45.8	46.7	57.2	57.2	49.4	49.4	31.5	31.3	24		
UTK Energy Balance		46.9	47.8	59.2	59.2	52.0	52.0	33.4	33.0			

The UTK computer tool was then exercised against the field data collected on the UT-Zero Prototype between Jan 21-22, 2011 to observe the code's ability to predict exterior, façade and interior temperatures. Jan 21 and 22 were days with clear sky and the outdoor temperature reached a high of 7°C (45°F) and a nighttime low of about -4°C (25°F).

The code predicted the exterior temperature of the façade within a ±2 °C tolerance. Figure 3.3 shows that the computer code under-predicts exterior glass temperature at peak irradiance and also over-predicts it during the evening hours. The source of the error is believed due to the accuracy of the anemometer measurements, which were gleaned from data collected on the campus of ORNL instead of directly on site. A weather station was not available for the study and sensitivity runs show the exterior glass temperature is strongly affected by the wind and the night-sky temperature.

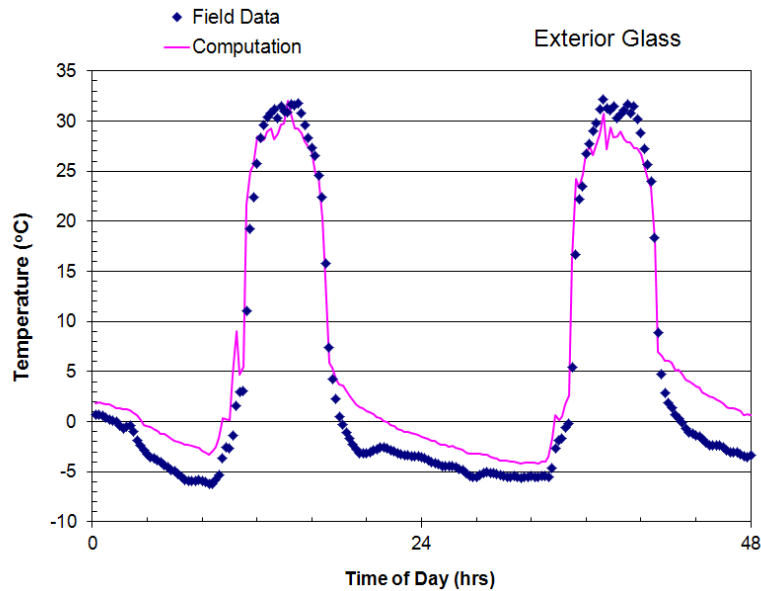


Figure 3.3 Computer tool benchmark made against exterior glass temperature for the UT-Zero façade

The code predicted the interior glass temperature of the façade within an average deviation of ± 1.3 °C from the measured data. Figure 3.4 shows that the computer code did a good job predicting the diurnal trends measured in the UT-Zero façade. Because heat transfer is driven by temperature gradient, the model’s ability to predict glass temperature shows that it can accurately predict the long-wave radiation crossing into the conditioned space. Short-wave prediction was proved against benchmarks for the triple pane window SHGC provided by LBNL.

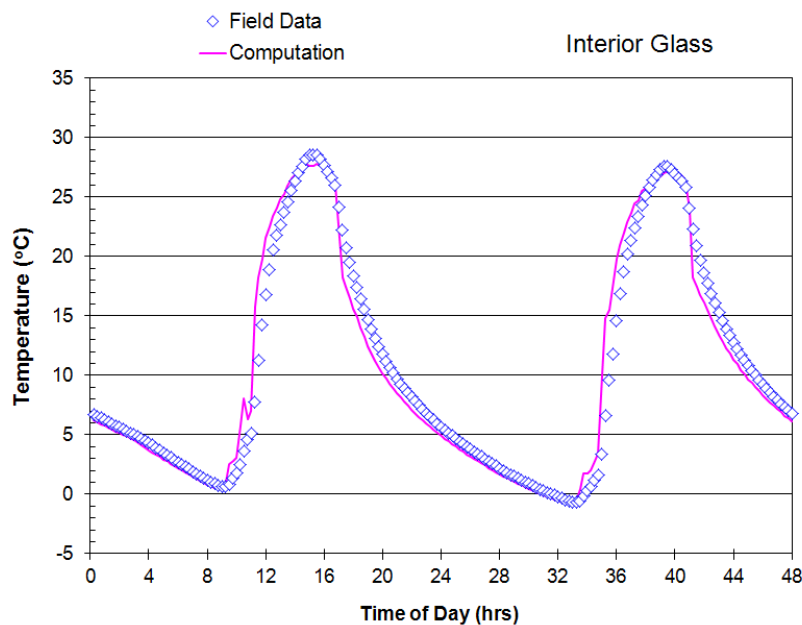


Figure 3.4 Computer tool benchmark made against the interior glass temperature for the UT-Zero façade; data for Jan 21-22, 2011.

The benchmarking of the UT-Zero prototype provided us confidence to proceed in the formulation and validation of the computer tool for the Living Light double façade window assembly. As stated, the Living Light house features a quad window composed of glass and polyester film dividers.

A blind was added to the vertical air cavity and modeled for both a open or closed cavity; where the open cavity can be either natural or forced convections flows. The blind is opaque and has a solar reflectance of 0.60. It modifies the fraction of energy reflected from the blind and incident on the blind as compared to the conventional net radiation technique outlined in Siegel and Howell. The code was also coupled to an energy recovery ventilator modeled using heat exchanger effectiveness as detailed in CSA Standard C439-09.

3.3 Simulation Results

A full year of TMY3 weather data was used to simulate the Living Light north- and south-facing facades. Several runs were made to deduce a best operating procedure for the facades working in combination with the mini-split heat pumps and the energy recovery ventilator, as shown in Figure 3.5. EnergyPlus computed the heating and cooling loads for the Living Light house and output an hourly performance file which was read into the UTK code in order to couple indoor and outdoor boundary conditions to the façade computations. Details for the ERV are provided in Section 5.2.

A run was made for a double pane window simply because it is the conventional system installed in most homes and therefore is a good control. Its performance is compared to the dynamic façade system operated at 70 cfm of continuous airflow and in another run at 200 cfm of continuous air flow, Fig. 3.5. Airflow rates are limited by the operation of the ERV. The combination quad window and façade glass assembly drops the annual house load by roughly 60% of the load computed for a double pane north- and south-facing window assembly.

Several more runs were made with the blind made active in the façade. Results for the ERV pulling 200 cfm during the sunlight hours but off at night and with the blind open from 8 AM till 10 AM and 5 PM till 10 PM (keeping the blinds closed except when occupants are at home in the early morning and late afternoon and evening) yielded best performance and dropped house load due to the window assembly by 90% of the double pane assembly. It is seen that the dynamic double façade system accomplishes its goal by maximizing the visual connection to the outdoors, while showing impressive energy savings when compared to a traditional window assembly.

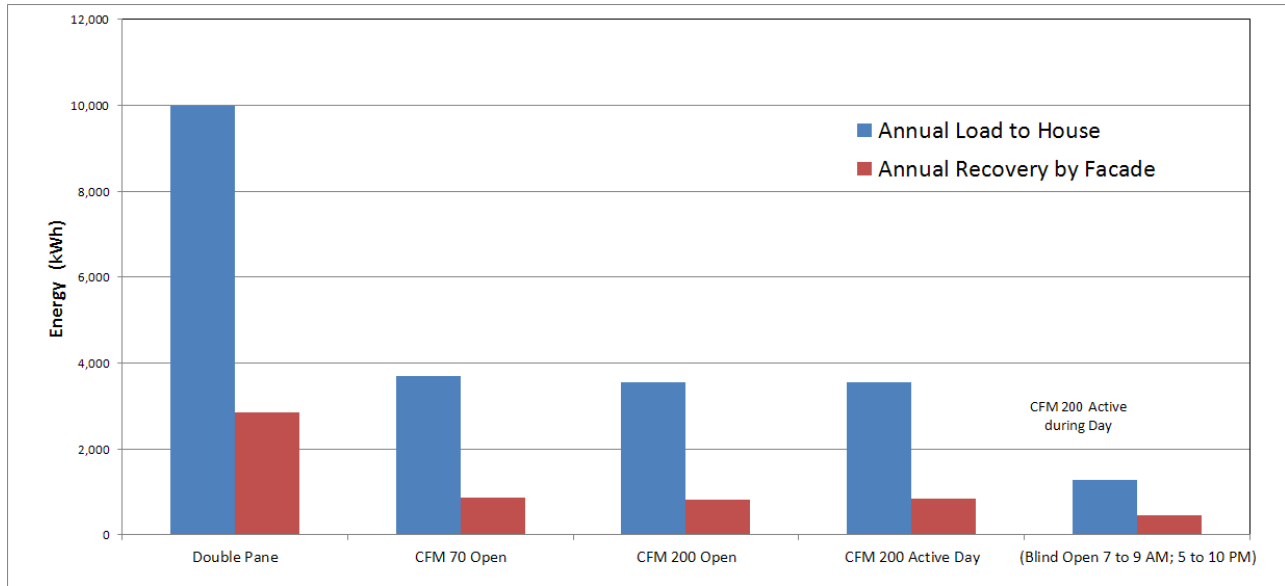


Figure 3.5 Different façade systems were simulated to deduce the best assembly and operating procedure for the Living Light house. The difference in the blue and red bars is approximately the load that the heat pumps must bear to maintain comfort conditions.

4.0 Photovoltaic Power

The Living Light house makes use of an innovative design in photovoltaic (PV) power through the use of copper, indium, gallium, and selenium (CIGS) technology. The CIGS film is wrapped in a cylindrical shape that provides a passive self tracking system for collecting direct sunlight from morning to evening as the sun moves across the sky. (Figure 4.1) Additionally, the cylindrical shape allows for maximum collection of diffuse sunlight and sunlight reflected off of the white reflective cool roof. (Figure 4.2) Because this type of PV cell collects more sunlight in the early morning and evening hours than a traditional flat plate collector, a cylindrically shaped PV cell will generate more power throughout the course of a day than a traditional fixed flat plate collector. (Figure 4.3)

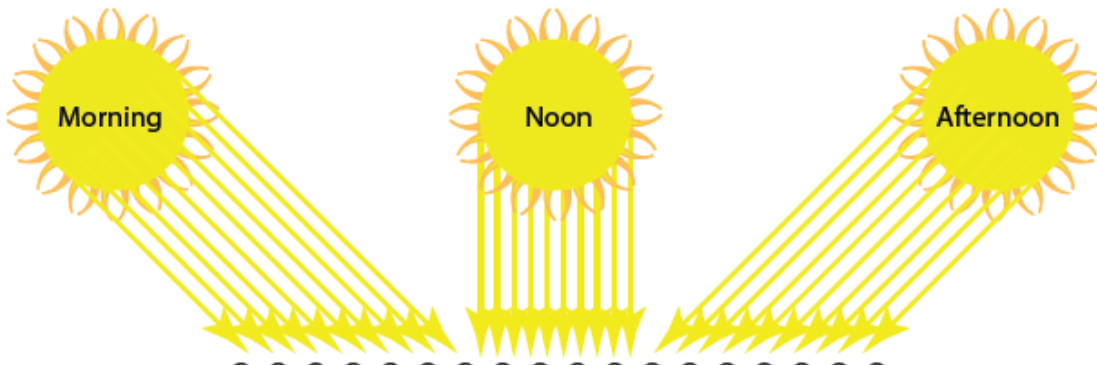


Figure 4.1: Passive Self Tracking of the Cylindrical Shape³

³ Design Installation Guide, Solyndra Inc.

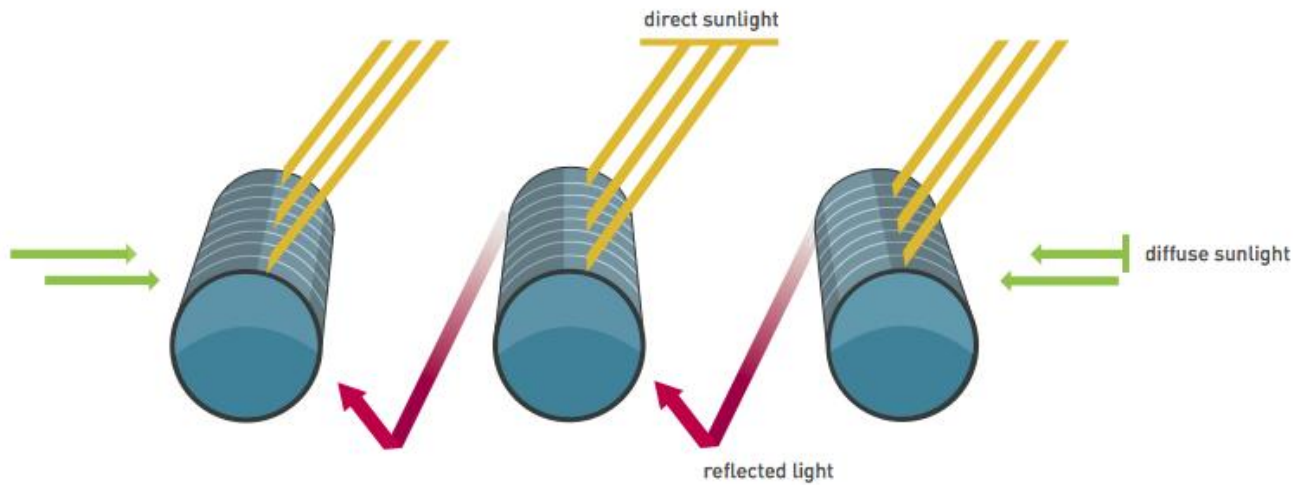


Figure 4.2: Three Ways of Collecting Sunlight⁴

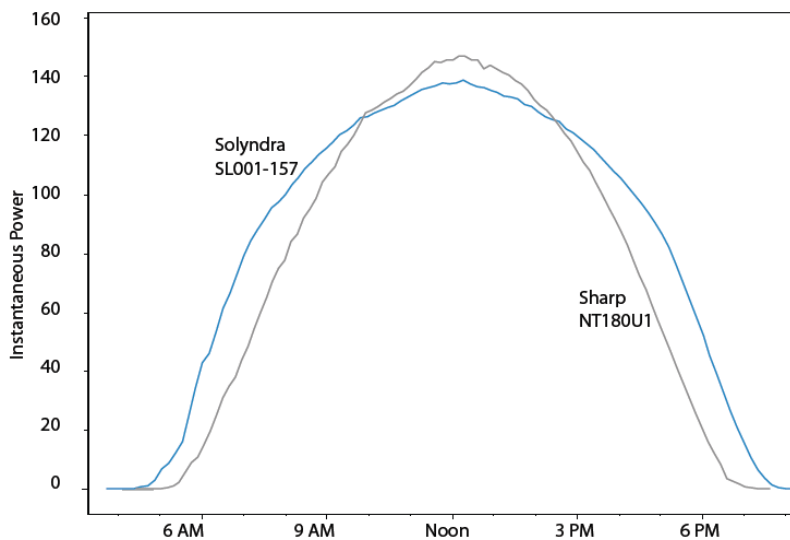


Figure 4.3: Solyndra Power Production⁵

The cylindrically shaped PV modules are placed across the low-slope and reflective roof, maximizing solar collection with best use of available roof space. The Living Light house took advantage of this by integrating the PV cells into a shading overhang to passively shade the south façade and block unwanted solar radiation in the summer while still allowing solar heat gain from lower winter sun angles. Figure 4.4 shows the benefit of the shading overhang as it reduces the cooling load of the house by 16.7% and reduces the cooling energy by 18% compared to the house with no overhang.

⁴ Forecasting Energy Yield, Solyndra Inc.

⁵ Forecasting Energy Yield, Solyndra

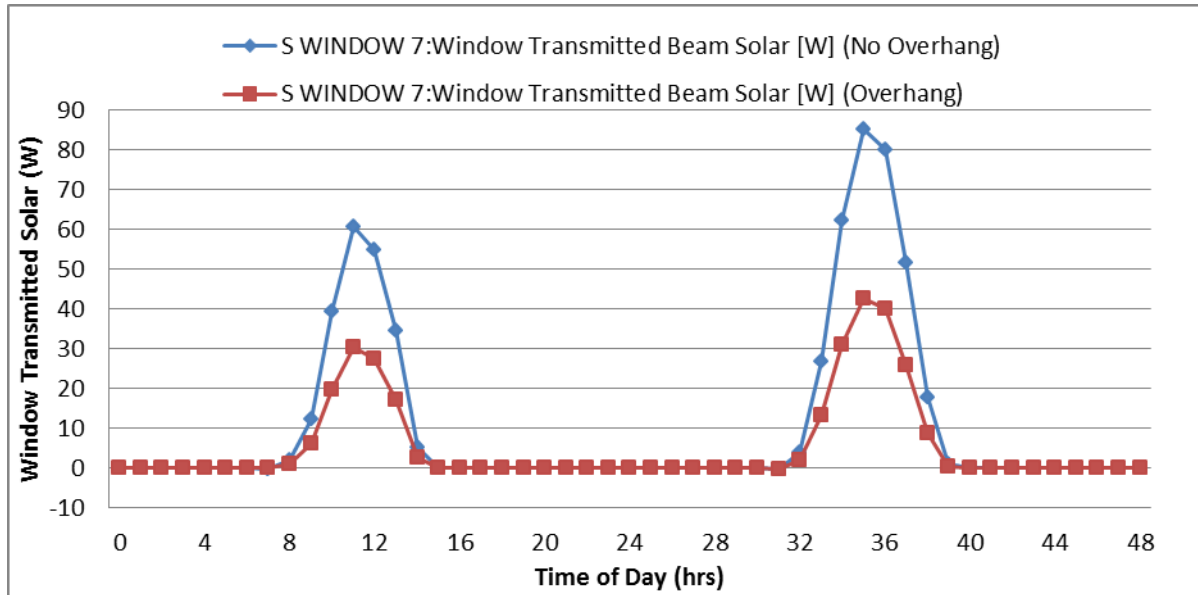


Figure 4.4: Window Transmitted Beam Solar through a South Facing Window with and without a Shading Overhang.

Table 5: Shading Overhang Analysis

	Max Cooling Load (tons)	Total Cooling Energy (ton-hrs)
No Overhang	2.69	3,940
PV Overhang (50% transmittance)	2.24	3,231
Percent Difference (%)	16.7%	18%

Solyndra has developed an Energy Yield Forecast tool which the Living Light was used to estimate the energy production of the system in varying climates, specifically Nashville, TN and Washington, D.C. The output of this calculator was used to find overall power production which is used at the end of this report. In total there are 60, 182 W PV modules. Five modules are connected in series to form a string. Six strings are connected in parallel to form a 5.45 kW array. Two arrays are sufficient enough to provide 3 foot overhangs on the north and south façade which yields a system power rating of 10.9 kW.

5.0 Heating, Ventilation, and Air Conditioning Design

The heating, ventilation, and air-conditioning (HVAC) system in the Living Light house is composed of two air-to-air ductless-mini split heat pumps and an energy recovery ventilator. The humid Tennessee's Climate has hot and humid days in the summer with temperatures in excess of 90°F while winters are moderately cold experiencing average overnight lows slightly below freezing. This type of climate is very suitable for air-to-air heat pumps which can efficiently heat, cool, and dehumidify to comfortably condition the living space.

5.1 Heating and Cooling

Ductless mini-split heat pumps were selected to eliminate bulky duct runs and therefore eliminate duct losses to unconditioned spaces. This also makes them ideal for retrofit installations. Furthermore, ductless mini-splits use inverter driven compressor technology which allows them to run at variable capacity to meet small changes in the heating or cooling load which enhances the efficiency of the units. The Daikin Quaternity ductless mini-splits in the Living Light house have efficiency ratings of 22 SEER and 10.55 HSPF. This means the units will consume almost half the energy of standard SEER 13 heat pumps. Additionally, the variable capacity of the units allows them to condition the air better, keeping the space more comfortable by running for longer periods of time. One specific advantage of the Daikin Quaternity system over other ductless mini-splits on the market is that with the Quaternity, occupants can set the relative humidity for the space, meaning increased comfort without over cooling. This is an important feature during hot and humid summer days in the Tennessee climate. Additionally, the Quaternity system uses an advanced flash streamer air purifier that effectively eliminates all unpleasant odors such as cooking odors, pet odors, cigarette smoke, allergens, viruses, and bacteria. This means the occupants of the Living Light home will be enjoying comfortable, fresh, clean air all year long.

It is particularly important to properly size the HVAC system for a specific building in its target climate. EnergyPlus was the main tool used to perform loads calculations. Figure 5.1 and Table 5.1 give the results of a yearly simulation of the Living Light house in Nashville, TN.

Table 5.1: Zone Heating and Cooling Summary Monthly

	ZONE/SYS SENSIBLE COOLING ENERGY [ton-hrs]	ZONE/SYS SENSIBLE COOLING RATE {Maximum}[ton]	ZONE/SYS SENSIBLE HEATING ENERGY [kBtu]	ZONE/SYS SENSIBLE HEATING RATE {Maximum}[Btu/h]
January	6.49	0.38	3876.96	14034.99
February	10.13	0.56	3288.24	14280.22
March	41.83	0.65	1157.36	9189.37
April	89.57	0.82	765.13	8299.31
May	164.64	0.84	116.63	5597.28
June	251.37	1	5.73	1336.42
July	306.83	0.98	0	0
August	279.35	0.96	0	0
September	180.55	0.99	27.58	2098.77
October	96.69	0.82	546.31	6134.57
November	49.53	0.76	1321.38	9421.94
December	8.52	0.4	3108.32	11992.04
Annual Sum or Average	1485.49		14213.65	
Minimum of Months	6.49	0.38	0	0
Maximum of Months	306.83	1	3876.96	14280.22

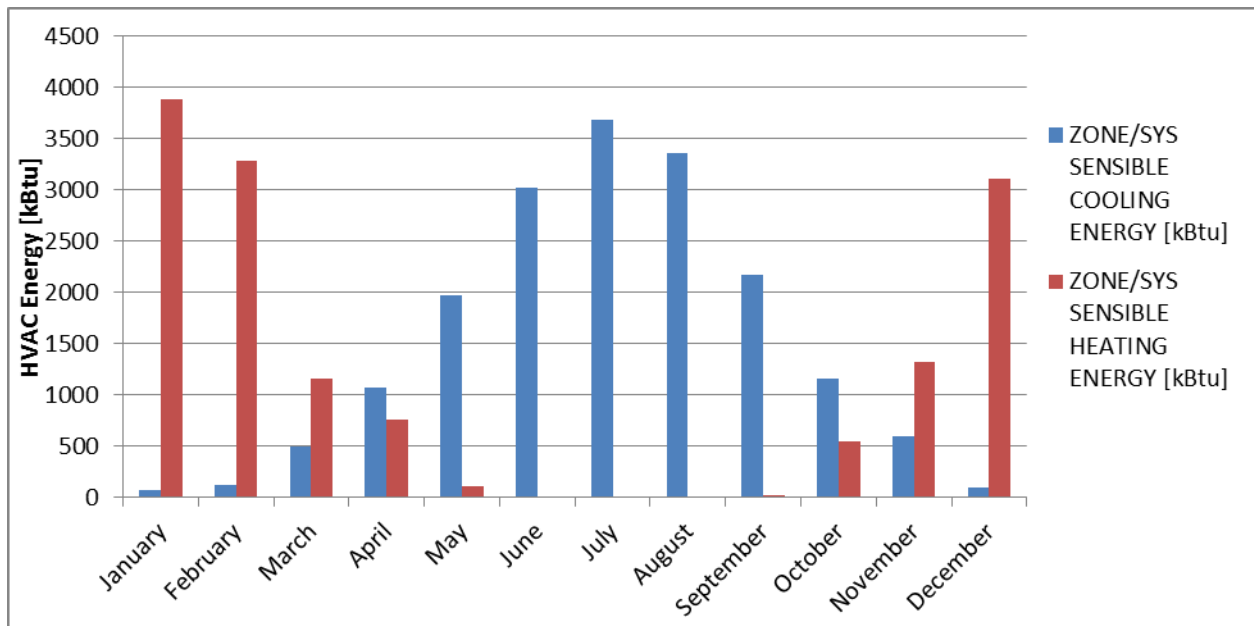


Figure 5.1: Monthly Cooling and Heating Energy

As shown in Table 5.1, the Living Light house would normally need a 1ton system for its target climate, however, to perform at a high level during the Solar Decathlon Competition, additional loads simulations were performed. The competition schedule was used to simulate conditions during the competition week so that the heating and cooling system of the Living Light house could be sized appropriately to maintain the comfort zone conditions at all required times. Of particular interest was the load required to bring the Living Light house back to temperature and humidity one hour after the public tour ends and during the measured contests when large internal heat gains are present. As Figure 5.2 shows, the Living Light house will need approximately 8000 W capacity to gain full points in the comfort zone competition. From these results, the Living Light team has selected a 2 ton system. It should be additionally noted that it is impossible to predict weather conditions during competition week. This simulation shows conditions for given set of weather conditions where our actual competition weather conditions may be completely different. However, this simulation shows extremely high temperatures in the mid 90's and so we don't for see any additional capacity needed for competition use.

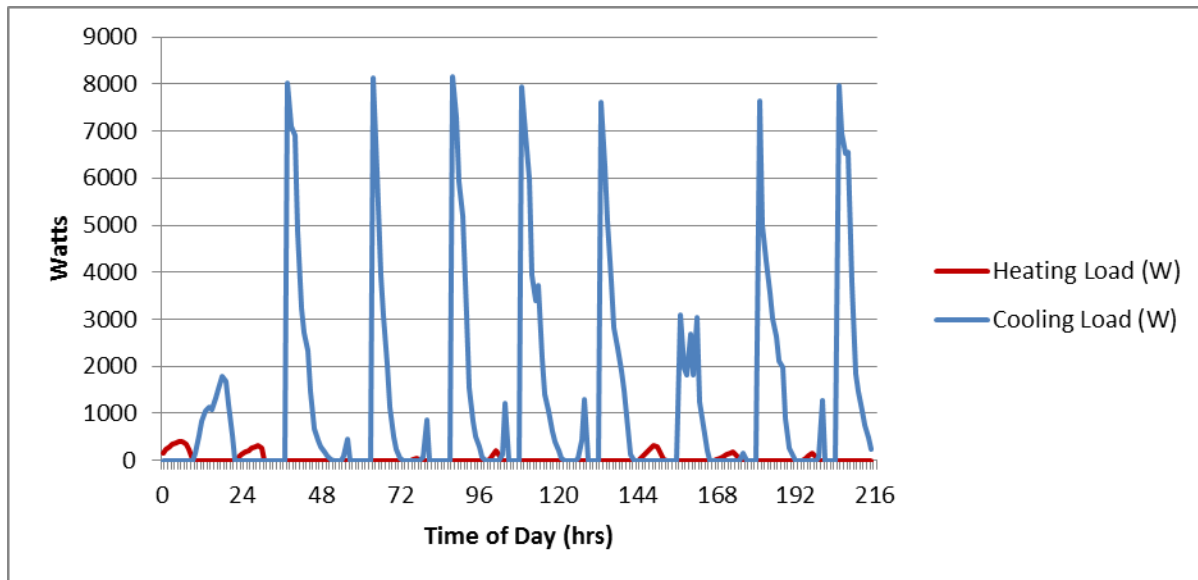


Figure 5.2: Heating and Cooling Loads for Simulated Competition Week

The Living Light house was compared to both the Building America Research Benchmark Home and a standard builder's test house from an Oak Ridge National Lab study, "Tennessee Valley Authority's Campbell Creek Energy Efficient Homes Project: 2010 First Year Performance Report July 1, 2009–August 31, 2010". Both of these baseline houses use a SEER 13 single speed heat pumps in contrast to Living Light's SEER 22 variable capacity heat pump. Table 5.2 shows the contrast between heating and cooling energy for the three houses. The total energy consumption for heating and cooling the Living Light house in the Nashville Tennessee climate was found to be 2,3820kWh compared to 4,269 kWh for the Campbell Creek house and 4,916 for the BA Benchmark. It is noted that the Campbell Creek house data was normalized to be comparable to an equivalent 1000 ft² house. Due to the high performance envelope and an energy efficient HVAC system, Living Light house shows impressive energy savings, using roughly 50% of the energy needed to heat and cool a standard builder or benchmark home in the Tennessee climate

Table 5.2: Yearly HVAC Loads Comparison

	LIVING LIGHT House	Campbell Creek1 House	Building America Benchmark
<i>ft</i> ²	740	1,000	740
Heating (kWh/yr)	1,220	1,622	2,909
Cooling (kWh/yr)	1,163	2,647	2,006
Total (kWh/yr)	2,382	4,269	4,916

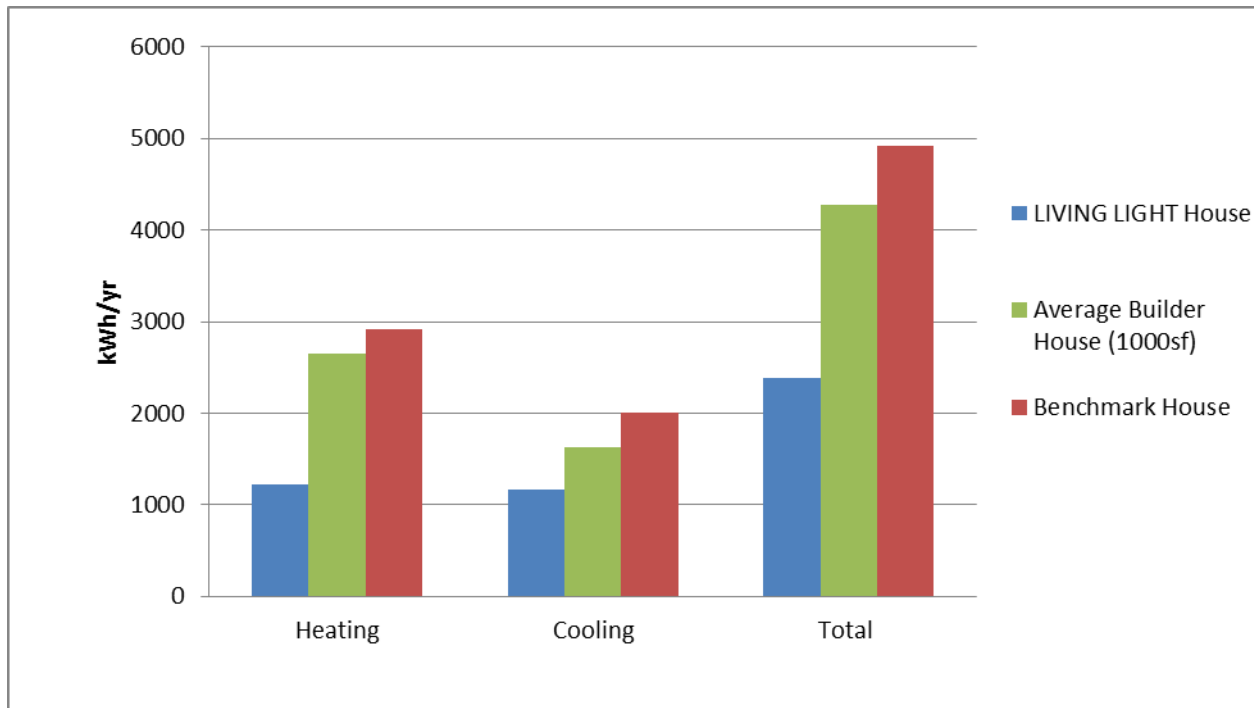


Figure 5.3: Heating and Cooling Comparison of the Living Light house to an Equivalent 1000 *ft*² Average Builder House.

5.2 Ventilation

Ventilation control is another important aspect to energy efficient house design. In order to increase indoor air quality, an ERV is used to supply fresh air to the Living Light house based upon ASHRAE 62.2 requirements as shown below.

$$Q_{vent} = 0.01A_{floor} + 7.5(N_{br} + 1) = 0.01(750) + 7.5(1 + 1) = 22.5 \text{ cfm}$$

The ERV saves energy by exchanging both sensible and latent heat between fresh and exhaust airstreams. In this way, heat is kept inside the condition space in winter and humidity is controlled in the summer. Team Tennessee selected an ERV manufactured by UltimateAir. This unit utilizes a variable speed controller that will ensure the proper amount of

ventilation for the Living Light house. The Ultimate Air unit is also the most efficient on the market, providing 95% heat recovery efficiency and up to 75% moisture transfer capability. As described before in section 3, the Living Light house uses a dynamic envelope ventilation strategy making use of the ERV and a double glass façade on the north and south walls. The ventilation schemes are controlled by the home automation and control system and can be easily interpreted in three different modes; ventilating, heating, and cooling.

The Tennessee climate experiences about 2,244 hours or 25% of the year in which ambient temperatures are between 60°F and 76°F. During these conditions, the occupants of the Living Light house will be notified that conditions are optimal for whole house ventilation. The occupant can then open the operable windows within the north façade, the ductless mini-splits will be turned off, and a small in-line duct fan will ventilate the house.

In the cooling mode, as noted earlier in the double façade section, makeup air will be introduced into the home on a prescribed cycle through the north façade and the moderately cool air will exchange heat in an Energy Recovery Ventilator (ERV) while stale air from the home will be exhausted through the south facing façade cavity to improve fenestration performance. In winter, solar irradiance will heat air in the south-facing façade cavity using a blind assembly that acts as a solar collector to preheat the fresh airstream before exchanging heat with the exhaust airstream in the ERV. The stale exhaust air from the ERV will be exhausted out the north façade to help buffer heat loss. This concept is depicted in Figure 5.4 below.

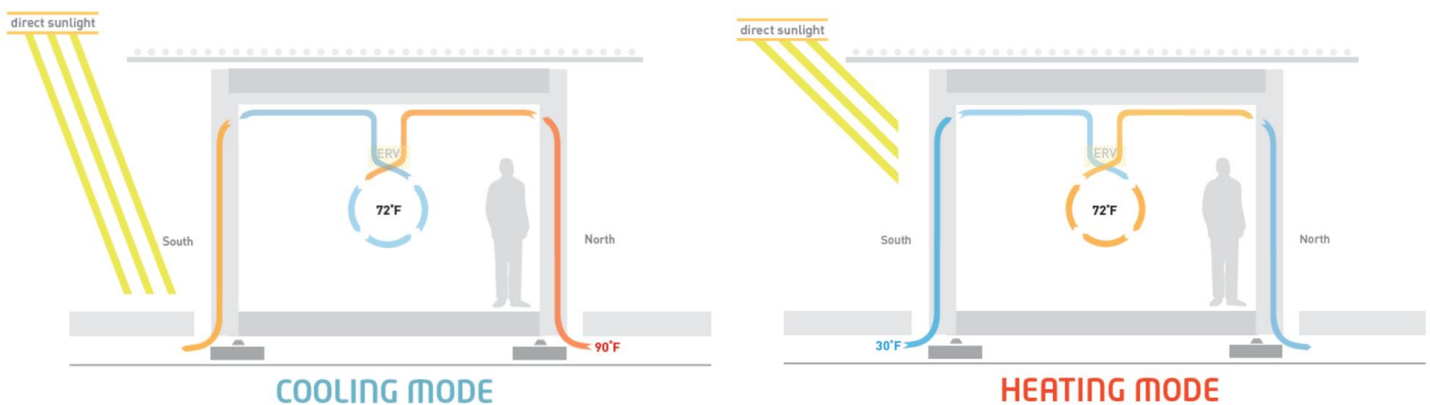


Figure 5.4: Dynamic Envelope Ventilation Strategy

6.0 Water Systems

Seeing as the sun is an abundant source of free energy, the design of the water systems in the Living Light house began by analyzing solar thermal options. The solar thermal options were deemed unfavorable because the quality of energy that is gained from solar water heating is less when compared to the quality of a pure electric system. For these reasons, it was decided that water heating should be done in an efficient way that maintained the highest possible amount of photovoltaic roof space. Ultimately, water heating in the Living Light house will be satisfied in an efficient way with a heat pump water heater.

6.1 Solar Thermal vs. All Electric System

Early on in the design process, before any of the systems had been selected, a simple study was conducted to determine if it would be better to use a solar thermal system, composed of an evacuated tube solar thermal collector with solar thermal water storage and a water to air heat exchanger for space heating or an all-electric system with Solydra's PV collectors, a mini-split heat pump system, and a heat pump water heater. The results of the study are shown in Tables 6.1 and 6.1 which provide a comparison of the performance of each system with respect to outside temperatures.

Table 6.1: System efficiencies and COPs with Varying Temperature

System efficiencies at different Temperatures	Rated Efficiencies	Cooling Season (85 F Average)	Heating Season (32 F)	Competition Week (75 F)
Solydra PV Collector Efficiency	0.077	0.07161	0.077	0.07315
Evacuated Tube Efficiency (space heating)	0.132	0.132	0.12	0.1296
Evacuated Tube Efficiency (water heating)	0.33	0.33	0.3	0.324
Fujitsu HP COP	4.396	5.07	4.396	5.07
GE Water Heater EF	2.35	2.35	2.35	2.35

Table 6.2: Heat Output of Various Systems with Varying Temperature

Energy produced from 100 Btu striking the roof		At Rated Efficiencies	Cooling Season (85 F Average)	Heating Season (32 F)	Competition Week (75 F)
Space Heating (Btu)	Solar Thermal System	13.2	Useless	12	Useless, probably cooling
	PV System	33.8492	36.30627	33.8492	37.08705
Water Heating (Btu)	Solar Thermal System	33	33	30	32.4
	PV System	18.095	16.82835	18.095	17.19025

As the tables show, there is a large advantage for the PV System in space heating and a large advantage for the Solar Thermal System in water heating. There is about double the output from the solar thermal system for water heating and nearly triple the output in space heating for the PV system during competition week temperatures.

The numbers favor the PV system in conjunction with a heat pump water heater because it is closer to the efficiency of the solar thermal system from a water heating perspective than the solar thermal system is to the PV system from a space heating perspective. Using an estimated percent of whole house energy usage of 25% for space heating and 15% for water heating, it was calculated that the PV system will be 55% more effective at converting sunlight into usable energy at the rated efficiencies. Another advantage to the all PV system is that we will likely be cooling and dehumidifying during the competition and the solar thermal system would likely be oversized if it were designed for space heating in our climate.

6.2 Water Heater Selection

Heat pump water heaters are able to extract heat from ambient air to heat water and thus are more efficiently than the standard electric resistance water heater. They are capable of performing at energy factors in the 2-3 range, while electric resistance water heaters cannot go above 1. This means that you use up to 60% less energy. Considering that water heaters are one of the largest energy consuming devices in a household, it was very clear that a heat pump water heater was an advantageous choice for the Living Light house. A full cost and energy usage analysis was performed to determine the optimal heat pump water heater. Table 6.3 shows the analysis between the GE and Stiebel Eltron units which were respectively the least expensive and most efficient units we could find.

Estimated Annual Operating Cost (EAO) using \$0.09/kWh for Knoxville utility rate:

$$EAO = 365days \times \frac{12.03}{EF} \times \frac{\$}{kWh}$$

Table 6.3: GE vs. Stiebel Eltron Heat Pump Water Heater

Models	Price of Water Heater	EF	Estimated Annual Operating Cost
GE	\$1,500	2.35	\$164
Stiebel Eltron	\$3,000	2.5	\$154
Additional cost of Siebel Eltron Unit			\$3,000-\$1,500=\$1,500
Estimated annual operating cost savings of Stiebel Eltron			\$164-\$154=\$10 per year
Additional Payback period for Stiebel Eltron			\$1,500/\$10 per year = 150 years

The most cost effective heat pump hot water heater is the one made by GE. It is the second most efficient and has the least expensive initial cost. The Stiebel Eltron unit is more efficient but would take 150 years to recover the costs over the GE unit. The only reason to choose the Stiebel Eltron unit would be if a 50 gallon tank is too small. This is not the case seeing as a 50 gallon water tank is sufficient to provide hot water to the Living Light target market of two people. Additionally, for the competition, past teams using 50 gallon heat pump water heaters were very successful in the hot water draw competitions.

7.0 Overall Energy Analysis

In order to adequately compare the estimated energy consumption of the Living Light house to a standard reference, the Building America Research Benchmark Definition for the year 2009 was followed extensive to develop a benchmark house and its associate energy end uses. These procedures were also used develop the occupancy schedules, internal loads, and other associated parameters that would affect the energy consumption of the Living Light house. Additionally, the Oak Ridge National Laboratory Research Home Campbell Creek 1 (CC1), was used as another comparative baseline case house. CC1 represents a standard builder home and was built as a 2,400 sf home and therefore many parameters were normalized to 1,000 sf to adequately compare to the 740 sf Living Light house. A multitude of equipment, software, and analysis techniques were used to evaluate the final energy consumption of the Living Light house. EnergyPlus was used to determine the heating and cooling loads of the BA Benchmark house and the Living Light house. The BA Benchmark Analysis spreadsheet was used to determine the energy end uses of associate appliances and miscellaneous electric loads as well as hourly profiles for occupancy and internal loads. These were input into EnergyPlus for proper analysis. An additional excel spreadsheet was used to determine the energy end use of the water heater based upon water use schedule as defined by the Building America Research Benchmark and associate Energy Factor (EF) of the water heater. Tests performed by senior capstone design students verified energy end uses of appliances and those results were used to calculate energy consumption of the Living Light house for the Solar Decathlon Competition week.

7.1 Yearly Energy Analysis

An a yearly basis, the Living Light house shows energy savings in every energy end use category and is equivalent in energy used for outdoor air ventilation. As seen in Table 7.1, the Living Light house produces more than twice the energy it is expected to consume on a yearly basis giving it a net energy production of 8,929 kWh/yr. This surplus of energy can be used to sell back to the grid at attractive rates in Tennessee, \$0.22/kWh, or used to power an electric vehicle .

Table 7.1 Summary of Site Energy Consumption by End Use Using BA Research Benchmark

End Use	Annual Site Energy					
	BA Benchmark		Avg. Builder House (CC1 at 1000sf)		BA Prototype	
	(kWh)	(therms)	(kWh)	(therms)	(kWh)	(therms)
Space Heating	2,910	-	2,647	-	1,220	-
Space Cooling	2,006	-	1,623	-	1,163	-
DHW	2,660	-	3,424	-	1,005	-
Lighting	790	-	941	-	506	-
Appliances & MELs	2,438	-	5,270	-	1,807	-
OA Ventilation	110	-	-	-	110	-
Total Usage	10,914	-	13,905	-	5,810	-
Site Generation	-	-	-	-	14,749	-
Net Energy Use	10,914	-	13,905	-	(8,939)	-

*Normalized from 2,400 sf to 1,000 sf

As Table 7.2 depicts, the Living Light house uses an impressive 47% of the total energy that the Building America Benchmark house uses and 58% of what the CC1 house uses. The major energy saving components of the Living Light house are in space heating and in domestic hot water.

Table 7.2 Summary of Source Energy Consumption by End Use Using BA Research Benchmark

End Use	Estimated Annual Source Energy			Source Energy Savings			
	Benchmark (Mbtu/yr)	Builder (Mbtu/yr)	Prototype (Mbtu/yr)	Percent of End Use		Percent of Total Use	
				BA Base	Bldr Base	BA Base	Bldr Base
Space Heating	33	30	14	58%	54%	15%	10%
Space Cooling	23	19	13	42%	28%	8%	3%
DHW	31	39	12	62%	71%	15%	17%
Lighting	9	11	6	36%	46%	3%	3%
Appliances & MELs	28	61	21	26%	66%	6%	25%
OA Ventilation	1	-	1	0%	-	0%	-
Total Usage	125	160	67	47%	58%	47%	58%
Site Generation	-	-	(169)	-	-	135%	106%
Net Energy Use	125	160	(103)	182%	164%	182%	164%

*Shows Percent of End Use

Figure 7.1 shows a graphical comparison between each end use of the three houses compared and again shows impressive energy savings for the Living Light house in the major energy use subsystems.

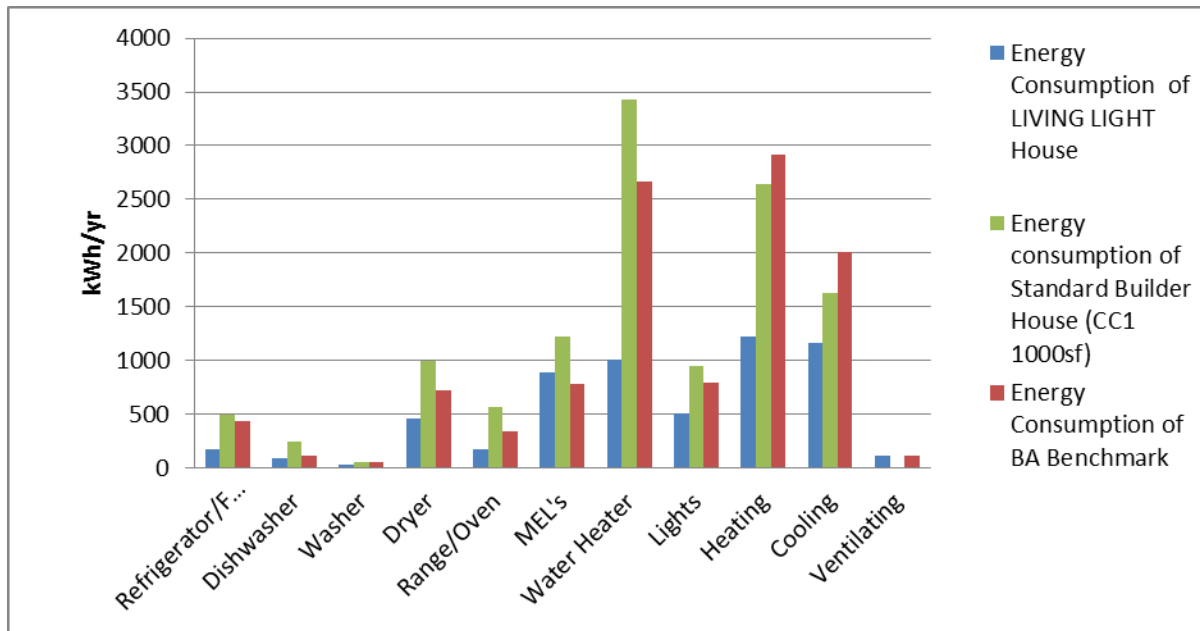


Figure 7.1 Comparison of the energy consumption of Living Light House components.

We also estimate that the Living Light house uses less than 30% of the energy from appliances that a home with typical appliances uses. Figure 7.2 shows that there are reductions in energy consumption for every house component except miscellaneous electric loads (MEL's) as compared to the Building America Benchmark. The increase in energy for MEL's is attributed to the home automation and control system of which are absent in typical homes. However, this is an important feature of the Living Light house as it gives it a certain "wow" factor and helps the occupant be more informed about their energy usage so they can begin to make smarter, energy conscious decisions. This is a subjective energy savings category which was not included in this analysis.

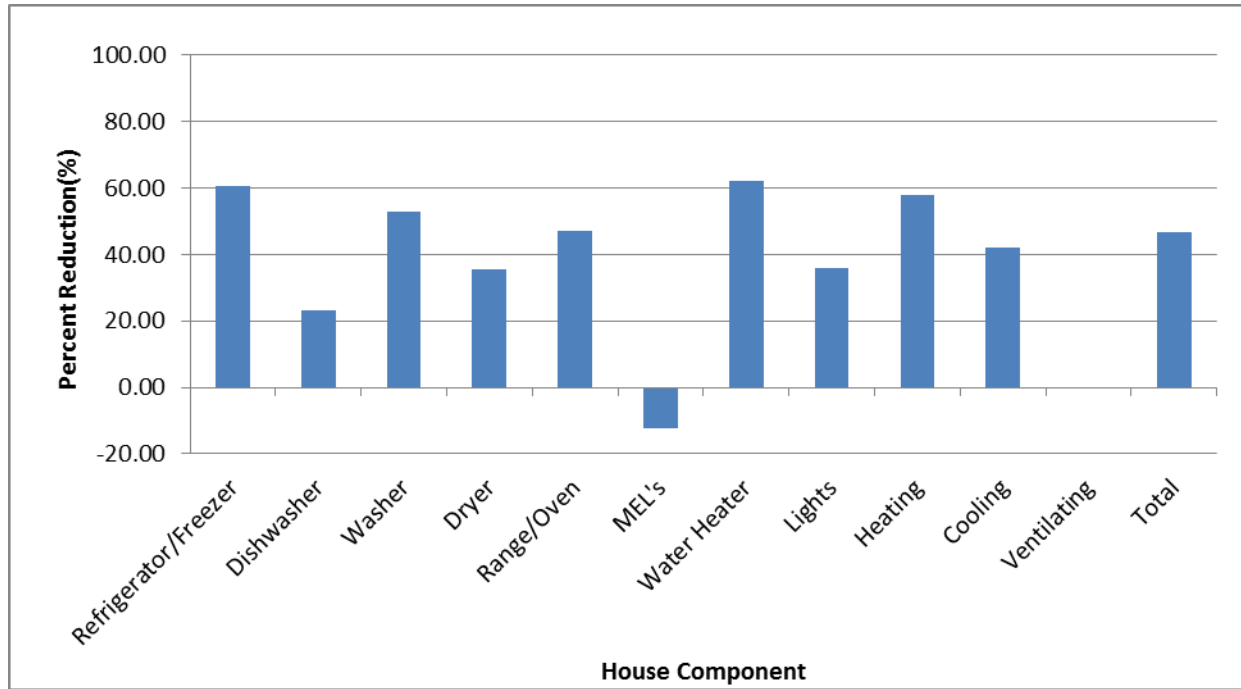


Fig. 7.2.Percentage Reduction in Energy the Living Light house components compared to the Building America Benchmark house.

7.2 Competition Performance

An energy analysis was performed on the Living Light house for the week of the competition (September 23rd through October 2nd) to determine how much energy would be consumed and how much each individual house component would consume. An hour by hour energy consumption estimate was performed based upon the competition schedule given in the Solar Decathlon Rules. The energy produced by the cylindrical photovoltaic tubes was also determined for the week of competition based on Solyndra's Energy Yield Forecast Tool in order to compare the energy produced to the energy consumed by the Living Light house. Figure 7.3 demonstrates that the Living Light house will produce ample energy to complete the competition tasks. The simulation shows that we expect to produce 377 kWh of energy while only consuming 144 kWh. This gives us 233 kWh of extra energy for the week of the Solar Decathlon competition. Though not a part of competition performance, as stated earlier, this surplus of energy is expected because the house was designed with extra capacity to sell back to the grid at attractive rates in Tennessee or to charge an electric vehicle. It is important to point at that this analysis was performed on a specific week from the given weather file in EnergyPlus and Solyndra's Energy Yield Forecast Tool. The actual competition performance will be dependent on the weather of the week. However, because of the large energy difference in our current simulation and because of the benefit of the cylindrical tubes in cloudy weather, we predict that the Living Light house will perform exceptionally well during the competition week.

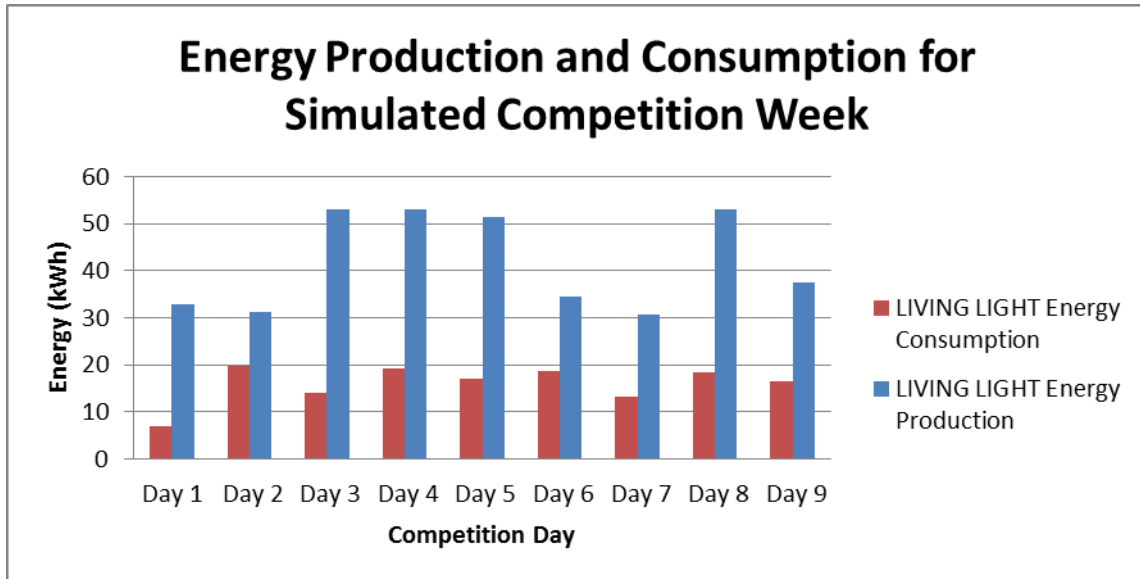


Figure 7.3 Energy consumed by the Living Light house compared to the energy produced by the PV tubes during competition week for each day.

Figure 7.4 shows a timeline of energy production and consumption of the Living Light house. From this graph it can be seen that the energy production peaks in the middle of each day of competition because this is when the photovoltaic tubes receive the most sunlight. On the other hand, energy consumption peaks are based on when the majority of the contests take place during the competition.

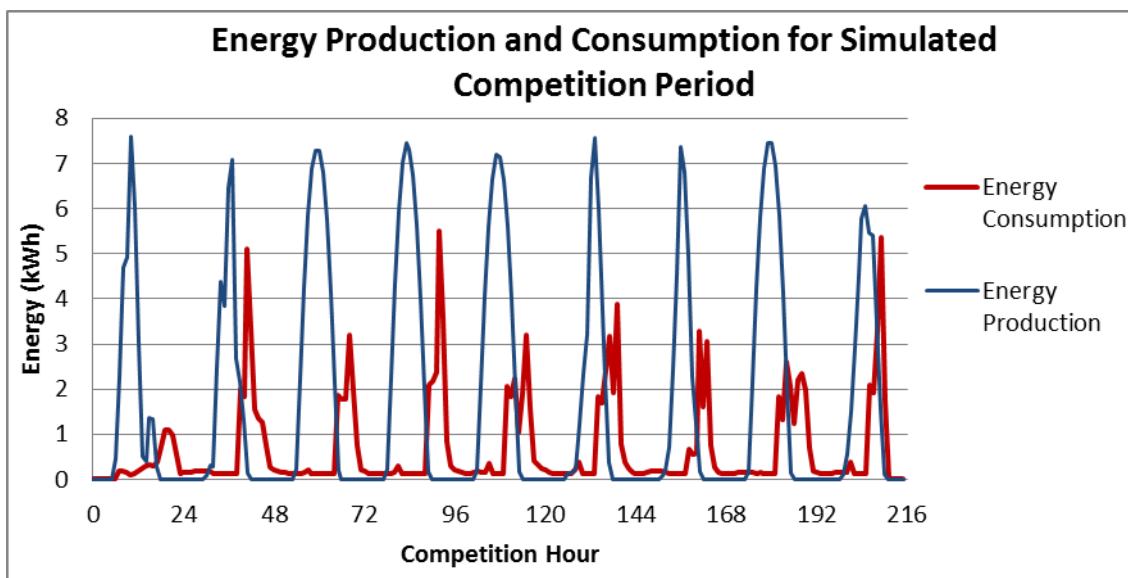


Figure 7.4 Timeline of when energy is consumed and when energy is produced for the Living Light house.

Figure 7.5, shown below, is a depiction of percentages of energy consumed by each appliance in the Living Light house during the days of competition in the Solar Decathlon. This graph indicates that the Living Light team needs to focus on reducing consumption of HVAC, water heating, and energy to run the control system on the laptop to reduce the energy consumption of the house during the competition.

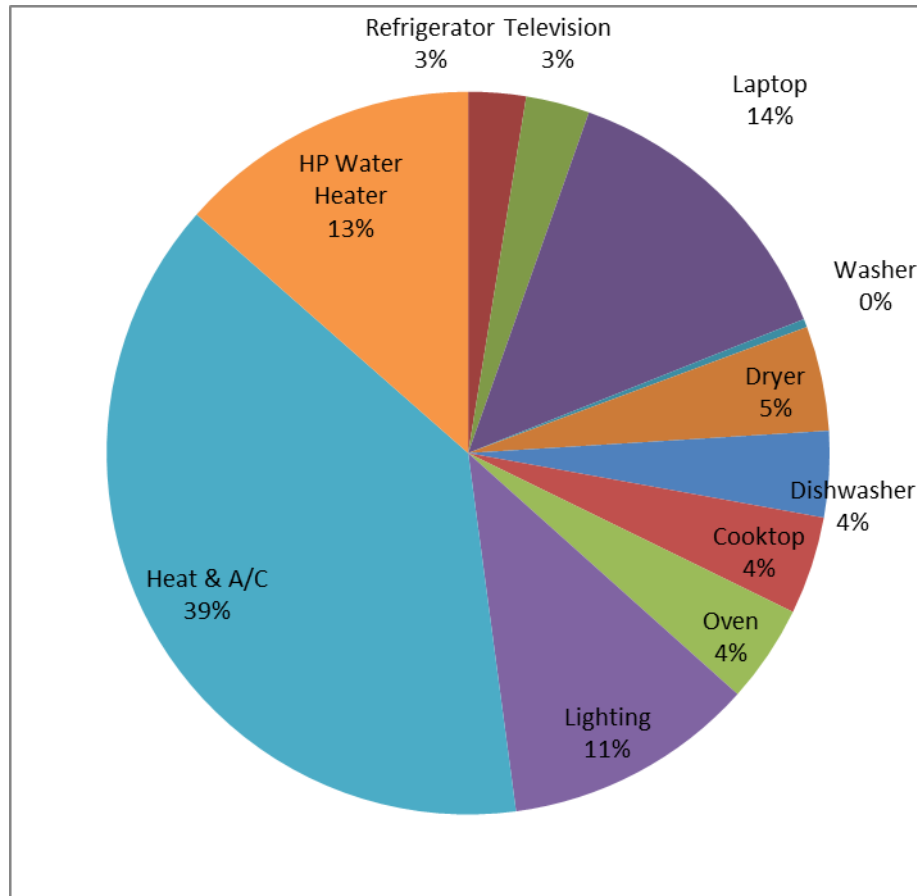


Figure 7.5 Percentage breakdown of energy used by each appliance during competition week.

Overall, the results of the Solar Decathlon competition week are expected to be very successful. The systems selected for the Living Light house are some of the most energy efficient on the market today. This will allow the house to operate very efficiently compared to other houses of a similar size. Tests performed on appliances for competition tasks ensure that Team Tennessee will gain maximum points in each of the measured contests.



TENNESSEE
US DOE SOLAR DECATHLON 2011

UNIVERSITY OF TENNESSEE, KNOXVILLE
1715 VOLUNTEER BLVD, ROOM 313, KNOXVILLE, TN 37996
865.974.5211 | LIVLIGHT@UTK.EDU

Construction Specifications

Division 00 – Procurement and Contracting Requirements

00 01 07

SEALS PAGE

00 01 15 LIST OF DRAWINGS

PART 1 - GENERAL

1.01 LIST OF DRAWINGS

G-000	L-301	A-102	A-507	M-601
G-001	L-501	A-103	A-601	M-901
G-101	L-502	A-111	I-101	E-101
G-102	L-503	A-201	I-501	E-102
G-103	L-504	A-202	I-601	E-201
G-104	L-505	A-301	F-101	E-601
G-201	L-506	A-311	P-101	E-602
G-501	L-507	A-312	P-102	E-603
G-901	L-601	A-401	P-103	T-101
C-101	S-101	A-402	P-201	T-501
C-102	S-102	A-403	P-501	T-601
C-103	S-103	A-404	P-601	X-101
C-104	S-201	A-405	P-901	X-201
L-101	S-301	A-501	P-902	X-501
L-102	S-302	A-502	P-903	O-101
L-103	S-303	A-503	M-101	O-102
L-104	S-501	A-504	M-102	O-103
L-105	S-601	A-505	M-201	O-104
L-201	A-101	A-506	M-501	

1.02 STRUCTURAL SUBMISSION

- A. The following is a list of all drawings and specifications sections that have been or will be stamped by the qualified, licensed design professional in the stamped structural submission.

L-101	L-501	L-507	S-1.2	S-2.6	S-3.4
L-102	L-502	L-601	S-2.1	S-2.7	
L-103	L-503	S-0.1	S-2.2	S-2.8	
L-104	L-504	S-0.2	S-2.3	S-3.1	
L-201	L-505	S-1.0	S-2.4	S-3.2	
L-301	L-506	S-1.1	S-2.5	S-3.3	

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 00 01 15

00 31 00 AVAILABLE PROJECT INFORMATION

PART 1 - GENERAL

1.01 PRELIMINARY SCHEDULE BY PHASE

- A. Schematic Design Phase January 2010 – April 2010
- B. Design Development Phase May 2010 – November 2010
- C. Construction Documents Phase November 2010 – March 2011
- D. Construction Phase January 2011 – June 2011
- E. System and Building Testing Phase July 2011 – August 2011
- F. Competition Phase September 13, 2011 – October 5, 2011

1.02 PROJECT BUDGET INFORMATION

- A. Construction Budget: \$450,000
- B. Total Project Budget: \$1,000,000

1.03 CONSTRUCTION FACILITY

- A. The UT Solar Decathlon 2011 House will be constructed in a warehouse facility provided by the University of Tennessee.
 - 1. 3408 Henson Road, Knoxville, TN 37921

END OF SECTION 00 31 00

00 73 43 WAGE DETERMINATION

Combined Request and Decision form for

Wage Determination

Request made by	
Name of person	George S. Criss
Title	Director of Facilities Planning
Department, Agency, or Bureau	The University of Tennessee Division of Facilities Planning
Address, phone, and fax	5723 Middlebrook Pike, Suite 119 Knoxville, TN 37996-0040 Phone: 865-974-2231 Fax: 865-974-7313

Decision rendered by
State of Tennessee Dept. of Labor and Workforce Development Labor Standards Division 220 French Landing Dr. Nashville, Tennessee 37243-1002

Date of request	Date of Advertisement	Supersedes Decision
10/11/2010	10/13/2010	

Wage Determination	
Decision Number	T-33277

Building Rates	<input checked="" type="checkbox"/> Apply <input type="checkbox"/> Do not apply
Highway Rates	<input type="checkbox"/> Apply <input checked="" type="checkbox"/> Do not apply

If Work is in multiple building rate regions, a separate request is required for each region; and, if in multiple counties within a region, all counties must be listed.

Report to	
INSPECTOR KIMBERLY STONER DEPT. OF LABOR & WORKFORCE DEV. DIVISION OF LABOR STANDARDS 1610 UNIVERSITY AVENUE, 2ND FL. KNOXVILLE, TN. 37921-6741	
Date assigned 10/11/2010	Assigned by Michael Dattilo

The Project		
City	State	County
Knoxville	TN	Knox
Project Identification		
Solar Decathlon University of Tennessee Knoxville		
Brief Project Description		
Sustainable Research Structure		

The project identification and brief project description given herein shall not act to define, expand, or limit the Work required by the Contract Documents.

Such information provided herein is intended only as information to the Department of Labor and Workforce Development. No other use or interpretation is intended.

END OF SECTION 00 73 43

Division 01 - General Requirements

01 10 00

SUMMARY

PART 2 - GENERAL**2.01 PROJECT INFORMATION**

- A. Project: Living Light, UT Solar Decathlon 2011
 - 1. Construction Location: 3408 Henson Road, Knoxville, TN 37921
 - 2. Competition Location: National Mall, Washington DC.
- B. Owner: University of Tennessee, Knoxville
- C. Architect: University of Tennessee, Knoxville Solar Decathlon Team
- D. Contractor: Blaine Construction Corporation
- E. The Work consists of Design, construction, transportation and assembly of a 800 sq.ft. house.
- F. Work by Owner:
 - 1. Signage
 - 2. Audio visual equipment
- G. Owner-Furnished Items: The following products will be furnished by Owner and shall be installed by Contractor as part of the Work:
 - 1. 60 Solyndra SL-001-182 Solar Panels
 - 2. Tough Trac Roof Rack
 - 3. Scissor Lift
 - 4. Generator
 - 5. All materials and products donated to the University of Tennessee for inclusion in the UT Solar Decathlon 2011 house.

2.02 WORK RESTRICTIONS

- A. Contractor's Use of Premises: During construction, Contractor will have use of area indicated. Contractor's use of premises is limited only by Owner's right to perform work or employ other contractors on portions of Project.
 - 1. Owner will occupy premises during construction. Perform construction only during normal working hours 8 AM to 5 PM Monday thru Friday, other than holidays, unless otherwise agreed to in advance by Owner. Clean up work areas and return to usable condition at the end of each work period.
 - 2. Driveways, Walkways, and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.



- B. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

END OF SECTION 01 10 00

01 25 00 SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the contract documents and proposed by Contractor.
1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other project requirement but may offer advantage to Contractor or Owner.

1.02 SUBSTITUTION REQUESTS

- A. Submit three (3) copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include specification section number and title and drawing numbers and titles. Show compliance with requirements for substitution and the following, as applicable:
1. Statement indicated why specified product or fabrication or installation cannot be provided, if applicable.
 2. Coordination information, including a list of changes or modifications needed to other parts of the work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 3. Detailed comparison of significant qualities of proposed substitution with those of the work specified, include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the work specified.
 4. Product data, including drawings and descriptions of products and fabrication and installation procedures.
 5. Samples, where applicable or requested.
 6. Certificates and qualification data, where applicable or requested
 7. List of similar installations for completed projects with project names and addresses and names and addresses of Architects and Owners.
 8. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated
 9. Research reports evidencing compliance with building codes in effect for project
 10. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the work, including effect on the overall contract time. If specified product or method of construction cannot be provided within the contract time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 11. Cost information, including a proposal of change, if any, in the contract sum.

12. Contractor's certification that proposed substitution complies with requirements in the contract documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
13. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

B. Architect's Action: If necessary, architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution, Architect will notify of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

1. Forms of Acceptance: Change order, construction change directive, or Architect's supplemental instructions for minor changes in the work.
2. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.03 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.04 COORDINATION

A. Modify or adjust affected work as necessary to integrate work of the approved substitutions.

1.05 SUBSTITUTIONS

A. Substitutions for Cause: Submit request for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements.
2. Requested Substitution is consistent with the contract documents and will produce indicated results.
 - a. Substitution request is fully documented and properly submitted.
 - b. Requested substitution will not adversely affect Contractor's construction schedule.
 - c. Requested substitution has received necessary approvals of authorities having jurisdiction
 - d. Requested substitution is compatible with other portions of the work.
 - e. Requested substitution has been coordinated with other portions of the work.
 - f. Requested substitution provides specified warranty.
 - g. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

- B. Substitutions for Convenience: Architect will consider requests for substitution, when the following conditions have been satisfied, and if received within 60 days after the notice to proceed. Requests received after that time may be considered or rejected at the discretion of architect. If the following conditions are not satisfied, architect will return requests without action, except to record noncompliance with these requirements:
1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner and similar considerations.
 2. Requested substitution does not require extensive revisions to the contract documents.
 3. Requested substitution is consistent with the contract documents and will produce indicated results.
 4. Substitution request is fully documented and properly submitted.
 5. Requested substitution will not adversely affect contractor's construction schedule.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. Requested substitution is compatible with other portions of the work.
 8. Requested substitution has been coordinated with other portions of the work.
 9. Requested substitution provides specified warranty.
 10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

END OF SECTION 01 25 00

PART 1 - GENERAL

1.01 APPLICATIONS FOR PAYMENT

- A. Submit to Designer
- B. Format and copies:
 - 1. Use AIA Document G702, Application and Certificate for Payment.
 - 2. Complete all header information including Project Title, SBC Number, application number, and period of application.
 - 3. Use AIA Document G703, Continuation Sheet, itemized with the line items and values of the Schedule of Values accepted by the Designer, and values and percentages for each line item.
 - 4. Submit four copies bearing an original notarized signature.
 - 5. Each copy shall have required attachments.
- C. Attachments for Applications for Payment:
 - 1. Continuation sheets as described above.
 - 2. Completed form for attestation regarding Personnel Used in Contract Performance, exhibited as Section 01 29 76.13, dated the same as the Application for Payment.
 - 3. Attachments required by Section 01 29 76.5, Payments for Stored Materials.
- D. Attachments for a **final** Application for Payment:
 - 1. The Contractor may submit an Application for Payment which proposes final payment in accordance with requirements described in the Contract Conditions.
 - 2. In such case the Contractor shall, with the Application for Payment, submit the following.
 - a. Certification of payment of debts and claims submitted as a completed copy of the form exhibited in Section 01 29 76.9, General Contractor's Affidavit.
 - b. Stamped or embossed Consent of Surety to Final Payment using AIA Document G707A or a similarly formed letter.

1.02 CERTIFICATES FOR PAYMENT

- A. In accordance with the format of AIA Document G702 the Designer will use the Contractor's Application for Payment to develop and submit to the Owner a Certificate for Payment indicating the amount certified.
- B. If the Designer is in disagreement with amounts claimed the Designer may either return the Application to the Contractor for revision and resubmittal or revise the Application by hand to indicate corrections the Designer considers appropriate and the corresponding amount certified.
- C. In a routine processing of a Certificate for Payment the Designer will submit to the Owner three counterparts with original signatures and attachments and retain one for the Designer's records.

1.03 PUBLIC NOTICE PRIOR TO FINAL PAYMENT

- A. A. Within ten days of receipt of a Certificate of Payment which proposes final payment to the Contractor the Owner will advertise a public notice that communicates the following:
 - 1. 1. The Contractor has applied for final payment.
 - 2. 2. Written notice of any unsettled claims for labor, material, or services provided to the Contractor or its Subcontractors may be provided to the Owner within thirty (30) days of appearance of the advertisement.
 - 3. 3. The sole purpose of such notice is to inform the Owner of unsettled claims.
 - 4. 4. Claimants must pursue remedies in accordance with applicable law.
- B. Advertisement will be in a general circulation newspaper published in the locality of the project.
- C. The Owner will not make final payment prior to the end of the 30 day period.

END OF SECTION 01 29 76

01 29 76.5 PAYMENTS FOR STORED MATERIALS

PART 1 - GENERAL

1.01 MATERIALS STORED ON-SITE

- A. A. The Contractor requesting payment for materials on-site shall submit with each Application for Payment an inventory of such materials approved for on-site storage on hand at the end of the billing period, and support any new additions to such inventories by copies of a vendor's invoices that would set forth quantities and price substantiating the Contractor's right to payment.

1.02 FORMATS FOR INVENTORY AND STANDARD ENDORSEMENT FORM

- A. An example inventory is shown below with the minimum required information. Other formats may be used. The inventories for on-site and off-site materials shall be itemized and totaled separately and a combined total for material stored shown.
- B. A blank example Standard Endorsement Form is shown below in the required format.



STORED MATERIAL INVENTORY FOR PAYMENT APPLICATION DATED (DATE)	
Contractor Name: Project Name:	
<u>ON-SITE STORED MATERIAL</u>	AMOUNT
ABC Company Name, Item No.123	\$4,600.00
AAA Company Name, Item No. 555-A	\$12,100.00
XYZ Company Name, Item No. 98.6	\$890.00
TOTAL MATERIAL STORED <u>ON-SITE</u>	\$17,590.00
<u>OFF-SITE STORED MATERIAL</u>	AMOUNT
Acme Company Name, Item No. Z-321	\$31,200.00
Best Company Name, Item No. 007	\$785.00
A-1 Company Name, Item No. BR549	\$4,321.00
TOTAL MATERIAL STORED <u>OFF-SITE</u>	\$36,306.00
TOTAL MATERIAL STORED	\$53,896.00
<u>ATTACHED INVOICES</u>	AMOUNT
<u>FOR NEW ADDITIONS TO STORED INVENTORY</u>	
ABC Company Name, Item No. 123	\$4,600.00
Best Company Name, Item No. 007	\$785.00

END OF SECTION 01 29 76.5



01 29 76.9 GENERAL CONTRACTOR'S AFFIDAVIT

COUNTY OF _____, STATE OF TENNESSEE

FROM: _____
(Contractor)

TO: The University of Tennessee

RE: Contract entered into the _____ of _____ 20____, between the above-mentioned parties for the construction of a at _____

KNOW ALL MEN BY THESE PRESENTS:

1. The undersigned hereby certifies that all work required under the above Contract has been performed in accordance with the terms thereof, that all materialmen, subcontractors, mechanics, and laborers have been paid and satisfied in full, and that there are no outstanding claims of any character (including disputed claims or any claims to which the Contractor has or will assert any defense) arising out of the performance of the contract which have not been paid in full.
2. The undersigned further certifies that to the best of his knowledge and belief there are no unsatisfied claims for damages resulting from injury or death to any employees, subcontractors, or the public at large arising out of the performance of the Contract, or any suits or claims for any other damage of any kind, nature, or description which might constitute a lien upon the property of the Owner.
3. The undersigned makes this affidavit for the purpose of receiving final payment in full settlement of all claims against the Owner arising under or by virtue of the Contract, and acceptance of such payment is acknowledged as a release of the Owner from any and all claims arising under or by virtue of the Contract.

This _____ of _____ 20____.

Signature

Title

Firm

COUNTY OF _____

STATE OF _____

Personally before me, the undersigned authority, appeared _____, who, after being duly sworn, stated on his oath that he had read the above statement and that the same is true and correct.

Notary Public

My commission expires _____

This _____ of _____ 20____.

END OF SECTION 01 29 76.9



01 29 76.13 ATTESTATION REGARDING PERSONNEL USED IN CONTRACT PERFORMANCE

Project Title:	
Contractor Legal Entity Name:	
Federal Employer Identification Number (or Social Security Number):	

The Contractor, identified above, does hereby attest, certify, warrant, and assure that the Contractor shall not knowingly utilize the services of an illegal immigrant in the performance of this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant in the performance of this Contract.

Signature: _____

Date: _____

NOTICE: This attestation MUST be signed by an individual empowered to contractually bind the Contractor. If said individual is not the chief executive or president, this document shall attach evidence showing the individual's authority to contractually bind the Party.

Print Name of Signatory: _____

Print Title of Signatory: _____

END OF SECTION 01 29 76.13

01 31 00 PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 PROJECT COORDINATION

- A. The General Contractor and Subcontractors shall review other sections of work applicable to their work and ascertain requirements in other sections applicable to their own work. Each shall be held responsible for coordination and inclusion of the work indicated as if it were in the particular subcontractor's section. The Architect shall be advised of any discrepancies or conflicts at the earliest moment.
- B. All subcontractors, suppliers, etc. shall be responsible for knowing what information is given on all sheets of the plans and specifications concerning their particular work. If an item or piece of work is shown on drawings, it shall be included in the contract. The reverse condition shall also apply

1.02 PROJECT MEETINGS

- A. Pre-Construction Meeting
 1. A pre-construction conference will be scheduled immediately with the award of the contract.
 2. Contractor shall be present and accompanied by the project coordinator, job superintendent, and all major subcontractors.
- B. Progress Meetings
 1. The Owner, the Contractor, Subcontractors, material suppliers, and vendors whose presence is necessary, must attend meetings when called by Architect or his or her representative for the purpose of discussing the execution of the work.
 2. Meetings will be held monthly or as required, at a time and place designated by the owner and the Architect or their representatives.
 3. Decisions, instructions, and interpretations given by Architect or his or her representative at these meetings shall be binding and conclusive on the Contractor.
 4. Proceedings of these meetings will be recorded and contractor will be furnished a reasonable number of copies for use and for distribution to the various subcontractors, material suppliers, and vendors involved.
 5. At each meeting, Contractor shall be prepared to give construction progress reports, schedule updates, and reports on upcoming work.

1.03 PROJECT WEBSITE

- A. Web Address: <http://livinglightutk.com>

END OF SECTION 01 31 00

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Contractors shall submit shop drawings, product data and samples, and all other items required for review in accordance with this section and related requirements in the general conditions and paragraph 1.2 with reasonable promptness.
- B. Subcontractors shall make submittals promptly so as to cause no delay in the work or in the work of any other subcontractor
- C. Submittals shall contain:
 - 1. The date of submission and the dates of any previous submissions
 - 2. The project title and number
 - 3. Contractor Identification
 - 4. The names of
 - a. Contractor
 - b. Supplier
 - c. Manufacturer
 - 5. Identification of the project, with the specification section number, and locations at which materials and/or equipment are to be installed.
 - 6. Details shall be identified by reference to sheet and detail, schedule or room numbers shown on contract drawings.
 - 7. Field dimensions, clearly identified as such, made by the Contractor or Subcontractor.
 - 8. Relation to adjacent or critical features of the work of materials.
 - 9. Applicable standards, such as ASTM or federal specification numbers.
 - 10. Identification of deviation from contract documents.
 - 11. Identification of revisions on resubmittals
 - 12. An 8" x 8" blank space for Contractor and Architect/Engineer Stamps
 - 13. Five complete copies
 - 14. Contractor's approval stamp

1.02 STANDARDS OF PRODUCT APPROVAL

- A. The naming of products and/or materials is done for the express purpose of establishing a basis of durability, efficiency, appearance, and simplification of maintenance, and not for the purpose of limiting competition. Other manufacturer's materials or articles may be used providing the material or article is presented to and approved by the Owner and Architect subject to conditions hereinafter described.
- B. Approved Equal: Wherever products are specified describing proprietary items, model numbers, catalog numbers, or "as approved equal" to a specific manufacturer, establishing proof of the equality of the products to that specified shall be the responsibility of the Contractor. Equality of all products is vested in the Architect whose decision shall be final and binding upon all concerned. Should use of a product be

denied by the Architect as not being equal to that specified, the Contractor shall use either the product specified or one of equal quality as approved by the Architect at no additional or extra cost to the Owner.

- C. Agency or Association: When products are specified in accordance with Federal Specifications, American Standards, ASTM Standards or other recognized association standards, the Contractor shall present proof from the manufacturer certifying that the product complies with the particular referenced standard where requested or specified, supporting test data shall be submitted to substantiate compliance.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Review shop drawings, product data and samples prior to submission
- B. Verify
 1. Field measurements
 2. Field construction criteria
 3. Catalog numbers and similar data
 4. Conformance with specifications and drawings
 5. All dimensions and quantities
- C. Coordinate each submittal with requirements of the work and of the contract documents
- D. Notify the Architect/Engineer in writing, at time of submission, of any deviations in the submittals from requirements of the contract documents
- E. Stamp "Approved" or "Approved as Noted", sign, and date submission
- F. Begin no fabrication or work which require submittals until return of submittals with Architect/Engineer approval.
- G. Failure of the Contractor to fulfill these responsibilities will result in the submittal(s) being returned to the Contractor, unchecked by the Architect, for proper handling.

1.04 QUALITY ASSURANCE

- A. Product literature shall permit the Architect and Engineers to determine which materials, equipment, and systems will be accepted in the project and shall consist of brochures, catalog cuts, or other data sufficient to clearly identify subject items; optional features to be utilized; performance characteristics; limitations; physical dimension; conformance with standards, codes, fire ratings, acoustical ratings, appearance, characteristic, and any other pertinent data to identify it as either item specified or as equal to that specified. Statements such as "as specified" will not suffice.
- B. Shop Drawings
 1. Shop drawings facilitate integration, coordination, and progress of the work and are not to be considered contract documents.
 2. The Architect and Engineers will review shop drawings for general design requirements only.

3. Variations from contract documents so minor as to involve no change in contract amount may be accepted if acceptance is in the Owner's interest, as determined by the architect. Do not construe the Architect's review as allowing the following:
 - a. Variation from contract documents, except as specifically authorized or requested by the Architect.
 - b. Relieving the Contractor of responsibility for errors in details or dimensions.
 - c. Departures from additional details or instruction previously furnished by the Architect.
 - d. Relieving the Contractor of responsibility for integrating and coordinating various trades and separate contracts.

- C. Samples: Review of samples shall permit the Architect and Engineers to physically verify conformance of materials, products, fixtures, or devices with contract documents either by inspection or testing.
 1. Review of samples will be only for characteristics or uses named in such review and shall not be taken to change or modify any contract requirement, except as specifically authorized or requested by the Architect.
 2. Samples shall set standards for items or characteristics of which samples are representative and after sample has been reviewed, no further change in brand, make, or quality will be permitted.

END OF SECTION 01 33 00

01 40 00 QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work includes, but is not necessarily limited to, services provided by the Contractor's Construction Superintendent in cooperation with the Contractor's Quality Control Department to provide controls and assurance that the materials and workmanship meet the minimum standards by code, and the contract drawings and specifications.
- B. Quality Assurance: The testing laboratory will be qualified to the Owner's approval in accordance with ASTM E-329, Latest Edition

1.02 TESTING REQUIREMENTS

- A. It shall be the Contractor's responsibility to provide quality control. Quality control shall consist of, but not limited to:
 - 1. Engineering design by vendors required to incorporate their work.
 - 2. Materials and parts delivered to or manufactured at the site and incorporated into the site or structures.
 - 3. Construction methods and sequence.
- B. Failure of materials and equipment tested or inspected:
 - 1. The Contractor shall be charged for retesting and re-inspection resulting from the Contractor's noncompliance with the contract as evidenced by tests and inspections by the Owner's testing agency.
 - 2. Previous acceptance may be withdrawn and material or equipment of which tested samples are representative may be subject to removal and replacement by the Contractor at his expense with material or equipment meeting specification requirements.
 - 3. The Architect may refuse consideration of further samples of same brand or make for testing.
 - 4. At the Owner's discretion, defective material and equipment may be permitted to remain in place subject to adjustment of contract sum.
- C. Payment for Testing
 - 1. Inspections and tests required to establish compliance with the contract documents will be made by a prequalified, independent testing agency selected by the Owner. The cost of the services of such agency will be paid by the Owner.
 - 2. Inspections or tests required by codes or ordinances, or by a plan approval authority, and made by a legally constituted authority shall be the responsibility of, and paid for by, the Contractor. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.
 - 3. The independent agency employed by the Owner shall prepare the test reports, logs, and certificates applicable to the specific inspections and test and promptly deliver the specified number of copies of same to the designated parties.

1.03 STANDARD AND INDUSTRY SPECIFICATIONS

- A. Material or operations specified by reference to the published specifications of a manufacturer, testing agency, society, association, or other published standards shall comply with the requirements in the latest revision thereof and amendments or supplements thereto in effect on the date of invitation to bidders.
- B. Discrepancies between referenced standards and contract documents shall be brought to the attention of the architect for interpretation. Material or work specified by reference to conform to a standard, code, law, or regulation shall be governed by contract drawings and specification when they exceed the requirements of such references; referenced standards shall govern when they are more stringent.

1.04 MANUFACTURER'S DIRECTIONS

- A. Manufactured articles, materials and equipment shall be utilized as directed by the manufacturers unless herein specified to the contrary. Discrepancy between an installation required by the contract drawings and specifications and the manufacturer's instructions and recommendations shall be resolved by the Architect in writing before the work may proceed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. The control of the field operation will be required as follows:
 - 1. Review documents and shop drawings, codes, procedures, preparations, workmanship qualification, and approved materials.
 - 2. Observe surfaces and areas to receive construction, works, and operation's methods and installation practices.
 - 3. Control personally, or through foreman or other appropriate supervisors to ensure that installation is properly controlled and quality is maintained.
 - 4. Ensure that scheduled tests are made after Contractor has determined that construction is ready for testing.
 - 5. Ensure code required code inspections are made before work is covered and keep copies of paperwork on file.
- B. Observations
 - 1. The General Contractor shall contact the Architect to perform observations at the following milestones, the Contractor shall give at least 24 hours notice and shall allow sufficient time for potential corrections prior to covering of work with concrete, etc.
 - a. Sensor Installation

3.02 JOB CONDITIONS

- A. Furnish promptly without additional charge, access, reasonable facilities, labor, and materials necessary for safe, convenient tests and inspections whether required on or off jobsite. Testing shall include the checkout of utilities, operation of systems and equipment for readiness, and the direction of initial start-up and testing of equipment in the presence of the Owner's maintenance personnel.

3.03 TESTING PROCEDURES

- A. Blower Door Test
- B. Other Required Testing
 - 1. Contractor shall arrange for all testing required in the contract documents.
- C. Scheduling
 - 1. Cooperate with testing program as necessary to avoid delays. When material or work is not ready at times scheduled for tests and inspections, Contractor is responsible for costs of additional tests and inspections occasioned by delays.
 - 2. Premium time fees for testing performed after regular working hours or on Saturday, Sunday or on legal holidays shall be paid for by the Contractor, except when such testing is required for Owner requested overtime work.
- D. Complete Work
 - 1. Should the Architect require tests and inspections for work completed before final acceptance of entire work, furnish necessary facilities, labor and materials to uncover or remove work in question to extent necessary.
 - 2. If such work is found defective owing to fault of the Contractor, the Contractor shall defray expense of removal, tests, and inspections and satisfactory reconstruction. Time extension may not be granted.
 - 3. If such work is found to conform with requirements of the contract, the Contractor shall be reimbursed by the Owner for facilities, labor, and materials required for removal and costs of satisfactory reconstruction in accordance with contract amounts for extra work. Reasonable time extension shall be granted.

3.04 SPECIFICATIONS

- A. Each section of the specifications shall establish the approved products and the required testing. The architect may schedule such additional testing as he deems necessary or finds appropriate.

END OF SECTION 01 40 00

01 41 00 REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 CODES REQUIREMENTS

- A. U.S. Department of Energy Solar Decathlon 2011
 - 1. U.S. Department of Energy Solar Decathlon 2011 Building Code
 - 2. 2009 International Residential Code (IRC) of the International Code Council with Amendments
 - 3. 2009 International Energy Conservation Code
 - 4. 2008 National Electric Code (NEC) of National Fire Protection Agency (NFPA)
- B. State of Tennessee
 - 1. 2006 International Building Code, excluding chapters 11 & 27
 - 2. 2006 International Fire Code
 - 3. 2006 NFPA 101 Life Safety Code
 - 4. 2006 International Energy Conservation Code
 - 5. 2009 International Residential Code
 - 6. 2002 North Carolina Accessibility Code with 2004 Amendments
- C. In cases of conflict, the most stringent requirements shall apply.

1.02 LAWS

- A. All activities associated with the design, construction, transportation, and exhibition of the University of Tennessee Solar Decathlon 2011 project are required to abide by applicable Federal, State, and Local Laws and Regulations.

1.03 RULES

- A. U.S. Department of Energy Solar Decathlon 2011
 - 1. Project is designed to abide by the rules set forth by the U.S. Department of Energy Solar Decathlon 2011 Rules.

1.04 PERMITS

- A. State of Tennessee
 - 1. Project will undergo review and inspections by the State of Tennessee Fire Marshall's Office for State Buildings. The University of Tennessee Solar Decathlon team will be responsible for submitting all documentation for approval. The University of Tennessee Solar Decathlon team will work with General Contractor to schedule onsite inspections as necessary for permitting process as dictated by the State of Tennessee Fire Marshall's Office.

END OF SECTION 01 41 00

01 50 00 TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

- A. Electric Power: Available from a portable generator provided by the team. Provide connections and extensions of services as required for construction operations.
- B. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

PART 2 - PRODUCTS

2.01 OWNER PROVIDED EQUIPMENT

- A. Generators
 1. Honda Generator- EU6500iS
 2. AC output: 120/240V 6500W max
 3. Full GFCI Protection
 4. Noise: 60dB(A)

PART 3 - EXECUTION

3.01 TEMPORARY UTILITY INSTALLATION

- A. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

3.02 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of permanent facility, or no later than Substantial Completion.

END OF SECTION 01 50 00

01 53 00 TEMPORARY FOUNDATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Temporary Building Foundations
 - 2. Temporary Deck Foundations
- B. Related Sections:
 - 1. Division 05 12 00 "Structural Steel Framing"
 - 2. Division 05 30 00 "Metal Fabrications"
 - 3. Division 06 10 00 "Rough Carpentry"

PART 2 - PRODUCTS

2.01 BUILDING FOUNDATIONS

- A. Building Footings
 - 1. Fabricated by Quality Steel
- B. GeoMat Fabric
 - 1. Manufacturer: US Fabrics, Inc
 - 2. Products: US80NW or US90NW
 - 3. Substitutions are allowed when proposed substitution is of equal or greater tensile strength and equal or smaller woven openings.
- C. Structural Cribbing
 - 1. Reference drawings and section 06 10 00

2.02 DECK FOUNDATIONS

- A. Deck Footings
 - 1. Pieramid Foundation Systems Inc: The Ultimate Pier adjustable pier standard
 - a. Model: PIER 12
 - b. Minimum Attachment Shear Strength: 2360 lb-f
 - c. Minimum Height: 12.75 in
 - d. Maximum Height: 18 in
 - e. Maximum Axial Load: 10,000 lb-f
- B. Connection Plate
 - 1. Reference drawings and section 05 50 00

- C. Plywood Base
 - 1. Reference drawings and section 06 10 00

PART 3 - EXECUTION

3.01 INSTALLATION, BUILDING FOUNDATIONS

- A. For foundations at four corners of the building (to be assembled by team as follows):
 - 1. 5 ft 6 in x 5 ft 6 in geotextile fabric shall be centered on foundation location to provide adequate surface protection on competition site.
 - 2. Lay 4 ft x 4 ft bed of sand approximately 1" in thickness. Sand to be centered on geotextile fabric to ensure sand does not spill onto competition site.
 - 3. Place cribbing components on center of sand bed.
 - 4. Set Footing on cribbing and adjust as needed to provide level foundation for house.
- B. For foundations at six house foundations along north and south building perimeters (to be assembled by team as follows)
 - 1. 4 ft x 4 ft geotextile fabric shall be centered on foundation location to provide adequate surface protection on competition site
 - 2. Lay 3 ft x 3 ft bed of sand approximately 1" in thickness. Sand to be centered on geotextile fabric to ensure sand does not spill onto competition site.
 - 3. Place cribbing components on center of sand bed.
 - 4. Set footing on cribbing and adjust as needed to provide level foundation for house.

3.02 ASSEMBLY, DECK FOUNDATIONS

- A. Reference drawings for deck foundation assembly

END OF SECTION 01 53 00

Division 05 - Metals

05 12 00 STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections
 - 1. Division 05 40 00 "Cold-Formed Metal Framing"
 - 2. Division 09 91 00 "Painting"

1.02 REFERENCE STANDARDS

- A. American Institute of Steel Construction 360-05 "Specification for Structural Steel for Buildings."
- B. AISC 303-05 "Code of Standard Practice for Steel Buildings and Bridges."
- C. "Specifications for Structural Joints Using ASTM A325 or A490 Bolts" approved by The Research Council on Structural Connections.
- D. American Welding Society D1.1 "Structural Welding Code- Steel" and ASTM Standards for Welding.

1.03 SUBMITTALS

- A. Shop Drawings
 - 1. Submit shop drawings indicating all shop and erection details, including cuts, copes, connections, holes, splices, camber, threaded fasteners, rivets, and welds.
 - 2. All welds, both shop and field, shall be indicated by AWS "Welding Symbols".
 - 3. Indicate exposed surfaces and edges, and surface preparation being used.
 - 4. Indicate special tolerances and erection requirements.

1.04 PRODUCT HANDLING

- A. Structural steel members that are stored at the project site shall be above ground on platforms, skids, or other supports.
- B. Other materials shall be stored in a weather-tight and dry place, until ready for use in the work.
- C. Use special care in handling architecturally exposed structural steel to prevent twisting, warping, nicking, and other damage.

PART 2 - PRODUCTS**2.01 MATERIAL**

- A. Rolled structural shapes and plates shall meet ASTM A36 and ASTM A46. Hollow structural shapes shall meet ASTM A53 and ASTM A500. Steel wide flange shapes shall meet ASTM A992.
- B. Provide products with an average recycled content of steel products such that post-consumers recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.
- C. Welded Tie Back Anchors:
 - 1. Manufacture according to structural drawings
 - 2. Tested and Certified according to OSHA requirements for fall protection systems.

2.02 FABRICATION

- A. Fabricate structural steel in accordance with AISC 360-05 and AISC 303-05.
- B. Fabricate and assemble in shop to the greatest extent possible.
- C. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
- D. Fabricate exposed surfaces of architecturally exposed structural steel smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and edges. Fabricate free of mill marks, including rolled trade names and stamped or raised identification, and with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
- E. Shear connectors: prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- F. High strength bolts: install according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
- G. Weld connections: comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work. Welding shall be accomplished by certified welders.
- H. For architecturally exposed structural steel, use weld sizes, fabrication sequence, and equipment that will limit distortions to allowable tolerances. Provide continuous welds of uniform size and profile. Grind butt and groove welds flush to adjacent surfaces. Make fillet welds oversize and grind to uniform profile with smooth face and transition.
- I. Priming

1. Shop prime steel surfaces except the following:
 - a. Surfaces to be field welded.
 - b. Surfaces to be high-strength bolted with slip-critical connections.
 - c. Galvanized surfaces.
2. Surface preparation: clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP2 "Hand Tool Cleaning" and SSPC-SP3 "Power Tool Cleaning."
3. Immediately after surface preparation, apply primer according to manufacturer's written instructions and at a rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine architecturally exposed structural steel for kinks, warping, gouges, and other imperfections before erecting.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.02 EXECUTION

- A. Erect structural steel in accordance with the AISC specifications and additional requirements of this section.
- B. Erection tolerances
 1. Maintain erection tolerances of structural steel within AISC 303-05.
 2. Architecturally exposed structural steel erection tolerances shall be as indicated.
- C. Field assembly
 1. Structural steel frames shall be accurately assembled to the lines and elevations indicated, with the specified erection tolerances.
 2. The various members forming parts of a complete frame or structure after being assembled shall be aligned and adjusted accurately before being fastened.
 3. Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact.
 4. Bearing surfaces and surfaces which will be in permanent contact shall be cleaned before the members are assembled.
 5. Splices shall be permitted only where indicated.

3.03 QUALITY CONTROL

- A. Testing: Field and shop welds and bolted connections will be subject to testing and inspection. Qualified independent testing and inspection agency will perform field tests and report results promptly.
- B. Remove and replace work where test results indicate that it does not comply with specified requirements.
- C. Additional testing at contractor's expense will be performed to determine compliance of replaced or additional work with specified requirements.
- D. Architect will observe architecturally exposed structural steel in place to determine acceptability relating to aesthetic effect.

END OF SECTION 05 12 00

05 14 13

ARCHITECTURALLY EXPOSED STRUCTURAL ALUMINUM FRAMING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Photovoltaic Roof Rack System.
- B. Photovoltaic Roof Rack Footing.

1.02 RELATED SECTIONS

- A. Division 07 53 00 "Elastomeric Membrane Roofing."
- B. Division 07 62 00 "Sheet Metal Flashing and Trim."
- C. Division 07 65 00 "Flexible Flashing."
- D. Division 26 31 00 "Photovoltaic Collector."

1.03 QUALITY ASSURANCE

- A. Installer responsibilities:
 - 1. Inquire and comply with all local and state building codes that apply to this installation.
 - 2. Consult with engineer to inspect and determine that all roofs, rafters, trusses, and all structure support the solar array and live load conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Tough Trac Incorporated

2.02 MATERIALS

- A. Tough Trac Roof Rack Components.
 - 1. Power Arm, 6005-T5 Aluminum.
 - 2. Vertical Support with Welded Base Plate, 6005-T5 Aluminum.
 - 3. Power Arm Connector Tubes, 6005-T5 Aluminum.
 - 4. Standard Rail Slide Mounts, 6005-T5 Aluminum.
 - 5. Standard Rail.
 - 6. Standard Rail Connector Tubes, 6005-T5 Aluminum.
 - 7. Square 1 3/16" x 1 3/16".

8. Top Mount End Clamps, 6005-T5 Aluminum.
9. Top Mount Mid Clamps, 6005-T5 Aluminum.

2.03 ACCESSORIES

- A. High-Strength Bolts, Nuts, and Washers provided by Tough Trac.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Follow all installation directions provided by manufacturers.
- B. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- C. Coordinate work closely with roofing contractor.
- D. All roof penetrations shall be done by roofing contractor.

END OF SECTION 05 14 13

05 40 00 COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Non-load-bearing wall framing.
 - 2. Floor joist framing.
 - 3. Ceiling joist framing.
 - 4. Façade panel support.
 - 5. Suspended ceiling supports.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: All structural design properties have been computed in accordance with CSA S136-01, when applicable.

1.03 SUBMITTALS

- A. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.

1.04 QUALITY ASSURANCE

- A. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
 - 1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."
- B. Comply with AISI's "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Steelform

2.02 NON-LOAD-BEARING INTERIOR WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 18 mil.
 - 2. Flange Width: 1-3/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and same minimum base-metal thickness as steel studs.

2.03 NON-LOAD BEARING EXTERIOR WALL FRAMING

- A. Steel Studs: Deltastud, of web depths indicated on drawings.
 - 1. Flange width: 1-1/4 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and same minimum base-metal thickness as steel studs.

2.04 FLOOR AND CEILING JOIST FRAMING

- A. Steel Joists: Megajoist 1200S162-54
 - 1. Flange width: 1-5/8.
 - 2. Web depth: 12 inches.

2.05 FAÇADE PANEL SUPPORTS

- A. Z- channels: Manufacturer's standard z-channel.

2.06 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members, unless otherwise indicated.
- B. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- C. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

2.07 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- B. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
- C. Install framing members in one-piece lengths.
- D. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- E. Install insulation, specified in Section 07 21 00 in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings that are inaccessible on completion of framing work.
- F. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
- G. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.02 NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as indicated on drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
 - 1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- E. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable curtain-wall-framing system.

3.03 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacing indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space joists not more than 2 inches (51 mm) from abutting walls, and as indicated on drawings.
- D. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on shop drawings.
 - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated on shop drawings. Fasten bridging at each joist intersection as follows:
 - 1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
 - 2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.04 FIELD QUALITY CONTROL

- A. Field and shop welds will be subject to testing and inspecting.
- B. Remove and replace work where test results indicate that it does not comply with specified requirements.

3.05 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, which ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

05 50 00 METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 01 53 00 "Temporary Foundations"
 - 2. Division 06 10 00 "Rough Carpentry"
 - 3. Division 06 60 00 "Plastic Fabrications"
 - 4. Division 08 43 13 "Aluminum-Framed Storefronts"
 - 5. Division 08 44 13 "Aluminum Curtain Walls"

1.02 SUBMITTALS

- A. Submit shop drawings indicating all shop and erection details including cuts, connections, holes, threaded fasteners, welds, connections to adjacent construction, elevations, etc.
- B. Shop drawings shall meet or exceed all applicable codes and regulations.
- C. No fabrication shall commence until shop drawings are approved.

1.03 AGENCY STANDARDS

- A. Comply with applicable portions of the standards of The American Society for Testing Materials (ASTM).
- B. Comply with the latest American Welding Society (AWS) "Structural Welding Code" for welding materials and processes, and for qualification of welding operators.
- C. Fabrication shall be by a licensed shop.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials shall be new and shall conform to the following requirements, latest editions:
 - 1. Structural steel shapes: as per ASTM A992.
 - 2. Steel plates, channels, and angles: as per ASTM A36.
- B. Fastenings shall be as indicated in drawings and specifications.
- C. Shop coat primer: SSPC-PAINT 13.64 No. 13 Red or Brown, unless noted otherwise.

2.02 CONNECTION PLATE AT DECK FOOTINGS

- A. Fabricated per drawings.
- B. Steel to be 11-gauge and galvanized.

2.03 PLATE AT BASE OF RAMP

- A. Fabricated per drawings.
- B. 1/8" Aluminum Diamond Plate
- C. Connect to ramp with Sierra Pacific 1/4" x 0.40" x 18" continuous hinge.

2.04 AWNING SUPPORT

- A. Fabricated per drawings.
- B. All steel to be galvanized.

2.05 SUPPORT ANGLE AT INTERIOR CURTAIN WALL HEAD

- A. Fabricate per drawings.
- B. All steel to be shop primed.

2.06 SUPPORT ANGLE AT EXTERIOR STOREFRONT JAMB

- A. Fabricate per drawings.
- B. All steel to be galvanized.

PART 3 - EXECUTION**3.01 INSTALLATION, GENERAL**

- A. All work performed as per standard practices of AISC and National Association of Architectural Metal Manufacturers.
- B. Provide all bolts, anchors, screws, shop and field connections, and miscellaneous fasteners required to make installation complete.
- C. Wherever dissimilar metals come into contact, neoprene washers, spacers, gaskets or other approved materials shall be inserted between them to provide insulation against electrolytic action.

- D. The fabricator shall verify all dimensions of work adjoining the work hereunder. Such other work shall be inspected before fabrication and installation of items specified herein. Measurements of adjoining work shall be obtained so that work shall fit closely to space provided.
- E. Templates: the fabricator shall furnish all necessary templates and pattern required by other trades. He shall also furnish all items except as otherwise specified, pertaining to work hereunder, that are to be built into work.
- F. Do not field cut or alter structural members.
- G. At exposed steel components, grind welds smooth and flush prior to finishing.

END OF SECTION 05 50 00

05 52 00 METAL RAILINGS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings
- B. Structural analysis data signed and sealed by a qualified professional engineer registered in the state where Project is located.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Hollaender Manufacturing

2.02 RAILING SYSTEMS

- A. Product description: Handrail system is designed to meet the requirements of the Americans with Disabilities Act. ADA handrail is designed to allow for easy site assembly and installation of handrail on both new constructions and alterations. All hardware is stainless steel and anodized aluminum. Grab rail meets both ADAAG and UFAS codes.
 - 1. 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.

2.03 RAILING COMPONENTS

- A. 1-1/2" Adjustable Speed Tee
 - 1. Post Inline
 - 2. Mill Finish
 - 3. Standard Hardware
- B. End Loop
 - 1. 2 Rail
 - 2. ADA Anodized
- C. Tangent Bend
 - 1. Anodized
- D. 1-1/2" Interlocking Splice 4" L
 - 1. Mill Finish

- 2. 302 SS Hardware
- E. 1-1/2" HD Square Base Flange 1:12
 - 1. Mill Finish
 - 2. Standard Hardware
- F. 1-1/2" Extruded Wall Flange
 - 1. Mill Finish
 - 2. Standard Hardware with Gasket
- G. 1-1/2" Tee-E
 - 1. Mill Finish
 - 2. Standard Hardware
- H. 1-1/2" Pipe
 - 1. Schedule 40 Anodized Aluminum
 - 2. Anodized 215-R1
- I. 1-1/2" Plug
 - 1. Schedule 40 O.D. Pipe
 - 2. Mill Finish

2.04 FABRICATION

- A. The pipe handrail/guardrail shall be constructed with internally spliced and mechanically fastened, smooth and continuous A.D.A. Railing System of aluminum fittings.
- B. Bracket shall be externally connected to the post by means of an anodized aluminum, tubular rivet nut, and an austenitic 302 alloy stainless steel, hexagon socket, button head, cap screw. The bracket shall be connected to the underside of the rail by means of two stainless steel, flat countersunk head, Type F self-tapping screws that conform to ANSI/ASME- B18.6.4.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Pipe fittings shall be internally connected to the pipe by means of an internal splicing. Pop rivets, sheet metal screws, and adhesives shall not be an acceptable fastening method. The brackets and fittings shall be of high-tensile aluminum-magnesium alloy 535.0 manufactured in compliance with ASTM B26, cast from high-purity ingot 535.2 conforming to ASTM B179.
- B. Handrail brackets and pipe fittings shall provide a continuous, uninterrupted gripping surface with no sharp edges or projections.

- C. The design of the handrail bracket shall provide a 1 ½" clearance between the posts and the rail, and allow for adjustment of the rail to match the angle of the ramp.

END OF SECTION 05 52 00

05 73 50 PERFORATED METAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Architectural Components

1.02 RELATED SECTIONS

- A. Section 05 40 00- "Cold-Formed Metal framing"
- B. Section 05 50 00-"Metal Fabrications"

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations
 - 2. Storage and handling requirements and recommendations
 - 3. Installation methods
- C. Shop Drawings: Submit drawings indicating the following:
 - 1. Pattern and perforation type
 - 2. Panel sizes
 - 3. Panel thickness
 - 4. Installation details
 - 5. Provisions for reinforcement and anchoring
- D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation
- B. Store products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

1.05 COORDINATION

- A. Coordinate fabrication of perforated metal components with fabrication of work on or in which the panels will be installed.

- B. Providing final size measurements to manufacturer in time to avoid delay in the construction schedule.

PART 2 - PRODUCTS

2.01 PRODUCTS

- A. Manufacturer: Accurate Perforating

2.02 MATERIALS

- A. Materials:
 - 1. Aluminum
- B. Standard Pattern Types: Slot Perforations
 - 1. Pattern Number: SL006
 - a. Material: Aluminum
 - b. Slot Size: 9/32 in by 1-27/32 in (7 by 47mm)

2.03 ATTACHMENT SYSTEMS

- A. Attachment System: Custom system as indicated on the Drawing.

2.04 FABRICATION

- A. Fabricate perforated metal panels in accordance with approved shop drawings.
- B. Fabricate compatible attachment system

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until openings and substrates have been properly prepared to receive the products of this section.
- B. Verify dimensions, tolerances and method of attachment with other work on-site.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation

- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide suitable means of anchorage acceptable to manufacturer such as dowels, anchor clips, bar anchors, expansion bolts and shields and toggles.
- C. Anchor supports securely with allowance for necessary thermal movement and structural support
- D. Erect metalwork square, plumb, straight and true, accurately fitted, with tight joints and intersections
- E. Do not install component parts that are observed to be defective. Including warped, bowed, dented, abraded and broken members
- F. Do not cut, trim, weld or braze component parts during erection in manner that would damage finish, decrease strength, or result in visual imperfection or failure in performance. Return component parts that require alteration to shop for refabrication, if possible, or for replacement with new parts.
- G. Separate dissimilar metals and use gasketed fasteners, isolation shim, or isolation tape where needed to eliminate possibility of corrosive or electrolytic action between metals.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 05 73 50

Division 06 - Wood, Plastics, and Composites

06 10 00

ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Wood blocking, cants, and nailers.
 2. Wood sleepers.
 3. Plywood sheathing, decking, and subflooring.
 4. Framing with dimensional lumber and deck.
 5. Fasteners.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

- A. Deleted
- B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Provide dressed lumber, S4S, unless otherwise indicated.
- C. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, and Use Category UC3b for exterior construction not in contact with the ground.
- B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- E. Application: Treat all rough carpentry unless otherwise indicated.

2.03 DIMENSION LUMBER FRAMING

- A. Framing at deck: Construction or No. 2 grade and:
1. Southern pine; SPIB.

2.04 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
 2. Nailers.
 3. Cants.
 4. Sleepers.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.
- C. For concealed boards, provide lumber with 15 percent maximum moisture content and the following species and grades:
1. Mixed southern pine, No. 2 grade; SPIB.

2.05 PLYWOOD

- A. Subflooring and Decking: DOC PS 1, Exposure 1, C-D Plugged, not less than $\frac{3}{4}$ inch nominal thickness.
- B. Vertical Sheathing: DOC PS 1, Exposure 1, C-D Plugged, not less than $\frac{1}{2}$ inch nominal thickness.
- C. Plywood shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacturing.
1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with galvanized finish.
- B. Power-Driven Fasteners: NES NER-272.
- C. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.

2.07 JOIST HANGERS

- A. Manufacturer: Simpson Strong Tie Co., Inc.

1. Model: LUS210
 - a. Finish: galvanized
2. Model: CC0Q3
 - a. Finish: galvanized
3. Model: LUS26
 - a. Finish: galvanized
4. Model: ML26Z
 - a. Finish: galvanized
5. Model: LUC26Z
 - a. Finish: galvanized

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit.
- B. Where wood-preserved-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- C. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- D. Install plywood backing panels by fastening to studs.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Comply with AWPAs M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," 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.

END OF SECTION 06 10 00

06 15 33 WOOD PATIO DECKING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Wood used for exterior patio decking.
 - 2. Hardware for exterior patio decking
- B. Related Sections:
 - 1. Division 06 10 00 "Rough Carpentry"
 - 2. Division 06 20 13 "Exterior Finish Carpentry"

1.02 ACTION SUBMITTALS

- A. Samples: Submit sealed samples of each sealant specified.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage, and deterioration.

1.04 PROJECT CONDITIONS

- A. Environmental Limitations: Obtain and comply with woodwork manufacturer's and installers coordinated advice for optimum temperature and humidity conditions for woodwork during its storage.

1.05 WARRANTY

- A. Manufacturer's standard warranty.

PART 2 - PRODUCTS

2.01 EXTERIOR DECKING, GENERAL

- A. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidence of compliance with grading rule requirements, and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
 - 1. For Exposed Lumber furnish pieces with grade stamps applied to ends or on back of each piece, or omit grade stamps entirely and provide certificate of grade compliance issued by inspection agency.

2.02 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Species: American Cypress
 - 1. Preservative Treatment by pressure process.
 - 2. Length: 5 ft

2.03 INSTALLATION MATERIALS

- A. Fasteners:
 - 1. Exposed square drive deck screws painted to match deck finish.

2.04 FINISHES

- A. Finish Materials: Clear matte sealant, single coating.
- B. Shop Finishing: Transparent finish work to provide sealer coat to all sides.

PART 3 - EXECUTION

3.01 PREPARATION, GENERAL

- A. Surface Preparation: The surface of the decking should be sealed with a sealant in accordance to manufacturer's specifications.

3.02 INSTALLATION, GENERAL

- A. Special Techniques:
 - 1. Set carpentry to required levels and lines, with members plumb, true to line, cut and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

3.03 INSTALLATION REQUIREMENTS

- A. The decking should be installed in accordance to the manufacturer's specifications using specified deck fasteners.
- B. Follow manufacturer's provided installation guide.

END OF SECTION 06 15 33

06 20 13 EXTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Description of Work:
1. Provide all exterior finish carpentry work as indicated on the Drawings and as specified herein. Including, but not limited to:
 - a. Exterior wood standing and running trim along the exterior cabinetry.
 - b. All other exterior finish carpentry work indicated.
 - c. Hardware at exterior casework
- B. Related Sections:
1. Sections that directly relate to work of this Section include, but are not limited to:
 - a. Section 06 10 00 "Rough Carpentry"
 - b. Section 06 13 33 "Wood Patio Decking"
 - c. Division 22 - "Plumbing"
 - d. Section 26 27 13 "Electricity Metering"

1.02 REFERENCES

- A. Definitions: Exterior architectural woodwork includes wood blocking, shims, and nailers for installing woodwork items unless concealed within other construction prior to woodwork installation.

1.03 ACTION SUBMITTALS

- A. Product Data: Submit sample with sealant as selected by the Architect.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage, and deterioration.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Obtain and comply with woodwork manufacturers and installers coordinated advice for optimum temperature and humidity conditions for woodwork during its storage.

1.06 WARRANTY

- A. A manufacturer's standard warranty will be issued.

PART 2 - PRODUCTS**2.01 MATERIALS, GENERAL**

- A. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidence of compliance with grading rule requirements, and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
 - 1. For Exposed Lumber furnish pieces with grade stamps applied to ends or on back of each piece, or omit grade stamps entirely and provide certificated of grade compliance issued by inspection agency.

2.02 FINISHES

- A. Finish materials: Clear Matte sealant, single coating.
- B. Shop Finishing: Transparent finish work to provide sealer coat to all sides.

2.03 WOOD PRESERVATIVE TREATED MATERIAL

- A. Species: American Cypress
 - 1. Preservative Treatment by pressure process.

2.04 INSTALLATION MATERIALS

- A. Screws: Select material, type, size, and finish required for each use, nonferrous metal or hotdip galvanized, unless otherwise indicated.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
- C. Fasteners for use with Pressure Preservative treatment: Stainless steel, type 304 or better.

2.05 EXTERIOR CASEWORK HARDWARE

- A. Concealed Hinges:
 - 1. Mounting: Full Overlay
 - 2. Self-Closing
 - 3. Hinge Arm: Straight
 - 4. Opening Angle: 110 degrees
 - 5. Material: Cup: Steel, Hinge Arm: Steel
 - 6. Finish: Nickel Plated.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: The surface of the wood should be sealed with a sealant in accordance to manufacturer's specifications.

3.02 INSTALLATION

- A. Special Techniques
 1. Set Carpentry to required levels and lines, with members plumb, true to line, cut and fitted.
 2. Secure work to prevent checks or warps. Finish carpentry work shall be properly framed, closely fitted, and accurately set to the required lines and levels and shall be rigidly secured in place.
 3. Follow manufacturer's provided installation guide.

END OF SECTION 06 20 13

06 41 00 INTERIOR ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Interior casework at:
 - a. Kitchen and Kitchen Island
 - b. Bathroom
 - c. Zoom Room and Bedroom Closet
 - 2. Finished plywood panels at interior
 - 3. Miscellaneous wood trim
- B. RELATED SECTIONS:
 - 1. Division 06 10 00 "Rough Carpentry"
 - 2. Division 06 20 23 "Interior Finish Carpentry"
 - 3. Division 11 31 00 "Residential Appliances"
 - 4. Division 12 36 00 "Countertops"
 - 5. Division 12 58 00 "Residential Furniture"
 - 6. Division 22 41 00 "Residential Plumbing Fixtures"

1.02 ACTION SUBMITTALS

- A. Submit shop drawings to verify dimensions.
- B. Submit sample of finish as selected by Architect.

1.03 QUALITY ASSURANCE

- A. Quality Standard: Architectural Woodwork Institute's "Architectural Woodwork Quality Standards"

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage, and deterioration.

1.05 PROJECT CONDITIONS

- A. 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 INTERIOR CABINETRY, GENERAL**

- A. Grade: Lumber shall be of the best grade obtainable or the respective kinds, as defined by the rules of the recognized associations of lumber manufacturers producing the materials specified and shall be thoroughly dried to a moisture content of six (6) percent.

2.02 MANUFACTURERS

- A. Ernie Gross Woodwork, Inc

2.03 MATERIALS

- A. Hardboard: AHA A135.4
- B. Hardwood Plywood and Face Veneers: HPVA HP-1, made with adhesive containing no urea formaldehyde.
 - 1. Finish: As selected by architect
 - 2. Interior finishes shall have fire spread rating \leq 200

2.04 FABRICATION

- A. Shop Finishing of Interior Architectural Woodwork
 - 1. Complete fabrication to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 2. 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.
 - 3. Finishes: Same grades as items to be finished.
 - 4. Finish architectural woodwork at the fabrication shop, defer only final touch up until after installation.
 - 5. Apply one coat of sealer or primer to concealed surfaces of woodwork. Apply two coats to back of paneling and to end grain surfaces.

2.05 ACCESSORIES

- A. Cabinet Hardware and Accessory Materials
 - 1. Pocket Door System: Hafele 1234- Accuride
 - a. Material: Steel
 - b. Finish: Zinc
 - c. Color: Black
 - 2. Pivoting Sliding Door System: Hafele Hawa – Turnaway
 - 3. Pull-out Cabinet Slides System: Hafele EKU-Forte 170/B40 Partial Extension, Top/Bottom Mounted.
 - a. Material: Galvanized steel

4. Hafele 152.22.900 Flush Handle
 - a. Material: Aluminum, anodized, matt
 - b. Diameter 75mm
5. Hafele 124.02.920 Edge Pull
 - a. Material: Aluminum, Silver Annodized

B. Kitchen Hardware and Accessory Materials

1. Concealed Hinges: Hafele A Series Slide-On
 - a. Hinge Type: 13
 - b. Mounting: Full Overlay
 - c. Self Closing
 - d. Hinge Arm: Straight
 - e. Opening Angle: 110 degrees
 - f. Material: Cup Steel, Hinge Arm: Steel
 - g. Finish: Nickel Plated.
2. Hafele 422.04 Accuride Drawer Slide
 - a. Full extension
 - b. Slide mount BB slide
 - c. 100 lb capacity
3. Hafele 106.74.902 Aluminum Handle Cabinet Pull
 - a. Finish: Silver Annodized
 - b. Length:
 - 1) Dishwasher: 5"
 - 2) Refrigerator: 7"
 - 3) Freezer: 5"
4. Hafele 124.02.920 Edge Pull
 - a. Material: Aluminum, Silver Annodized

C. Bathroom Hardware and Accessory Materials:

1. Concealed Hinges: Hafele A Series Slide-On
 - a. Hinge Type: 13
 - b. Mounting: Full Overlay
 - c. Self Closing
 - d. Hinge Arm: Straight
 - e. Opening Angle: 110 degrees
 - f. Material: Cup Steel, Hinge Arm: Steel
 - g. Finish: Nickel Plated

D. Allowable Alternatives

1. Hardware with equal characteristics and capacities as hardware specified.

2.06 INTERIOR FINISHED PLYWOOD PANELS

- A. Thickness: ¼"
- B. Finish Grade

- C. Finish: Cherry
- D. Interior finishes shall have fire spread rating \leq 200

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. 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.
- C. Install woodwork to comply with referenced quality standard for grade specified.
- 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 filed flush with woodwork.
- F. Standing and Running trim: install with minimum number of joints possible, using full length pieces.
- G. Anchor paneling to supports with concealed panel-hanger clips and by blind nailing on back-up strips, splined-connections strips, and similar associated trim and framing.
- H. Cabinets: Install so doors and drawers are accurately aligned.

END OF SECTION 06 41 00

06 42 00 WOOD PANELING

PART 1 - GENERAL

1.01 QUALITY STANDARDS

- A. Provide experienced, well-trained workers competent to complete the work as specified. Fabricator/installer shall be experienced in performing work of similar type and scope.
- B. Unless approved by the Architect, provide all related products and accessories from one manufacturer.

1.02 SUBMITTALS

- A. Submit samples as required for approval by the Architect.

1.03 PRECONSTRUCTION AND PREPARATION

- A. Examine and verify that job conditions are satisfactory for speedy and acceptable work
- B. Field Measurements: Secure field measurements before installation of the work.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Materials must be transported flat and kept dry and protected from the elements and handled with care.
- B. Storage and Protection: Materials must be stored flat and kept dry in a warehouse/storage facility, protected from exposure to harmful weather conditions, at temperatures and humidity conditions recommended by the manufacturer.

1.05 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.06 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide Prodema Prodex

2.02 MATERIALS

- A. Exterior Grade Wood Composite Panel:

1. Wood Veneer
 - a. Color: Deep Brown
2. Panel Dimensions
 - a. 48" x 96" x thickness,
 - b. Thickness: ¼"
3. Dimensional Tolerances
 - a. Length ±2mm, Width ±2mm, Thickness ±0.55mm (10mm thick panel).
4. Surface Burning Characteristics
 - a. Flammability: Class 1 and Class A
 - b. Flame Spread: 10

- B. Exterior Grade Wood Composite Panel Inside Double Facade

1. Wood Veneer
 - a. Color: Pale
 - b. Finish: Smooth Satin
2. Panel Dimensions
 - a. 48" x 96" x thickness,
 - b. Thickness: ¼"
3. Dimensional Tolerances
 - a. Length ±2mm, Width ±2mm, Thickness ±0.55mm (10mm thick panel).
4. Surface Burning Characteristics
 - a. Flammability: Class 1 and Class A
 - b. Flame Spread: 10

2.03 FABRICATION

- A. Fabricate composite panels and accessory items in accordance with manufacturer's recommendations and approved submittals.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine alignment of backup structure prior to installing panels. Do not proceed until all defects are corrected.

3.02 INSTALLATION

- A. Cut panels to size indicated on drawings per manufacturer's instructions
- B. Install solid exterior wall panels plumb and level and accurately spaced
- C. Fasten solid interior wall panels to supporting substrate with adhesive approved for use with adjoining construction.
- D. Provide clear sealant at all joints between panels to create waterproof barrier

3.03 DAMAGED MATERIAL

- A. Repair or replace all damaged material to the satisfaction of the Architect.

3.04 CLEANING

- A. Do not use abrasive cleaners or cleaning tools. Dry wipe down panel sections as work progresses.
- B. Provide final cleaning of the wall system.

3.05 PROTECTION

- A. Protect installed product and finish surfaces from damage during construction

END OF SECTION 06 42 00

06 60 00 PLASTIC FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Acrylic awning
 - 2. Acrylic Façade Panel above door
- B. Related Sections
 - 1. Division 05 40 00- "Cold-formed Metal Framing"
 - 2. Division 05 50 00- "Metal Fabrications"
 - 3. Division 26 50 00- "Lighting"

PART 2 - PRODUCTS

2.01 ACRYLIC PANELS

- A. Awning Panel
 - 1. Cast Acrylic
 - 2. Thickness: 1 ¼ in
 - 3. Size: 4 ft wide x 1 ft 11 ¾ in
 - 4. Polish edges
- B. Façade Panel above door
 - 1. Extruded acrylic
 - 2. Thickness: ¼ in
 - 3. Size: 4 ft wide x 1 ft 5 13/16 in

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Set panels level, plumb, and true to line, without warp or rack.
- B. Fasten panels securely in place.

END OF SECTION 06 60 00

Division 07 - Thermal and Moisture Protection

07 13 00

SHEET WATERPROOFING

PART 1 - GENERAL**1.01 SUMMARY**

- A. This section includes the following:
 - 1. Self-adhesive Rubber Membrane

1.02 SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing and testing substrate, technical data, and tested physical and performance properties of waterproofing.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum of 20-years experience in the productio of sheet membrane waterproofing.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to project site in original packages with seals unbroken, labeled with manufacturer's name, prodct brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store rolls according to manufacturer's written instructions.
- C. Protect stored materials from direct sunlight.

1.05 PROJECT CONDITIONS

- A. Environmental limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
- B. Maintain adwquate ventilation during preparation and application of waterproofing materials.

PART 2 - PRODUCTS**2.01 SELF-ADHESIVE WATERPROOF MEMBRANE**

- A. Product: Grace Ice and Water Shield
 - 1. Thickness: 40 mil

2. Tensile Strength: 250 psi
3. Elongation: 250%
4. Permeance (max): 0.05 Perms

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

- A. Install Grace Ice and Water Shield directly on a clean, dry, continuous surface. Remove dust and dirt. Protrusions from the surface must be removed. Surface shall have no voids, damaged, or unsupported areas. Repair surface before installing the membrane.
- B. Prime surface with Perm-A-Barrier WB Primer if adhesion is found to be marginal.

3.02 WATERPROOF MEMBRANE APPLICATION

- A. Apply Grace Ice and Water Shield in fair weather when the air and membrane are at temperatures of 40 degrees fahrenheit or higher.
- B. Cut membrane into 10-15 ft lengths and reroll loosely. Peel back 1-2 ft of release liner, align the membrane, continue to peel the release liner from the membrane. Press the membrane in place with heavy hand pressure. Side laps must be a minimum of 3.5 inches and end laps a minimum of 6 inches. For valley and ridge application, peel the release liner, center the sheet over the valley or ridge, drape, and press it in place. Work from the center of the valley or ridge outward in each direction and start at the low point and work up the surface.
- C. For successive membrane courses, align the edge of the release liner with the dashed line provided on the surface of the membrane to achieve the 3.5in side lap.
- D. Install the membrane such that all laps shed waer. The membrane may be installed either vertically or horizontally.

3.03 PROTECTION AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 13 00

07 21 00 THERMAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Insulation and Air Sealing system, including the following items:
1. Batt insulation
 2. Air infiltration barrier with Flexible Seal Technology

1.02 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Instructions: Submit the following:
1. General installation/application instruction.
 2. Environmental conditions required for installation and installation techniques
 3. Safety requirements for application of products.

1.03 QUALITY ASSURANCE

- A. Qualifications, Installer's/Applicator's: Company specializing in performing work of this section with the following minimum requirements:
1. Successfully competed manufacturer's training.

1.04 SUSTAINABLE DESIGN QUALITY ASSURANCE

- A. Certifications
1. VOC Emissions: Complies with GREENGUARD Product Emission Standard For Children & Schools.
 2. Recycled Content: For fiberglass insulation, 50 percent minimum.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protection, General:
1. Store and protect products in accordance with manufacturers' instructions
 2. Store with seals and labels intact and legible
 3. Store inside and in a dry location
 - a. Protect insulation materials from moisture and soiling.
 - b. Provide ventilation to prevent condensation and degradation of products.
 4. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
- B. Deliver materials in recyclable containers and packaging.

1.06 WARRANTY

- A. Manufacturer's Standard Warranty

PART 2 - PRODUCTS

2.01 PRODUCT

- A. Insulation and Air Sealing System: EnergyComplete™ with Flexible Seal Technology Whole Home Insulation and Air Sealing System by Owens Corning.

2.02 SYSTEM DESCRIPTION

- A. General: System consists of an air infiltration barrier applied to joints between materials of the exterior and interior wall framing to eliminate air infiltration into the building and the installation of insulation to reduce thermal transmission.

2.03 PERFORMANCE CRITERIA

- A. Minimum R-Value, Batt Insulation:
 1. Thickness, 3-1/2 inch: R-15.
 2. Thickness, 5-1/2 inch: R-21.
 3. Thickness, 12 inch: R-38.

2.04 MATERIALS

- A. Batt Insulation (Type 2): ASTM C 665, Type II, Class C preformed glass fiber batt type, Kraft paper faced one side. Where two layers of batt insulation are installed, exterior batt shall be Kraft paper faced one side and interior batt shall be unfaced.
- B. Spray Foam Sealant.
 1. Tack-Free: Dry to the touch within 20 minutes
 2. Pressure Build: AAMA 812, less than 0.1 psi
 3. Water Vapor Permeance:
 - a. ASTM E 96 (dry cup): 40 perm
 - b. ASTM E 96 (wet cup): 110 perm.
 4. Dimensional Stability: ASTM D 2126, maximum 1.0% linear change at -40°F, ambient RH after 2 weeks max 2.0% linear change at 100°F, 97% RH after 2 weeks.
 5. Durability: ASTM C 719, more than 10 cycles; no cohesive failure or cracking
 6. Flame Spread: ASTM E 84, 10
 7. Smoke Developed: ASTM E 84, 20.
 8. Leakage Rate: ASTM E 283, less than 0.01 cfm/ft.2 at 1.57 psf (75 Pa) and 6.24 psf (300 Pa) pressure

2.05 ACCESSORIES

- A. Provide accessories per insulating system manufacturer's recommendations
- B. Water-Resistive Weather Barriers: Comply with requirements of Section 07 27 00 "Water-Resistive Weather Barriers"
- C. Insulation Fasteners: Impale clip of galvanized steel; type recommended by insulation manufacturer for particular use intended

PART 3 - EXECUTION

3.01 GENERAL

- A. Comply with Manufacturer's Instructions for safety, preparation, and application of products.

3.02 EXAMINATION

- A. Examine substrates, flashing conditions, penetrations, adjoining construction and the conditions under which work is to be installed
 - 1. Verify that surfaces are dry and free of oil, grease, dust, rust, or other contaminant.
- B. Report unacceptable conditions.
- C. Do not proceed with the Work until unsatisfactory conditions have been corrected and surfaces are acceptable.
- D. Verify the following conditions have been sealed with the air infiltration barrier before installing insulation and before closing in framing cavities:
 - 1. Gaps between window units and framing.
 - 2. Gaps between door heads, jambs, and sills and wall framing.
 - 3. Interface of band joists or rim joists and plates and subfloor.
 - 4. Duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditioned space.

3.03 PREPARATION

- A. Before beginning work, protect windows, plumbing fixtures, finish materials, and finish surfaces within work area from overspray by covering them with a plastic film. Secure edges of film to assure air infiltration barrier with flexible seal technology does not get behind the film
- B. Sweep area to receive air infiltration barrier application to remove dust and other contaminants that will interfere with providing a thorough seal

- C. Wear chemical gloves, goggles or a face shield, a long sleeved shirt, and, if the installation site is dusty, a dust mask when applying EnergyComplete™ Air Infiltration Barrier with Flexible Seal Technology.
- D. If using products other than EnergyComplete™ Air Infiltration Barrier with Flexible Seal Technology that contain isocyanate, comply fully with OSHA regulations regarding protective clothing, breathing apparatus, ventilation, and restricting access to areas of application.
- E. Fill, with fiberglass insulation, medium-sized gaps (gaps between 3/8 inch and 3 inches) between surfaces to be sprayed. Cover gaps greater than 3 inches with rigid, nonporous material such as gypsum board, expanded polystyrene insulation, extruded polystyrene insulation, sheathing, OSB, particle board, agrifiber particle board, or plywood secured to framing and apply sealant at the perimeter.

3.04 AIR INFILTRATION BARRIER WITH FLEXIBLE SEAL APPLICATION

- A. Apply in accordance with manufacturers instructions.
- B. Apply continuously and evenly to joints in the following conditions:
 1. At penetrations between conditioned and unconditioned spaces.
 2. At interface between the sheathing and stud where a sheathing seam is known to exist.
 3. At the interface between windows/doors and the framed opening.
 4. On the face of all top plates of exterior walls
 5. At interface between the bottom plate and the sheathing
 6. At interface between the top plate and the sheathing
 7. At interface between the bottom plate and the subfloor
 8. At any horizontal, mid-cavity sheathing seams
 9. At insulated floor of room above unconditioned space
 10. At interface between the band joist and the plate below it.
 11. At interface between the band joist and the subfloor above it.
- C. Do not install air infiltration barrier with flexible seal technology within 3" of a heat source.
- D. Do not allow there to be excessive overspray.

3.05 INSTALLATION OF INSULATION, GENERAL

- A. Comply with 2009 IECC requirements indicated on Table 402.4.2 Air Barrier and Insulation Inspection Component Criteria.
- B. Install insulation system according to manufacturer's instructions.
- C. Do not install insulation on top of or within 3" of recessed light fixtures unless the fixtures are approved for such use.
- D. Install insulation at band joists rim joists.

- E. Within exterior wall framing, install insulation between pipes and backside of sheathing. Cut insulation material as required to fit around wiring and plumbing.
- F. Where showers and bathtubs are located on exterior walls, install insulation and vapor retarder air barrier between units and exterior.

3.06 INSTALLATION- BATT INSULATION

- A. Install batt insulation in accordance with ASTM C 1320.
- B. Install in exterior walls, roof and ceiling spaces without gaps or voids.
 - 1. Fluff insulation to full thickness for specified R-value before installation.
 - 2. Do not compress insulation
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation.
- E. Securing Insulation: Secure insulation in place using the following method
 - 1. Friction fit.
- F. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
- G. Place water-resistive weather barrier where indicated on drawings
- H. Water-Resistive Weather Barrier Installation: Comply with requirements of Section 07 27 00 "Water-Resistive Weather Barriers."

3.07 CLEANING

- A. Remove plastic film coverings.
- B. Clean overspray from materials, equipment, and fixtures that were not to receive flexible seal technology.
- C. Remove damaged materials, equipment, and fixtures if overspray can not be cleaned without blemish and install new materials, equipment, and fixtures identical to item before damage occurred.

END OF SECTION 07 21 00

07 22 00 ROOF AND DECK INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Contour Tapered Tile Rigid Insulation.
- B. Related Sections
 - 1. Division 05 14 13 "Architecturally-Exposed Aluminum Framing."
 - 2. Division 07 13 00 "Sheet Waterproofing."
 - 3. Division 07 53 00 "Elastomeric Membrane Roofing."
 - 4. Division 07 62 00 "Sheet Metal Flashing and Trim."
 - 5. Division 07 72 00 "Roof Accessories."
 - 6. Division 22 13 16 "Sanitary Waste and Vent Piping."

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C 1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

1.03 QUALITY ASSURANCE

- A. All products shall be inspected for damage prior to installation.

1.04 DELIVERY, STORAGE, & HANDLING

- A. Insulation must be protected from open flame and kept dry at all times.

1.05 WARRANTY

- A. Standard manufacturer's warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Provided by Energy Systems Incorporated

2.02 MATERIALS

- A. Contour Taper Tile Rigid Insulation.
1. Rigid Roof Insulation.
 - a. Density: 1 1/4 pounds per cubic foot.
 - b. Tapered at 1/4" / 1'.
 - c. Compressive Strength: 13.
 - d. Design R-Value: 4.25 per inch at 40 degrees.
 2. Rigid Interior Floor Insulation.
 - a. Density: 2 pounds per cubic foot.
 - b. Tapered at 1/4" / 1', minimum taper of 1/4".
 - c. Compressive strength 25.
 - d. Design R-Value of 4.76 per inch at 40 degrees.
 3. Rigid Shower Pan Insulation.
 - a. Density: 2 pounds per cubic foot.
 - b. Tapered at 1/4" / 1', minimum taper of 1/4".
 - c. Compressive strength 25.
 - d. Design R-Value of 4.76 per inch at 40 degrees.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Follow shall strictly follow manufacturer's instructions.
- B. Install only as much insulation as can be covered the same day by completed roof covering material.

END OF SECTION 07 22 00

07 27 00

WATER-RESISTIVE WEATHER BARRIER

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Water-resistive weather barrier for rainscreen assemblies.

1.02 RELATED REQUIREMENTS

- A. Division 05 40 00 "Cold-formed metal framing" for rainscreen cladding supports on water-resistive weather barrier.
- B. Division 06 10 00 "Rough Carpentry" for exterior wall sheathing substrate for water-resistive weather barrier.
- C. Division 07 42 23 "Wood Wall Panels" for rainscreen cladding over water-resistive weather barrier.

1.03 QUALITY ASSURANCE

- A. Single Source: Provide water-resistive weather barrier and accessories that are products of or recommended for use by a single manufacturer.
- B. Manufacturer Qualifications: Approved manufacturer of products listed in this Section with minimum 5 years experience in manufacture of similar products in successful use in similar applications.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Installer, affected trade contractors, and inspector. Invite Owner and Architect.
 - 1. Coordinate substrate installation in relation to requirements for water-resistive weather barrier.
 - 2. Coordinate window, door, and other openings and penetrations of water-resistive weather barrier.

1.05 ACTION SUBMITTALS

- A. Product Data:
 - 1. Provide manufacturer's standard installation instructions and details for water-resistive weather barrier and rainscreen components and accessories.

1.06 WARRANTY

- A. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to provide replacement material for water-resistive barrier installed in accordance with manufacturer's instructions that fails due to material defects for the life of the building.

PART 2 - PRODUCTS

2.01 MANUFACTURER AND PRODUCT

- A. VaproShield, WallShield Water-Resistive Weather Barrier, and Rainscreen Underlayment.

2.02 WATER-RESISTIVE WEATHER BARRIER

- A. Water-Resistive Weather Barrier: Water-resistive weather barrier consisting of multiple layers of UV-stabilized spun-bonded polypropylene.
1. Water Vapor Permeance tested to ASTM E 96 Method B: 212 perms (12180ng/Pa.s.m²)
 2. Water Resistance tested to AATCC 127, 550 mm hydrostatic head for 5 hours: No leakage
 3. Tensile Strength tested to ASTM D 882: 25 lbf/inch (43.8 N/mm), machine direction; 20 lbf/inch (35.0 N/mm), cross-machine direction
 4. Surface Burning Characteristics tested to ASTM E 84: Class A, Flame-spread index of less than 25, Smoke-development index of less than 450
 5. Application Temperature: No temperature restrictions
 6. Allowable UV Exposure Time: 270 days
 7. Physical Dimensions: 0.020 inches (0.51 mm) thick, 59 inches (1.45 m) wide and 5 oz per sq. yd. (17 g/sq. m.)
 8. Color: Black

2.03 RAINSCREEN ACCESSORIES

- A. General: Provide manufacturer's rainscreen design components and flashing elements for a complete, weather-tight, ventilated wall installation.
- B. Flashing and Lap Tapes: Self-adhering single- and double- sided adhesive flashing, lap, and transition tapes, as recommended by manufacturer for application.
1. Single-Sided Tape: 20 mil by 3 inch (76 mm) wide lap and edge tape.
 2. Double-Sided Tape: 30 mil by 1 inch (25 mm) wide lap tape.
 3. UV-Resistant Black Tape: 35 mil by 4 inch (102 mm) wide exposed open joint tape.
- C. Fasteners: Manufacturer's recommended corrosion-resistant, cap-headed steel or stainless steel nails, staples, or screws used in conjunction with manufacturer's spray adhesive, as appropriate for substrate.
- D. Sealants: Type recommended by manufacturer for application, meeting requirements of Division 07 90 00 "Joint Protection."

PART 3 - EXECUTION**3.01 INSPECTION**

- A. Examine substrate with Installer present for compliance with requirements and other conditions that would adversely affect installation or performance of water-resistive weather barrier. Correct deficient conditions prior to proceeding with water-resistive barrier installation.

3.02 SUBSTRATE PREPARATION

- A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean and dry substrate for breathable membrane application.

3.03 WATER-RESISTIVE WEATHER BARRIER INSTALLATION

- A. General: Install water-resistive weather barrier in accordance with manufacturer's instructions over exterior sheathing. Secure water-resistive barrier to substrate to prevent damage prior to installation of cladding.

- B. Window and Louver Openings

1. Install lap strip water-resistive weather barrier around jambs, extending along wall surface a minimum of 9 inches (230 mm).
2. Secure prefabricated water-resistive weather barrier corners at head of opening.
3. Install lap strip of water-resistive weather barrier across head of opening, extending horizontally beyond corners minimum of 6 inches (150 mm).
4. Cut water-resistive weather barrier along leading edge of header 2 inches (50 mm) beyond jamb to allow insertion of window nailing flange behind water-resistive weather barrier.

- C. Door Openings

1. Install water-resistive weather barrier lap strip around jambs, extending along wall surface a minimum of 9 inches (230 mm).
2. Secure prefabricated water-resistive weather barrier corners at head of opening.
3. Install lap strip of water-resistive weather barrier across head of opening, extending horizontally beyond corners minimum of 6 inches (150 mm).
4. Cut water-resistive weather barrier along leading edge of header 2 inches (50 mm) beyond jamb to allow insertion of door nailing flange behind weather barrier.

- D. Pipe and Conduit Penetrations

1. Install manufactured penetration sleeves sized for penetration and installed as recommended by sleeve manufacturer.
2. Prepare water-resistive weather barrier skirt with minimum 12 inches (300 mm) of fabric on all sides at counter-flashed penetrations. Make multiple cuts to form a star-shaped opening in fabric and place over penetration. Extend skirt fabric along penetrating item and seal to penetrating item with single-sided tape.

- E. Water-Resistive Weather Barrier
 1. Begin water-resistive weather barrier installation at bottom of wall, mechanically fastening water-resistive weather barrier at bottom and top at 24 inches (600 mm) o.c. Seal bottom edge of water-resistive weather barrier to substrate in continuous bead of non-skinning butyl sealant or butyl tape.
 2. Install water-resistive weather barrier at overlapped lap strips and penetration skirts. Overlap at vertical laps minimum of 6 inches (150 mm) with taped joints or 12 inches (300 mm) without tape. Overlap at horizontal laps minimum of 6 inches (150 mm). Insert water-resistive weather barrier under bottom edge of lap strips and penetration skirts; do not tape bottom edge of skirts and lap strips.
 3. Extend water-resistive weather barrier 6 inches (150 mm) over corners.
 4. Shingle subsequent courses of water-resistive weather barrier. Do not place vertical laps above openings.
 5. Use additional mechanical fasteners in field of sheet and tape joints if water-resistive weather barrier will be left exposed prior to installation of cladding.
- F. Exposed Rainscreen Water-Resistive Weather Barrier
 1. Use manufacturer's recommended UV-resistant black-surfaced water-resistive weather barrier material or UV-resistant black tape at open joints in spaced rainscreen cladding systems.

3.04 PROTECTING AND CLEANING

- A. Protect installed water-resistive weather barrier from damage due to construction activities, high wind conditions, and extended exposure to weather.
- B. Inspect exposed water-resistive weather barrier prior to installation of cladding. Remove water-resistive weather barrier materials that have been damaged and replace. Patch damaged areas as recommended by manufacturer.

END OF SECTION 07 27 00

07 42 23 WOOD WALL PANELS

PART 1 - GENERAL

1.01 QUALITY STANDARDS

- A. Provide experienced, well-trained workers competent to complete the work as specified. Fabricator/installer shall be experienced in performing work of similar type and scope.
- B. Unless approved by the Architect, provide all related products and accessories from one manufacturer.

1.02 SUBMITTALS

- A. Submit manufacturer's installation instructions
- B. Submit samples as required for approval by the Architect.

1.03 PRECONSTRUCTION AND PREPARATION

- A. Examine and verify that job conditions are satisfactory for speedy and acceptable work
- B. Field Measurements: Secure field measurements before installation of the work.
- C. Preinstallation Meeting: Conduct preinstallation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Materials must be transported flat and kept dry and protected from the elements and handled with care.
- B. Storage and Protection: Materials must be stored flat and kept dry in a warehouse/storage facility, protected from exposure to harmful weather conditions, at temperatures and humidity conditions recommended by the manufacturer.

1.05 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.06 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide Prodema Prodex

2.02 MATERIALS

- A. Exterior Grade Wood Composite Panel:
 - 1. Wood Veneer
 - a. Color: Deep Brown
 - 2. Panel Dimensions
 - a. 48" x 96" x thickness,
 - b. Thickness: ¼"
 - 3. Dimensional Tolerances
 - a. Length ±2mm, Width ±2mm, Thickness ±0.55mm (10mm thick panel).
 - 4. Surface Burning Characteristics
 - a. Flammability: Class 1 and Class A
 - b. Flame Spread: 10
- B. Exterior Grade Wood Composite Panel Inside Double Facade
 - 1. Wood Veneer
 - a. Color: Pale
 - b. Finish: Smooth Satin
 - 2. Panel Dimensions
 - a. 48" x 96" x thickness,
 - b. Thickness: ¼"
 - 3. Dimensional Tolerances
 - a. Length ±2mm, Width ±2mm, Thickness ±0.55mm (10mm thick panel).
 - 4. Surface Burning Characteristics
 - a. Flammability: Class 1 and Class A
 - b. Flame Spread: 10

2.03 FABRICATION

- A. Fabricate composite panels and accessory items in accordance with manufacturer's recommendations and approved submittals.

PART 3 - EXECUTION**3.01 INSPECTION**

- A. Examine alignment of backup structure prior to installing sub-frame. Do not proceed until all defects are corrected.

3.02 INSTALLATION

- A. Comply with Manufacturer's "General Guidelines for Panel Installation"
- B. Cut panels to size indicated on drawings, per manufacturer's instructions.
- C. Install solid exterior wall panels plumb and level and accurately spaced in accordance with manufacturer's recommendations and approved submittals.
- D. Fasten solid interior wall panels to supporting substrate with fasteners [and adhesive] approved for use with adjoining construction.

3.03 DAMAGED MATERIAL

- A. Repair or replace all damaged material to the satisfaction of the Architect.

3.04 CLEANING

- A. Do not use abrasive cleaners or cleaning tools. Dry wipe down panel sections as work progresses.
- B. Provide final cleaning of the wall system.

3.05 PROTECTION

- A. Protect installed product and finish surfaces from damage during construction

END OF SECTION 07 42 23

07 53 00 ELASTOMERIC MEMBRANE ROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Membrane Roofing.
- B. Membrane Flashings.

1.02 RELATED SECTIONS

- A. Section 06 10 00 - Rough Carpentry: Roof blocking installation and requirements.
- B. Section 07 22 00 - Roof and Deck Insulation
- C. Section 07 62 00 - Sheet Metal Flashing and Trim
- D. Section 07 70 00 - Roof Specialties and Accessories
- E. Section 15 43 00 - Plumbing Specialties

1.03 REFERENCES

- A. American Society of Civil Engineers (ASCE) - ASCE 7 - Minimum Design Loads for Buildings and Other Structures, Current Revision.
- B. ANSI/SPRI RP-4 "Wind Design Standard For Ballasted Single-ply Roofing Systems".
- C. ANSI/SPRI WD-1 "Wind Design Standard for Roofing Assemblies".
- D. ASTM International (ASTM):
 1. ASTM C 208 - Standard Specification for Cellulosic Fiber Insulating Board.
 2. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 3. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 4. ASTM D 41 - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
 5. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 6. ASTM D 624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 7. ASTM D 816 - Standard Test Methods for Rubber Cements.
 8. ASTM D 4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

9. ASTM D 4637 - Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane.
 10. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
- E. Factory Mutual (FM Global):
1. Approval Guide.
 - a. Factory Mutual Standard 4470 - Approval Standard for Class 1 Roof Covers.
 - b. Loss Prevention Data Sheets 1-28, 1-29.
- F. International Code Council (ICC):
1. 1. International Building Code (IBC).
- G. National Roofing Contractors Association (NRCA) - Low Slope Roofing and Waterproofing Manual, Current Edition.
- H. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - Architectural Sheet Metal Manual.
- I. Underwriters Laboratories (UL):
1. TGFU R1306 - "Roofing Systems and Materials Guide".
 2. UL-790 - Standard Test Method for Fire Tests of Roof Coverings.
- J. ANSI/ASHRAE/IESNA Standard 90.1 (2007): Energy Standard for Buildings Except Low-Rise Residential Buildings
- 1.04 DESIGN CRITERIA
- A. Drainage: Provide a roof system with positive drainage where all standing water dissipates within 48 hours after precipitation ends.
- B. Building Codes:
1. Roof system will meet the requirements of all federal, state and local code bodies having jurisdiction.
- 1.05 SUBMITTALS
- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Detail Drawings:
1. Submit approved plan, section, elevation or isometric drawings which detail the appropriate methods for all flashing conditions found on the project.
 2. Coordinate approved drawings with locations found on the Contract Drawings.

- D. Selection Samples: For each finish product specified, two complete sets of chips representing manufacturer's full range of available colors, membranes, and thicknesses.
- E. Verification Samples: For each finish product specified, two samples, minimum size 4 inches (100 mm) square representing actual product, color, and patterns.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All products specified in this section will be supplied by a single manufacturer with a minimum of twenty (20) years experience.
- B. Installer Qualifications:
 - 1. All products listed in this section are to be installed by a single installer with a minimum of five (5) years demonstrated experience in installing products of the same type and scope as specified.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation, installation techniques and workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local authorities having jurisdiction.

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Refer to manufacturer's specifications for general job site considerations.
- C. Material Safety Data Sheets (MSDS) must be on location at all times during the transportation, storage and application of materials.
- D. When positioning membrane sheets, exercise care to locate all field splices away from low spots and out of drain sumps. All field splices should be shingled to prevent bucking of water.
- E. When loading materials onto the roof, the contractor must comply with the requirements of the building owner to prevent overloading and possible disturbance to the building structure.

- F. Proceed with roofing work only when weather conditions are in compliance with the manufacturer's recommended limitations, and when conditions will permit the work to proceed in accordance with the manufacturer's requirements and recommendations.
- G. Proceed with work so new roofing materials are not subject to construction traffic. When necessary, new roof sections shall be protected and inspected upon completion for possible damage.
- H. Provide protection, such as 3/4 inch thick plywood, for all roof areas exposed to traffic during construction. Plywood must be smooth and free of fasteners and splinters.
- I. The surface on which the insulation or roofing membrane is to be applied shall be clean, smooth, dry, and free of projections or contaminants that would prevent proper application of or be incompatible with the new installation, such as fins, sharp edges, foreign materials, oil and grease.
- J. New roofing shall be complete and weathertight at the end of the work day.
- K. Contaminants such as grease, fats and oils shall not be allowed to come in direct contact with the roofing membrane.

1.09 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's Total-System warranty, outlining its terms, conditions, and exclusions from coverage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Firestone Building Products
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 25 00.

2.02 SCOPE / APPLICATION

- A. Roof System: Provide a waterproof roof system, capable of withstanding uplift forces as specified in Design Criteria.
 - 1. Membrane Attachment: Fully Adhered.
- B. Base Flashing: Provide a waterproof, fully adhered base flashing system at all penetrations, plane transitions and terminations.
- C. Insulation: Provide a roof insulation system beneath the finish membrane.

2.03 ETHYLENE, PROPYLENE, DIENE TERPOLYMER (EPDM) MEMBRANE

- A. RubberGard Eco White Non-Reinforced Membrane: Cured, non-reinforced EPDM membrane meeting the requirements of ASTM D 4637 Type I.
 - 1. Color: White
 - 2. Membrane Thickness: 60 mil nominal.
 - 3. Sheet Dimensions:
 - a. Width: 16'-8" feet (3.048 m).
 - b. Length: 100 feet (30.48 m).

2.04 FLASHING ACCESSORIES

- A. EcoWhite QuickSeam Flashing.

2.05 CLEANERS, PRIMERS, ADHESIVES AND SEALANTS

- A. QuickPrime Plus.
- B. Firestone Splice Wash.
- C. Firestone Membrane PreWash.

2.06 EDGINGS AND TERMINATIONS

- A. EcoWhite QuickSeam Flashing.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Do not commence work until all other work trades have completed jobs that require them to traverse the deck on foot or with equipment.

- D. A vapor retarder / temporary roof may be applied to protect the inside of the structure prior to the roof system installation.

3.03 MEMBRANE PLACEMENT AND ATTACHMENT (Fully Adhered)

- A. Unroll and position membrane without stretching. Allow the membrane to relax for approximately 1/2 hour before bonding. Fold the sheet back onto itself so half the underside of the membrane is exposed.
- B. Apply the Bonding Adhesive in accordance with the manufacturer's published instructions, to both the underside of the membrane and the substrate. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.
- C. Roll the coated membrane into the coated substrate while avoiding wrinkles. Brush down the bonded half of the membrane sheet with a soft bristle push broom to achieve maximum contact.
- D. Fold back the unbonded half of the membrane sheet and repeat the bonding procedure.
- E. Install adjoining membrane sheets in the same manner, overlapping edges appropriately to provide for the minimum splice width. It is recommended that all splices be shingled to avoid bucking of water.

3.04 MEMBRANE SPLICING (Adhesive Splice)

- A. Fold the top sheet back and clean the dry splice area (minimum 3 inches wide) of both membrane sheets by scrubbing with clean natural fiber rags saturated with Splice Cleaner or HP-250 Primer. When using Sure-Seal (black) PRE-KLEENED membrane, cleaning the splice area is not required unless contaminated with field dirt or other residue.
- B. Apply Splicing Cement and In-Seam Sealant in accordance with the manufacturer's current application guidelines, and roll the top sheet onto the mating surface.
- C. Roll the splice with a 2 inch wide steel roller and wait at least 2 hours before applying Lap Sealant to the splice edge following the manufacturer's requirements.
- D. Field splices without In-Seam Sealant must be overlaid with uncured flashing.

3.05 FLASHING

- A. Wall and curb flashing shall be cured EPDM membrane. Continue the deck membrane as wall flashing where practicable.
- B. Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

3.06 DAILY SEALS

- A. On phased roofing, when the completion of flashings and terminations is not achieved by the end of the work day, a daily seal must be performed to temporarily close the membrane to prevent water infiltration.
- B. Use Sure-Seal Pourable Sealer or other acceptable membrane seal in accordance with the manufacturer's requirements.

3.07 CLEAN UP

- A. Perform daily clean-up to collect all wrappings, empty containers, paper, and other debris from the project site. Upon completion, all debris must be disposed of in a legally acceptable manner.
- B. Prior to the manufacturer's inspection for warranty, the applicator must perform a pre-inspection to review all work and to verify all flashing has been completed as well as the application of all caulking.

3.08 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 07 53 00

07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Flashing at roof, store front sill, louver sill and at base of façade panels.
 - 2. Sheet metal components at façade.
 - 3. Sheet metal components at interior of double façade.
 - 4. Sheet metal wrap at underside of building.
 - 5. Sheet metal lighting trough at floor and ceiling.

1.02 SUBMITTALS

- A. Submit shop drawings for approval prior to fabrication. Show locations, materials, shapes and methods of anchoring.

1.03 PRODUCT DELIVERY

- A. Deliver to jobsite all components required for incorporation into the work by other trades.
- B. Protect finished surfaces from scratching or discoloring.
- C. Protect exposed sheet metal from bending and denting.

1.04 REFERENCING STANDARDS

- A. NRCA Manual.
- B. Comply with applicable portions of "Architectural Sheet Metal Manual" by Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA).
- C. ASTM References: latest edition.

PART 2 - PRODUCTS

2.01 FLASHING, COUNTER FLASHING, AND FASCIA

- A. Aluminum Sheet Metal.
 - 1. Gauge: 20 gauge.
 - 2. Provide and install all necessary channels, clips, trim, edge accessories, fasteners and sealants to insure a watertight performance and coordinated appearance.

3. Finish: clear anodized.
4. Reference drawings for dimensions and location.

2.02 SHEET METAL COMPONENTS AT FAÇADE AND UNDERSIDE OF BUILDING.

- A. Aluminum sheet metal.
 1. Gauge: 20 gauge at underside of building, 16 gauge at façade.
 2. Provide and install all necessary channels, clips, trim, edge accessories, fasteners and sealants to insure a watertight performance and coordinated appearance.
 3. Finish: clear anodized
 4. Reference drawings for dimensions and location.

2.03 SHEET METAL LIGHTING TROUGH

- A. Aluminum sheet metal.
 1. Gauge: As recommended by SMACNA.
 2. Finish: clear anodized.
 3. Reference drawings for dimensions and locations.

2.04 MISCELLANEOUS MATERIALS

- A. For metal work, provide the type sealant and fasteners recommended by the producer of the metal sheets, for fabrication and installation.
- B. Bituminous coating: FS TT-C-494, or Mil-C-18480, or SSPC-Paint 12, cold-applied bituminous mastic, compounded for 15-mil dry film thickness coating.

2.05 DISSIMILAR METALS

- A. Wherever dissimilar metals come into contact, Neoprene washers, spacers, gaskets or other approved materials shall be inserted between them to provide insulation against electrolytic action.

PART 3 - EXECUTION

3.01 FABRICATION

- A. Shop fabricate work to greatest extent possible. Comply with details shown, and with applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry practices. Fabricate for waterproof and weather-resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, damage or deterioration of the work. Form work to fit substrates. Comply with material manufacturer instructions and recommendations. Form exposed sheet metal work without excessive oil canning, buckling and tool marks, true to line and levels as indicated, with exposed edges back to form hems.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with manufacturer's instructions for handling and installation of flashing and sheet metal work.
- B. Coordinate the work with other work for the correct sequencing of items which make up the entire membrane or system of weatherproofing or waterproofing and rain drainage. It is required that the flashing and sheet metal work be permanently watertight, and not deteriorate in excess of manufacturer's published limitations, use concealed slice plates in flashing.

3.03 INSTALLATION OF METAL WORK

- A. Comply with details and profiles as shown, and comply with SMACNA "Architectural Sheet Metal Manual" recommendations for installation of the work. No face nailing will be allowed.
- B. For non-moving seams provide soldered flat-lock seams.
- C. Provide for thermal expansion of all exposed sheet metal work exceeding 15'-0" running length.
- D. For flashing and trim, provide 10'-0" maximum pieces interlocked in a 6" lap and filled with mastic, and joints 2'-0" from corners and intersections.
- E. Conceal fasteners and expansion provisions wherever possible. Fold back edges on concealed side of exposed edges, to form a hem.
- F. Separate dissimilar metals by a 15-mil dry film thickness bituminous coating.
- G. Fabricate, support and anchor rain drainage system in a manner which will withstand thermal expansion stresses and full loading by water and/or ice, without damage, deterioration or leakage.

3.04 CLEANING

- A. Upon completion, contractor shall clean all residues from metals and leave in good, working condition without dents or scratches. Repair any breaks in coating with matching coating applied as recommended by coating manufacturer.

END OF SECTION 07 62 00

07 63 23

SHEET METAL ROOFING SPECIALITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Sheet metal gutters.
 - 2. Sheet metal downspouts.
- B. Related Sections
 - 1. Division 07 62 00 "Sheet Metal Flashing and Trim."
 - 2. Division 22 14 00 "Facility Storm Drainage."

1.02 SUBMITTALS

- A. Submit shop drawings for approval prior to fabrication. Show locations, materials, shapes and methods of anchoring.

1.03 PRODUCT DELIVERY

- A. Deliver to jobsite all components required for incorporation into the work by other trades.
- B. Protect finished surfaces from scratching or discoloring.
- C. Protect exposed sheet metal from bending and denting.
- D. Protect ferrous metals to prevent rusting.

1.04 REFERENCING STANDARDS

- A. NRCA Manual.
- B. Comply with applicable portions of "Architectural Sheet Metal Manual" by Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA).
- C. ASTM References: latest edition.

PART 2 - PRODUCTS

2.01 GUTTERS AND DOWNSPOUTS

- A. Configurations as per drawings.

- B. Sheet Aluminum.
- C. Finish: clear anodized.
- D. Size and gauge per SMACNA Architectural Manual, for 100-year storms.

2.02 SEALANT

- A. Manufacturer's standard non-staining type as recommended by gutter manufacturer for watertight construction.

2.03 DOWNSPOUT STRAINERS

- A. 1/4" galvanized wire basket strainers.

2.04 DISSIMILAR METALS

- A. Wherever dissimilar metals come into contact, Neoprene washers, spacers, gaskets or other approved materials shall be inserted between them to provide insulation against electrolytic action.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Seams and joints: all seams are to overlap in the direction of the water flow and shall be filled with sealant for waterproofing when necessary.

3.02 GUTTERS AND DOWNSPOUTS

- A. Before starting work, verify governing dimensions at building; examine, clean and repair if necessary any adjoining work on which this work is in any way dependent for its proper installation.
- B. Gutters and downspouts shall be installed in accordance with NRCA and SMACNA manuals, latest edition. Fabricate, support and anchor rain drainage system in a manner which will withstand thermal expansion stresses and full loading by water and/or ice, without damage, deterioration or leakage.
- C. Provide items not specifically detailed as required to provide a complete installation.
- D. Installation - Gutters
 1. Lap joints 1 inch minimum and rivet.
 2. Locate outer edge 1/2 inch minimum lower than back edge.
 3. Stiffen outer edge with hemmed return.
 4. Secure end caps with 1 in minimum width.

5. Secure gutter by fastening with bracket shaped to match gutter profile spaced 4 feet apart maximum.
6. Insure that water will not stand at any portion of gutter.

E. Conductor Heads

1. Extend downspout thimble 2 inches below gutter soffit, sized to fit, and 1/8 inch less than downspout.
2. Rivet thimble flanges to gutter bottom.

F. Downspouts

1. Telescope upper sections into lower sections 1-1/2 inch minimum.
2. Rivet.
3. Unless noted otherwise, attach to wall with 1-1/4 inch wide straps matching downspout material and 1 ga. heavier.
4. Locate straps at downspouts tops, bottoms, horizontal joints, and at 10 feet maximum centers.
5. Secure straps to wall with fastener heads covered with strap tabs.
6. Where applicable, extend 3 inches minimum into cistern piping, per details.

G. Downspout Strainers

1. Installed at each downspout location.
2. Fit tightly in each drain outlet.

3.03 FINAL CLEANING

- A. Upon completion, contractor shall clean all residues from metals and leave in good, working condition without dents or scratches. Repair any breaks in coating with matching coating applied as recommended by coating manufacturer.

END OF SECTION 07 63 23

07 65 00 FLEXIBLE FLASHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Flexible flashing at roof rack footings.
- B. Related Sections
 - 1. Division 05 14 13 "Architecturally-Exposed Aluminum Framing."
 - 2. Division 07 53 00 "Elastomeric Membrane Roofing."
 - 3. Division 07 62 00 "Sheet Metal Flashing"

1.02 SUBMITTALS

- A. Manufacturer's installation instructions

1.03 DELIVERY, STORAGE & HANDLING

- A. Deliver flexible flashing materials and components in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store flexible flashing materials in temperatures between 60 and 80 degrees F.
- C. When exposed to lower temperatures; restore to room temperature prior to use.
- D. Keep away from open flame or sources of ignition.
- E. QuickSeam Flashing is semi-cured; do not stretch.

1.04 WARRANTY

- A. Standard manufacturer's warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Firestone.

2.02 MATERIALS

- A. EPDM QuickSeam Flashing.
 - 1. Base: Rubber Polymer.
 - 2. Color: EcoWhite.
 - 3. Solvents: None.
 - 4. Percent Solids: 100%.
 - 5. Cured State: Semi-Cured.
 - 6. Thickness: 0.045" + or - 10%.
 - 7. Width: 12".

2.03 PERFORMANCE REQUIREMENTS

- A. ASTM C920: Standard Specification for Elastometric Joint Sealants; ASTM c1193: Standard Guide for Use of Joint Sealants; ASTM E96: Test Method for Water Vapor Transmission of Materials; ASTM E331: Standard Test Method for Water Penetration of Exterior Windows, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.

2.04 PREPARATION

- A. Verify substrate and surface conditions are in accordance with flexible flashing manufacturer recommended tolerances prior to installation.
- B. Review requirements for sequencing of installation at roof of flexible flashing assembly with installation of roof rack footings to provide a weather-tight flashing assembly.

2.05 INSTALLATION

- A. Follow all installation directions provided by manufacturer.
- B. Best when installed above 25 degrees Fahrenheit (-4 degrees Celsius)

END OF SECTION 07 65 00

07 72 00 ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Weatherhead for photovoltaic panel wiring.
 - 2. Electrical Conduit.
- B. Related Sections
 - 1. Division 05 14 13 "Structural Aluminum Framing."
 - 2. Division 07 53 00 "Elastomeric Membrane Roofing."
 - 3. Division 26 21 00 "Photovoltaic Collector."
 - 4. Division 26 24 00 "Low-Voltage Electrical Distribution."
 - 5. Division 48 19 16 "Electrical Power Generation Inverters."

1.02 SUBMITTALS

- A. Weatherhead and Conduit manufacturer Instructions.

1.03 WARRANTY

- A. Provide manufacturer's standard warranty for each product listed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Carlon

2.02 PRODUCT

- A. Service Entrance Cap.
 - 1. PVC.
 - 2. 2 inch diameter.
 - 3. For use with Sch. 40 and Sch. 80 rigid non-metallic conduit (RNC).
- B. Service Entrance Cap.
 - 1. PVC.
 - 2. 3/4 inch diameter.
 - 3. For use with Sch. 40 and Sch. 80 rigid non-metallic conduit (RNC).

- C. Rigid Nonmetallic Conduit.
1. PVC.
 2. Schedule 40.
 3. Material shall comply to NEMA Specification TC-2 (Conduit), TC-3 (Fittings) and UL 651 (Conduit) and 514b (fittings).
 4. Conduit and fittings shall carry a UL label (Conduit – on each 10 foot length; fittings – stamped or molded on each fitting).
 5. Conduit and fittings shall be identified for type and manufacturer and shall be traceable to location of plant and date manufactured. The markings shall be legible and permanent.
 6. The conduit shall be made from polyvinyl chloride compound (recognized by UL) which includes inert modifiers to improve weatherability and heat distortion. Clean rework material, generated by the manufacturer's own conduit production, may be used by the same manufacturer, provided the end products meet the requirements of this specification.
 7. The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar conductors or cables.
 8. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Follow manufacturer's provided installation instruction manual.

3.02 EXAMINATION

- A. Conduit and fittings shall be tested in accordance with the tested in accordance with the testing requirements defined in NEMA TC-2, NEMA TC-3 and UL-651 and 514. The acceptance criteria shall be given in the same standards.

END OF SECTION 07 72 00

07 90 00 JOINT PROTECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Applicator Qualifications

1. All sealant work for this project shall be done by a qualified sealant contractor approved by sealant manufacturer.
2. All sealant work shall be done by the same contractor and only one brand and type of sealant shall be used for each specific function.

1.02 GUARANTEE

- A. Sealant contractor shall guarantee work to be weatherproofed and free from defects listed below for a period of five (5) years from date of work acceptance.
- B. Guarantee shall cover repair and/or replacement of any defective sealant work. Defective sealant work shall include sagging, running, hardening, sponginess, cracking, shrinking, peeling, loss of adhesion or uneven tooling of sealant.

1.03 SUBMITTALS

- A. Submit for approval the manufacturer's latest product data on each proposed type of sealant, along with a sealant schedule indicating by sealant name or number the specific type proposed for each application.
- B. Submit other information as required in this section.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sealants

1. Dow Corning 795 Building Sealant
2. DAP Dynaflex '230' Premium Latex based sealant meeting federal specification TT-S-00230C, Type II, Class A. Low V.O.C.
3. Other sealants as listed in other sections of the specifications for specific applications.

B. Primers

1. One and two part material compatible with sealant materials.

C. Premolded Joint Fillers

1. Closed cell, non-extruding PVC foam.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Prepare joints in complete accordance with sealant and substrate manufacturer's printed instructions.
- B. Thoroughly clean all foreign matter such as dust, oil, grease, water, surface dirt, frost, wax, tar, asphalt, mastic compounds and waterproofing agents from surfaces to receive sealant.
- C. Perform compatibility and field adhesion testing on all substrate prior to sealant application.
- D. Joint filler: install joint filler of type and size specified, at proper depth in joint to provide sealant dimensions as indicated. Joint filler shall be of suitable size and shape so that when compressed (20% to 50%), it will fill joint as required.

3.02 SEALANT DIMENSIONS

- A. General: Joints to receive sealants shall be minimum of $\frac{1}{4}$ " deep unless indicated otherwise.
- B. Joints in porous surfaces: depth of the sealant may be equal to the width of joints up to $\frac{1}{2}$ " wide. For joints $\frac{1}{2}$ " to 1" wide, depth shall be $\frac{1}{2}$ "
- C. Joints in non-porous surfaces: depth shall be a minimum of $\frac{1}{2}$ " the applied width, and shall in no case exceed the applied sealant width.

3.03 INSTALLATION

- A. Prime surfaces as required. Special primer required at fiber cement board and cement board stucco. Select proper tip size for caulking gun so that sealant will extrude and seal opening with one pass of the gun.
- B. Apply sealant in complete accordance with manufacturer's printed instructions
- C. Tool and finish white or light colored sealants, use clean water or wet tool with tooling solution recommended by sealant manufacturer.
- D. Sealant locations
 - 1. Expansion and control joints, all exterior locations indicated in plans or normally requiring sealant
 - a. For exterior joints between the following materials: metal, DOW 795
 - b. Any locations not listed above shall be brought to architect's attention for sealant selection.
 - c. Color(s) to be selected by architect.

3.04 CLEANING

- A. Clean adjacent surfaces free of sealant or soiling resulting from this work as work progresses. Use solvent or cleaning agent as recommended by sealant manufacturer. All finished work shall be left in a neat, clean condition.

END SECTION 07 90 00

Division 08 - Openings

08 32 00 SLIDING GLASS DOORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Interior Sliding Door Track
 - 2. Interior Sliding Door Hardware
- B. Related Sections
 - 1. Division 08 80 00 "Glazing"

PART 2 - PRODUCTS

2.01 SLIDING DOOR TRACK

- A. Hafele Top Hung System, EKU-Porta 100/GF
 - 1. One Sliding door and one fixed door.
 - 2. Maximum Door Weight: 220 lbs
 - 3. Glass Thickness: 8mm

2.02 SLIDING DOOR HARDWARE

- A. Hafele handle
 - 1. Model: 151.77.001
 - 2. Finish: Stainless Steel matte

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Set doors level, plumb, and true to line, without warp or rack of frames and panels. Provide proper support and anchor securely in place.
- B. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- C. Clean aluminum surfaces and glass immediately after installing sliding glass door system. Remove nonpermanent labels from glass surfaces.
- D. Installation should follow the manufacturer's instructions.

END OF SECTION 08 32 00

08 42 00 ALUMINUM FRAMED ENTRANCES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Types of Kawneer Aluminum Entrances, glass and glazing, and door hardware and components.
2. Insulclad 260 Swing Door, Narrow stile 2-11/16" (68.3) vertical face dimension, 2-1/4" (57.2) depth, moderate traffic applications

B. RELATED SECTIONS:

1. Division 07 27 00 "Water-Resistive Weather Barriers"
2. Division 07 90 00 "Joint Protection"
3. Division 08 70 00 "Hardware"
4. Division 08 80 00 "Glazing"

1.02 SYSTEM DESCRIPTION

A. Entrance Performance Requirements:

1. Air Infiltration: For single acting offset pivot or butt hung entrances in the closed and locked position, the test specimen shall be tested in accordance with ASTM E 283 at a pressure differential of 6.24 psf (300 Pa) for single doors and 1.567 psf (75 Pa) for pair of doors. A single 3'0" x 7'0" (915 x 2134) entrance door and frame shall not exceed 0.50 cfm per square foot. A pair of 6'0" x 7'0" (1830 x 2134) entrance doors and frame shall not exceed 1.0 cfm per square foot.
2. Structural: Corner strength shall be tested per the Kawneer dual moment load test procedure and certified by an independent testing laboratory to ensure weld compliance and corner integrity [Testing procedure and certified test results available upon request].
3. Thermal Performance: Computer simulation testing shall be in accordance with NFRC 100/200/500 and AAMA 507-03.

1.03 SUBMITTALS

A. General:

1. Prepare, review, approve, and submit specified submittals in accordance with "Conditions of the Contract" and Submittals Sections. Product data, shop drawings, samples, and similar submittals are defined in "Conditions of the Contract."

1.04 WARRANTY

A. Manufacturer's Warranty: Submit for Owner's acceptance, manufacturer's standard warranty.

1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of

shipment by Kawneer. In addition, welded door corner construction shall be supported with a limited lifetime warranty for the life of the door under normal use.

1.05 QUALITY ASSURANCE

A. Qualifications

1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer.
2. Manufacturer Qualifications: Manufacturer capable of providing structural calculations, applicable independent product test reports, installation instructions, a review of the application method, customer approval and periodic field service representation during construction.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle entrance doors and components to avoid damage. Protect entrance doors against damage from elements, construction activities, and other hazards before, during and after entrance installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers:

1. Kawneer Company, Inc
2. Proprietary Product(s) System(s): Kawneer Aluminum Entrances
 - a. Series: Insulclad 260
 - b. Finish Color (See 2.6 Finishes)

2.02 MATERIALS

A. Aluminum (Entrances and Components):

1. Material Standard: ASTM B 221; 6063-T6 alloy and temper
2. The door stile and rail face dimensions of the 260 Insulclad entrance door will be as follows:
 - a. Door: 260
 - b. Vertical Stile: 2-11/16" (68.3)
 - c. Top Rail: 2-13/16" (71.5)
 - d. Bottom Rail: 4-7/16" (112.8)
3. Major portions of the door members to be 0.125" (3.2) nominal in thickness and glazing molding to be 0.05" (1.3) thick

4. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of entrance members are nominal and in compliance with Aluminum Standards and Data, published by The Aluminum Association.

- B. Glazing gaskets shall be either EPDM elastometric extrusions or a thermoplastic elastomer
- C. Thermal separators for door cladding shall be rigid polyvinylchloride (PVC) extrusions and VHB acrylic foam tape
- D. Provide adjustable glass jacks to help center the glass in the door opening

2.03 ACCESSORIES

- A. Fasteners: Where exposed, shall be aluminum, stainless steel or plated steel
- B. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action
- C. Entrance Hardware
 1. Weatherstripping:
 - a. Meeting stiles on pairs of doors shall be equipped with an adjustable astragal utilizing wool pile with polymeric fin.
 - b. The door weathering on a single acting offset pivot or butt hung door and frame (single or pairs) shall be Kawneer standard weathering. This is comprised of a thermoplastic elastomer weathering on a tubular shape with a semi-rigid polymeric backing.
 2. Sill Sweep Strips: Alcryn blade gasket sweep strip in a rigid polyvinylchloride (PVC) extrusion applied to the interior exposed surface of the bottom rail with concealed fasteners (Necessary to meet specified performance tests).
 3. Threshold: Extruded aluminum, one piece per door opening with ribbed surface, 6" wide
 4. Continuous Hinge: Aluminum Continuous Geared Hinge
 - a. Finish: #17 Clear
 5. Push/Pull: Reference Division 08 70 00 "Hardware"
 6. Lock and Latch Sets
 - a. Deadlock: Adams Rite MS-1850-050
 7. Cylinder(s)/Thumbturn: Kawneer standard keyed and thumbturn cylinder
 - a. Finished to match door
 - b. Latch: Reference Division 08 70 00 "Hardware"

2.04 RELATED MATERIALS

- A. Sealants: Refer to Joint Treatment (Sealants) Section
- B. Glass: Refer to Glass and Glazing Section

2.05 FABRICATION

A. Entrance System Fabrication:

1. Door corner construction shall consist of mechanical clip fastening, SIGMA deep penetration plug welds and 1-1/8" (28.6) long fillet welds inside and outside of all four corners. Glazing stops shall be hook-in type with EPDM glazing gaskets reinforced with non-stretchable cord.
2. Exposed portions of door cladding moldings shall be 3/32" (2.4) thick.
3. Aluminum cladding shall be interlocked with PVC separators and applied with VHB acrylic foam tape. There shall be no metal to metal contact, direct or indirect, between the cladding or the cladding attachments and the door structure.
4. Accurately fit and secure joints and corners. Make joints hairline in appearance.
5. Prepare components with internal reinforcement for door hardware
6. Arrange fasteners and attachments to conceal from view

2.06 FINISHES

A. Factory Finishing

1. Kawnear Permanodic® AA-M12C22A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear)

2.07 SOURCE QUALITY CONTROL

A. Source Quality: Provide Aluminum entrances specified herein from a single source

1. Building Enclosure System: When aluminum entrances are part of a building enclosure system, including storefront framing, windows, curtain wall system and related products, provide building enclosure system products from a single source manufacturer.

B. Fabrication Tolerances: Fabricate aluminum entrances in accordance with entrance manufacturer's prescribed tolerances

PART 3 - EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive entrance system and sill plate is level in accordance with manufacturer's acceptable tolerances.

1. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

3.02 INSTALLATION

- A. General: install entrance system in accordance with manufacturer's instructions and AAMA storefront and entrance guide specifications manual.
 - 1. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
 - 2. Provide alignment attachments and shims to permanently fasten system to building structure.
 - 3. Align assembly plumb and level, free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.
 - 4. Set thresholds in bed operating hardware for smooth operation
 - 5. Adjusting: Adjust operating hardware for smooth operation
- B. Related Products Installation Requirements
 - 1. Sealants (Perimeter): Refer to Joint Treatment (Sealants) Section.
 - 2. Glass: Refer to Glass and Glazing Section.
 - a. Reference: ANSI Z97.1, CPSC 16 CFR 1201 and GANA Glazing Manual.

3.03 CLEANING AND PROTECTION

- A. Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.
- B. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum entrances from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants. Remove and replace damaged aluminum entrances at no extra cost.

END OF SECTION 08 42 00

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Kawneer Architectural Aluminum Storefront Systems, including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of storefront units.
 - 1. Types of Kawneer Aluminum Storefront Systems include:
 - a. Trifab® VG 451 Storefront System – 2" x 4-1/2" (44.5 mm x 114.3 mm) nominal dimension; Non-Thermal; Front, Center, Back, Multi-Plane, Structural Silicone or Weatherseal Glazed (Type B); Screw Spline, Shear Block, Stick or Punched Opening Fabrication.
- B. Related Sections
 - 1. Division 07 27 00 "Water-Resistive Weather Barriers"
 - 2. Division 07 90 00 "Joint Protection"
 - 3. Division 08 44 13 "Glazed Aluminum Curtain Walls"
 - 4. Division 08 80 00 "Glazing"

1.02 DEFINITIONS

- A. Definitions: For fenestration industry standard terminology and definitions refer to American Architectural Manufacturers Association (AAMA) – AAMA Glossary (AAMA AG).

1.03 PERFORMANCE REQUIREMENTS

- A. General Performance: Aluminum-framed storefront system shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - 1. Design Wind Loads: Determine design wind loads applicable to the Project from basic wind speed indicated in miles per hour, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
 - a. Basic Wind Speed (MPH): (90)
 - b. Exposure Category (A, B, C, D): (B)
- B. Storefront System Performance Requirements:
 - 1. Wind loads: Provide storefront system; include anchorage, capable of withstanding wind load design pressures based on the IRC Building Code; 2009 Edition.
 - 2. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283. Air infiltration rate shall not exceed 0.06 cfm/ft² (0.3 l/s · m²) at a static air pressure differential of 6.24 psf (300 Pa).
 - 3. Water Resistance: The test specimen shall be tested in accordance with ASTM E 331. There shall be no leakage at a minimum static air pressure differential of 8 psf (383 Pa) as defined in AAMA 501

4. Uniform Load: A static air design load of 20 psf (958 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member. At a structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.

1.04 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, hardware, finishes, and installation instructions for each type of aluminum frame storefront system indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, hardware, and attachments to other work, operational clearances and installation details.
- C. Samples for Initial Selection: For units with factory-applied color finishes including samples of hardware and accessories involving color selection.
- D. Samples for Verification: For aluminum framed storefront system and components required.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An installer which has had successful experience with installation of the same or similar units required for the project and other projects of similar size and scope.
- B. Manufacturer Qualifications: A manufacturer capable of providing aluminum framed storefront system that meet or exceed performance requirements indicated and of documenting this performance by inclusion of test reports, and calculations.
- C. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
- D. Structural-Sealant Glazing: Comply with ASTM C 1401, "Guide for Structural Sealant Glazing" for design and installation of structural-sealant-glazed systems.
- E. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of aluminum framed storefront openings by field measurements before fabrication and indicate field measurements on Shop Drawings.

1.07 WARRANTY

- A. Manufacturers Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.

1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers:
 1. Kawneer Company Inc.
 2. Proprietary Products:
 - a. Series: Trifab® VG 451 (non-Thermal)
 - b. System Dimensions: 2" x 4-1/2" (44.5 mm x 114.3 mm)
 - c. Glass: Reference Division 08 80 00 "Glazing"

2.02 MATERIALS

- A. Aluminum Extrusions: Alloy and temper recommended by aluminum storefront manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" wall thickness at any location for the main frame and complying with ASTM B 221: 6063-T6 alloy and temper.
- B. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum window members, trim hardware, anchors, and other components.
- C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
- D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
- E. Sealant: For sealants required within fabricated storefront system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.
- F. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.

2.03 STOREFRONT FRAMING SYSTEMS

- A. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Where exposed shall be stainless steel.
- C. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action
- D. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- E. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle storefront material and components to avoid damage. Protect storefront material against damage from elements, construction activities, and other hazards before, during and after storefront installation.

2.04 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, extruded EPDM rubber.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.
- D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
- E. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type, and as follows:
 - 1. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.
 - a. Color: Matching structural sealant.

2.05 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."

2.06 FABRICATION

- A. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fit joints; make joints flush, hairline and weatherproof.
 - 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.

5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 6. Provisions for field replacement of glazing.
 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- B. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
 - C. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
 - D. Storefront Framing: Fabricate components for assembly using manufactures standard installation instructions.
 - E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- 2.07 ALUMINUM FINISHES
- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - B. Factory Finishing:
 1. Kawneer Permanodic® AA-M12C22A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weather tight aluminum framed storefront system installation.
 1. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing aluminum framed storefront system, accessories, and other components.

- B. Install aluminum framed storefront system level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
- C. Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.
- D. Install aluminum framed storefront system and components to drain condensation, water penetrating joints, and moisture migrating within aluminum framed storefront system to the exterior.
- E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Upon Owner's written request, provide periodic site visit by manufacturer's field service representative.

3.04 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean aluminum surfaces immediately after installing aluminum framed storefronts. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- B. Clean glass immediately after installation. Comply with glass manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION 08 43 13

08 44 13 GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Kawneer Architectural Aluminum Curtain Wall Systems, including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of curtain wall framing.
1. Types of Kawneer Aluminum Curtain Wall include:
 - a. 2-1/2" x 7-5/16" (63.5 x 185.7), outside glazed pressure plate format (installed as inside glazed)
- B. Related Sections:
1. Division 07 90 00 "Joint Protection"
 2. Division 08 43 13 "Aluminum-Framed Storefronts"
 3. Division 08 51 13 "Aluminum Windows"
 4. Division 08 80 00 "Glazing"

1.02 REFERENCES (INDUSTRY STANDARDS)

1.03 SYSTEM DESCRIPTION

- A. Curtain Wall System Performance Requirements:
1. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283. Air infiltration rate shall not exceed 0.06 cfm/ft² (0.3 l/s· m²) at a static air pressure differential of 6.24 psf (300 Pa).
 2. Water Resistance, (static): The test specimen shall be tested in accordance with ASTM E 331 and ASTM E 547. There shall be no leakage at a static air pressure differential of 15 psf (720 Pa) as defined in AAMA 501.
 3. Structural performance shall be based on Aluminum Association "Specification for Aluminum Structures" or CSA Standard CAN3-S157 "Strength Design in Aluminum". There shall be no deflection in excess of L/175 of the span of any framing member at design load.
 4. Thermal Transmittance (U-factor): When tested to AAMA Specification 1503, the thermal transmittance (U-factor) shall not be more than: 0.36 BTU/hr· ft²· °F (2.02 W/m²· °C)
 5. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than 83_{frame} and 72_{glass}, or Condensation Index (I): when tested to CSA-A440-00, the Condensation Index shall not be less than 76_{frame} and 65_{glass}.

1.04 SUBMITTALS

- A. General: Prepare, review, approve, and submit specified submittals in accordance with "Conditions of the Contract"

B. Quality Assurance/ Control Submittals:

1. Test Reports: Submit certified test reports showing compliance with specified performance characteristics

1.05 WARRANTY

A. Manufacturer's Product Warranty: Submit for Owner's acceptance, manufacturer's standard warranty:

1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by Kawneer

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer
2. Manufacturer Qualifications: Manufacturer capable of providing structural calculations, applicable independent product test reports, installation instructions, a review of the application method, customer approval and periodic field service representation during construction

B. Pre-Installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements

C. Mock up: Kawneer to provide sample mock up of section of curtain wall frame including operable window as coordinated with Architect.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact

B. Storage and Protection: Store materials from exposure to harmful weather conditions. Handle material and components to avoid damage. Protect curtain wall material against damage from elements, construction activities, and other hazards before, during and after curtain wall installation.

PART 2 - PRODUCTS

2.01 MANUFACTURES

A. Manufacturers

1. Kawneer Company, Inc.
2. Proprietary Product(s) System(s): Kawneer Aluminum Entrances
 - a. Series: 7500 Curtain Wall

- b. Finish Color: (See 2.6 Finishes)

2.02 MATERIALS

A. Aluminum (Curtain Wall and Components):

1. Material Standard: Extruded Aluminum, ASTM B 221, 6063-T6 alloy and temper.
2. Member Wall Thickness: Each framing member shall have a wall thickness sufficient to meet the specified structural requirements.
3. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of curtain wall members are nominal and in compliance with AA Aluminum Standards and Data.

2.03 ACCESSORIES

- A. Fasteners: Where exposed, shall be stainless steel.
- B. Gaskets: Interior-glazing gaskets shall be black closed cell neoprene sponge in vision area. Exterior glazing gaskets and interior gaskets at spandrel areas shall be black EPDM rubber.
- C. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- D. Thermal Barrier: Kawneer Isoweb® Thermal Break: All framing members shall consist of interior and exterior extruded aluminum sections that shall be integrated with two parallel, glass reinforced nylon strips forming a continuous composite assembly.

2.04 RELATED MATERIALS

- A. Sealants: Refer to Joint Treatment (Sealants) Section
- B. Glass: Refer to Glass and Glazing Section

2.05 FABRICATION

A. General:

1. Fabricate components per manufacturer's installation instructions and with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal. Vertical and horizontal members shall be tubular extrusions designed for shear block corner construction.
2. Accurately fit and secure joints and corners. Make joints flush, hairline and weatherproof
3. Prepare components to receive anchor devices. Fabricate anchors
4. Arrange fasteners and attachments to conceal from view

2.06 FINISHES

- A. Shop Finishing:

1. Kawneer Permanodic® AA-M12C22A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear)
2. Interior Caps: Wood Veneer: White Oak.

2.07 SOURCE QUALITY CONTROL

- A. Source Quality: Provide aluminum curtain walls specified herein from a single source.
 1. Building Enclosure System: When aluminum curtain wall are part of a building enclosure system, including entrances, entrance hardware, windows, storefront framing and related products, provide building enclosure system products from a single source manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive curtain wall system and sill plate is level in accordance with manufacturer's acceptable tolerances.
 1. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays

3.02 INSTALLATION

- A. General: Install curtain wall systems plumb, level and true to line, without warp or rack of frames with manufacturer's prescribed tolerances and installation instructions. Provide support and anchor in place.
 1. Dissimilar Materials: Provide separation of aluminum materials from sources of corrosion or electrolytic action contact points
 2. Glazing: Glass shall be inside glazed and held in place with extruded aluminum pressure plates anchored to the mullion using stainless steel fasteners.
 3. Water Drainage: Each light of glass shall be compartmentalized using joint plugs and silicone sealant to divert water to the horizontal weep locations. Weep holes shall be located in the horizontal pressure plates and covers to divert water to the exterior of the building.
- B. Related Products Installation Requirements
 1. Sealants (Perimeter): Refer to Joint Treatment (Sealants) Section
 2. Glass: Refer to Glass and Glazing Section.
 - a. Reference: ANSI Z97.1, CPSC 16 CFR 1201 and GANA Glazing Manual

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Upon Owner's written request, provide periodic site visit by manufacturer's field service representative.

3.04 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean aluminum surfaces immediately after installing aluminum framed storefronts. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- B. Clean glass immediately after installation. Comply with glass manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION 08 44 13

08 51 13 ALUMINUM WINDOWS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
1. AA®900 ISOWEB® Outswing or Inswing Casement Windows
 2. Heavy Commercial Grade (HC rating)/Architectural Grade (AW rating)
 3. Architectural details, product descriptions and product performance specifications are based on products manufactured by the Kawneer Company Inc.
- B. Related Sections:
1. Division 07 90 00 "Joint Protection"
 2. Division 08 44 13 "Glazed Aluminum Curtain Walls"
 3. Division 08 80 00 "Glazing"

1.02 SYSTEM DESCRIPTION

- A. General: Commercial Grade Architectural Aluminum Windows, including glass and glazing, metal panels, perimeter trims, sills and stools, window installation hardware and accessories, shims and anchors, and perimeter sealing of window units.
1. Aluminum Windows include: Kawneer Company, Inc., AA®900 ISOWEB® Window in accordance with AAMA /WDMA/CSA 101/I.S.2/A440-05 Standard/Specification for Windows, Doors, and Unit Skylights for a Class and Grade of C-HC90/C-AW90 and in accordance with CAN/CSA-A440-00 Windows.
- B. Test Units:
1. All test unit sizes and configurations shall conform to the minimum size in accordance with AAMA/WDMA/CSA 101/I.S.2/A440-05 for the designation C-HC90/C-AW90 and CAN/CSA-A440-00 Windows
 2. Units submitted for laboratory testing shall be units of the manufacturer's standard construction, glazed and assembled in accordance with the manufacturer's specifications and AAMA/WDMA/CSA 101/I.S.2/A440-05 and CAN/CSA-A440-00 Windows
- C. Casement Window Performance Requirements:
1. Wind loads: Provide window system; include anchorage, capable of withstanding wind load design pressures based on the IRC Building Code; 2009 Edition.
 2. Air Infiltration: The test specimen shall be tested in accordance with ASTM E283 at a minimum size of 36" x 60" (915 x 1524). Air infiltration rate shall not exceed 0.10 cfm/ft² at a static air pressure differential of 6.24 psf (300 Pa). The test specimen shall meet the A3 rating of less than 0.55 (m³/h)/m at 300Pa when tested in accordance with CAN/CSA-A440-00 Windows.
 3. Water Resistance: The test specimen shall be tested in accordance with ASTM E547 and ASTM E331 at a minimum size of 36" x 60" (915 x 1524). There shall be no leakage as defined in the test method at a static air pressure differential of 15 psf (720 Pa). The test specimen shall meet the B7

rating with no water leakage at 720 Pa when tested in accordance with CAN/CSA-A440-00 Windows.

4. Uniform Load Deflection: A minimum static air pressure difference of 90 psf (4310 Pa) shall be applied in the positive and negative direction in accordance with ASTM E330. There shall be no deflection in excess of $L/175$ of the span of any framing member. The test specimen shall meet
5. Uniform Load Structural: A minimum static air pressure difference of 135 psf (6465 Pa) shall be applied in the positive and negative direction in accordance with ASTM E330. The unit shall be evaluated after each load.
6. Component Testing: Window components shall be tested in accordance with procedures described in AAMA/WDMA/CSA 101/I.S.2/A440-05.
7. Thermal Transmittance (U-factor): When tested to AAMA Specification 1503, the thermal transmittance (U-factor) shall not be more than;
 - a. Outswing Casement: U-factor not more than .47 BTU/hr/ft²/°F.
 - b. Inswing Casement: U-factor not more than .43 BTU/hr/ft²/°F
8. Condensation Resistance Test (CRF): When tested in accordance with AAMA Specification 1503 and CAN/CSA-A440, the condensation resistance factor (CFR) shall not be less than;
 - a. Outswing Casement: CRF not less than 61 (53.2 I-frame).
 - b. Inswing Casement: CRF not less than 64 (50.2 I-frame).
9. Forced Entry Resistance: All windows shall conform to AAMA 1302.5.
10. Thermal Barrier Test: Thermal break shall be designed in accordance with AAMA TIR-A8 and tested in accordance with AAMA 505

1.03 SUBMITTALS

- A. General: Prepare, review, approve, and submit specified submittals in accordance with "Conditions of the Contract" and Submittals Sections. Product data, shop drawings, samples, and similar submittals are defined in "Conditions of the Contract."
- B. Quality Assurance/Control Submittals:
 1. Test Reports: Submit certified test reports showing compliance with specified performance characteristics.

1.04 WARRANTY

- A. Manufacturer's Product Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.
 1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by Kawneer.

1.05 QUALITY ASSURANCE

- A. Qualifications
 1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer.

2. Manufacturer Qualifications: Manufacturer capable of providing structural calculations, applicable independent product test reports, installation instructions, a review of the application method, customer approval and periodic field service representation during construction.
 - B. Pre-Installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.
 - C. Mock Up: Kawneer to provide sample mock up of section of curtain wall frame including operable window as coordinated with Architect
- 1.06 DELIVERY, STORAGE AND HANDLING
- A. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
 - B. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle window material and components to avoid damage. Protect window material against damage from elements, construction activities, and other hazards before, during and after window installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers:
 1. Kawneer Company, Inc.
 2. Proprietary Product(s) System(s): Kawneer Aluminum Window System
 - a. Series: AA®900 ISOWEB® Thermal Window System
 - b. Window Member Profile: 2-5/8" (67) nominal dimension.
 - c. Finish/Color: (See 2.09 Finishes)

2.02 MATERIALS

- A. Aluminum (Windows and Components): Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with the requirements of standards indicated below.
 1. Extruded Material Standard: ASTM B 221, 6063-T6 alloy and temper.
- B. Steel Reinforcement: Complying with ASTM A 36/ A 36M for structural shapes, plates and bars; ASTM A 611 for cold-rolled sheet and strip or ASTM A 570/ A 570M for hot-rolled sheet and strip.
- C. Weather-stripping: Ventilators shall be weather-stripped with extruded EPDM in accordance with ASTM C864.
- D. Glazing Gaskets: Dry glazing gaskets shall be an extruded EPDM in accordance with ASTM C864.

- E. Glazing Sealant: Wet glazing material shall be a 100 percent silicone, neutral-cure sealant in accordance with AAMA 805.2-94, Group A.
- F. Fasteners: Where exposed, shall be 300 Series Stainless Steel.
- G. Thermal Barrier: The thermal barrier shall be Kawneer ISOWEB® consisting of two parallel glass fiber-reinforced nylon strips installed continuously and mechanically bonded to the aluminum

2.03 HARDWARE

- A. Typical Hardware:
 - 1. Locking
 - a. Single Handle Multi-Point Locks
 - b. Finish: Satin
 - 2. Hinging
 - a. 4-Bar Hinges

2.04 ACCESSORIES

- A. Spacers, Setting Blocks, Gaskets, and Bond Breakers: Manufacturer's standard permanent, non-migrating types in hardness recommended by manufacturer, compatible with sealants, and suitable for system performance requirements.
- B. Framing system gaskets, sealants, and joint fillers as recommended by manufacturer for joint type.
- C. Sealants and joint fillers for joints at perimeter of window system as specified in Division 7 Section "Joint Sealants".
- D. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- E. Glazing: Factory glazing as required and specified in Division 8 Section "Glazing".

2.05 RELATED MATERIALS

- A. Sealants: Refer to Division 7 Section "Joint Sealants"
- B. Glass: Glass thickness and type shall be in accordance with glass manufacturer's recommendations for prescribed design pressure. Refer to Division 8 Section "Glass and Glazing".
 - 1. Factory glazing (if required) shall be in accordance with manufacturer's standard requirements.
 - 2. Glazing materials shall be compatible with aluminum and those sealants and sealing materials used in composite structure, which have direct contact with the gasket.
- C. Insulation: Refer to Division 7 Section "Building Insulation".

2.06 COMPONENTS

- A. The frame depth shall be not less than 2-5/8".
- B. All frame members shall have minimum wall thickness of 0.070" and shall provide the structural strength sufficient to meet the specified performance requirements.
- C. Glazing beads shall be extruded aluminum and shall be a minimum thickness of 0.060".
- D. Reference to tolerances for wall thickness and other cross-sectional dimensions of window members are nominal and in compliance with AA Aluminum Standards and Data.
- E. All references to dimensions for wall thicknesses and other cross-sectional dimensions of window members are nominal and in compliance with ANSI H35.2-1990.
- F. All frame members shall be tubular.

2.07 FABRICATION

- A. General: Fabricate components per manufacturer's installation instructions. When assembled, components shall be accurately fitted to produce hairline joints.
 - 1. Window Frame Joinery: Mitered and mechanically clipped and/or staked.
 - 2. Window Vent Joinery: Mitered and mechanically clipped and/or staked.
 - 3. Factory sealed frame and corner joints.

2.08 FINISHES

- A. Factory Finishing:
 - 1. Kawneer Permanodic® AA-M12C22A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive window system and sill plate is level in accordance with manufacturer's acceptable tolerances.
 - 1. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

3.02 INSTALLATION

- A. General: Install window system in accordance with manufacturer's instructions and AAMA window guide specifications manual.
1. Dissimilar Materials: Provide separation of aluminum materials from sources of corrosion or electrolytic action contact points.
 2. Weathertight Construction: Install sill members and other members in a bed of sealant or with joint filler or gaskets, to provide weathertight construction. Coordinate installation with wall flashings and other components of construction.
 3. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
 4. Provide alignment attachments and shims to permanently fasten system to building structure.
 5. Align assembly plumb and level, free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.
- B. Related Products Installation Requirements:
1. Sealants (Perimeter): Refer to Joint Treatment (Sealants) Section.
 2. Glass: Refer to Glass and Glazing Section.
 - a. Reference: ANSI Z97.1, CPSC 16 CFR 1201 and GANA Glazing Manual.

3.03 FIELD QUALITY CONTROL

- A. Field Tests: Kawneer to perform the following tests on the double-façade mock up at Kawneer's test facilities. Tests not meeting specified performance requirements and units having deficiencies shall be corrected.
1. Testing: Testing shall be performed by a qualified independent testing agency. Refer to Testing Section for payment of testing and testing requirements. Testing Standard per AAMA 502, including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 Water Infiltration Test.
 - a. Air Infiltration Tests: Conduct tests in accordance with ASTM E 783. Tests shall be conducted at a minimum uniform static test pressure of 1.57 psf or a specified, but not to exceed 6.24 psf. The maximum allowable rates of air leakage for field testing shall not exceed 1.5 times the project specifications.
 - b. Water Infiltration Tests: Water penetration tests shall be conducted at a static test pressure of 8 psf for Architectural (AW), 6.00 psf for Heavy Commercial (HC) and 3.00 psf for Commercial (C).
- B. Manufacturer's Field Services: Upon Owner's written request, provide periodic site visit by manufacturer's field service representative.

3.04 PROTECTION AND CLEANING

- A. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum window system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

- B. Cleaning: Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.

END OF SECTION 08 51 13

08 70 00 DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Door Hardware at exterior doors
- B. Related Sections
 - 1. Division 08 42 00 "Entrances"

1.02 SUBMITTALS

- A. Submit complete schedule showing factory serial numbers and sizes, etc. for approval. Schedules shall be clearly typewritten, and shall refer to openings by architectural number.
- B. Furnish copies of approved schedule to architect and to door and frame manufacturers.
- C. Furnish catalog cuts, drawings, and other descriptive data on hardware.
- D. All finish hardware and fitting shall be template type. Furnish door and frame manufacturers with templates for proper cutting, reinforcing and tapping for the hardware.

1.03 DISTRIBUTOR QUALIFICATIONS

- A. Hardware contractor must be an established firm dealing in contract builder's hardware with sample room, adequate inventory and capable of providing a competent representative to service hardware on the job as may be required.
- B. Must be a regular franchised distributor for all materials required.

1.04 WARRANTY

- A. Manufacturer's standard warranty

PART 2 - PRODUCTS

2.01 QUALITY

- A. Furnish hardware as specified for quality, material, function and size, which shall be implied by corresponding name or type reference.

- B. All dimensions given are minimum
- C. All materials shall be free from any sand holes and/or other imperfections.

2.02 MATERIAL

- A. Manufacturer
 - 1. Continuous Hinge: Reference Division 08 42 00 "Entrances"
 - 2. Lock and Latch Sets:
 - a. Deadlock: Reference Division 08 42 00 "Entrances"
 - 3. Push/Pull:
 - a. Hager Companies Door Push/Pull Set
 - b. Material: US32D Satin Stainless Steel
 - c. Design Option: 12 Round Wrought Door Pull
 - d. Mounting Option: Per recommendation of manufacturer of aluminum framed entrances
 - 4. Thresholds: Reference Division 08 42 00 "Entrances"
 - 5. Cylinders: Reference Division 08 42 00 "Entrances"
- B. Finish of Hardware to be as Follows:
 - 1. Aluminum anodized finish
 - 2. All finish hardware installed at aluminum entrance systems shall have anodized finished to match entrance

2.03 KEYS AND KEYING

- A. All locksets shall be keyed as directed by owner, as part of its sergeant master system.
- B. Supply two (2) keys for each lock

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install and adjust hardware so that:
 - 1. Hinges function freely without binding or dragging
 - 2. Locksets, latch sets and panic hardware function perfectly with bolts or pins fitting perfectly into strikes
- B. After installation, all templates, instruction sheets and installation details, shall be placed in a file folder to turn over to owner when building is accepted.
- C. After building is occupied, the hardware supplier shall instruct the owner's representative in the proper use, servicing, adjustment and maintenance of hardware

- D. Mounting heights, sizes and quantities shall be in accordance with the latest specifications of the American National Standards Institute (ANSI) relative to hardware; the intent being to establish as the standard a low maintenance, durable, easily operated system. Heights and mounting shall also be in accordance with requirements of ANSI 17.1 and ADA
- E. Hardware contractor shall examine drawings, projections of trim and rebates to permit each door to free-swing 180 degrees or to its closest adjacent wall. He shall check thickness of doors and verify sizes of other hardware before it is delivered to site.
- F. Surface type door pulls, door closures and door holders shall be installed with sex bolts and machine screws, length to door thickness.
- G. Adjustment: Check loads and latches for correct hand and correct operation of specified lock functions. Adjust all spring loaded devices for operation against wind conditions, friction from door coordinators and latch friction. Leave the complete hardware installation operating in conformity with the manufacturer's design intent.

3.02 SCHEDULE

- A. Set No. 1: Exterior Aluminum Doors
 - 1. Each to have:
 - a. 2 Hager Companies Door Push/Pulls
 - b. 1 Deadlocks: Reference Division 08 42 00 "Entrances"
 - c. 1 Thresholds: Reference Division 08 42 00 "Entrances"
 - d. 1 cylinder: Reference Division 08 42 00 "Entrances"

END OF SECTION 08 70 00

08 80 00 GLAZING

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Glazed curtain walls.
 - 4. Storefront framing.
 - 5. Backsplash
 - 6. Glass Cover at Floor Lighting

1.02 SUBMITTALS

- A. Submit labeled sample of glazing materials for approval, with complete specifications

1.03 QUALITY ASSURANCE

- A. Comply with provisions of the consumer product safety standard for architectural glazing materials (16 CFT 1201)
- B. The glazier must examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing is to be performed, and notify the contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with glazing until unsatisfactory conditions have been corrected in a manner acceptable to the glazer.
- C. Environmental requirements: installation of glass products at ambient air temperature below 40 degrees F is prohibited. Do not proceed with installation of liquid sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
- D. Glazing contractor shall obtain compatibility and adhesions test reports from sealant manufacturer, indicating that glazing materials were tested for compatibility and adhesions with glazing sealant, as well as other glazing materials including insulating units.

1.04 WARRANTY

- A. Provide manufacturer's standard warranty for each glass product specified.

PART 2 - PRODUCTS

2.01 GLASS PRODUCTS

- A. Transparent Glass at Interior Curtain Wall of Double Facade
 - 1. Serious Materials Suspended Film Glass
 - a. Outer Lite: ¼" Cardinal 272- tempered
 - b. Inner Lite: ¼" Clear- tempered
 - c. Film: Double 88F
 - d. Gas: Argon
 - e. Spacers: Steel- Mill Finish
 - f. OA Thickness: 2"
- B. Translucent Glass at Interior Curtain Wall of Double Façade
 - 1. Serious Materials Suspended Film Glass
 - a. Outer Lite: ¼ " Cardinal 272-tempered
 - b. Inner Light: ¼ " Clear- tempered
 - c. Film: Obscure
 - d. Gas: Argon
 - e. Spacers: Steel-Mill Finish
 - f. OA Thickness: 2"
- C. Glass at Exterior Storefront of Double Façade
 - 1. AGC Flat Glass: Single Pane, tempered
 - a. Thickness: 9/16"
 - b. Coating: low-e at interior face
- D. Glass at Exterior Doors
 - 1. AGC Flat Glass: U4 Insulated Glass Unit, tempered
 - a. Acid etched
- E. Glass at Interior Doors
 - 1. AGC Flat Glass: single pane, tempered
 - a. Thickness: 8mm
 - b. Acid etched both surfaces
- F. Glass Backsplash
 - 1. AGC Flat Glass: Krystal Kolours
 - 2. Color: Flat pure white
- G. Glass Cover at Floor Lighting
 - 1. AGC Flat Glass: single pane, tempered
 - a. Thickness: ½ inch
 - b. Acid etched

PART 3 - EXECUTION

3.01 STANDARDS AND PERFORMANCE

- A. All glass shall be set by skilled glaziers in strict accordance with glass and frame manufacturers' printed instructions.
- B. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind, including loss or breakage of glass, failure of sealants of gaskets to remain watertight and airtight, deterioration of glazing materials and other defects in the work.
- C. Protect glass from edge damage at all time during handling, installation and operation of the building.
- D. Glazing channel dimensions as shown are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. The glazier is responsible for providing correct glass size for each opening, within the tolerances and necessary dimensions established.
- E. Comply with combined recommendations of glass manufacturer and manufacturer of sealants and other materials used in glazing, except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.
- F. Comply with "glazing manual" by flat glass marketing association except as shown and specified otherwise, and excepts as specifically recommended otherwise by the manufacturers of the glass and glazing materials.
- G. Inspect each piece of glass immediately before installation, and eliminate any, which have observable edge damage or face imperfections.
- H. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.
- I. Install insulating glass units to comply with recommendations by sealed insulating glass manufacturers association, except as otherwise specifically indicated or recommended by glass and sealant manufacturers.

3.02 PREPARATION FOR GLAZING

- A. Verify that site conditions are acceptable for installation of the glass.
- B. Verify openings for glazing are correctly sized and within tolerance.
- C. Verify that a functioning weep system is present.
- D. Verify that the minimum required face and edge clearances are being followed.

- E. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings with are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastometric sealants are used.
- F. Apply primer or sealer to joint surfaces wherever recommended by sealant manufacturer.
- G. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.03 GLAZING

- A. Install products using the recommendations of manufacturers of glass, sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those in the “Gana Glazing Manual”
- B. Verify that insulating glass (IG) unit secondary seal is compatible with glazing sealants.
- C. Install glass in prepared glazing channels and other framing members
- D. Install setting blocks in rabbets as recommended by referenced glazing standards in Gana Glazing Manual and IGMA Glazing Guidelines
- E. Provide bite on glass, minimum edge and face clearances and glazing material tolerances recommended by Gana Glazing Manual
- F. Provide weep system as recommended by Gana Glazing Manual
- G. Set glass lites in each series with uniform pattern, draw, bow and similar characteristics
- H. Distribute the weight of the glass unit along the edge rather than at the corner
- I. Comply with manufacturer’s and referenced industry recommendations on expansion joints and anchors, accommodating thermal movement, glass openings, use of setting blocks, edge, face and bite clearances, use of glass spacers, edge blocks and installation of weep systems.
- J. Do not attempt to cut, seam, nip or abrade glass that is tempered, heat strengthened or coated.
- K. Clean and trim excess materials from the glass and stops or frames promptly after installation, and eliminate stains and discolorations.
- L. Gasket glazing. Miter cut and bond ends together at corners where gaskets are used for channel glazing, so that gaskets will not pull away from corners and result in voids or leaks in the glazing system.
- M. Provide bite, face clearance and edge clearance as recommended by glass and framing manufacturers.
- N. Protect glass from edge damage during handling and installation

- O. Prevent glass from contact with contaminating substances that result from construction operations, such as weld spatter, fireproofing or plaster.

3.04 CURE, PROTECTION AND CLEANING

- A. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surface of glass.
- B. Remove and replace glass which is broken, chipped, cracked, scratched, marred, pitted, obscured, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.
- C. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash off) to the deterioration of glazing materials and other work.
- D. Clean excess sealant or compound from glass and framing members immediately after application, using solvents or cleaners recommended by manufacturers.
- E. Glass to be cleaned according to:
 - 1. Serious materials
 - 2. AGC
- F. Do not use scrapers or other metal tools to clean glass.

END OF SECTION 08 80 00

08 91 00 LOUVERS

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

- A. Comply with SMACNA (Sheet Metal and Air Conditioning contractors National Association) Architectural sheet metal manual recommendations for fabrication, construction details, and installation procedures, except as otherwise indicated.
- B. Provide louvers meeting requirement of test method AMCA standard 500. Manufacturer shall submit AMCA test data substantiating compliance
- C. Verify size, location and placement of louver units prior to fabrication. Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units.

1.02 SUBMITTALS

- A. Submit shop drawings for the fabrication and erection of louver assemblies, which are not completely shown by manufacturer's data sheet. Include details of sections and connections. Show anchorage and accessory items. Provide wind force rating in PSF.
- B. Submit sample of finish as selected by Architect

1.03 WARRANTY

- A. Manufacturer's standard warranty

PART 2 - PRODUCTS

2.01 GENERAL

- A. Aluminum extrusions: ASTM B 221, Alloy 6063-T5
- B. Fasteners: use same material as items fastened, unless otherwise indicated. Fasteners for exterior applications may be hot-dip galvanized, stainless steel, or aluminum. Provide types, gages and lengths to suit unit installation conditions. Use Philips flat-head machine screws for exposed fasteners, unless otherwise indicated.
- C. Anchors and inserts: use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled-in-place anchors.

2.02 ALUMINUM LOUVERS

- A. Greenheck EDD-401 Stationary Louver Dual Drainable Blade
1. Frame: heavy gauge extruded 6063-TS aluminum, 4in x 0.125 in nominal wall thickness
 2. Blades: Drainable design, heavy gauge extruded 6063-T5 aluminum, 0.081 in nominal wall thickness, positioned at 45° angles on approximately 4 in centers.
 3. Construction: mechanically fastened
 4. Insect screen: ¾ in x 0.051 in flattened expanded aluminum in removable frame, inside mount (rear)
 5. Finish: Painted, Grey
- B. Conceal supporting framework from vision on outside face of louver by placing braces, mullions and brackets on inside face. Provide close fitting, field-made splice joints in blades designed to permit expansion and contraction without deforming blades or framework.

2.03 ACCESSORIES

- A. Louver Screen
1. Provide removable screens for all exterior louvers used for ventilation
 2. ¾ in x 0.051 in flattened expanded aluminum in removable frame, inside mount.
- B. 1 inch Flange Frame
1. Provide flange frame at four sides at each louver
 2. Finish: Painted, Grey

PART 3 - EXECUTION

3.01 INSPECTION

- A. Subcontractor shall be responsible for inspection of site, field measurements and approval of mounting surfaces and installation conditions.
- B. Subcontractor shall verify that site is free of conditions that interfere with louver installation and operation and shall begin installation only when any unsatisfactory conditions have been rectified.

3.02 INSTALLATION

- A. Installation shall comply with manufacturer's specifications, standards and procedures.

END OF SECTION 08 91 00

Division 09 - Finishes

09 28 00

BACKING BOARDS AND UNDERLAYMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Backing boards at bathroom.
- B. Related Sections
 - 1. Division 05 40 00 "Cold Formed Metal Framing"
 - 2. Division 06 42 00 "Wood Paneling"

1.02 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under same cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

PART 2 - PRODUCTS

2.01 WATER-RESISTANT BACKING BOARD

- A. Hardie Backer 500 Board
 - 1. Thickness: 042"
 - 2. Weight: 2.6 lbs per sq ft.
 - 3. Size: 4' x 8'

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates with installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damage, and mold damage.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Installation shall comply with manufacturer's instructions

END OF SECTION 09 28 00

09 54 00 SPECIALTY CEILINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. System Description
 - 1. Wood veneer ceiling planks
 - 2. Exposed grid suspension system
 - 3. Fasteners, main runners, wall angle moldings and accessories.
- B. Related Sections:
 - 1. Division 05 40 00 "Cold-Formed Metal Framing"

1.02 SUBMITTALS

- A. Installation Instructions: Submit manufacturer's installation instructions as referenced in Part 3 Installation.
- B. Samples: Minimum 3-1/2 inch or 5-1/2 inch samples of specified panel; 8 inch long samples of exposed wall molding and suspension system, including main runner.
- C. Shop drawings: Layout and details of ceilings. Show locations of items which are to be coordinated with, or supported by the ceilings.
- D. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying products at the expense of the Contractor performing the work.

1.03 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide ceiling panel units and grid components by a single manufacturer.
- B. Fire Performance Characteristics: Identify ceiling components with appropriate markings of applicable testing and inspecting organization.
 - 1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 for Class A products.
 - a. Flame Spread: 25 or less
 - b. Smoke Developed: 50 or less
 - 2. HPVA (Hardwood Plywood and Veneer Association) certification and audit program per ASTM E-84 tunnel test.
- C. Woodworking Standards: Manufacturer must comply with specified provisions of Architectural Woodworking Institute quality standards.

- D. Woodworks Channeled, as with other architectural features located at the ceiling, may obstruct or skew the planned fire sprinkler water distribution pattern, or possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.
- E. Coordination of Work: Coordinate ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store ceiling components in a dry interior location in their cartons prior to installation to avoid damage. Store cartons in a flat, horizontal position. The protectors between the panels should not be removed until installation.
- B. Do not store in unconditioned space with humidity greater than 55 percent or lower than 25 percent relative humidity and temperatures lower than 50 degrees or greater than 86 degrees. Panels must not be exposed to extreme temperatures, for example close to a heating source or near a window with direct sunlight.
- C. Handle ceiling units carefully to avoid chipped edges or damage to units in any way.

1.05 PROJECT CONDITIONS

- A. Wood Veneer ceiling materials should be permitted to reach room temperature and have a stabilized moisture content for a minimum of 72 hours before installation.
- B. The wood veneer panels should not be installed in spaces where the temperature or humidity conditions vary greatly from the temperatures and conditions that will be normal in the occupied space.
- C. As interior finish products, the wood veneer panels are designed for installation in temperature conditions between 50 degrees and 86 degrees, in spaces where the building is enclosed and HVAC systems are functioning and will be in continuous operation. Relative humidity should not fall below 25 percent or exceed 55 percent.

1.06 WARRANTY

- A. Wood Veneer Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to:
 - 1. Ceiling Panels: Defects in materials or factory workmanship.
 - 2. Grid System: Rusting and manufacturing defects.
- B. Warranty Period:
 - 1. 1. Wood veneer panels: One (1) year from date of installation.

2. Grid: Ten years from date of installation.

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.07 MAINTENANCE

- A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
1. Ceiling Units: Furnish quantity of full-size units equal to 5.0 percent of amount installed.
 2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Ceiling Panels:
1. Armstrong World Industries, Inc.
- B. Suspension Systems:
1. Armstrong World Industries, Inc.

2.02 DESCRIPTION

- A. Wood Veneer Ceiling Units
1. Product: WoodWorks
 2. Surface Texture: Smooth
 3. Composition: Wood
 4. Finish: Manufacturer's standard natural veneer - Natural Variations
 5. Species: Natural Variations Beech
 6. Size: 5 1/4" inch X 8 feet X 3/4inch
 7. Edge Banding and Trim: To match face veneer
 8. Noise Reduction Coefficient (NRC): ASTM C 423, Classified with UL label on product carton, 0.4
 9. Flame Spread: Class A HPVA
 10. Dimensional Stability: Standard
- B. SUSPENSION SYSTEMS
1. Components: All main beams and cross tees shall be commercial quality hot-dipped galvanized (galvanized steel, aluminum, or stainless steel) as per ASTM A 653. Main beams and cross tees are double-web steel construction with 15/16 inch type exposed flange design. Exposed surfaces chemically cleansed, capping pre-finished galvanized steel (aluminum or stainless steel) in baked

- polyester paint. Main beams and cross tees shall have rotary stitching (exception: extruded aluminum or stainless steel).
- a. Structural Classification: ASTM C 635 Intermediate Duty.
 - b. Color: Black and match the actual color of the selected ceiling tile, unless noted otherwise.
 - c. Acceptable Product: Prelude XL 15/16" Exposed Tee as manufactured by Armstrong World Industries, Inc.
2. High Humidity Finish: Comply with ASTM C 635 requirements for Coating Classification for Severe Environment Performance at bathroom ceiling.
 - a. SS Prelude Plus by Armstrong World Industries, Inc. - 100% Type 304 STAINLESS Steel.
 - b. Structural Classification: ASTM C 635 duty class.
 - c. Color: Stainless
 3. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1,. Reference drawings for suspension method.
 4. Edge Moldings and Trim: Metal or extruded aluminum of types and profiles indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, including light fixtures, that fit type of edge detail and suspension system indicated. Provide moldings with exposed flange of the same width as exposed runner.

PART 3 - EXECUTION

3.01 EXAMINATION, GENERAL

- A. Proper designs for both supply air and return air, maintenance of the HVAC filters and building interior space are essential to minimize soiling. Before starting the HVAC system, make sure supply air is properly filtered and the building interior is free of construction dust.

3.02 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

3.03 INSTALLATION

- A. Install suspension system and panels in compliance with ASTM C636; CISCA Seismic Guidelines; approved construction drawings; with the authorities having jurisdiction; and in accordance with the manufacturer's installation instructions, WoodWorks Linear Ceilings Installation Instructions.
- B. Suspend linear carriers from overhead construction with cold formed metal framing, reference drawings. Install linear carriers 24 inches on center (or less).
- C. Install wall moldings at intersection of suspended ceiling and vertical surfaces.

- D. Follow the instructions found in WoodWorks Linear Installation instructions for border treatment of the WoodWorks Linear Planks.

3.04 ADJUSTING AND CLEANING

- A. Replace damaged and broken panels.
- B. Clean exposed surfaces of ceilings panels, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 54 00

09 64 00 WOOD FLOORING

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 06 10 00 "Rough Carpentry"
 - 2. Division 07 27 00 "Water-Resistive Weather Barriers"

1.02 ACTION SUBMITTALS

- A. Submit finishes as selected by Architect.
- B. Shop drawings show floor pattern layout.

1.03 QUALITY ASSURANCE

- A. Installer shall be experienced in the wood flooring industry and shall have a minimum of five years experience in the installation of similar products.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver the flooring to a preferred site in unopened cartons. Protect flooring from exposure to moisture. Moisture producing activities such as drywall, concrete, masonry, painting, and grouting must be completed and cured prior to delivery of wood flooring.
- B. Cartons of hardwood should be delivered to and stored in the environmentally controlled area in which the material will be expected to perform. The material should be stored in the environment it is expected to perform in.
- C. Do not install flooring until all other significant construction work is complete.

1.05 WARRANTY

- A. Warranty is standard manufacturers.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Solid Wood Flooring
 - 1. Species: White Oak

2. Dimensions:
 - a. Width: 5 inch
 - b. Thickness: $\frac{3}{4}$ inch
 - c. Length: 5 ft
 3. Finish: Single Clear polyurethane sealant/stain.
 4. Construction: Solid wood flooring construction.
 5. Edge detail/end detail: Square edge/Square ends.
 6. Milling: Tongue and groove sides, end matched.
 7. Fire Ratings: Class B when tested in accordance with ASTM E 84.
 8. Flame Spread \leq 200
- B. Solid Wood Drainage Flooring
1. Species: American Cypress
 2. Dimensions:
 - a. Width: 3 $\frac{1}{2}$ INCH actual, 4 inch nominal
 - b. Thickness: $\frac{3}{4}$ INCH actual, 1 inch nominal
 - c. Length: 5 ft
 3. Finish: Single Clear polyurethane sealant/stain.
 4. Construction: Solid wood flooring construction.
 5. Edge detail/end detail: Square edge/Square ends.
 6. Fire Ratings: Class B when tested in accordance with ASTM E 84.
 7. Flame Spread \leq 200
- C. Hardness Information: Natural wood products have no minimum hardness specifications since hardness is characteristic of the species and cannot be controlled. The most widely accepted test is the Janka Ball Test (ASTM D 1037-96A) and the results are only use to compare the PSI rating of one species against another. Individual values may vary due to the denseness of cell structure, grain of wood, etc. Rating refer to the hardness of the face species only.
1. Cypress: 1375

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Wood Subfloors:
1. Wood Subfloors must be dry, clean, structurally sound, and flat to within $\frac{3}{16}$ " in 10 FT. Subfloors should be well nailed and/or glued, free of voids, with flat joint alignment.
 2. Ensure that all nail heads are set flush with or below surface.
 3. Wood subfloors must be sanded smooth to remove varnish, high edges, chips or other contaminants. Use thick $\frac{5}{8}$ " or $\frac{3}{4}$ " APA-CDX grade underlayment plywood or equivalent. Allow $\frac{1}{8}$ " - $\frac{1}{4}$ " expansion space between sheets with staggered joints.
 4. Leave $\frac{3}{4}$ " minimum expansion space at all vertical obstructions.
- B. All Subfloors

1. Coordinate work with that of other trades prior to installation so that no discrepancies may exist with installation of doors, frames, saddles, floor drains, or any materials that would interfere in any other way.
2. Notify architect of moisture test results and any unsatisfactory conditions that have been corrected. Beginning hardwood floor installation is an indication that the installer finds the substrate and job site conditions are suitable for installation. Do not begin installation until unsatisfactory conditions have been corrected. Failure to call attentions to defects or imperfections will be construed as acceptance and approval of the sub floor

3.02 PREPARATION

- A. Scour all wood sub-floors using a 20 grit sandpaper.
- B. Sweep and vacuum substrate, and ensure that surface is free of oil, grease, wax, dust, or any other foreign substance.
- C. If approved self-leveling underlayments are used, they must dry sufficiently (run moisture test) and be sanded smooth before installing floor.

3.03 INSTALLATION

- A. Solid Wood Flooring
 1. Follow manufacturer's installation instructions supplied in each carton of material.
- B. Solid Wood Drainage Flooring
 1. Place waterproof barrier at drainage floor in accordance to manufacturer's instructions.
 2. The drainage floor should be installed in accordance to drawings.

3.04 PROTECTION

- A. Protect finished floor from abuse by other trades using heavy kraft paper or equivalent. Keep traffic out of spaces and areas where flooring is being installed until adhesive has set. Light Foot traffic after 10-12 hours. Normal traffic after 24 hours.

3.05 MAINTENANCE

- A. Clean the floor as needed with pre-approved cleaning agent per manufacturer's instructions.

END OF SECTION 09 64 00

09 91 00 PAINTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. The work of this section includes, but is not limited to, painting all exposed steel at interior of building.

B. RELATED SECTIONS

1. Division 05 12 00 "Structural Steel Framing"

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination

B. LEED Submittals:

1. This work shall be scheduled and coordinated with other trades and shall not proceed until other work and or job conditions are as required to achieve satisfactory results.
2. The contractor shall examine the specifications for the various other trades and shall thoroughly familiarize himself with all their provisions regarding painting.

1.03 ACTION SUBMITTALS

- A. Samples: Submitted for approval not less than two weeks before any painting will start. Rejected samples shall be resubmitted until approval. Obtain approval in writing before delivering materials.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. All materials used on the job shall be stored in a single place designated by the architect. Such storage place shall be kept neat and clean and all damage thereto or its surroundings shall be made good. Any soiled or used rags, wasted, and trash must be removed from the building every night and every precaution taken to avoid the danger of a fire.

1.05 FIELD OR SITE CONDITIONS

- A. After painting operations begin in a given area, broom cleaning will not be allowed, cleaning shall then be done only with commercial vacuum equipment.
- B. Adequate illumination shall be provided in all areas where painting operations are in progress.

PART 2 - PRODUCTS**2.01 ACCEPTABLE MANUFACTURERS**

- A. Provide products of one of the following manufacturers that meet or exceed specified requirements.
 - 1. Benjamin Moore and Co.
 - 2. Pittsburgh Paints
 - 3. Porter Paint Co.
 - 4. ICI Glidden Devol

2.02 PAINT MATERIALS

- A. All paints, varnishes, enamel, lacquers, stains, paste fillers, and similar materials must be delivered in the original containers with the seals unbroken and labels intact, and with the manufacturers instructions printed thereon.
- B. Solvents shall be pure and of highest quality, and shall be approved by the architect. They shall bear identifying labels on the containers, with the manufacturers instructions printed thereon.
- C. Paint shall be well ground, shall not settle badly, cake or thicken in the container, shall be readily broken with a paddle to a smooth consistency and shall have easy brushing properties.
- D. Paint shall arrive on the job ready-mixed, except for tinting or undercoats and possible thinning.
- E. All thinning and tinting materials shall be as recommended by the manufacturer for the particular material thinned or tinted.

2.03 ACCESSORY MATERIALS

- A. This work shall include all required ladder, scaffolding, drop cloths, masking, scrapers, tools, sandpaper, dusters, cleaning solvents, etc. as required to perform the work and achieve the results herein specified.

PART 3 - EXECUTION**3.01 EXAMINATION**

- A. Before starting any work, surfaces to receive paint finishes shall be examined carefully for defects which cannot be corrected by the procedures specified herein under "Preparation of Surfaces" and which might prevent satisfactory painting results. Work shall not proceed until such damages are corrected.
- B. The commencing of work in a specific area shall be construed as acceptance of the surfaces, and thereafter the contractor shall be fully responsible for satisfactory work as requires herein.

3.02 PREPARATION

A. Preparation of Surfaces:

1. Surfaces shall be clean, dry, and adequately protected from dampness
2. Surface shall be free of any foreign material which will adversely affect adhesion or appearance of applied coating.
3. Mildew shall be removed and the surface neutralized
4. Efflorescence on any area shall be corrected before painting.

3.03 APPLICATION

- A. All materials shall be mixed, thinned, modified and applied only as specified by the manufacturer's directions.
- B. All priming coats and undercoats shall be tinted to the approximate shade of the final coat.
- C. The contractor not only shall protect his work at all times, but shall also protect all adjacent work and materials by suitable covering or other method during progress of his work. Upon completion of the work, he shall remove all paint spatters from the floors, glass and other surfaces. He shall remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and shall leave his part of the work in clean, orderly and acceptable condition.
- D. Remove and protect hardware, accessories, device plates, lighting fixtures, factory finished work, and similar items, or provide ample in place protection. Upon completion of each space, carefully replace all removed items.
- E. All materials shall be applied under adequate illumination, evenly spread and smoothly flowed on to avoid runs, sags, holidays, brush marks, air bubbles, and roller stipple.
- F. Coverage and hide shall be complete. When color or undercoats show through final coat of paint, the surface shall be covered by additional coats until the paint film is of uniform finish, color, appearance, and coverage at no additional cost to the owner.
- G. All coats shall be thoroughly dry before applying succeeding coats.

3.04 PAINT SCHEDULE

- A. Steel
 1. Two coats of QUICK-DRY ENAMEL satin
 2. Color: White

END OF SECTION 09 91 00

Division 10 - Specialties

10 28 16

BATH ACCESSORIES

PART 1 - GENERAL**1.01 ACTION SUBMITTALS**

- A. Submit samples for all finishes as selected by Architect.

1.02 DELIVERY, STORAGE, AND HANDLING

- A. Deliver items in manufacturer's original unopened protective packaging.
- B. Store materials in original protective packaging to prevent soiling, physical damage, or wetting
- C. Handle so as to prevent damage to finished surfaces.

PART 2 - PRODUCTS**2.01 HANGER**

- A. Hanger: Mirabelle
 - 1. Model: MIRWHRHSN
 - 2. Finish: Satin Nickel
 - 3. Quantity: 3

2.02 TOILET ROLL HOLDER

- A. Toilet Roll Holder: Mirabelle
 - 1. Model: MIRWH1PTHSN
 - 2. Material: Satin Nickel
 - 3. Quantity: 1

2.03 TOWEL HANGER

- A. Towel Hanger: Mirabelle
 - 1. Model: MIRWH18TBSN
 - 2. Material: Satin Nickel
 - 3. Quantity: 1

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Use concealed fasteners wherever possible.
- B. Provide anchors, bolts and other necessary fasteners, and attach accessories securely to walls and partitions in locations as shown or directed.
- C. Install exposed mounting devices and fasteners finished to match the accessories.
- D. Secure bathroom accessories in accordance with manufacturer's instructions for each item and each type of substrate.
- E. Mounting heights shall be as recommended for handicapped access and at the locations indicated on drawings.

3.02 PROTECTION

- A. Maintain protective covers on all units until installation is complete.
- B. Remove protective covers at final clean-up of installation.

END OF SECTION 10 28 16

Division 11 - Equipment

11 28 13

COMPUTERS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

- A. Regulatory Requirements; Comply with provisions of the following product certifications:
 - 1. UL and NEMA: Provide electrical components required as part of the computer that are listed and labeled by UL and that comply with applicable NEMA standards.
- B. Energy Ratings: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program where possible

PART 2 - PRODUCTS

2.01 COMPUTERS BY OWNER

- A. Portable Tablet
 - 1. Product: Dell Inspiron Mini Duo
 - 2. Accessories: Audio Dock

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Freestanding Equipment: Place in final locations after finishes have been completed in each area.

END OF SECTION 11 28 13

11 31 00 RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
1. Division 25 11 00 "Home Automation and Control Systems"

1.02 SECTION REQUIREMENTS

- A. Regulatory Requirements: Comply with provisions of the following product certifications:
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.
- B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with the US Architectural and Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
- C. Energy Ratings: Provide appliances that qualify for the EPA/DOE Energy Star product labeling program

PART 2 - PRODUCTS

2.01 RESIDENTIAL APPLIANCES

- A. Cooktop
1. Bosch NIT3065UC
 - a. Energy Source: Electric
 - b. Number of Cooktop burners: 4
 - c. Number of Electric cooking zones: 4
 - d. Number of Induction elements: 4
 - e. Watts: 7,200 W
 - f. Current: 40 A
 - g. Volts: 208-240 V
 - h. Frequency: 60 Hz
- B. Oven
1. GE Profile Advantium 120 Above-the-Cooktop Oven PSA1201RSS
 - a. Oven cavity: 1.7 Cu. Ft
 - b. Input Amps/Watts (max): 15/1800

- c. Input Volts/Hertz: 120/60
 - d. Voltage: 120V
- C. Downdraft Vent
- 1. Bosch DHD3014UC
 - a. Material: Stainless Steel
 - b. Current: 10A
 - c. Volts: 120V
 - d. Frequency: 60hz
 - e. Plug Type: 120V- 3 prong
 - f. Number of Speed Settings: 3 stage
- D. Downdraft Internal Blower 600 CFM
- 1. Bosch DHG601DUC
 - a. Material: Lacquered
 - b. Watts (W): 530 W
 - c. Volts (V): 120 V
 - d. Frequency: 60 Hz
 - e. Plug Type: 120V-3 prong
- E. Downdraft Recirculator Module
- 1. Bosch DHDRM36UC
 - a. Color/Finish: White
- F. Refrigerator/Freezer
- 1. Sun Frost RF-12
 - a. Number of Compressors: 2
 - b. 110V AC
 - c. Current Draw: 1A
 - d. Maximum Current Draw: 6A
 - e. Max Lead Dimensions: 21 feet
 - f. Walnut wood veneer, unfinished
 - g. Hinge on left side of door
- G. Dishwasher
- 1. Bosch SHV43P13UC
 - a. Tub Material: Stainless Steel
 - b. Watts: 1400W
 - c. Current: 12A
 - d. Volts: 120V
 - e. Frequency: 60Hz
 - f. Silence level: 50dB
 - g. Number of Cycles: 4
- H. Clothes Dryer
- 1. GE DCVH485EKMS
 - a. Capacity: 4.0 Cu. Ft

- b. Color: White
 - c. Heat Selections: 5
 - d. Fuel Type: Electric
- I. Clothes Washer
- 1. GE WCVH4815KMS
 - a. Capacity: 2.6 Cu ft.
 - b. Color: White
 - c. Motor Speed: Variable
 - d. Maximum Spin Speed: 1400 RPM
- J. Spin Dryer
- 1. Manufacturer: Spin X
 - a. Volts: 110-120V
 - b. Frequency: 60 Hz

PART 3 - EXECUTION

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 11 31 00

11 52 00 AUDIO-VISUAL EQUIPMENT

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

- A. Regulatory Requirements: Comply with provisions of the following product certifications:
 - 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.
- B. Energy Ratings: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program where possible

PART 2 - PRODUCTS

2.01 AUDIO-VISUAL EQUIPMENT BY OWNER

- A. Television: Wall Mounted Flat Screen Television
 - 1. Sharp 26" Built in Side loading DVD player.
 - a. Model Number: LC-26DV28UT
- B. Audio System
 - 1. Sharp Audio Sound Bar
 - a. Model Number: HT-SB300

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mounted Equipment: Use only wall mounting approved for use with selected equipment. Minimum of one fastener to be secured to an existing wall stud. Verify that clearances are adequate for proper functions and rough openings are completely concealed.
 - 1. Coordinate mounting of television with installation of the Zoom Room Bed.

3.02 RESIDENTIAL APPLIANCES

- A. Freestanding Equipment: Place in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- B. Test each item of audio-visual equipment to verify proper operation. Make necessary adjustments.
- C. Verify that accessories required have been furnished and installed.

END OF SECTION 11 52 00

Division 12 - Furnishings

12 21 13

HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Related Sections
 - 1. Division 25 11 00 "Home Automation and Control Systems"
 - 2. Division 26 05 19 "Low-Voltage Electrical Conductors and Cables"

1.02 DESCRIPTION OF WORK

- A. Furnish and install horizontal metal blinds
- B. Furnish and install a complete blind system at full-length of each double facade

1.03 QUALITY ASSURANCE

- A. Installer's qualifications: the installer shall be qualified to install the product specified, as demonstrated by prior experience.

1.04 SUBMITTALS

- A. Show drawings: indicate field-measured dimensions of openings which are to receive blinds. Details on mounting surface and sill conditions and details of corners and conditions between adjacent blinds.
- B. Color samples: submit a sample of each type and color of material specified

1.05 DELIVERY, STORAGE AND HANDLING

- A. Packing and shipping: materials shall be delivered to the project in original unopened packaging with labels intact.
- B. Storage
 - 1. Materials shall be stored in a clean area which is free of corrosive fumes, dust and away from construction activities.
 - 2. Materials shall be stacked horizontally using plastic or wood shims such that drainage and ventilation are provided for and such that water cannot accumulate in, about or upon the containers.
 - 3. Stacks shall be covered with tarpaulins or plastic such that ventilation is provided for and such that contaminants are prevented from contacting surfaces.

1.06 PROJECT/SITE CONDITIONS

- A. Roof must be tight. Interior windows and frames installed and glazed and interior doors hung.
- B. Ceilings, window pockets, electrical, and mechanical work above the product shall be complete
- C. Electrical power (110 volt AC) shall be available for installer's tools within 500 ft of product installation area.

1.07 LIFETIME WARRANTY

- A. Manufacturer's standard warranty

PART 2 - PRODUCTS

2.01 MANUFACTURER AND PRODUCT DESCRIPTION

- A. 2 in Horizontal Aluminum Blinds
 - 1. Basis of Design: Bali Heritage
 - 2. Color: Black
- B. Motor:
 - 1. Manufacturer: Somfy RTS Motor 400 Series
- C. Universal RTS Interface
 - 1. Manufacturer: Somfy
 - 2. Product: RTS Interface
 - 3. Part Number: 1810506
- D. RTS Repeater
 - 1. Manufacturer: Somfy
 - 2. Product: RTS Repeater - Range Expander
 - 3. Part Number: 1810791

PART 3 - EXECUTION

3.01 INSPECTION

- A. Window treatment subcontractor shall be responsible for inspection of site, field measurements and approval of mounting surfaces and installation conditions.
- B. Subcontractor shall verify that site is free of conditions that interfere with blind installation and operation and shall begin installation only when any unsatisfactory conditions have been rectified.

3.02 INSTALLATION

- A. Installation shall comply with manufacturer's specifications, standards and procedures.
- B. Coordinate installation and connection of motor with work in section 23 11 00 and Division 26
- C. Provide support brackets as per manufacturer's installation instructions
- D. See installation instruction packaged with blinds for more installation details
- E. Provide adequate clearance to permit unencumbered operation of blind and hardware
- F. Demonstrate blinds to be in uniform and smooth working order

3.03 CLEANING

- A. Clean soiled blinds with a mild soap solution only. Do not use cleaning methods involving heat, bleach, abrasives or solvents. Do not use window cleaner or cloths with paper content.
- B. Ensure proper drying following cleaning by providing adequate ventilation.

END OF SECTION 12 21 13

12 36 00 COUNTERTOPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Countertop at Kitchen Island
 - 2. Countertop at Kitchen Counter
 - 3. Counter at Exterior Casework
- B. Related Sections:
 - 1. Division 06 20 13 "Exterior Finish Carpentry"
 - 2. Division 06 41 00 "Architectural Wood Casework"

1.02 ACTION SUBMITTALS

- A. Submit shop drawings to verify dimensions.
- B. Submit sample of finish as Selected by Architect.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Countertop: Cambria
 - 1. Finish: White Cliff
- B. Setting Materials
 - 1. Sealant: Clear 100% kitchen and bath silicone sealant.

2.02 FABRICATION

- A. Thickness: 2 ½ inches
- B. Edge Detail: Straight, slightly eased at top.
- C. Countertop wraps around edge of Kitchen Island and extends to floor, refer to Drawings.
 - 1. Under counter Fixtures: Make cutouts for under counter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth end curves.
 - a. Edge Detail: Vertical, slightly eased at top and bottom surfaces and projecting 3/16 inch into fixture opening.

2. Counter-mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for plumbing fittings and similar items.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install countertops by adhering to supports with water-cleanable epoxy adhesive.
- B. Apply sealant to gap between countertops and splashes where needed.

3.02 CLEANING

- A. Clean countertops as work progresses. Remove adhesive and sealant smears immediately.

END OF SECTION 12 36 00

12 58 00 RESIDENTIAL FURNITURE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Specifications for bed and mattress
- B. Related Sections:
 - 1. Division 06 41 00 "Architectural Wood Casework"

1.02 WARRANTY

- A. Manufacturer Warranty: In the event your mattress wears out or either the bed motor or any moving part, including, but not limited to wooden slats, drive trains, wireless remote (excluding batteries) and control unit, ceases to function due to normal wear and tear, for a period of ten years from the date of purchase of your bed, Zoom Room will replace the mattress, motor and or moving part upon receipt of a written request from you using the printable form, together with the unusable part, if requested. Please note that cabinets and cabinet parts and the mattress cover are explicitly not covered, and that Zoom Room will not replace any mattress, motor or moving part that is damaged or ceased to function due to anything other than manufacturing defect or normal wear and tear.

PART 2 - PRODUCTS

2.01 BED

- A. Zoom Room Murphy Bed
 - 1. Mattress size: Queen, Width: 4'11" x Length: 6'5 ½"
 - 2. Mattress Mechanism Weight: 146 lbs.
 - 3. Mattress Weight: 41 lbs
- B. Custom Cabinetry
 - 1. Reference Division 06 41 00 "Architectural Wood Casework"

PART 3 - EXECUTION

3.01 PREPARATION

- A. Once the cabinet is built install flat screen TV (if a TV is going to be hung on the cabinet) before installing the Zoom Room bed.

- B. Be sure to route all audio, video, and electrical wiring correctly before you install the mechanism.
- C. Any and all wiring that is routed through the TV panel (this requires the installer to drill a hole in the TV panel) must be fixed to the inside panels using electrical tape or cable clips. (wires can be routed either on the left side or the right side of the cabinet)
- D. Note: All hole should be drilled so the they will be covered by the television after it is mounted.
- E. Installation of the Zoom Room mechanism can begin once all of the wiring is secured to the inside of the panels and routed correctly through the gap in the Bolsters.

3.02 INSTALLATION

1. Cabinet installation to be completed by a Zoom Room professional or qualified local mill worker.
2. Install according to manufacturer's instructions.

END OF SECTION 12 58 00

12 93 00 SITE FURNISHINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes
 - 1. Bicycle racks
- B. Related Sections
 - 1. Division 06 10 00 "Rough Carpentry"
 - 2. Division 06 20 13 "Exterior Finish Carpentry"

1.02 WARRANTY

- A. All products come with a limited lifetime warranty against original defects.

PART 2 - PRODUCTS

2.01 BICYCLE RACK

- A. Manufacturer: Delta Cycle
 - 1. Product name: The Leonardo
 - 2. Size: 11"Hx3.5"Wx6"D
 - 3. Bicycle Rack Construction: Hot dipped galvanized finish
 - 4. Style: Single wall-mounted
 - 5. Installation Method: Permanent surface mount

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Wall should be capable of supporting 40 lbs.
- B. Install according to manufacturer's instructions
- C. Avoid mounting rack in a position where personal injury could result from rack protruding into walking path.
- D. Avoid drilling into any electrical, plumbing or other service fixtures that may be hidden within a wall.

END OF SECTION 12 93 00

Division 14 – Conveying Equipment

14 83 16

SCISSOR LIFT PLATFORMS

PART 1 - GENERAL**1.01 SUMMARY****A. Section Includes:**

1. This specification describes the terms of use, requirements, and product data for the scissor lift platform needed for assembly and disassembly of the house.

PART 2 - PRODUCTS**2.01 MANUFACTURERS****A. Genie****2.02 PRODUCT BY OWNER****A. GS 2668 RT Scissor Lift Platform**

1. Dimensions:
 - a. Length: 8' 9"
 - b. Width: 5' 8"
 - c. Height: 5' 7"
 - d. Wheelbase: 6' 1"
 - e. Turning Radius Outside: 12' 1"
2. Lift:
 - a. Max Lift Height: 26'
 - b. Max Lift Capacity: 1,250 lbs.
 - c. Max Extension Deck Capacity: 300 lbs.
3. Engine:
 - a. Power: 22 hp
 - b. Kubota DF 752
4. Operational:
 - a. Travel Speed: 3.8 mph.
 - b. Raise/Lower Time: 30/35 sec.

PART 3 - EXECUTION**3.01 SAFETY AND IMPLEMENTATION**

- A. All operators must comply with all safety standards and regulations set forth by the Solar Decathlon.

- B. All operators must be certified to operate equipment and carry certifications card at all times during operation.
- C. Scissor Lifts must only travel on protective pads provided to protect the grass of the National Mall.

END OF SECTION 14 83 16

Division 21 - Fire Suppression

21 13 00

FIRE-SUPPRESSION SPRINKLER SYSTEM

PART 1 - GENERAL**1.01 SUMMARY**

- A. Related Sections:
1. Division 21 30 00 "Fire Pumps."
 2. Division 21 40 00 "Fire-Suppression Water Storage"

1.02 SCOPE

- A. Furnish all labor, materials, tools, equipment, and perform all work and services necessary for or incidental to the furnishing and installation, complete, of all fire protection systems. All material shall be new, unused, and of first class construction, designed and guaranteed to perform the service required.
- B. The local authority having jurisdiction shall approve all work and material. The fire protection/fire detection and alarm systems shall use UL listed materials and equipment, and shall be installed in accordance with manufacturer's specifications, the insurance carrier and NFPA R13D.
- C. The fire protection drawings contained within the construction documents are for concept only. The installing sprinkler contractor shall submit directly to the fire marshal's office, or other inspection agencies, for review detailed installation drawings and hydraulic calculations. The drawings and calculations shall be signed by a responsible managing employee and submitted by a registered fire protection contractor. The sprinkler contractor shall submit approved installation drawings to the architect prior to commencing the work. The sprinkler contractor's installation drawings, especially sprinkler head locations, shall be coordinated with the architectural reflected ceiling plan and other architectural or structural features of the building. The system shall be installed according to the approved drawings.
- D. The sprinkler system shall be the wet type.

PART 2 - PRODUCTS**2.01 FIRE LINE**

- A. The fire line shall be installed by a licensed sprinkler contractor.
- B. The fire line shall be schedule 40 steel pipe. All elbows and fittings shall be steel with mechanical joints.
- C. The fire line shall be hydrostatically tested for leakage at normal system operating pressure and thoroughly flushed out in accordance with NFPA R13D.

2.02 PIPE

- A. All interior piping above ground shall be schedule 40 black steel pipe with steel fittings designed to withstand a working pressure of not less than 175psi.

2.03 PIPE HANGERS

- A. Space pipe hangers in accordance with requirements of NFPA. Hanger rods, inserts and clamps shall be constructed as approved by NFPA.

2.04 INSPECTOR'S TEST

- A. Install an approved inspector's test connection at the end of the branch line that is most remote from the system supply, and at the highest point on the system. The discharge from the inspector's test must be unobstructed and visible and located in a manner approved by NFPA.

2.05 VALVES

- A. Maintenance and check valves shall be approved by NFPA. Test valves shall be approved and conform to requirements of NFPA.

2.06 SPRINKLER HEADS

- A. All sprinkler heads shall be the quick response type and carry both the UL listing and factory mutual approval. All sprinkler heads shall be of type and operating temperature as required by specific location of installation.
- B. All sprinkler heads shall be Tyco Rapid Response Series LFII Residential concealed 4.2K-factor pendant sprinklers with flush-mounted deflector to allow half-throw. 3" escutcheon plate shall be used. Finish to be chrome.
- C. Spare heads of every type used on the project shall be included in the spare head cabinet. A sprinkler wrench specifically adapted to removal and replacement of every type of head used on the project shall be included in the spare head cabinet.

PART 3 - EXECUTION

3.01 CODES AND STANDARDS

- A. The sprinkler system shall comply with all codes, requirements, regulations, and provisions of the law of the state of Tennessee and NFPA R13D.
- B. The contractor must hold a state of Tennessee certification in cross connection.

3.02 INSTALLATION

- A. The installed system shall be complete in every respect and shall include but not limited to the following: heads, check valve with detector or backflow preventer (if required by authority having jurisdiction), heat actuated devices, fittings, piping, valves, test valve, maintenance valve, hangers and all other required items.
- B. Install the fire line complete and make arrangements for the connection to the fire safety tank.
- C. Refer to architectural reflected ceiling plan for exact location of heads.

3.03 TESTS AND INSPECTIONS

- A. Work included herein shall include all tests and inspections by the inspecting agencies and any permits or inspection fees connected therewith. The use of waterglass shall not be permitted. Following all testing, the system shall be returned to functional and operational condition at no extra cost to the owner. After approval, the contractor shall obtain the approval certificates and deliver them to the architect.

END OF SECTION 21 13 00

21 24 16

DRY CHEMICAL FIRE EXTINGUISHING EQUIPMENT

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section Includes:
 - 1. Fire Extinguisher.

1.02 SUBMITTALS

- A. Qualification: The product exceeds the minimum UL rating of 2A-10BC.

1.03 PRODUCTS

- A. MANUFACTURERS
 - 1. First Alert.
- B. PRODUCT
 - 1. Home 2 First Alert Fire Extinguisher.

PART 2 - EXECUTION**2.01 INSPECTIONS**

- A. Inspect products upon arrival for damage or misuse.
- B. Product should be stored in appropriate locations for easy access.

END OF SECTION 21 24 16

21 30 00 FIRE PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Pumps serving the sprinkler system.
- B. Related Sections:
 - 1. Division 211300 "Fire-Suppression Sprinkler Systems".

1.02 SUBMITTALS

- A. Installation Instructions

1.03 QUALITY ASSURANCE

- A. Use only approved liquids by manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 PUMPS

- A. SPD Inc. R13D certified fire sprinkler pump
 - 1. Model: G3000
 - 2. Mounting: Floor mounted.
 - 3. Horse power: 2 HP
 - 4. Flow: 55 GPM.
 - 5. Pressure: 35 PSI

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install according to manufacturer's instructions.

END OF SECTION 21 30 00

21 40 00 FIRE-SUPPRESSION WATER STORAGE

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 21 13 00 "Fire-Suppression Sprinkler Systems "

PART 2 - PRODUCTS

2.01 FIRE-SUPPRESSION WATER STORAGE TANKS

- A. Plastic Water Storage Tank
 - 1. MDPE
 - 2. 500 gallon capacity
 - 3. 92" L x 48" W x 29" H
 - 4. One tank for fire protection purposes
 - 5. Provide:
 - a. Fill: 6" or greater with vented lid
 - b. Water outlet: 1 ½"
 - c. Drain: 2"

2.02 DISTRIBUTION PIPES AND FITTINGS

- A. Schedule 40 Steel Pipes and Fittings: Refer to Division 21 13 00.

PART 3 - EXECUTION

3.01 FIRE-SUPPRESSION STORAGE TANK INSTALLATION

- A. Install fire-suppression storage tanks level.
- B. Install fire-suppression storage tanks according to guidelines
 - 1. Accessibility, ease of maintenance, and removal should be taken into consideration when installing tanks.
 - 2. Adequately support all pipes and valves. Do not apply excess weight on water tanks.
 - 3. Tanks are not designed for storage of fluid in vacuum conditions or higher pressure above atmospheric.
 - 4. Use caution when handling all tanks.
- C. Fill fire-suppression storage tank with water.

END OF SECTION 21 40 00

Division 22 - Plumbing

22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL**1.01 SUMMARY****A. Related Sections**

1. Division 22 11 16 "Domestic Water Piping"
2. Division 22 11 23 "Domestic Water Pumps"
3. Division 22 12 00 "Facility Potable-Water Storage Tanks"
4. Division 22 13 16 "Sanitary Waste and Vent Piping"
5. Division 22 13 53 " Facility Septic Tanks"
6. Division 22 14 00 "Facility Storm Drainage"
7. Division 22 33 00 "Electric Domestic Water Heaters"
8. Division 22 41 00 "Residential Plumbing Fixtures"

PART 2 - PRODUCTS**2.01 SLEEVES**

- A. Mechanical Sleeve Seals: Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. PVC Pipe: ASTM D 1785, Schedule 40.

2.02 MOTORS**A. Motor Characteristics**

1. Motor Smaller than 3/4 HP: Single phase.
2. Frequency Rating: 60 Hz
3. Voltage Rating: NEMA standard voltage for circuit voltage to which motor is connected.
4. Service Factor: 1.15 for open drip-proof motors; 1.0 for totally enclosed motors.
5. Duty: Continuous duty at ambient temperature of 105 degrees F and at altitude of 3300 feet above sea level.
6. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
7. Enclosure: unless otherwise indicated, open drip-proof.
8. Motors Used with Variable-Frequency Controllers: Ratings, characteristics and features coordinated with and approved by controller manufacturer.

2.03 HANGERS AND SUPPORTS

- A. Hanger and Pipe Attachments: Factory fabricated with galvanized coatings; nonmetallic coated for hangers in direct contact with copper tubing.

2.04 PRESSURE GAGES AND TEST PLUGS

- A. Pressure Gages: Direct-mounting, indicating-dial type complying with ASME B40.100. Dry metal case, minimum 2-1/2 inch diameter with red pointer on white face, and plastic window. Minimum accuracy 3 percent of middle half of range. Range two times operating pressure.
- B. Test Plug: Corrosion-resistant brass or stainless steel body with two self-sealing rubber core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping. Minimum pressure and temperature rating 500 psig at 200 degrees F.

PART 3 - EXECUTION

3.01 MOTOR INSTALLATION

- A. Anchor motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions.

3.02 GENERAL PIPING INSTALLATIONS

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Floor, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.
- D. Install unions at final connection to each piece of equipment
- E. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

3.03 GENERAL EQUIPMENT INSTALLATIONS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, 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.
- D. Install equipment to allow right of way for piping installed at required slope.

3.04 HANGERS AND SUPPORTS

- A. Comply with MSS SP-69 and MSS SP-89. Install building attachments to structural steel.
- B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.
- C. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment
- D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS ½ to NPS 4 to allow off-center closure for hanger installation before pipe erection.
 - 2. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS ½ to NPS 8
 - 3. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS ½ to NPS 8
 - 4. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS ½ to NPS 2.
- E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS ¾ to NPS 20.
 - 2. Carbon or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS ¾ to NPS 20, if longer ends are required for riser clamps.

END OF SECTION 22 05 00

22 11 16 DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 22 05 00 "Common Work Results for Plumbing"
 - 2. Division 22 11 23 "Domestic Water Pumps"
 - 3. Division 22 33 00 "Electric Domestic Water Heaters"
 - 4. Division 22 41 00 "Residential Plumbing Fixtures"

1.02 SECTION REQUIREMENTS

- A. Comply with NSF 14 for plastic, potable domestic water piping and components.
- B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS, GENERAL

- A. PEX Tube and Fittings: ASTM 877, SDR 9 PEX tubing and ASTM 1807, metal insert-type fittings with copper or stainless steel crimp rings.
 - 1. Manufacturer: Rehau
 - 2. Manifold: Sioux Chief ½" Pex Ball Valve for each outlet.
- B. PVC Pipe: ASTM D 1785, Schedule 40.
 - 1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.
- C. Valves:
 - 1. Water Heater SH Valve: Sioux Chief ¾" FIP Swival x 1/8" full-slip FSWT Water Heater connector.
 - 2. Main Shut Off Valve: Sioux Chief Replace-A-Valve ¾" Full-Port Ball Valve, sweat connection.
 - 3. Maintenance Shut Off Valve: Sioux Chief Replace-A-Valve ¾" and ½" Full-Port Ball Valve, sweat connection.
 - 4. Ball Check Valves: Apollo ¾" Ball Check Valve.
 - a. Model: 6110401
 - b. 0.5 Cracking PSI
 - c. Material: Bronze
- D. Transition Fittings: Manufactured piping coupling or specified piping system fitting. Same size as pipes to be joined and pressure rating at least equal to pipes to be joined.
- E. Cleanouts

1. Install cleanouts in accessible locations at intersection of soil and waste lines beneath the structure ahead of the wastewater pump as indicated on the drawings.
2. Cleanouts shall be full size of trap or pipe. Full size Y or T branches shall be provided for cleanouts as required at the building.

2.02 EXPANSION TANK

- A. PLT-5 Potable Hot Water Expansion Tank
 1. Volume: 2.1 gallons
 2. Diameter: 8"
 3. Height: 11"

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with requirements in Division 22 Section "Commons Work Results for Plumbing" for basic piping installation requirements.
- B. Install wall penetration system at each service pipe penetration through exterior wall. Make installation watertight. Comply with requirements in Division 22 Section "Commons Work Results for Plumbing" for wall penetration systems.
- C. Install shutoff valve, drain valve, strainer, pressure gauge, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Commons Work Results for Plumbing" for pressure gauges.
- D. Install domestic water piping without pitch for horizontal piping and plumb for vertical piping.
- E. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.
- F. Support vertical piping.
- G. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

3.02 INSPECTION AND CLEANING

- A. Inspect and test piping systems as follows:
 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

- B. Clean and disinfect potable and non-potable domestic water piping by filling system with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

3.03 PIPING SCHEDULE

- A. Above Ground Exterior Piping: PVC Pipes.
- B. Interior Distribution Piping: PEX piping.

3.04 VALVE SCHEDULE

- A. Drawings indicate valve types to be used.
- B. Install ball valves close to main on each branch and riser serving two or more plumbing fixtures or equipment connections and where indicated.
- C. Install ball valves on inlet to each plumbing equipment item, on each supply to each plumbing fixture not having stops on supplies, and elsewhere as indicated.
- D. Install drain valve at base of each riser, at low points of horizontal runs and where required to drain water distribution piping system.

END OF SECTION 22 11 16

22 11 23 DOMESTIC WATER PUMP

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections
 - 1. Division 22 11 16 "Domestic Water Piping"

1.02 SECTION REQUIREMENTS

- A. Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.01 DOMESTIC WATER PUMPS

- A. Walrus TQ1C400 Inverter Control Pump
 - 1. Power: ½ HP
 - 2. Cycle: 60 Hz
 - 3. Phase: 3
 - 4. Voltage: 230V
 - 5. Amps: 3.0A
 - 6. Pre-Set Constant Pressure: 28 PSI
 - 7. Nominal Capacity: 11 GPM
 - 8. N.W.: 25.4 lbs
 - 9. Casing: Glass filled noryl
 - 10. Impeller: glass filled noryl

2.02 MOTORS

- A. NEMA MG 1, "Standard for Motors and Generators." Include NEMA listing and labeling.
- B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Controller, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with HI 1.4
- B. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings and accessories.
- C. Support pumps and piping so weight of piping is not supported by pump volute.
- D. Install electrical connections for power, controls and devices
- E. Connect piping with valves that are at least the same size as piping connecting to pumps.
- F. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- G. Install shutoff valve and strainer on suction side of pumps.
- H. Install nonslam check valve and throttling valve on discharge side of pumps.
- I. Install thermostats in hot-water return piping.
- J. Install pressure gages on suction and discharge of each pump. Install at integral pressure gage tapings where provided.

END OF SECTION 22 11 23

22 12 00 FACILITY POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 22 05 00 "Common Work Results for Plumbing"
 - 2. Division 22 11 16 "Domestic Water Piping"

PART 2 - PRODUCTS

2.01 POTABLE-WATER STORAGE TANKS

- A. Plastic Water Storage Tank
 - 1. MDPE
 - 2. 500 gallon capacity
 - 3. 92" L x 48" W x 29" H
 - 4. Two tanks to be allocated for potable water supply
 - 5. Provide:
 - a. Fill: 6" or greater with vented lid
 - b. Water outlet: 1"
 - c. Drain: 2"

2.02 DISTRIBUTION PIPES AND FITTINGS

- A. PEX Pipes and Fittings: Refer to Division 22 11 16.

PART 3 - EXECUTION

3.01 FACILITY POTABLE-WATER STORAGE TANK INSTALLATION

- A. Install potable-water storage tanks level.
- B. Install potable-water storage tanks according to guidelines
 - 1. Accessibility, ease of maintenance, and removal should be taken into consideration when installing tanks.
 - 2. Adequately support all pipes and valves. Do not apply excess weight on water tanks.
 - 3. Tanks are not designed for storage of fluid in vacuum conditions or higher pressure above atmospheric.
 - 4. Use caution when handling all tanks.
- C. Fill potable-water storage tank with water.

END OF SECTION 22 12 00

22 13 16 SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections
 - 1. Division 22 05 00 "Common Work Results for Plumbing"
 - 2. Division 22 13 52 "Facility Septic Tanks"

1.02 SECTION REQUIREMENTS

- A. Minimum Pressure Requirement for Soil, Waste and Vent: 10-foot head of water (30 kPa)
- B. Comply with NSF 14, "Plastic Piping Components and Related Materials," for plastic piping components

PART 2 - PRODUCTS

2.01 PIPES AND FITTINGS

- A. PVC Plastic, DWV Pipe and Fittings: ASTM D 2665, Schedule 40, plain ends with PVC socket-type, DWV pipe fittings

2.02 FLOOR DRAINS

- A. Sioux Chief Manufacturing: 1 ½ in PVC Solvent Weld Module Drain

2.03 DRAINAGE FLOOR MEMBRANE

- A. Sheet Waterproofing: Waterproof, mildew resistant membrane

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. Install floor penetration system at each pipe penetration through floor. Make installation watertight. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for floor penetration systems.
- B. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends and long-sweep bends. Sanitary tees and short-sweep ¼ bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8 bend fittings if 2

fixtures are installed back to back or side by side with common drainpipe. Straight tees, elbows and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- C. Install required gaskets according to manufacturer's written instruction for use of lubricants and other requirements. Maintain swab in piping and pull past each joint as completed.
- D. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- E. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- F. Do not enclose, cover or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- G. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.

3.02 PIPE SCHEDULE

- A. Aboveground Applications: PVC plastic, DWV pipe and fittings with solvent-cemented joints.

3.03 DRAINAGE FLOOR MEMBRANE

- A. Install drainage floor membrane per manufacturer's installation instructions and drawings.

END OF SECTION 22 13 16

22 13 36

PACKAGED, WASTEWATER PUMP UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections
 - 1. Division 22 13 16 "Sanitary Waste and Vent Piping"

1.02 SECTION REQUIREMENTS

- A. Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.01 PACKAGED, WASTEWATER PUMP UNIT

- A. Sanivite SFA Saniflo
 - 1. Power: 2/10 HP
 - 2. Cycle: 60 Hz
 - 3. Voltage: 120V
 - 4. Amps: 5,5 A
 - 5. N.W.: 7.7 lbs
 - 6. Pump Protection: IP44

2.02 MOTORS

- A. NEMA MG 1, "Standard for Motors and Generators." Include NEMA listing and labeling.
- B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Controller, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with HI 1.4

- B. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings and accessories.
- C. Support pumps and piping so weight of piping is not supported by pump volute.
- D. Install electrical connections for power, controls and devices
- E. Connect piping with valves that are at least the same size as piping connecting to pumps.
- F. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- G. Install shutoff valve and strainer on suction side of pumps.
- H. Install nonslam check valve and throttling valve on discharge side of pumps.
- I. Install thermostats in hot-water return piping.
- J. Install pressure gages on suction and discharge of each pump. Install at integral pressure gage tapings where provided.

END OF SECTION 22 13 36

22 13 53

FACILITY SEPTIC TANKS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 22 05 00 "Common Work Results for Plumbing"
 - 2. Division 22 13 16 "Sanitary Waste and Vent Piping"

PART 2 - PRODUCTS

2.01 WASTE WATER STORAGE TANKS

- A. Plastic Water Storage Tank
 - 1. MDPE
 - 2. 500 gallon capacity
 - 3. 92" L x 48" W x 29" H
 - 4. Two tanks to be allocated for waste water storage
 - 5. Provide:
 - a. Fill: 6" or greater with vented lid
 - b. Water inlet: 3"
 - c. Drain: 2"
 - 6. Custom inlet/outlet locations to be coordinated with manufacturer prior to purchase.

2.02 DISTRIBUTION PIPES AND FITTINGS

- A. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, for solvent-cement or elastomeric gasket joints.
 - 1. Solvent Cement: ASTM D 2564.
 - 2. Gaskets: ASTM F 477, elastomeric seal.

END OF SECTION 22 13 53

22 14 00 FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections
 - 1. Division 22 05 00 "Common Work Results for Plumbing"
 - 2. Division 07 63 00 "Sheet Metal Roofing Specialties"

1.02 SYSTEM DESCRIPTION

- A. Definition: This system is designed to harvest all the rainwater that is captured by our house.
- B. Performance Requirements: The System must be free of leaks to prevent water from escaping the system and leaking into the ground. The pumps for the system must be certified by outside source.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Exterior Storm Water Piping: schedule 40 PVC
- B. Plastic Water Storage Tank
 - 1. 50 gallon capacity
 - 2. 20"L x 48"W x 14.5"H
 - 3. One tank to be allocated for rainwater collection.
 - 4. Provide:
 - a. Fill: 6" or greater with vented lid
 - b. Water inlets and outlet: 1 ¼"
 - c. Drain: 2"
- C. Hand Pump: Northern Industrial Large Cast Iron Hand Pump.
 - 1. Finish: unfinished.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
- B. Refer to the drawings for the layout and slope of the pipes.

END OF SECTION 22 14 00

22 33 00

ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections
 - 1. Division 22 10 00 "Domestic Water Piping"
 - 2. Division 22 11 16 "Domestic Water Piping"

1.02 SECTION REQUIREMENTS

- A. Comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable -water-tank linings
- B. Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design or New Low-Rise Residential Buildings"

1.03 WARRANTY

- A. Submit a written warranty executed by manufacturer agreeing to repair or replace water heaters that fail in materials or workmanship within five years from date of Substantial Completion. Failures include, but are not limited to, tanks and elements.

PART 2 - PRODUCTS

2.01 WATER HEATERS, GENERAL

- A. Insulation: Suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls
- B. Anode Rods: factory installed, magnesium
- C. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.
- D. Drain Valve: Factory or field installed.

2.02 ELECTRIC WATER HEATERS

- A. Product:
 - 1. GE Geospring Hybrid Electric Residential Water Heater

- B. Size/Capacity
 - 1. 50 gallon capacity
- C. Condensation Drain Tubes
- D. Combination temperature and pressure-relief valve. Comply with Standard for Relief Valves and Automatic Gas Shut-Off Devices for Hot Water Supply Systems, ANSI 721.22
 - 1. Pressure not to exceed 150 PSI
- E. Electrical connections
 - 1. Metallic conduit/cable or nonmetallic sheathed cable
 - 2. ½" or ¾" electrical fittings

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Locate water heater in a clean dry area as near as practical to the area of greatest heated water demand. Required 5-1/2" minimum clearance between any object and the Front and Rear covers and 14" clearance at the top of water heater.
 - 1. Room size less than 700 cubic feet: ventilation required.
- B. Recommended to install an expansion tank between the water heater and the check valve to relieve thermal expansion.
- C. Install hot and cold water supply connections in accordance with GE recommendations. Install shut-off valve in the cold water line.
- D. Drain Line completely installed per local code.
- E. Install electrical connections: all wiring must comply to local codes or National Electrical Code ANSI/NFPA 70
- F. Verify control panel displays 120°F Hybrid Mode

3.02 CLEANING

- A. Comply with GE cleaning recommendations

END OF SECTION 22 33 00

22 41 00 RESIDENTIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 22 05 00 "Common Work Results for Plumbing"
 - 2. Division 22 11 00 "Domestic Water Piping"

1.02 ACTION SUBMITTALS

- A. Product Data: Submit samples for all finishes as selected by Architect.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver items in manufacturer's original unopened protective packaging.
- B. Store materials in original protective packaging to prevent soiling, physical damage, or wetting.
- C. Handle so as to prevent damage to finished surfaces.

1.04 WARRANTY

- A. Provide standard manufacturer's warranty for each product listed.

PART 2 - PRODUCTS

2.01 WATER CLOSET

- A. Water Closet: Mirabelle Wall-Mounted Toilet
 - 1. Model: MIRWH220WH
 - 2. Finish: Semi Gloss White
- B. Tank: Geberit In-wall Tank System
 - 1. Model: UP200
 - 2. Polyethylene outlet
 - 3. Pex-C supply
 - 4. Finish: Polished Chrome

2.02 BATHROOM SINK

- A. Sink: Duravit Architec

1. Model: 044958
2. Material: Porcelain
3. Size: 22"
4. Finish: Gloss White

B. Faucet: Mirabelle

1. Model: MIREDD1HVFPUBN
2. Material: Brass
3. Finish: Brushed Nickel

C. Drain: Duravit Architec

1. Model: 005024
2. Material: Stainless Steel
3. Finish: Polished Chrome

D. Trap: Kohler Bottle Trap

1. Model: K-9033-BN
2. Material: Brass
3. Finish: Vibrant Brushed Nickel

2.03 KITCHEN SINK

A. Sink: Mirabelle Undermount Sink

1. Model: MIRUC1520Z

B. Faucet: Ravenel

1. Model: MIRXRA102SS
2. Material: Brass
3. Finish: Stainless Steel

2.04 SHOWER HEAD

A. Mirabelle 8" Showerhead

1. Model: MIRWHSHWRHDCP
2. Finish: Satin Nickel

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Reference drawings for configuration and locations.
- B. Use concealed fasteners wherever possible.

- C. Provide anchors, bolts and other necessary fasteners, and attach accessories securely to walls and partitions in locations as shown or directed.
- D. Install exposed mounting devices and fasteners finished to match the accessories.
- E. Secure bathroom accessories in accordance with manufacturer's instructions for each item and each type of substrate.
- F. Mounting heights shall be as recommended for handicapped access and at the locations indicated on drawings.
- G. Recessed units shall have adequate lintels or headers installed as appropriated to the wall construction in which installed.

3.02 PROTECTION

- A. Maintain protective covers on all units until installation is complete.
- B. Remove protective covers at final clean up of installation.

END OF SECTION 22 41 00

Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC)

23 00 00 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

PART 1 - GENERAL**1.01 SUMMARY****A. Section Includes:**

1. The work required under this specification consists of all air conditioning and ventilation systems (HVAC)
2. Heating, ventilating and air conditioning shall include all materials, equipment accessories, tools and labor required to install the following systems:
 - a. Electric Cooling and Heating System
 - b. Exhaust and Ventilation System

B. Related Sections:

1. Division 23 05 00- "Common Work Results for HVAC"
2. Division 23 07 00- "HVAC Insulations"
3. Division 23 31 00- "HVAC Ducts and Casings"
4. Division 23 37 00- "Air Outlets and Inlets"
5. Division 23 72 00- "Air to Air Energy Recovery Ventilator"
6. Division 23 81 00- "Decentralize Unitary HVAC Equipment"

1.02 ACTIVE SUBMITTALS: ELECTRICAL WIRING

- A. Provide electrical power wiring for mechanical equipment from load side of disconnect switch (provided by electrical) to unit terminals. In addition, provide and install all control devices and wiring. All electrical work shall be in accordance with the requirements of electrical specifications.
- B. All electrical components and materials shall be UL labeled.

1.03 FURNISH ITEMS FOR INSTALLATION:

- A. Field verify electrical characteristics before ordering equipment

1.04 CONNECTING FOR EQUIPMENT FURNISHED BY OTHERS

- A. Where drawings indicate owner-furnished equipment or items furnished by other trades to be connected under this contract, provide piping, valves, miscellaneous fittings and other appurtenances for proper connections.
- B. Where drawings indicate utility rough-in for owner-furnished equipment, terminate utilities with caps, plugs, or valves as indicated to insure convenient final connection.

1.05 PERMITS, CODES AND STANDARDS

- A. Obtain all permits and pay all fees in connection with work specified under Division 23
- B. Obtain and deliver to the Architect certification of inspection issued by authorities having jurisdiction. Perform work in accordance with standards listed below except where specifications or State and Local Codes are more stringent.
 - 1. Canadian Standards Association (CSA)
 - 2. American Society of Mechanical Engineers (ASME)
 - 3. American Water Works Association (AWWA)
 - 4. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - 5. American Society for Testing and Material (ASTM)
 - 6. Sheet Metal and Air Conditioning Contractors Association (SMACNA)
 - 7. Underwriters' Laboratory (UL)
 - 8. Air Conditioning and Refrigeration Institute (ARI)
 - 9. International Mechanical Code (IMC)
 - 10. International Gas Code (IGC)

1.06 INSTRUCTIONS, BROCHURES AND AS-BUILT DRAWINGS

- A. Deliver to the Architect three sets of wiring diagrams, submittals, shop drawings, operating instructions and catalog sheets for replacement parts, mounted in flexible vinyl-covered loose leaf notebook. Each set shall be complete and bound separately.

1.07 SHOP DRAWINGS AND SUBMITTALS

- A. Submit shop drawings specified in following Sections of Specifications (See Special Conditions Section of Specifications for number required and preparation data). Prior to submitting shop drawings, examine submittal data to assure that information is in accord with contract requirements, and that equipment proposed will fit into available space, filter service, maintenance, etc. All submittals shall bear Contractor's stamp showing he has checked the submittals for performance, suitability, space, etc. All submittals shall be identified in accord with the drawings.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Do not order materials, until Architect's approval is obtained
- B. Capacities, sizes and other conditions specified and indicated on drawings are minimum

PART 3 - EXECUTION

3.01 COORDINATION

- A. Schedule work and coordinate with other trades to avoid delays, interferences and unnecessary work.
- B. Furnish information required to revise footing elevations, structural elements, chases, openings in floors and walls and to provide clearances, which may be required to accommodate work.

3.02 INSPECTION

- A. Do not cover any work until it has been tested, inspected and approved by the Architect and authorities having jurisdiction. Provide at least 24 hours notice for required observation and approval visits to site by Architect and authorities having jurisdiction.

3.03 CUTTING AND PATCHING

- A. Cutting and patching due to error on the part of this contractor or where other trades were not given sufficient advance notice of the need for holes, chases, etc., will be the responsibility of this contractor. Any damage done or cuts made in installing work will be repaired, employing the services of the trade whose work is cut or damaged.

3.04 SUPERVISION

- A. This contractor shall employ a competent mechanic in each phase of work to continuously supervise the work. Insofar as possible, keep the same supervisor and workmen on the job for the full length of construction.

3.05 CLEAN UP

- A. The contractor shall be responsible for removing all debris created by him, and all scrap materials accumulated by him during the process of installation. The premises shall be left clean and neat, and all equipment shall be left in first-class condition. It shall be the responsibility of the contractor to protect his own equipment, and to keep it clean and free from damage. Painting shall not be a part of these specifications, but the contractor shall leave all equipment clean and free from grease and in a condition ready to be painted, except all other-wise unprotected ferrous material shall be painted for corrosion protection. The contractor shall exercise reasonable care in the protection of the equipment of other trades in congested areas. Clean and flush all lines of foreign matter before connection. Provide a clean set of filters at start of occupancy by Owner.
- B. Painting: Touch-up all damaged paint. Paint all otherwise unprotected ferrous surfaces in accor with painting section.

END OF SECTION 23 00 00

23 05 00 COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Equipment nameplate data requirements
2. Labeling and identifying mechanical systems and equipment.
3. Field-fabricated metal and wood equipment supports
4. Installation requirements common to equipment specification sections
5. Cutting and patching
6. Touch-up painting and finishing.

B. Related Sections:

1. Division 23 00 00- "Heating, Ventilating, and Air Conditioning (HVAC)"
2. Division 23 07 00- "HVAC Insulations"
3. Division 23 31 00- "HVAC Ducts and Casings"
4. Division 23 37 00- "Air Outlets and Inlets"
5. Division 23 72 00- "Air to Air Energy Recovery Ventilator"
6. Division 23 81 00- "Decentralize Unitary HVAC Equipment"

1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms
- 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 Installation: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

1.03 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract
- B. Product data for following piping specialties:
 1. Mechanical sleeve seals
 2. Identification materials and devices
- C. Samples of color, lettering style and other graphic representation required for each identification material and device

- D. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment
 - E. Coordination drawings for access panel and door locations
 - F. Prepare coordination drawings according to Division 1 Section "Submittals" to a 1/4 inch equals 1 foot scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:
 - 1. Proposed locations of piping, ductwork, equipment and materials. Include the following:
 - a. Planned duct systems layout, including elbows radii and duct accessories.
 - b. Clearances for installing and maintaining insulation
 - c. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance
 - d. Equipment service connections and support details
 - e. Exterior wall and floor penetrations
 - 2. Scheduling, sequencing, movement and positioning of large equipment into the building during construction
 - 3. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - 4. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers and other ceiling-mounted items.
 - G. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article of this Section
- 1.04 QUALITY ASSURANCE
- A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code- Steel"
 - B. ASME A13.1 for lettering size, length of color field, colors and viewing angles of identification devices.
 - C. Equipment Selection: Equipment of greater or larger power, 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. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.
- 1.05 DELIVERY, STORAGE AND HANDLING
- A. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor

- B. Protect flanges, fittings, and piping specialties from moisture and dirt
- C. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending

1.06 INSTRUCTIONS, BROCHURES AND AS-BUILT DRAWINGS

- A. Deliver to the Architect three sets of wiring diagrams, submittals, shop drawings, operating instructions and catalog sheets for replacement parts, mounted in flexible vinyl-covered loose leaf notebook. Each set shall be complete and bound separately.

1.07 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components
- B. Arrange for chases, slots and openings in building structure during progress of construction to allow for mechanical installations.
- C. Sequence, coordinate and integrate installations of mechanical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- D. 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.
- E. Coordinate installation of identifying devices after completion of covering and painting, where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8
 - 1. BCuP Series: Copper-phosphorus alloys
 - 2. Bag1: Silver Alloy
- B. Solvent Cements: Manufacturer's standard solvents complying with the following:
 - 1. Acrylonitrile-Butadiene-Styrene (ABS): ASTM D 2235.
 - 2. Chlorinated Poly (Vinyl Chloride) (CPVC): ASTM F 493
 - 3. Poly(Vinyl Chloride) (PVC): ASTM D 2564

2.02 IDENTIFYING DEVICES AND LABELS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 15 Sections. Where more than single type is specified or listed application, selection is Installer's option, but provide single selection for each product category.
- B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances and similar essential data
 - 2. Location: an accessible and visible location
- C. Stencils: Standard stencils, prepared for required applications with letter sizes conforming to recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inches-high letters for ductwork and not less than 3/4-inch-high letters for access door signs and similar operation instructions.
 - 1. Materials: Fiberboard
 - 2. Material: Brass
 - 3. Stencil Paint: Standard Exterior type stenciling enamel; black except as otherwise indicated; either brushing grade or pressurized spray-can form and grade
 - 4. Identification Paint: Standard identification enamel of colors indicated or if not otherwise indicated for piping systems, comply with ASME A13.1 for colors
- D. Plastic Duct Markers: Manufacture's standard laminated plastic, color coded duct markers. Conform to following color code:
 - 1. Green: Cold air
 - 2. Yellow: Hot Air
 - 3. Yellow/Green: Supply Air
 - 4. Blue: Exhaust, outside, return and mixed iar
 - 5. For hazardous exhausts, use colors and designs recommended by ASME A131.1
 - 6. Nomenclature: Include the following
 - a. Direction of air flow
 - b. Duct service (supply, return, exhaust, etc)
 - c. Duct origin (from)
 - d. Duct designation (to)
 - e. Design cfm
- E. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color melamine subcore, except when other colors are indicated).
 - 1. Fabricate in sizes required for message
 - 2. Engraved with engraver's standard letter style of sizes and with wording to match equipment identification
 - 3. Punch for mechanical fastening
 - 4. Thickness: 1/16 in, except as otherwise indicated

5. Thickness: 1/8 in except as otherwise indicated
 6. Thickness: 1/16 in for units up to 20 square inches or 8 inches long; 1/8 in for larger units
 7. Fasteners: self-tapping stainless steel screws or contact-type permanent adhesive
- F. Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:
1. Green: Cooling equipment and components
 2. Yellow: Heating equipment and components
 3. Yellow/green: combination cooling and heating equipment and components
 4. Brown: Energy reclamation equipment an components
 5. Blue: Equipment an components that do not meet any of above criteria.
 6. For hazardous equipment, use colors and designs recommended by ASME A13.1
 7. Nomenclature: Include following, matching terminology and schedules as closely as possible:
 - a. Name an plan number
 - b. Equipment service
 - c. Design capacity
 - d. Other design parameters such as pressure drop, entering and leaving conditions and rpm.
 8. Size: approximate 2 ½ by 4 in for control devices, dampers and valves; and 4 ½ by 6 in for equipment
- G. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.
1. Multiple Systems: where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as “Boilder No.3”, “Air Supply No. 1H,” or “Standpipe F12”

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION- COMMON REQUIREMENTS

- A. Install equipment to provide the maximum possible headroom, where mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
- D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- E. Install equipment giving right-of-way to piping systems installed at a required slope.

3.02 LABELING AND IDENTIFYING

- A. Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.
 - 1. Lettering Size: Minimum 1/4-inch-high lettering for name of unit where viewing distance is less than 2 feet, 1/2-inch-high or distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
 - 2. Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.
- B. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows, showing duct system service and direction of flow.
 - 1. Location: In each space where ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet.
- C. Adjusting: Relocate identifying devices which become visually blocked by work of this Division or other Divisions.

3.03 PAINTING AND FINISHING

- A. Refer to Division 9 Section "Painting" for field painting requirements.
- B. Damage and Touch-Up: Repair marred and damaged factory painted finishes with materials and procedures to match original factory finish.

3.04 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1 "Structural Welding Code - Steel."

3.05 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 the trades involved.
- B. Repair cut surfaces to match adjacent surfaces

END OF SECTION 23 05 00

23 07 00 HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.
- B. Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.
- C. Related Sections:
 - 1. Section 23 00 00- "Heating, Ventilating, and Air Conditioning (HVAC)"
 - 2. Section 23 05 00- "Common Work Results for HVAC"
 - 3. Section 23 31 00 "HVAC Ducts and Casings"

1.02 DESCRIPTION OF WORK

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation
 - a. Flexible Unicellular
 - 2. Ductwork System Insulation
 - a. Fiberglass
 - b. Flexible Unicellular

1.03 QUALITY ASSURANCE

- A. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E-84 (NFPA-255) method.
- B. Duct Coverings and Linings: Insulation shall not flame, flow, smolder, or smoke when tested in accordance with ASTM C411 at the temperature to which it is exposed in service or 250°F, whichever is higher.
- C. Foam Plastic: Insulation shall conform to 2603 of International Building Code.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERES

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - 1. Owens-Corning Fiberglass Corp.

2.02 PIPING INSULATION MATERIALS

- A. Flexible Unicellular Piping Insulation: ASTM C-534, Type I tubing, foamed vinyl nitrile, or foamed polyolefin HH-I-573B, UL 94 Flammability Class (below 180°F).
- B. Adhesives, Sealers and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.03 DUCTWORK INSULATION MATERIALS

- A. Flexible Fiberglass Ductwork Insulation: ASTM C553 and ASTM C 1290 (250°) 1lb. density, thermal conductivity $K=0.27$ at 75° (ASTM C-1290) 1 lb.
- B. Jackets for Fiberglass Ductwork Insulation: ASTM C1136 Reinforced foil-kraft vapor barrier facing, 0.05 perms (FSK Facing, → 0.02 ASTM E-9).
- C. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- D. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 HVAC PIPING SYSTEM INSULATION

- A. Cold Piping (40oF [4.4oC] to ambient) and Dual Temperature Piping (40oF to 250oF):
 - 1. Refrigerant suction lines.
 - 2. Flexible Unicellular: 0.393" thick for refrigerant lines

3.03 DUCTWORK SYSTEM INSULATION

- A. Application Requirements: Insulate the following ductwork:
 - 1. Outdoor air intake ductwork between air entrance and fan inlet.
 - 2. Outdoor air exhaust ductwork between fan outlet and air exit.
- B. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:
 - 1. Flexible Fiberglass: 1/2" to 1" thick on ductwork above the double glass façade and 1" thick on all other sections specified in 3.03 part A.

3.04 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- E. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded units except where specified form or type is indicated. Miter flexible unicellular insulation-DO NOT BEND.

- F. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except penetrations through fire rated construction and where otherwise indicated.

3.05 INSTALLATION OF DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation materials with smooth and even surfaces.
- C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage
- E. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated. Interrupt insulation at penetrations through fire rated walls or floors.
- F. Install UL Listed insulation systems in strict accordance with Listing.

3.06 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration

END OF SECTION 23 07 00

23 23 00 REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.
- B. Related Sections:
 - 1. Section 23 00 00 "Heating, Ventilating, and Air Conditioning (HVAC)"
 - 2. Section 23 05 00 "Common Work Results for HVAC"
 - 3. Section 23 07 00 "HVAC Insulation"
 - 4. Section 23 81 00 "Decentralized Unitary HVAC Equipment"

1.02 DESCRIPTION OF WORK

- A. Extent of refrigerant piping work is indicated on drawings and schedules, and by requirements of this section.
- B. Insulation of refrigerant piping is specified in other Division 15 sections, and is included as work of this section.

1.03 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. ANSI Compliance: Fabricate and install refrigerant piping in accordance with ANSI B31.5 "Refrigerant Piping", and extend applicable lower pressure limits to pressure below 15 psig.
 - 2. State/Local Code Compliance: Fabricate and install refrigerant piping in accordance with state and local codes.
 - 3. ASHRAE Compliance: Fabricate and install refrigerant piping in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for refrigerant piping specialties.
- B. Shop Drawings: Submit isometric drawings of refrigerant piping system including, but not necessarily limited to, pipe and tube sizes, elevations, slopes of horizontal runs, and refrigerant piping specialties.
- C. Maintenance Data: Submit maintenance data and parts lists for refrigerant piping materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual

PART 2 - PRODUCTS**2.01 MATERIALS AND PRODUCTS**

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 Code for Refrigerant Piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems. Where more than one type of material or products are indicated, selection is Installer's options.

2.02 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division 15 Basic Mechanical Materials and Methods section, "Mechanical Identification", in accordance with the following listing:
1. Refrigerant piping: Plastic pipe markers

2.03 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division 15 "Pipes and Pipe Fittings", in accordance with the following listing
1. Tube size 4-1/8" and Smaller: Copper tube, Type ACR, hard-drawn temper; wrought-copper, solder-joint fittings; brazed joints
 2. Brazed Joints: Braze joints using American Welding Society (AWS) classification BCuP-4 for brazing filler metal.
 3. Exterior Flexible Refrigerant Lines: Gates Corporation: PolarSeal Hose, 6AC134A – 3353-0903
 4. Female Braze-On Stems Steel (Descr. 6ACA-6FBO-S 7332-01905
 5. Shutoff Valve: JB Industries V34200-1A552 (1/4" ODF and 3/8" ODF)

2.04 BASIC PIPING SPECIALTIES

- A. General: Provide piping specialties complying with Division 23 "Pipes and Pipe Fittings" section, in accordance with the following listing
1. Pipe escutcheons
 2. Drip pans
 3. Sleeves
 4. Sleeve seals
 5. Condensate line
- B. Angled and Access Valves:
1. Angled Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300o F (149o C) temperature rating, 500 psi working pressure.
 2. Access Valves: Working pressure 500 psi with access port

3. Manufacturer: Subject to compliance with requirements, provide angle valves of one of the following:
 - a. Henry Valve Co
 - b. Parker Hannifin Corp.,; Refrigeration & Air Conditioning Div.
 - c. Sporlan Valve Co.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which refrigerant piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division 15 Basic Mechanical Materials and Methods section.

3.03 INSTALLATION OF REFRIGERANT PIPING

- A. General: Install refrigerant piping in accordance with Section 23 05 00 and in compliance with equipment manufacturer's recommendations.
- B. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.
- C. Bleed dry nitrogen through refrigerant piping during brazing operation.

3.04 INSTALLATION OF PIPING SPECIALTIES

- A. General: Install mechanical identification in accordance with Section 23 05 00.

3.05 INSTALLATION OF SUPPORTS AND ANCHORS

- A. Install supports and anchors in accordance with requirements of Section 23 05 00.

3.06 INSTALLATION OF SPECIAL REFRIGERANT VALVES

- A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing, replace after joints are completed.

3.07 EQUIPMENT CONNECTIONS

- A. General: Connect refrigerant piping to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.08 FIELD QUALITY CONTROLS

- A. Refrigerant Piping Leak Test: Prior to initial operation, clean and test refrigerant piping in accordance with ANSI B31.5, "Refrigeration Piping". Perform initial test with dry nitrogen, using soap solution to test all joints. Perform final test with 27" vacuum, and then 200 psi using halide torch. System must be entirely leak-proof.
- B. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

3.09 DEHYDRATION AND CHARGING SYSTEM

- A. Install core in filter dryer after leak test but before evacuation
- B. Evacuate refrigerant system with vacuum pump, until temperature of 35o F (2o C) is indicated on vacuum dehydration indicator, or pressure of 2.5 mm of mercury absolute is reached.
- C. During evacuation, apply heat to pockets, elbows, and low spots in piping.
- D. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
- E. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
- F. Complete charging of system, using new filter dryer core in charging line. Provide full operation charge.

END OF SECTION 23 23 00

23 31 00 HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Related Sections:
 - 1. Division 23 00 00- "Heating, Ventilation, and Air Conditioning"
 - 2. Division 23 05 00- "Common Work Results for HVAC"

1.02 DESCRIPTION OF WORK

- A. Extent of low pressure ductwork is indicated on drawings and in schedules, and by requirements of this section. Low pressure ductwork is hereby defined as ductwork subjected to velocities of 2500 fpm or less, and operating pressure of 2" w.g. or less, positive or negative.
- B. Types of low pressure ductwork required for project include the following:
 - 1. Heating and/or air conditioning supply and return air systems
 - 2. Fresh air supply systems
 - 3. Mechanical exhaust systems
 - 4. Kitchen exhaust systems
 - 5. Dampers
 - a. Low pressure manual dampers
 - b. Control dampers
 - c. Counterbalanced relief dampers
 - 6. Duct hardware
 - 7. Flexible Air Ducts
 - 8. Flexible connections
 - 9. Air Distribution Devices
 - 10. Louvers
 - a. Reference Section 08 91 00
 - 11. Power ventilators
 - a. Centrifugal Duct Fan
- C. Refer to Section 23 07 00 insulation sections for external insulation required in conjunction with low pressure ductwork; not work of this section.
- D. Refer to Division-26 sections for the following work; not work of this section.
 - 1. Power supply wiring
- E. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:

1. Control wiring between field-installed controls, indicating devices, and ventilators.

1.03 QUALITY ASSURANCE

- A. SMACNA Standards: Comply with SMACNA "HVAC Duct Construction Standards Metal and Flexible, 1985 ed." for fabrication and installation of low pressure ductwork.
- B. ASHRAE Standards: Comply with ASHRAE Handbook and Product Directory, 2004 Equipment Volume, Chapter 16, "Duct Construction", for fabrication and installation of low pressure ductwork.
- C. NFPA Compliance: Comply with ANSI/NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and ANSI/NFPA 90B "Standards for the Installation of Warm Air Heating and Air-Conditioning Systems".
- D. AMCA Compliance: Provide power ventilators which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Rating Seal.
- E. UL Compliance: Provide power ventilators which are listed by UL and have UL label affixed.
- F. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.
- G. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
- H. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets."
- I. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual."
- J. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
- K. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
- L. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
- M. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."
- N. UL Compliance: Provide flexible air ducts listed as UL 181 Class 0 or Class 1.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications on manufactured products and factory-fabricated ductwork, used for work of this section.

- B. Shop Drawings: Submit dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to space enclosure. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting.
- B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ANSI/ASTM A-527, lockforming quality, with ANSI/ASTM A-525, G90, zinc coating; mill phosphatized for exposed locations.

2.02 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Duct Sealant: Non-hardening, non-migrating mastic or liquid elastic sealant (type applicable for fabrication/ installation detail) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Hardcast Iron Grip IG-601, or equal.
- C. Duct Cement: Non-hardening migrating mastic or liquid neoprene based cement (type applicable to fabrication/ installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
- D. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - 1. Interior support materials of not less than $\frac{1}{4}$ in diameter or $\frac{3}{16}$ in thickness may be plain (not galvanized)

2.03 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards".
- B. Greenheck: Motorized Control Dampers: VCDR-53
- C. Control Dampers: Refer to Division-23 section "Control Systems: for control dampers; not work of this section.

2.04 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
 - 1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.

2.05 AIR DISTRIBUTION DEVICES

- A. General: Except as otherwise indicated, provide manufacturer's standard Air Distribution Devices where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide Air Distribution Devices that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria rating for each size device as listed in design manufacturer's current data.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

2.06 POWER VENTILATORS

- A. General: Except as otherwise indicated, provide standard prefabricated power ventilator units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.
- B. Centrifugal Ventilators: Fantech: FG12
 - 1. Provide thermal overload protection in the fan motor

2.07 LAUNDRY ACCESSORIES

- A. Hooded Wall Vent with Damper
 - 1. Manufacturer: FamCo
 - 2. Product: Round Wall Vent

3. Finish: Painted Black

B. Supply and Drain Fixture

1. Manufacturer: Symmons
2. Product: Laundry-Mate W-602X

2.08 FABRICATION

- A. Shop fabricate ductwork in 4, 8, 10, or 12 ft. lengths, unless otherwise indicated or required to complete runs. Pre-assemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.
- B. Shop fabricate ductwork of gages and reinforcement complying with SMACNA "Low Pressure Duct Standards".
- C. Shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Handbook and Product Directory, Equipment Volume, Chapter 1, "Duct Construction".
- D. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to associated duct width (throat and heel shall be radiused); and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30o for contracting tapers and 20o for expanding tapers.
- E. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible.

2.09 FACTORY-FABRICATED DUCTWORK

- A. General: At installer's option, provide factory-fabricated duct and fittings, in lieu of shop-fabricated duct and fittings.
- B. Material: Galvanized sheet steel complying with ANSI/ASTM A-527, lockforming quality, with ANSI/ASTM A-525, G90 zinc coating, mill phosphatized.
- C. Gauge: 28 ga. minimum for round and oval ducts and fittings, 4" through 12" diameter.
- D. Elbows: One piece construction for 90o and 45o elbows 14" to 12". Provide multiple gore construction for larger diameters with standing seam circumferential joint.
- E. Divided Flow Fittings: 90o tees, constructed with saddle tap spot welded and bonded to duct fitting body.
- F. Fabricated Ductwork: Ducts may be fabricated locally or factory-fabricated
- G. Available Manufacturers: Subject to compliance with requirements, manufacturers offering factory-fabricated ductwork which may be incorporated in the work include, but are not limited to, the following:

- H. Manufacturer: Subject to compliance with requirements, provide factory-fabricated ductwork of one of the following: United Sheet Metal Division, United McGill Corporation.
- I. Exposed Spiral Duct: Fabricate in accord with 1975 SMACNA Medium Pressure Duct Standards (20-60 ga.). Duct shall be architecturally treated and phosphatized and/or paint-grip treated for exposed application

PART 3 - EXECUTION

3.01 INSTALLATION OF DUCTWORK

- A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (5% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts and where indicated on drawings as required for air balancing.
- B. Seal ductwork, after installation, to seal class recommended, and method prescribed in SMACNA "Low Pressure Duct Standards - 5th Edition".
- C. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- D. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- E. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- F. Support ductwork in manner complying with SMACNA "Low Pressure Duct Standards" hangers and supports section.

3.02 CLEANING AND PROTECTION

- A. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

3.03 BALANCING

- A. Balance air flow rates within + 10% of those shown on the drawings

3.04 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA Standards, and in accordance with recognized industry practices to ensure that products serve intended function
- B. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.05 INSTALLATION OF AIR OUTLETS AND INLETS

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
- C. Locate Air Distribution Devices, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans".

3.06 INSTALLATION OF FLEXIBLE AIR DUCT

- A. Install flexible air ducts as final connections to air distribution devices in lengths not exceeding five feet at contractor's option.
- B. Install flexible air ducts in accord with UL listing and manufacturer's instructions.
- C. Flexible air ducts must be stretched tightly and adequately supported. Minimize bends. Ducts must have straight approach to air distribution devices

- D. Minimum connections to collars shall consist of three wraps of tape over liner and three wraps of tape over insulation jacket plus metal screw clamp or drawband over tape

3.07 FIELD QUALITY CONTROLS

- A. Testing: After installation of ventilators has been completed, test each ventilator to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

END OF SECTION 23 31 00

23 37 00 AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 23 00 00- "Heating, Ventilating, and Air Conditioning"
 - 2. Division 23 05 00- "Common Work Results for HVAC"
 - 3. Division 23 31 00 "HVAC Ducts and Casings"

1.02 DESCRIPTION OF WORK

- A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.
- B. Types of air outlets and inlets required for project include the following:
 - 1. Ceiling air diffusers and grilles
 - 2. Louvers
 - a. Reference Section 08 91 00
 - 3. Wall supply and return grilles
- C. Refer to other Division-23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.
- D. Refer to other Division-23 sections for balancing of air outlets and inlets; not work of this section.

1.03 CODES AND STANDARDS

- A. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
- B. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
- C. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
- D. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
- E. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutter".
- F. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

- G. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details
 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 OUTLETS AND INLETS

- A. Ceiling Air Diffusers
1. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
 2. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
 3. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for type of ceiling systems which will contain each type of ceiling air diffuser.

4. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. The following requirements shall apply to nomenclature indicated on schedule:
 - B. Ceiling Diffusers:
 1. Product: Price LV1 Linear Vane Diffuser
 2. Linear (LR): Extruded aluminum continuous slot, single or multiple
 3. Pattern: 1 Way (1-W): Fixed face fro 1 direction air flow, directions indicated on drawings
 4. Nominal Duct Width: 8 in
 5. Material: Aluminum
 6. Frame type: 1000
 7. Finish: Clear iodized, aluminum anodize (A-A)
 - C. Wall Mounted Supply Grill
 1. Product: Price Aeroblade Supply Grille (Model 21)
 2. Mounting: 1-1/4"
 3. Dimensions: See Air Distribution Equipment Schedule on Sheet M-601
 4. Single deflection, individually adjustable airfoil blades
 5. Blades parallel to long dimension
 6. Louver Spacing: 3/4"
 7. Material: Steel
 8. Finish: Paint, Black
 - D. Custom Wood Grille (Owner Provided)

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans".

END OF SECTION 23 37 00

23 72 00 AIR-TO-AIR ENERGY-RECOVERY EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Energy Recovery Ventilator

B. Related Sections:

1. Division 23 00 00 "Heating, Ventilating and Air Conditioning (HVAC)"
2. Division 23 05 00 "Common Work Results for HVAC"
3. Division 233100 "HVAC Ducts and Casings".
4. Division 233400 "HVAC Fans".
5. Division 233700 "Air Outlets and Inlets".

1.02 ACTION SUBMITTALS

- A. Manufacturer's Instructions.

1.03 QUALITY ASSURANCE

- A. The energy recovery ventilator shall be certified by the Home Ventilating Institute (HVI) under CSA 439. Both a heating and an air conditioning test must be run to demonstrate year round energy recovery.
- B. Products shall be licensed to use the AMCA-Certified Rating Seal.
- C. Power ventilators shall comply with UL 1812, Standard for Ducted Air to Air Heat Exchangers.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. The Unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use with specified maintenance, for a period of five years from the date of purchase.

1.04 WARRANTY

- A. Manufacturer's Standard Warranty.

PART 2 - PRODUCTS

2.01 ENERGY RECOVERY VENTILATORS

A. Product:

1. UltimateAir RecoupAerator 200DX, energy recovery ventilator.
 - a. Capable of transferring both sensible and latent energy between air streams with a minimum Apparent Sensible Effectiveness (ASE) of 93% and a Sensible Recovery Efficiency (SRE) of 81% in the Heating Season
 - b. Minimum Total Recovery Effectiveness (TRE) of 40% in the Cooling Season
 - c. Must be capable of suspending heat exchange while exhausting indoor air and bringing in cooling outside air at temperatures between 55-70 degrees F.
 - d. The unit shall accomplish energy recovery in both heating and coolings seasons and shall have the capacity to operate continuously

B. Housing: Removable, steel casing, square, one-piece.

C. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Polymer heat exchanger.
3. Multi-function timer.
4. MERV 12 filtration.
5. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

D. Capacities and Characteristics:

1. Airflow: 70-200 cfm
2. Static Pressure: <1" inches wg.
3. Volts: 120.
4. Phase: Single.
5. Hertz: 60
6. Frost Control: modulating pre-heater or water-to-air module to be used with outside temperatures are below 10 degrees F for extended periods of time

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation to be by a licensed HVAC technician and in accordance to the manufacturer's specifications.
- B. After installation is complete, test the operation of the RecoupAerator according to the instructions.

3.02 BALANCING AND DRAIN

- A. The unit shall be self-balancing when installed with ducting conforming to external static duct pressure limits across each fan as specified in the installation manual and shall not require a drain.

3.03 MOUNTING

- A. The unit shall be capable of being mounted either horizontally or vertically

3.04 MAINTENANCE

- A. Check pre-filters and energy transfer/filtration material every 6 months or when the check filter light comes on.
- B. Clean pre-filters every 3 to 4 months if continuously operated, or every 6 months otherwise.
- C. Replace energy transfer/filtration material when necessary.
- D. Check exterior weather caps regularly.
- E. Lightly vacuum or dust the cabinet interior yearly.

END OF SECTION 23 72 00

23 81 00 DECENTRALIZED UNITARY HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. System description

1. The variable capacity, heat pump air-conditioning system shall be a Daikin Inverter Driven series (heat/cool model) Quaternary system. The system shall consist of a wall mounted evaporator model FTXG12HVJU exclusively matched to outdoor model RXG12HVJU, direct expansion (DX), air-cooled, Daikin rotary swing variable speed driven compressor using R-410A refrigerant. The system shall include dehumidification control and "Flash Streamer" air purification technology. The outdoor unit is a horizontal discharge air variable speed condenser fan using a single-phase power supply. The system shall have a self-diagnostic function, 3-minute time delay mechanism and have a factory pre-charge of R-410A adequate for 33 feet of total length. The system shall have automatic restart capability after a power failure has occurred and a low voltage cut-off feature to prevent stalling during power supply issues.

B. Related Sections

1. Division 23 00 00 "Heating, Ventilating, and Air Conditioning (HVAC)"
2. Division 23 05 00 "Common Work Results for HVAC"
3. Division 23 23 00 "Refrigerant Piping"
4. Division 25 11 00 "Home and Automation and Control Systems"

1.02 ACTION SUBMITTALS

- A. Product Data: The units shall be listed by Electrical Laboratories (ETL), in accordance with UL-1995 certification and bear the cETL label. All wiring shall be in accordance with the National Electric Code (NEC). Each combination shall be rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210/240 and bear the ARI label. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function. The outdoor unit will be factory charged for a length of 33 feet of refrigerant with R-410A refrigerant. A holding charge of dry nitrogen shall be provided in the evaporator. System efficiency shall meet or exceed:

1. Model: Indoor FTXG, Outdoor RXG12HVJU
 - a. Seer: 22
 - b. EER: 14.0
 - c. HSPF: 10.55
 - d. COP: 4.04

1.03 INFORMATIONAL SUBMITTALS

- A. The system performance shall be in accordance with ARI 210/240 test conditions as shown in the performance table below.

1. Model: Indoor FTXG, Outdoor RXG12HVJU
 - a. Cooling Capacity: 5,300-15,700
 - b. Heating Capacity: 4,400-19,100
 - c. Cooling Power (watts): 260-1,300
 - d. Heating Power (watts): 220-2,2100
2. The cooling performance is based on 80°F DB / 67°F WB for the indoor unit and 95°F DB / 75°F WB for the outdoor unit and 25 feet of piping. The heating performance is based on 70°F DB / 60°F WB for the indoor unit and 47°F DB / 43°F WB for the outdoor unit and 25 feet of piping.
3. The system performance shall meet Energy Star CEE Tier 2 specifications.
4. The system cooling performance shall include dehumidification control between 45%-60% RH.
5. The operating range in cooling will be 14°F DB ~ 109°F DB. The system will stop functioning below -4°F DB.
6. The operating range in heating will be -4°F DB ~ 75°F DB.
7. The system shall be capable of maximum refrigerant piping of 33 feet, with 26 feet maximum vertical difference, without any oil traps or additional equipment.

1.04 WARRANTY

- A. The units shall have a manufacturer's warranty for parts other than the compressor for a period of five (5) years from date of installation. The units shall have a limited labor warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of seven (7) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of Daikin AC (Americas) Inc. according to Daikin's Terms and Conditions and Warranty Policy then in effect.

PART 2 - PRODUCTS

2.01 INDOOR UNIT GENERAL

- A. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
- B. Unit Cabinet: The indoor unit shall have a white, "flat screen" finish. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom). The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
- C. Fan: The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings. The fan blades shall include "saw edge" indentations to reduce operation sound and increase the airflow rate. An auto-swing louver for adjustable air flow (both vertically and horizontally) is standard via the wireless remote control furnished with each system. The indoor fan shall offer a choice of five speeds, plus quiet and auto settings.

- D. Filter: The filter function shall include “Flash Streamer” air purification technology. The return air filter provided will be a mildew proof, removable and washable filter.
- E. Coil: The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger. The coil shall include a “re-heater” heat exchanger for dehumidification control. All tube joints shall be brazed with silver alloy or phoscopper. All coils will be factory pressure tested. A condensate pan shall be provided under the coil with a drain connection.
- F. Electrical: The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60-hertz power from the outdoor unit. The allowable voltage range shall be 187 volts to 253 volts.
- G. Control: The unit shall have a wireless remote infrared controller capable to operate the system. It shall have Automatic Operation, Dry Operation, Dry Cooling Operation and Air Purifying Operation. The controller shall consist of an On/Off Power switch, Mode Selector, Fan Setting, Swing Louver, On/Off Timer Setting, Temperature Adjustment, °C or °F Temperature Display, Humidity Adjustment, Flash Streamer Air Purification, Comfort Airflow, Comfort Sleep, Cooling Breeze, Child Lock, Information and Powerful Operation.
1. On/Off switch power the system on or off mode.
 2. Mode selector shall operate the system in auto, cool, heat, fan or dry operation
 3. Fan setting shall provide five fan speeds.
 4. Swing louver shall adjust the airflow (horizontal and vertical) blades independently.
 5. On/Off timer is used for automatically switching the unit on or off.
 6. Temperature adjustment allows for the increase or decrease of the desired temperature.
 7. Humidity adjustment allows for the increase or decrease of the desired humidity setting between 45%-60% RH in 5% increments.
 8. Flash Streamer Air Purification shall decompose and remove viruses, allergens and odors with a high-speed electron discharge streamer unit.
 9. Comfort Airflow shall adjust the airflow direction and rate so that the air from the unit does not blow directly on the occupants of the room.
 10. Comfort Sleep operation in heating mode shall control the room temperature to support comfortable sleeping and a pleasant wake-up.
 11. Cooling Breeze shall oscillate the airflow in a 1Hz rhythm to ensure comfort even with a higher set-point temperature.
 12. Child Lock shall restrict the remote controller operations to avoid misuse by children.
 13. Information shall display the current room temperature and humidity and outdoor temperature.
 14. Powerful operation allows quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time period.
 - a. The remote control shall perform Fault Diagnostic functions, which may be system, related, indoor unit or outdoor unit related depending on the fault code.
 - b. Temperature range on the remote control shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode. Humidity range on the remote control shall be 45%-60% RH in 5% increments.
 - c. The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote control.

- H. Additional Control: The unit shall be equipped with additional KRP Board, Part# KRP413A1S to interface with Home Automation and Control System
- I. Sound: Indoor unit sound levels shall not exceed:
 - 1. Indoor Daikin Model: FTX12HVJU
 - a. Cooling Mode Sound Level: 43/35/27 dB
 - b. Heating Mode Sound Level: 43/36/29 dB

2.02 OUTDOOR UNIT, GENERAL

- A. The outdoor unit shall be specifically matched to the corresponding indoor unit size (e.g. FTXG15HVJU/RXG15HVJU). The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls.
- B. Unit Cabinet: The cabinet shall be ivory white with a finished powder coated backed enamel paint.
- C. Fan: The fan shall be a direct drive, propeller type fan. The motor shall be inverter drive, permanently lubricated type bearings, inherent. The fan shall be capable of operating in “silent operation” which lowers the outdoor fan speed in either cool, heat or auto modes. A fan guard is provided on the outdoor unit to prevent contact with fan operation. Airflow shall be horizontal discharge through a “twisted” grill for optimum airflow and lower operating sound.
- D. Coil: The outdoor coil shall be nonferrous construction with corrugated fin tube. Refrigerant flow from the condenser will be controlled via a metering device.
- E. Compressor: The compressor shall be a Daikin rotary swing inverter-driven compressor. The outdoor unit shall have an accumulator, four-way reversing valve. The compressor shall have an internal thermal overload. The outdoor unit can operate with a maximum vertical height difference of 26 feet and overall maximum length of 33 feet without any oil traps, liquid or suction line changes.
- F. Electrical: The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power. The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts. The outdoor shall be controlled by a microprocessor located in the outdoor and indoor units via commands from the infrared remote controller. Dedicated EEV’s shall be provided for capacity control during part load of the indoor unit.
- G. Sound: Outdoor unit sound levels shall not exceed:
 - 1. Outdoor Daikin Model: RXG12HVJU
 - a. Cooling Mode Sound Level: 49 dB
 - b. Heating Mode Sound Level: 48 dB

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. The system shall be installed by a Daikin factory trained contractor/dealer

END OF SECTION 23 81 00

Division 25 – Integrated Automation

25 11 00

HOME AUTOMATION AND CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. System Description

1. Ventilation Control: The home automation and control system shall control the ventilation of the home in four distinct modes through the use of relays and control dampers within the ductwork. The damper control for each mode is shown in the drawings.
 - a. Cooling Mode: Fresh air to the ERV will be brought in through the bottom of north façade cavity and stale air from the ERV will be exhausted through the bottom of the south façade cavity. ERV will run at 70 cfm 20 minutes every hour.
 - b. Heating Mode: Fresh air to the ERV will be brought in through the bottom of south façade cavity and stale air will be exhausted through the bottom of the north façade cavity. Temperature and humidity sensors within the exhaust airstream of the duct will detect when condensation is eminent on within north façade. This will trigger duct dampers to adjust such that air is exhausted out through the backup exhaust system [i.e. the system will switch to Cooking/Bathroom Ventilation Mode. ERV will run at low speed, 70 cfm, 20 minutes every hour.
 - c. Ventilation Mode: The ERV and ductless mini-splits will be turned off and all duct dampers except damper 5 will be closed. The in-line duct fan will provide whole house ventilation. Fan will run based on thermostat.
 - d. Cooking Mode: When the recirculation range hood is turned on, the ductless mini-split in the kitchen shall turn off and the ventilation system shall turn on in heating mode with backup-exhaust. ERV will run at high speed, 200 cfm, when range hood is on.

B. Section includes

1. Methods and procedures for start up, verification of operation
 - a. Start up, verification of operation
 - b. Safety
 - c. Terminology

C. Related Sections

1. Division 08 “Openings”
2. Division 11 “Equipment”
3. Division 12 “Furnishings”
4. Division 22 “Plumbing”
5. Division 23 “HVAC”
6. Division 26 “Electrical”
7. Division 48 “Electric Power Generation”

1.02 REQUIREMENTS

- A. The installer is to ensure that all related work is co-ordinated among all specification sections and divisions.

1.03 DEFINITIONS

- A. Acronyms, Abbreviations, and Definitions
- B. C-Bus: Clipsal Communication Bus
- C. CIS: Clipsal Integrated Systems
- D. HVAC: Heating, Ventilation, Air Conditioning
- E. PC: Personal Computer
- F. DLT: Digital Labeling Technology

PART 2 - QUALITY ASSURANCE

- A. Have factory trained personnel continuously supervise onsite work.
- B. Adhere to Living Light Safety Plan
- C. Ensure all C-Bus devices bear "C-bus enabled" logo

PART 3 - PRODUCTS

3.01 SYSTEM DESCRIPTION

- A. General
 - 1. Work covered by this section consists of the fully operational controls system, including but not limited to
 - a. Building controllers.
 - b. Data communication equipment.
 - c. Software/Hardware complete with full documentation.
 - d. Complete operating and maintenance manuals.
- B. Product List
 - 1. General
 - a. CAT5 cable
 - 1) Cable ties
 - b. Glass Insulated Connection Wire
 - 1) Manufacturer: Omega

- 2) Product Number: EXGG-2CU-20
- c. High efficiency switching power supply
 - 1) Manufacturer: Veris
 - 2) Product Number: PS24-7.5W and PS12-7.5W
- d. Homegate PC Interface License
 - 1) Manufacturer: Schneider Electric
 - 2) Product Number: SLC5000SDHG24
- e. Two Position Damper Actuator
 - 1) Manufacturer: Belimo
 - 2) Product Number: TF-120-S US and FSLF24-S-FC US
- f. Wiser Controller
 - 1) Manufacturer: Schneider Electric
 - 2) Product Number: WHC5918
- 2. Input
 - a. Ceiling Mounted Occupancy Sensor
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus SLSCPS1000
 - b. Power Pack for Occupancy Sensor
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus, SLSP1277
 - c. Infrared (IR) Receiver
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus, 8050/2LD
 - d. DLT button interface
 - 1) Manufacturer: Schneider
 - 2) Product: C-Bus SLC5085DL
 - e. 4 Channel General Input Unit
 - 1) Manufacturer: Schneider Electric
 - 2) Product Number: SLCE5504TGI
 - f. Pascal Automation Controller
 - 1) Manufacturer: Schneider Electric
 - 2) Product Number: SLC5500PACA
 - g. Saturn™ 2 button keypads
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus SLC5082NL2
- 3. Output
 - a. Infrared (IR) Emulator
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus 5034NIRT
 - b. 4 Channel 0-10VDC Analog Dimmer
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus SLCLE5504TAMP
 - c. 4 Channel , 20A, 120V Voltage free relay
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus SLC5504TRVF20
 - d. 12 Channel, 10A, 120V Voltage free relay

- 1) Manufacturer: Square-D
- 2) Product: C-bus L5512RVFP
- e. DMX Gateway
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus 5500DMX
- f. Phase Angle Dimmer Unit
 - 1) Manufacturer: Schneider
 - 2) Product: C-bus SLC5508TD2A
4. Data Acquisition
 - a. Current transformer - 100 AMP
 - 1) Manufacturer: Square-D
 - 2) Product Number: ECT075100SC
 - b. Current transformer – 50 AMP
 - 1) Manufacturer: Square-D
 - 2) Product: ECT075050SC
 - c. Thermister
 - 1) Manufacturer: Veris,
 - 2) Product Number: TEF00
 - d. RTD
 - 1) Manufacturer: Veris
 - 2) Product Number: TRAB0
 - e. RTD Transmitter
 - 1) Manufacturer: Veris
 - 2) Product Number: AA10F8
 - f. Heat Flux Transducer
 - 1) Manufacturer: Concept Engineering
 - 2) Product Number: F-00204
 - g. HD Deluxe Humidstat
 - 1) Manufacturer: Veris
 - 2) Product Number: HD5XMSTA1
 - h. C-Bus PIR Multi Sensor
 - 1) Manufacturer: Schneider Electric
 - 2) Product: PIR Multi Sensor
 - i. Power meter
 - 1) Manufacturer: Power Logic
 - 2) Product Number: E4833
5. Enclosure Cabinet
 - a. Manufacturer: Square D
 - b. Product: Clipsal 60M Enclosure
 - c. Product Number: SLC36C
 - d. Accessories:
 - 1) Mounting Pan with gray surface-mount cover
 - a) Product Number: SLC60MSG
 - 2) Two Duplex Power Receptacles
 - a) Product Number: SDM4AC
 - 3) Filler Plate, 4M

- a) Product Number: SLC4CSF8
 6. Design Requirements
 - a. Design wiring, conduit, and other links between elements of the system.
 - b. Supply Programmable controllers to fulfill all project requirements.
 - c. Reviewing controller location.
 - d. Provide utility and power to the control system.
 7. Language Requirements.
 - a. Provide an English interface.
 - b. Provide primary hardware to software interface with documentation to be in English
 - c. Provide System manager software in English for optimal operating efficiency.
 - d. Include (in English) all input and output commands, assigned limits, graphic displays, and report generation.
 - e. All controls system wiring will be at 50 volts or less
 8. Product Requirements
 - a. System to use Clipsal C-bus communication protocol
 - b. Components to be installed in NEMA panels
 - c. Wiring in panels to be run within PVC wall wire ducting
 - d. Wiring to be terminated in appropriately labeled terminal blocks
 9. Installation
 - a. Manufacturer's Recommendations
 - b. All installations carried out according to supplied manufacturer's data.
- C. Computer Built By Owner
1. Video Card: ASUS ENGT240/DI/1GD3/A GeForce GT 240 1GB 128-bit DDR3 PCI Express 2.0 x16 HDCP Ready Video Card
 2. CPU: AMD Phenom II X2 545 Callisto 3.0GHz 2 x 512KB L2 Cache 6MB L3 Cache Socket AM3 80W Dual-Core Processor HDX545WFK2DGI - OEM
 3. Mother Board: MSI 890FXA-GD70 Socket AM3 AMD 890FX ATX Motherboard, Supports AMD Phenom II CPUs, Dual DDR3 2133 OC, SATA III RAID, CrossFire Ready, IEEE 1394
 4. Hard Drive: Western Digital Caviar Black WD7501AALS 750GB 7200 RPM 32MB Cache SATA 3.0Gb/s 3.5" Hard Drive -Bare Drive
 5. RAM: Kingston HyperX Blu 4GB (2 x 2GB) 240-Pin DDR3 SDRAM DDR3 1333 Desktop Memory Model KHX1333C9D3B1K2/4G
 6. Power Supply: RAIDMAX HYBRID 2 RX-630SS 630W ATX12V V2.2/ EPS12V SLI Ready CrossFire Ready Modular Modular LED Power Supply
 7. Case: Rosewill Blackbone Black Steel / Plastic ATX Mid Tower Computer Case
 8. Monitor: IN1920 47 cm Widescreen HD Monitor
 9. Mouse and Keyboard: V7 CK0M1-6N6 Black USB Wired Standard Multimedia Keyboard/Mouse Combo - OEM
 10. Wireless Network Adapter: TRENDnet TEW-623PI IEEE 802.11b/g, IEEE 802.11n (draft) 32-Bit PCI Rev. 2.1/2.2/2.3 Wireless N-Draft Adapter Up to 300Mbps Wireless Data Rates 64/128-bit WEP (Hex & ASCII), WPA/WPA2, WPA-PSK/WPA2-PSK
 11. CD Drive: Sony Optiarc Black 24X DVD+R 8X DVD+RW 12X DVD+R DL 24X DVD-R 6X DVD-RW 12X DVD-RAM 16X DVD-ROM 48X CD-R 32X CD-RW 48X CD-ROM 2MB Cache SATA CD/DVD Burner - OEM

12. Extra Ethernet Adapter: Rosewill RC-411 10/ 100/ 1000Mbps PCI-Express Network Adapter 1 x RJ45

PART 4 - EXECUTION

4.01 INSTALLATION

- A. Provide equipment to verify correct installation of components. Provide multimeters, two-way radios.
- B. The instrumentation accuracy for the testing equipment should be more accurate than the equipment being tested.
- C. Locations to be readily acceptable and approved.
- D. Debug system software if necessary.
- E. Install all required network components
- F. Demonstrate full functionality of control system.

END OF SECTION 25 11 00

Division 26 - Electrical

26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application
- B. Comply with 2008 NFPA 70, State of Tennessee Electrical Code, and all local codes.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. Floor Boxes: sheet metal, rectangular

2.02 CONDUCTOR AND CABLES

- A. Conductors:
 - 1. Conductors, No. 8 AWG and Smaller: Solid copper
 - 2. Conductors, No. 6 AWG and larger: Stranded copper
 - 3. Insulation: Thermoplastic, rated at 75 deg C minimum
 - 4. Wire Connectors and Splices: Units of size, ampacity rating, material, type and class suitable for service indicated.
 - 5. Products: Furnish products listed as classified by Underwriters' Laboratories Inc or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
- B. Cable Type NM-B Cable: Comply with UL 719 with Type THHN/THWN conductors complying with UL- 83
- C. Cable Type SEU: Comply with UL 854 with Type THHN/THWN conductors complying with UL 83 or Type XHHW-2 conductors complying with UL 44
- D. Cable Type UF-B: Comply with UL 493 with Type THHN/THWN conductors complying with UL 83.

2.03 GROUNDING MATERIALS

- A. Conductors: Solid for No. 8 AWG and smaller, and stranded for No. 6 AWG and larger unless otherwise indicated.
 - 1. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction
 - 2. Bare, Solid-Copper Conductors: Comply with ASTM B 3

3. Bare, Stranded-Copper Conductors: Comply with ASTM B 8

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts with clamp-type pipe connectors sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 ELECTRICAL IDENTIFICATION MATERIALS

- A. Conductor Identification Materials: Color-Coding Conductor Tape: Self-adhesive vinyl tape 1/2 to 2 inches wide.
- B. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with circuit identification legend machine printed by thermal transfer or equivalent process
- C. Self-adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized steel backing; and with colors, legend and size required for application
- E. Equipment Identification Labels: Engraved, laminated acrylic or melamine label; punched or drilled for screw mounting. White letters on a dark-gray background; red letters for emergency systems
- F. Fasteners: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers

2.05 SUPPORT AND ANCHORAGE COMPONENTS

- A. Raceway and Cable Supports: As described in NECA 1
- B. Conduit and Cable Devices: Steel and malleable iron hangers, clamps and fittings
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded malleable iron body and insulating wedging
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates shapes and bars; black and galvanized
- E. Mounting, Anchoring and Attachment Components:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete.
 - 2. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element

3. Through Bolts: Structural type, hex head, high strength; complying with ASTM A 325.
4. Toggle Bolts: All-steel springhead type
5. Hanger Rods: Threaded steel

2.06 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends
- B. Cast-Iron Pipe Sleeves: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated
- C. Sleeves for Rectangular Openings: Galvanized-steel sheet
- D. Sleeve Seals: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable
 1. Pressure Plates: Carbon steel. Include two for each sealing elements
 2. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL EQUIPMENT INSTALLATION REQUIREMENTS

- A. Install electrical equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated
- B. Install electrical equipment to provide for ease of disconnecting the equipment with minimum interference to other installations
- C. Install electrical equipment to allow right of way for piping and conduit installed at required slope.
- D. Install electrical equipment to ensure that connecting cable and wireways are clear of obstructions and of the working and access space of other equipment.
- E. Install sleeve and sleeve seals of type and number required for sealing electrical service penetrations of exterior walls.
- F. Comply with NECA 1.

3.02 RACWAYS AND CABLE INSTALLATION

- A. Conceal cables, unless otherwise indicated, within finished walls, ceilings and floors
- B. Install cables at least 6 inches away from parallel runs of water pipes. Locate horizontal raceway runs above water piping.

- C. Connect motors and equipment subject to vibration, noise transmission, or movement with a 72-inch maximum length of flexible conduit.

3.03 WIRING METHODS

- A. Service Entrance: Type SE or USE-2 multiconductor cable
- B. Exposed Feeders, Branch Circuits, and Class 1 Control Circuits, Including in Crawlspace: Nonmetallic-sheathed cable, Type NM or NMC
- C. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspace: Nonmetallic-sheathed cable, Type NM or NMC
- D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire mesh, and strain relief device at terminations to suit application
- E. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

3.04 GROUNDING

- A. Grounding Conductors: Install bare copper conductor, #4 AWG minimum.
- B. Pipe and Equipment Grounding Conductor Terminations: Bolted
- C. Connections to Structural Steel: 2 hole compression lug. All structural steel shall be grounded.
- D. Install grounding conductors routed along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact or damage.
- E. Install ground rods driven into ground according to ground rod manufacturer's instructions.
- F. Make Connections without exposing steel or damaging coating.
- G. Install bonding straps and jumpers in locations accessible for inspection and maintenance, except where routed through short lengths of conduit
- H. Bond straps directly to basic structure, take care not to penetrate any adjacent parts
- I. Test completed grounding system at each location where a maximum ground-resistance level is specified at service disconnect enclosure grounding terminal.
 - 1. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance
 - 2. Perform tests by fall-of-potential method according to IEEE 81
 - 3. Report measured ground resistances that exceed the following values:

- a. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms
 - b. Power Distribution Units or panelboards Serving Electronic Equipment: 5 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance

3.05 IDENTIFICATION

- A. Power-Circuit Conductor Identification: For No. 8 AWG conductors and larger, at each location where observable, identify phase using color-coding conductor tape
- B. Warning Labels for Enclosures for Power and Lighting: Comply with 29 CFR 1910.145; identify system voltage with black letters on an orange background. Apply to exterior of door cover, or other access
- C. Equipment Identification Labels
 1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label with clear protective overlay. Provide a single line of text with ½ inch high letters on 1 ½ inch high label; where two lines of text are required, use labels 2 inches high
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment
 - c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.
 2. Equipment to be Labeled
 - a. Panelboards, electrical cabinets, and enclosures
 - b. Motor-control centers
 - c. Disconnect switches
 - d. Enclosed circuit breakers
 - e. Motor starters
 - f. Power transfer equipment
 - g. Contactors
- D. Verify identity of each item before installing identification products
- E. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment
- F. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate
- G. Install system identification color banding for raceways and cables at 50 foot maximum intervals in straight runs, and at 25 foot maximum intervals in congested areas
- H. Color Coding for Phase Identification, 600 V and Less: Underground service, feeder and branch-circuit conductors
 1. Colors for 240/120-V Circuits
 - a. Phase A: Black

- b. Phase B: Red
- c. Neutral: White
- 2. Field Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points

3.06 INSTALLATION OF HANGERS AND SUPPORTS

- A. Fasten hangers and supports securely in place, with provisions for thermal and structural movement. Install with concealed fasteners unless otherwise indicated
- B. Separate dissimilar metals and metal products from contact with wood or cementitious materials, by painting each metal surface in area of contact with a bituminous coating or by other permanent separation
- C. Multiple Cables: Install on trapeze-type supports fabricated with steel slotted channel
- D. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used from strength determination shall be weight of supported components plus 200 lb
- E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated or required by Code:
 - 1. To wood: fasten with lag screws or through bolts
 - 2. To steel: beam clamps (MSS Type 19, 21, 23, 25, Or 27) complying with MSS SP-69 or Spring-tension clamps
 - 3. To light steel: sheet metal screws
 - 4. Items mounted on hollow walls and nonstructural building surfaces: mount on slotted channel racks attached to substrate

3.07 SLEEVE AND SLEEVE-SEALS INSTALLATION

- A. Cut sleeves to length for mounting flush with both wall surfaces
- B. Extend sleeves installed in floors 2 inches above finished floor level
- C. Size pipe sleeves to provide $\frac{1}{4}$ inch annular clear space between sleeve and cable unless sleeve seal is to be installed
- D. Interior Penetrations of Non-Fire Rated Wall and Floors: Seal annular space between sleeve and cable using joint sealant appropriate for size, depth and location of joint according to Division 07 Section "Joint Penetration"
- E. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work

- F. Aboveground Exterior Floor Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals

END OF SECTION 26 05 00

26 05 19 LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Wire and cable for 600 volts and less
- B. Wiring connectors and connections

1.02 RELATED SECTIONS

- A. Division 26 05 00 "Common Work Results for Electrical"
- B. Division 26 05 33 "Raceway and Boxes for Electrical Systems"
- C. Division 26 24 16 "Panelboards"
- D. Division 26 27 13 "Electricity Metering"
- E. Division 26 27 26 "Wiring Devices"

1.03 REFERENCES

- A. NECA 1- Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006
- B. NETA STD ATS- Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- C. NFPA 70- National Electrical Code; National Fire Protection Association; 2008.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of 2008 NFPA 70.
- B. Products: Furnish products listed as classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS**2.01 WIRING REQUIREMENTS**

- A. Dry Locations: Use only building wire with Type THHN insulation
- B. Wet or Damp Interior Locations: Use only building wire with Type THHN-2/THWN-2 or XHHW-2 insulation in raceway.
- C. Exterior Locations: Use only building wire with Type THHN/THWN or XHW insulation in raceway
- D. Use stranded conductor for feeders and branch circuits 8 AWG and smaller
- E. Use conductor not smaller than 12 WG for power and lighting circuits.
- F. Use conductor not smaller than 16 WG for control circuits
- G. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
- H. Shall have designated ground conductor. Ground path via armor jacket shall not be acceptable.

2.02 BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor: Copper
- C. Insulation Voltage Rating: 600 volts
- D. Insulation: NFPA 70, Type THHN
- E. Insulation Color: Conductor sizes 8 AWG and smaller shall have solid color insulation as required for phasing. Conductors sizes 6 AWG and larger may be black in color.

2.03 METAL CLAD CABLE

- A. Description: NFPA 70, Type MC
- B. Conductor: Copper
- C. Insulation Voltage Rating: 600 volts
- D. Insulation Temperature Rating: 60 degrees C
- E. Insulation Material: Thermoplastic

- F. Armor Material: Thermoplastic
- G. Armor Design: Interlock metal type

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather
- B. Verify that mechanical work likely to damage wire and cable has been completed
- C. Verify that raceway installation is completed and supported

3.02 INSTALLATION

- A. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA
- B. Routine wire and cable as required to meet project conditions
 1. Wire and cable routing indicated is approximate unless dimensioned
 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
- C. Use wiring methods indicated
- D. Pull all conductors into raceway at same time
- E. Use suitable wire pulling lubricant as required.
- F. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure. Do not support cables from ceiling suspension system or rest cable on ceiling panels.
- G. Use suitable cable fittings and connectors
- H. Neatly train and lace wiring inside boxes, equipment and panelboards
- I. Clean conductor surfaces before installing lugs and connectors
- J. Make splices, taps and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- K. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- L. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

- M. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller
- N. Identify and color code wire and cable under provisions of Section 26 05 00. Identify each conductor with its circuit number or other designation indicated.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA STD ATS, except Section 4.
- B. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2.

END OF SECTION 26 05 19

26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 26 05 00 "Common Work Results for Electrical"
 - 2. Division 26 05 19 "Low-Voltage Electrical Conducts and Cables"
 - 3. Division 26 24 16 "Panel Boards"
 - 4. Division 26 27 13 "Electrical Metering"

1.02 DESCRIPTION

- A. This section specifies general grounding requirements of electrical equipment operations and to provide a low impedance path for possible ground fault currents.

PART 2 - PRODUCTS

2.01 GROUNDING ELECTRODES

- A. Ground Rod
 - 1. 5/8 in diameter by 8 feet long zinc-coated steel rod
- B. Quantity: One (1) ground electrodes
- C. Electrode plates shall be bonded to each other with an uninsulated 4 AWG minimum stranded bare copper conductor attached to the grounding plate rod with a listed connector device (clamp) or via exothermic weld. Bonding conductors should be in contact with the ground and placed in order to avoid trip hazards

PART 3 - EXECUTION

3.01 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings and as hereinafter specified.
 - 1. Reference Section 26 05 00 "Common Work Results for Electrical"
- B. System Grounding:
 - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means.

- C. Equipment Grounding: Metallic structures including (ductwork, and building steel), enclosures raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be grounded.

3.02 WIREWAY GROUNDING

- A. Ground and bond Metallic Wireway Systems as follows
 1. Bond the metallic structures of wireway to provide 100 percent electrical continuity throughout the wireway system by connecting a 16 mm, 6 AWG, bonding jumper at all intermediate metallic enclosures and across all section junctions.
 2. Install insulated 16 mm, 6 AWG, bonding jumpers between the wireway system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 16 meters (50 feet).
 3. Use insulated 16 mm, 6 AWG, bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.
 4. Use insulated 16 mm, 6 AWG, bonding jumpers to ground cable tray to column mounted building ground plates at each end and approximately every 15 meters (50 feet).

3.03 INSTALLATION

- A. Reference drawings for location.
- B. Drive each rod vertically in the earth.

END OF SECTION 26 05 26

26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL

- A. Furnish outlet boxes for lighting fixtures, wall receptacles, switches, and other boxes as required. Also, pull boxes and junction boxes shall be furnished as required.

1.02 RELATED WORK

- A. General provisions of the contract general and supplementary conditions, and Division 01 specification sections, general requirements, apply to this section.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Ceiling boxes: Ceiling outlet boxes shall be 4-inch octagon and 2-1/8" deep. Provide extension rings where additional volume is required. All ceiling outlet boxes shall have fixture stud of no bolt, self-locking type installed if required to hang fixture specified at that outlet.
- B. Wall boxes: Light wall switch boxes shall be a minimum size of 4" high by 2-1/8" wide by 2-1/8" deep. Where more than one gang occurs, 4" square boxes or additional larger boxes shall be used with device ring attached.
- C. Manufactures: Boxes and fittings shall be Appleton, Steel City, Raco, Efcor, Crouse-Hinds, or equal.
- D. Pull and junction boxes shall be galvanized or sherardized sheet metal or code thickness with lapped and welded joints and with 3/4" flange. They shall be rigidly supported on ceiling or wall conduit runs entering a box shall not be considered as adequate support.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install pull and/or junction boxes in conduit lines wherever necessary to avoid excessive length of runs or number of bends in run. No run shall exceed 100 feet without a pull box.
- B. Pull and junction boxes shall be accessible and sized in accordance with provisions or Article No 370-18 of 2008 National Electrical Code.
- C. Pull and junction boxes shall be installed so that cover shall be accessible at all times.

END OF SECTION 26 05 33

26 24 16 PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 26 05 00 "Common Work Results for Electrical"
 - 2. Division 26 05 19 "Low-Voltage Electrical Conductors and Cables"
 - 3. Division 26 27 26 "Electricity Metering"
 - 4. Division 26 28 13 "Fuses"
 - 5. Division 26 28 16 "Enclosed Switches and Circuit Breakers"

1.02 SECTION REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in 2008 NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush and surface mounted cabinets, NEMA 250, Type 1.
 - 1. Front: Secured to box with concealed trim clamps
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- B. Phase, Neutral, and Ground Buses: Tin plated aluminum.
- C. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin plated aluminum.
 - 2. Phase and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus Configured Terminators: Mechanical Type.
- D. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- E. Panelboard Short-Circuit Current Rating: Rated for series connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series connected short-circuit rating by an NRTL.
- F. Circuit Breakers: Reference section 26 28 16.

- G. Fuses: Reference section 26 28 13.

2.02 DISTRIBUTION PANELBOARD

- A. Product: Square D Load Center
 1. Single phase load center
 2. Indoor main breaker, 150 amp trip
 3. Bus Rating: 225 amp, 120/240 VAC
 4. Max Branch circuits: 42
 5. Provide with ground bar
 6. Provide with branch breakers as indicated on drawings.

2.03 DISCONNECT COMBINER

- A. Product: Solar BOS Disconnect Combiner CS55-06-05-N 3
 1. Voltage: 600 VDC Rated
 2. Disconnect Switch: 55A
 3. Number of Circuits: 6
 4. Fuse Ampacity: 15
 5. Enclosure: NEMA 3R Steel

2.04 SOLAR LOAD CENTER

- A. Product: Square D
 1. Single Phase Load Center
 2. Main Lugs Only
 3. Rating: 150A; 120/240 VAC
 4. Enclosure Box: NEMA 1
 5. Two 30A Double Pole Breakers
 6. Max Branch Circuits: 8

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Stub four empty $\frac{3}{4}$ inch conduits from panelboard into accessible or designated ceiling space; stub four empty conduits into space below floor, as well as others as indicated on drawings.
- C. Arrange conductors into groups, bundle and wrap with wire ties.

- D. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer to create directory. Directory shall be installed under plastic.

END OF SECTION 26 24 16

PART 1 - GENERAL**1.01 SUMMARY**

- A. Related Sections:
 - 1. Division 26 05 00 "Common Work Results for Electrical."
 - 2. Division 26 05 19 "Low-Voltage Electrical Conductors and Cables."

1.02 SECTIONS REQUIREMENTS

- A. Submittals: Product Data and Shop Drawings.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended locations and application.
- C. Coordinate NREC for services and components they furnish.

PART 2 - PRODUCTS**2.01 EQUIPMENT FOR ELECTRICITY METERING BY COMPETITION ORGANIZERS**

- A. Meters will be furnished by NREL.
- B. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.
- C. Meter Sockets: Steady-state and short circuit current ratings shall meet indicated circuit ratings.
 - 1. Square D. URTRS213 B METER SOCKET
 - a. Ringed
 - b. 200 amp
 - c. Enclosure: NEMA 3R

2.02 EQUIPMENT FOR ELECTRICITY METERING BY HOMEOWNER

- A. Meter Socket:
 - 1. Square D: URTRS213 B Meter Socket
 - a. Ringed
 - b. 200 amp
 - c. Enclosure: NEMA 3R

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Comply with equipment installation requirements in NECA 1.
- B. Install equipment for NREL metering. Install raceways and equipment according to NREL's written requirements. Provide empty conduits for metering leads and extend grounded connections as required by NREL.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.

END OF SECTION 26 27 13

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 DEVICES

- A. Duplex GFCI Convenience Receptacles: 125 V, 20 A, straight blade, feed-through type. NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Wall-Box Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
 - 1. Control: button with single-pole or three-way switching to suit connections. Comply with UL 1472.
- C. Wall Plates, Finished Areas: Smooth, high-impact thermoplastic or Satin-finish stainless steel fastened with metal screws having heads matching plate color
- D. Wall Plates, Unfinished Areas: Smooth, high-impact thermoplastic with metal screws.
- E. Wall Plates, Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet locations.
- F. Floor Service Fittings:
 - 1. Floor Mounted Convenience Receptacles: NEMA WD 1, NEMA WD 6, Configuration 5-20R, and UL 498.
 - 2. Manufacturer: Hubbell
 - 3. Product: RACO Floor Box Kit ((6239NI)
 - 4. Nickel Plated Concealed Receptacle
- G. Exterior Receptacles:
 - 1. Weather-resistant , in compliance with NEC 406.8(8)(1)
 - 2. Housing Finish: To be selected by Architect
- H. Finishes: To be selected by Architect

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Install devices and assemblies plumb, level, and square with building lines.
- C. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- D. Install unshared neutral conductors on line and load side of dimmers.
- E. Mount devices flush, with long dimension vertical, and grounding terminal of receptacles on top unless otherwise indicated. Group adjacent devices under single, multigang wall plates.

END OF SECTION 26 27 26

26 27 29 ELECTRIC VEHICLE CHARGING STATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Electric vehicle (EV) charging stations

1.02 Related Sections

- A. Division 06 15 33 "Wood Patio Decking"
- B. Division 06 20 13 "Exterior Finish Carpentry"
- C. Division 12 93 00 "Site Furnishings"
- D. Division 26 05 00 "Common Work Results for Electrical"
- E. Division 26 05 19 "Low-Voltage Electrical Conductors and Cables"
- F. Division 26 27 26 "Panelboards"

1.03 Standards and Certifications

- A. SAE J1772 compliant
- B. NEC article 625 electric vehicle charging system
- C. UL and ULc to 2594

1.04 Scope of Work

- A. Install all materials, equipment, and service for a complete, fully operational electric vehicle (EV) charging station.
- B. Connect to electrical system provided under Division 26 as indicated on the drawings.

PART 2 - PRODUCTS

2.01 ELECTRIC VEHICLE CHARGING STATION BY OWNER

A. Blink Level 2 Wall Mount Charger

1. Input Voltage: 208 VAC to 240 VAC +/- 10%
2. Input Phase: Single
3. Frequency: 50/60 Hz
4. Input Current: 30 Amps (maximum); 12A, 16A, 24A available
5. Breaker Size: 40 Amps; settings at 15A/20A/30A available
6. Output Voltage: 208 VAC - 240 VAC +/- 10%
7. Output Phase: Single
8. Pilot: SAE J1772-compliant
9. Connector/Cable: SAE J1772-compliant; UL-rated at 30A maximum
10. Cable Length: 18 feet
11. Exterior Dimensions:
 - a. Wall Mount: 18" W x 22" H x 5-9/16" D
 - b. Cord Mount: 18" Diameter
12. Temperature Rating: -22o F (-30o C) to +122o F (+50o C)
13. Enclosure: NEMA Type 3R; sun-and-heat-resistant
14. Mounting: Wall-mount
15. User Interface:
 - a. Touch screen display
 - b. Charge status indicator
 - c. Charge statistics and history
 - d. Start/stop timing to allow coordination with electric utility on/off peak time of use rates

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/Engineer, 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 INSTALLATION

- A. Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings. System installation shall be coordinated with related and adjacent work. Define each circuit breaker.

3.03 DEMONSTRATION

- A. If required by the manufacturer for advanced installations, provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.
1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
 3. Review data in operation and maintenance manuals with the Owner's personnel.
 4. Schedule training with the Owner, through the Architect, with at least seven day's advanced notice.

3.04 PROTECTION

- A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the electric vehicle charging stations shall be without damage at time of Substantial Completion.

END OF SECTION 26 27 29

26 28 13 FUSES

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Division 26 05 00 "Common Work Results for Electrical"
 - 2. Division 26 24 16 "Panelboards"

1.02 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.

PART 2 - PRODUCTS

2.01 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.02 SPARE FUSE CABINET

- A. Cabinet: Gray, backed enamel finish, wall mounted, steel unit with full length, recessed piano-hinged door and key coded cam lock and pull.
 - 1. Size: Adequate for storage of space fuses specified with 15 percent spare capacity minimum.

PART 3 - EXECUTION

3.01 FUSE APPLICATIONS

- A. DC Disconnect Combiner: Class RK1, fast acting 600 VDC Rating.

3.02 INSTALLATION

- A. Install fuses so rating information is readable without removing fuse.

- B. Install labels indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.
- C. Install spare-fuse cabinet(s).

END OF SECTION 26 28 13

26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Related Sections
 - 1. Division 26 24 16 "Panel Boards"

1.02 SECTION REQUIREMENTS

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

PART 2 - PRODUCTS

2.01 MOLDED-CASE CIRCUIT BREAKERS

- A. Description: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Square D Home line Circuit Breakers: Single and two-pole configurations with 10,000 Amperes RMS-UL listed interrupting rating.
 - 2. GFCI Circuit Breakers: Square D Home line Ground Fault Circuit Interrupter. Single and two-pole configurations with 6-mA trip sensitivity
 - 3. AFCI Circuit Breakers: Square D Home line Arc-D-tect Arc Fault Circuit Interrupter. Single pole configurations with arc fault protection in accordance with UL 1699.
- B. Features and Accessories
 - 1. Lugs: suitable for number, size, trip ratings, and conductor material.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - 3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with ground-fault indicator; relay with adjustable pickup and time-delay settings, and push-to-test feature.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

2.02 ENCLOSURES

- A. NEMA AB 1, NEMA KS 1, NEMA 250 AND UL 50, to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with NECA 1.

3.02 FIELD QUALITY CONTROL

- A. Perform the following fielded tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 26 28 16

26 31 00 PHOTOVOLTAIC COLLECTOR

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Photovoltaic Collectors

1.02 RELATED SECTIONS

- A. Division 05 14 13 "Architecturally-Exposed Structural Aluminum Framing."
- B. Division 07 72 00 "Roof Accessories."
- C. Division 26 05 19 "Low-Voltage Electrical Conductors and Cables."
- D. Division 26 24 16 "Panelboards."
- E. Division 48 19 16 "Electrical Power Generation Inverters."

1.03 References

- A. 2008 National Electrical Code (NEC) – NEC Article 690.

1.04 SCOPE OF WORK

- A. Furnish and install all materials, equipment and service for a complete, fully operational photovoltaic system; ratings as specified herein.
- B. All routing of conduits, fasteners and supports, connections and all work associated with mounting array to racking system on roof shall be included.
- C. Connect to electrical system provided under Division 26 as indicated on the drawings.

1.05 COORDINATION

- A. Coordinate flashing equipment or mounting system to roof with roofing contractor including all roof penetrations and associated weatherproofing and sealing.

PART 2 - PRODUCTS

2.01 PHOTOVOLTAIC PANELS BY OWNER

A. Solyndra: 100 Series

1. 182 Watt Solar Panel.
2. The Solar Photovoltaic (SPV) panels shall be provided in an array, as indicated on the architectural drawings.
3. Module efficiency shall not be less than 15.7 percent. Cell efficiency shall not be less than 18.8 percent. Output power tolerance shall be +10% / -0% to assure the maximum rated output.
4. Reference drawings and section 05 14 13 for racking system.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The photovoltaic system shall be designed and installed by a factory certified installer of proposed system
- B. The complete Solar Photovoltaic System shall be provided in strict accordance with NEC article 690. Installation requirements related to this may be summarized, but not limited to the following:
 1. All DC and AC circuits shall be installed in conduit. PV source circuits and PV output circuits should not be contained in the same raceway.
 2. The roof mounted photovoltaic arrays shall be provided with DC ground-fault protection
 3. Circuit sizing, overcurrent protection and disconnecting means shall be sized for the specific application and equipment provided for this system.
 4. The connection to a module or panels on the roof mounted array shall be arranged to facilitate the removal of a module without interrupting the grounding system or disrupting connection of the remaining modules or panel to the inverters.

3.02 EXAMINATION

- A. Upon completion and before acceptance, system performance shall be demonstrated in the presence of the architect that all specified functions are accomplished and that the complete solar photovoltaic system meets the contract performance criteria. Provide seven calendar days minimum notice to architect prior to demonstration so that all interested parties may attend.
- B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; submit report indicating results to the architect.

END OF SECTION 263100

26 33 13 BATTERIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Batteries for Zoom Room Bed Battery Back Up
 - 2. Batteries for Zoom Room Bed Remote Control
 - 3. Batteries for Television Remote Control
 - 4. Batteries for Stereo Remote Control
 - 5. Batteries for Ductless Mini Split Unit Remote Control
 - 6. Batteries for Computer
 - 7. Batteries for Smoke Detector Battery Back Up

- B. Related Sections:
 - 1. Division 11 28 13 "Computers"
 - 2. Division 11 52 00 "Audio-Visual Equipment"
 - 3. Division 12 38 00 "Residential Furniture"
 - 4. Division 23 81 00 "Decentralized Unitary HVAC Equipment"

PART 2 - PRODUCTS

2.01 BATTERIES FOR ZOOM ROOM BED BATTERY and SMOKE DETECTOR BACK UP

- A. Product: Energizer 522
 - 1. Classification: Alkaline
 - 2. Chemical System: zinc-magnesium dioxide (no added mercury or cadmium)
 - 3. Designation: ANSI-1604A, IEC-6LR61
 - 4. Nominal Voltage: 9 Volts

2.02 BATTERIES FOR ZOOM ROOM BED REMOTE CONTROL

- A. Product: Energizer A23
 - 1. Classification: Miniature Alkaline
 - 2. Chemical System: Manganese Dioxide
 - 3. Designation: ANSI-1181A
 - 4. Nominal Voltage: 9 volts

2.03 BATTERIES FOR TELEVISION, STEREO AND DUCTLESS MINI SPLIT UNIT REMOTE CONTROLS

- A. Product: Energizer NHIZ-850
 - 1. Classification: Rechargeable

2. Chemical System: Nickel-Metal Hydride
3. Designation: ANSI- 1.2H1
4. Nominal Voltage: 1.2 volts

2.04 BATTERIES FOR COMPUTER

Product: Dell Distributed 29 watt-hour 4 cell rechargeable battery

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install batteries in equipment according to manufacturer's instructions

END OF SECTION 26 33 13

26 50 00 LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Requirements:

1. Submittals: Product Data for each luminaire, including lamps.
2. Fixtures, Electrical Components, Devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with IEEC C2, "National Electrical Safety Code."
4. Coordinate ceiling-mounted luminaires with ceiling construction, mechanical work and security and fire-prevention features mounted in ceiling space and on ceiling.

B. Related Sections:

1. Division 08 80 00 "Glazing"
2. Division 09 54 00 "Specialty Ceiling"
3. Division 09 62 00 "Sheet Metal Flashing and Trim"
4. Division 21 13 00 "Fire-Suppression Sprinkler Systems"
5. Division 25 11 00 "Home Automation and Control Systems"
6. Division 26 05 00 "Common Work Results for Electrical"
7. Division 26 05 19 "Low-Voltage Electrical Conductors and Cables"
8. Division 26 05 33 "Raceways and Boxes for Electrical Systems"
9. Division 26 27 26 "Panelboards"

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Exterior Luminaires: Comply with UL 1598 and listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- D. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- E. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2.02 INDOOR FIXTURES

- A. Floor Color Change LED for Troughs:

1. Pixel Range Pixie Brink RGB
 2. Length: 4'
 3. Voltage: 36VDC
 4. Communication Protocol: DMX512
- B. Ceiling Fixture for Troughs:
1. Tubular Fluorescent
 2. Manufacturer: HE Williams
 3. Product: SM76-4-132-120V
 4. Stepped Dimming Ballast, 0/10/40/100%
 5. Ballast Type: Electronic T8, Side Mounted
 6. No. Lamps: 1
 7. Length: 4'
 8. Baffle:
 - a. Parasquare 1 – Small Cell Low Glare Parabolic Louver
 - b. Manufacturer: SLP
 - c. Thickness: .4"
 - d. Blade Spacing: .625"
 - e. Width: 9 ½"
 - f. Finish: Glossy Black
- C. Typical Can Light
1. 4" Miniature Downlight
 2. Product: Nora Lighting NS-401QT
 3. Mounting: Recessed ceiling
 4. Trim: NS-42G
 5. Lamp:
 - a. Pixel Range PixPar 20
 - b. Dimmable
- D. Linear Fixture (Mechanical Room)
1. 4' Linear Tubular Fluorescent
 2. Product: LaMar Lighting WN Series
 3. Model Number: WN-132-E8-U
- E. Illuminated Canopy
1. Manufacturer: Nora Lighting
 2. Product: NUTP2 Series High Output LED Tape Light
 3. Length: 12 inch; size for canopy installation.
 4. NATL-5100 LED Driver
- F. Bathroom Can Light Fixture
1. 4" LED IC/Airtight New Construction Housing with Lens
 2. Product: Nora Lighting
 3. Mounting: Recessed ceiling with platinum diffused reflector and flange
 4. Housing: NHIC-5 LED AT

5. UL Wet Location Listed

2.03 EXTERIOR FIXTURES

- A. LED Paver
 1. Product: Meteor Lighting
 2. Model: SH130C
 3. Voltage: 3.3V max
 4. Dimensions: 1.81" x 4.01"
 5. Exterior Finish: Polished Stainless Steel

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Set units level, plumb, and square with ceiling, walls, and floors and secure.
- B. Adequate support for all Fixtures. Conduit shall not be used for support.
- C. Adjust aimable lighting fixtures to provide required light intensities.

END OF SECTION 26 50 00

Division 28 – Electronic Safety and Security

28 31 46

SMOKE DETECTION SENSOR

PART 1 - GENERAL**1.01 SUMMARY****A. Related Sections:**

1. Division 26 05 19 “Low-Voltage Electrical Conductors and Cables.”

1.02 SECTION REQUIREMENTS**A. System Description: Non-coded, conventional, hardwired, zoned 24-V dc loop system.**

1. Initiating Device Circuits: NFPA 72, Class B, Style B.
2. Notification Appliance Circuits: NFPA 72, Class B, Style Y

B. Submittals: Product Data and system operating description.**C. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals, make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations.****D. Comply with NFPA 72****E. UL listed and labeled.****F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.****PART 2 - PRODUCTS****2.01 ALARM-INITIATING DEVICES****A. Smoke Detector: First Alert**

1. Model: SC120B
2. UL 1971, 120 V ac, self-restoring, hard-wired electric type.
3. Finished: White
4. 9V battery backup

2.02 WIRE AND CABLE**A. General: UL listed and labeled as complying with NFPA 70, Article 760.**

- B. Signal Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
- C. Non-Power-Limited Circuits: Solid copper conductors with 600 V rated, 75 degree C, color-coded insulation.
 - 1. Low Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install and test systems according to NFPA 72, Comply with NECA 1.
- B. Wiring method: Install wiring "fished" in concealed spaces and exposed on ceilings and walls where indicated.

END OF SECTION 28 31 46

Division 48 - Electrical Power Generation

48 19 16

ELECTRICAL POWER GENERATION INVERTERS

PART 1 - GENERAL**1.01 SUMMARY****A. Section Includes**

1. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

B. Related Sections

1. Division 26 05 00 "Common Work Results for Electrical"
2. Division 26 05 19 "Low-Voltage Electrical Conductors and Cables"
3. Division 26 31 00 "Photovoltaic Collector"

PART 2 - PRODUCTS**2.01 DC-AC INVERTER****A. Products**

1. Xantrex grid-tie, solar inverter GT5.0
 - a. Network number of phases: single phase
 - b. Nominal output power: 5kW AC-240V
 - c. Output current: 21 A-208V; 22A-240V
2. Xantrex XW- communications gateway
 - a. Communication network type: Ethernet, Wi-Fi
 - b. Communication port protocol: Xanbus
 - c. Port Ethernet: 10/100 B56-T
3. Xantrex- system control panel GT Monitor
 - a. Display type: Backlit LCD Screen
 - b. Data back up: Built-in Flash memory
 - c. Communication port protocol: Xanbus

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Wall-mounted Inverters: Securely anchor wall-mounting bracket to manufacturer's specifications before attaching inverter. Verify all clearances for adequate ventilation.
- B. Before testing any inverters ensure that all wires are properly connected and adequate circuit protection has been taken in accordance with NEC 690.

END OF SECTION 48 19 16



Generated by REScheck-Web Software
Compliance Certificate

Project Title: University of Tennessee Solar Decathlon House

Energy Code: **2009 IECC**
 Location: **Davidson County, Tennessee**
 Construction Type: **Single Family**
 Building Orientation: **Bldg. faces 180 deg. from North**
 Glazing Area Percentage: **71%**
 Heating Degree Days: **3999**
 Climate Zone: **4**

Construction Site:

Owner/Agent:

Designer/Contractor:

Compliance: Passes using UA trade-off

Compliance: **33.3% Better Than Code** Maximum UA: **417** Your UA: **278**

The % Better or Worse Than Code index reflects how close to compliance the house is based on code trade-off rules.
 It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Glazing or Door U-Factor	UA
Ceiling: Flat or Scissor Truss	740	38.0	2.5		21
Wall: Steel Frame, 16in. o.c. Orientation: Front	506	30.0	0.0		7
Window: Metal, Thermal Break, 3 Pane w/ Low-E SHGC: 0.41 Orientation: Front	433			0.179	78
Wall: Steel Frame, 16in. o.c. Orientation: Back	506	30.0	0.0		7
Window: Metal, Thermal Break, 3 Pane w/ Low-E SHGC: 0.41 Orientation: Back	433			0.179	78
Wall: Steel Frame, 16in. o.c. Orientation: Right Side	150	30.0	0.0		11
Door: Glass SHGC: 0.41 Orientation: Right Side	34			0.333	11
Wall: Steel Frame, 16in. o.c. Orientation: Left Side	150	30.0	0.0		11
Door: Glass SHGC: 0.41 Orientation: Left Side	34			0.333	11
Floor: Steel Frame, 16in. o.c., 2x6, Over Outside Air	740	38.0	0.0		43

Compliance Statement: The proposed building design described here is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the 2009 IECC requirements in REScheck-Web and to comply with the mandatory requirements listed in the REScheck Inspection Checklist.

 Name - Title

 Signature

 Date



Generated by REScheck-Web Software
Inspection Checklist

Ceilings:

- Ceiling: Flat or Scissor Truss, R-38.0 cavity + R-2.5 continuous insulation

Comments: _____

Above-Grade Walls:

- Wall: Steel Frame, 16in. o.c., R-30.0 cavity insulation

Comments: _____

- Wall: Steel Frame, 16in. o.c., R-30.0 cavity insulation

Comments: _____

- Wall: Steel Frame, 16in. o.c., R-30.0 cavity insulation

Comments: _____

- Wall: Steel Frame, 16in. o.c., R-30.0 cavity insulation

Comments: _____

Windows:

- Window: Metal, Thermal Break, 3 Pane w/ Low-E, U-factor: 0.179

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Metal, Thermal Break, 3 Pane w/ Low-E, U-factor: 0.179

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

Doors:

- Door: Glass, U-factor: 0.333

Comments: _____

- Door: Glass, U-factor: 0.333

Comments: _____

Floors:

- Floor: Steel Frame, 16in. o.c., 2x6, Over Outside Air, R-38.0 cavity insulation

Comments: _____

Floor insulation is installed in permanent contact with the underside of the subfloor decking.

Air Leakage:

- Joints (including rim joist junctions), attic access openings, penetrations, and all other such openings in the building envelope that are sources of air leakage are sealed with caulk, gasketed, weatherstripped or otherwise sealed with an air barrier material, suitable film or solid material.
- Air barrier and sealing exists on common walls between dwelling units, on exterior walls behind tubs/showers, and in openings between window/door jambs and framing.
- Recessed lights in the building thermal envelope are 1) type IC rated and ASTM E283 labeled and 2) sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.
- Access doors separating conditioned from unconditioned space are weather-stripped and insulated (without insulation compression or damage) to at least the level of insulation on the surrounding surfaces. Where loose fill insulation exists, a baffle or retainer is installed to maintain insulation application.
- Wood-burning fireplaces have gasketed doors and outdoor combustion air.

Air Sealing and Insulation:

- Building envelope air tightness and insulation installation complies by either 1) a post rough-in blower door test result of less than 7 ACH at 33.5 psf OR 2) the following items have been satisfied:
 - (a) Air barriers and thermal barrier: Installed on outside of air-permeable insulation and breaks or joints in the air barrier are filled or repaired.
 - (b) Ceiling/attic: Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed.
 - (c) Above-grade walls: Insulation is installed in substantial contact and continuous alignment with the building envelope air barrier.
 - (d) Floors: Air barrier is installed at any exposed edge of insulation.
 - (e) Plumbing and wiring: Insulation is placed between outside and pipes. Batt insulation is cut to fit around wiring and plumbing, or sprayed/blown insulation extends behind piping and wiring.
 - (f) Corners, headers, narrow framing cavities, and rim joists are insulated.
 - (g) Shower/tub on exterior wall: Insulation exists between showers/tubs and exterior wall.

Sunrooms:

- Sunrooms that are thermally isolated from the building envelope have a maximum fenestration U-factor of 0.50 and the maximum skylight U-factor of 0.75. New windows and doors separating the sunroom from conditioned space meet the building thermal envelope requirements.

Materials Identification and Installation:

- Materials and equipment are installed in accordance with the manufacturer's installation instructions.
- Insulation is installed in substantial contact with the surface being insulated and in a manner that achieves the rated R-value.
- Materials and equipment are identified so that compliance can be determined.
- Manufacturer manuals for all installed heating and cooling equipment and service water heating equipment have been provided.
- Insulation R-values and glazing U-factors are clearly marked on the building plans or specifications.

Duct Insulation:

- Supply ducts in attics are insulated to a minimum of R-8. All other ducts in unconditioned spaces or outside the building envelope are insulated to at least R-6.

Duct Construction and Testing:

- Building framing cavities are not used as supply ducts.
- All joints and seams of air ducts, air handlers, filter boxes, and building cavities used as return ducts are substantially airtight by means of tapes, mastics, liquid sealants, gasketing or other approved closure systems. Tapes, mastics, and fasteners are rated UL 181A or UL 181B and are labeled according to the duct construction. Metal duct connections with equipment and/or fittings are mechanically fastened. Crimp joints for round metal ducts have a contact lap of at least 1 1/2 inches and are fastened with a minimum of three equally spaced sheet-metal screws.

Exceptions:

Joint and seams covered with spray polyurethane foam.

Where a partially inaccessible duct connection exists, mechanical fasteners can be equally spaced on the exposed portion of the joint so as to prevent a hinge effect.

Continuously welded and locking-type longitudinal joints and seams on ducts operating at less than 2 in. w.g. (500 Pa).

- Duct tightness test has been performed and meets one of the following test criteria:
 - (1) Postconstruction leakage to outdoors test: Less than or equal to 59.2 cfm (8 cfm per 100 ft2 of conditioned floor area).
 - (2) Postconstruction total leakage test (including air handler enclosure): Less than or equal to 88.8 cfm (12 cfm per 100 ft2 of conditioned floor area) pressure differential of 0.1 inches w.g.
 - (3) Rough-in total leakage test with air handler installed: Less than or equal to 44.4 cfm (6 cfm per 100 ft2 of conditioned floor area) when tested at a pressure differential of 0.1 inches w.g.
 - (4) Rough-in total leakage test without air handler installed: Less than or equal to 29.6 cfm (4 cfm per 100 ft2 of conditioned floor area).

Heating and Cooling Equipment Sizing:

- Additional requirements for equipment sizing are included by an inspection for compliance with the International Residential Code.
- For systems serving multiple dwelling units documentation has been submitted demonstrating compliance with 2009 IECC Commercial Building Mechanical and/or Service Water Heating (Sections 503 and 504).

Circulating Service Hot Water Systems:

- Circulating service hot water pipes are insulated to R-2.
- Circulating service hot water systems include an automatic or accessible manual switch to turn off the circulating pump when the system is not in use.

Heating and Cooling Piping Insulation:

- HVAC piping conveying fluids above 105 degrees F or chilled fluids below 55 degrees F are insulated to R-3.

Swimming Pools:

- Heated swimming pools have an on/off heater switch.
- Pool heaters operating on natural gas or LPG have an electronic pilot light.
- Timer switches on pool heaters and pumps are present.

Exceptions:

Where public health standards require continuous pump operation.

Where pumps operate within solar- and/or waste-heat-recovery systems.

- Heated swimming pools have a cover on or at the water surface. For pools heated over 90 degrees F (32 degrees C) the cover has a minimum insulation value of R-12.

Exceptions:

Covers are not required when 60% of the heating energy is from site-recovered energy or solar energy source.

Lighting Requirements:

- A minimum of 50 percent of the lamps in permanently installed lighting fixtures can be categorized as one of the following:
 - (a) Compact fluorescent
 - (b) T-8 or smaller diameter linear fluorescent
 - (c) 40 lumens per watt for lamp wattage ≤ 15
 - (d) 50 lumens per watt for lamp wattage > 15 and ≤ 40
 - (e) 60 lumens per watt for lamp wattage > 40

Other Requirements:

- Snow- and ice-melting systems with energy supplied from the service to a building shall include automatic controls capable of shutting off the system when a) the pavement temperature is above 50 degrees F, b) no precipitation is falling, and c) the outdoor temperature is above 40 degrees F (a manual shutoff control is also permitted to satisfy requirement 'c').

Certificate:

- A permanent certificate is provided on or in the electrical distribution panel listing the predominant insulation R-values; window U-factors; type and efficiency of space-conditioning and water heating equipment. The certificate does not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels.

NOTES TO FIELD: (Building Department Use Only)



2009 IECC Energy Efficiency Certificate

Insulation Rating	R-Value
-------------------	---------

Ceiling / Roof	40.50
Wall	30.00
Floor / Foundation	38.00
Ductwork (unconditioned spaces):	_____

Glass & Door Rating	U-Factor	SHGC
---------------------	----------	------

Window	0.18	0.41
Door	0.33	0.41

Heating & Cooling Equipment	Efficiency
-----------------------------	------------

Heating System: _____	_____
Cooling System: _____	_____
Water Heater: _____	_____

Name: _____ Date: _____

Comments:

TYPE MC-COPPER CONDUCTOR-ALUMINUM ARMOR/THHN/THWN-2 INNERS

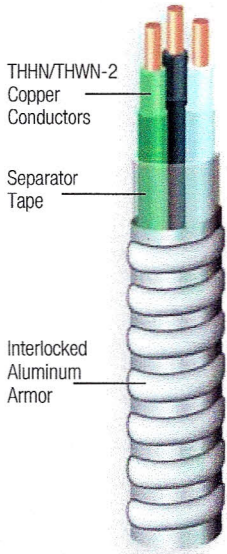
ENGINEERING SPECIFICATIONS:

Standards:

Underwriters Laboratories Standards UL-83, UL-1063, UL-1569 for type MC, Federal Specification A-A59544, IEEE 1202 (70,000 Btu/hr) Vertical Cable Tray Flame Test, and the National Electrical Code (NEC).



Listed E-301130



Applications:

- Permitted use for services, feeders, and branch circuits in industrial, commercial, and multi-residential buildings
- Acceptable for power, lighting, control, and signal circuits and utilized for indoor or outdoor applications
- Capable of concrete or cinder filled installation and allowable in concealed or exposed systems
- Permitted use in dry locations and embedded in plaster finish on brick or other masonry except in damp or wet locations
- Utilized for environmental air-handling spaces (NEC 300.22)
- Allowable in assembly occupancies (NEC 518.4)
- Permissible in theaters, audience areas of motion pictures, television studios, and similar locations (NEC 520.5)
- Allowable installations in approved raceways and cable trays (NEC 392)
- Suitable for installation under raised floors for IT equipment (NEC 645.5)
- Permitted in Class I Div. 2, Class II Div.2, and Class III Div. 1 Hazardous Locations and listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.

CONSTRUCTION:

Available in sizes 14 AWG through 2 AWG, Encore's Metal Clad Cable is constructed with soft-drawn copper, Type THHN/THWN-2 conductors rated 90°C dry/75°C wet locations. Sizes 14 AWG through 1 AWG contain a green, insulated grounding conductor. Larger sizes are supplied with a bare ground conductor. All conductors are cabled together with separator tape, containing the identification print legend, to form the cable core. Interlocked aluminum armor is applied over the entire assembly.

Type MC-Copper Conductor-Aluminum Armor/THHN/THWN-2 Inners

Conductors			Overall Diameter (inches)	Approximate Net Weight (lbs./1000 ft.)	Allowable Ampacity (amps)*		Standard Packaging	
AWG/No.	Type	Ground			90°C	Coil (ft.)	Reel (ft.)	
14/2	Solid	14	0.409	80	15	250'	1000'	
14/3	Solid	14	0.435	97	15	250'	1000'	
14/4	Solid	14	0.464	115	15	250'	1000'	
12/2	Solid	12	0.444	106	20	250'	1000'	
12/3	Solid	12	0.475	132	20	250'	1000'	
12/4	Solid	12	0.509	158	20	250'	1000'	
10/2	Solid	10	0.510	153	30	250'	1000'	
10/3	Solid	10	0.549	193	30	250'	1000'	
10/4	Solid	10	0.592	233	30	250'	1000'	
12/2	Stranded	12	0.462	110	20	250'	1000'	
12/3	Stranded	12	0.494	136	20	250'	1000'	
12/4	Stranded	12	0.530	162	20	250'	1000'	
10/2	Stranded	10	0.533	158	30	250'	1000'	
10/3	Stranded	10	0.574	199	30	250'	1000'	
10/4	Stranded	10	0.619	241	30	250'	1000'	
8/2	Stranded	10	0.649	215	55	200'	500'/1000'	
8/3	Stranded	10	0.705	280	55	200'	500'/1000'	
8/4	Stranded	10	0.783	347	55	200'	500'/1000'	
6/2	Stranded	8	0.727	307	75	125'	500'/1000'	
6/3	Stranded	8	0.820	408	75	125'	500'/1000'	
6/4	Stranded	8	0.901	547	75	100'	500'/1000'	
4/3	Stranded	8	0.935	584	95	100'	500'	
4/4	Stranded	8	1.029	739	95	100'	500'	
3/3	Stranded	6	1.018	727	110	100'	500'	
3/4	Stranded	6	1.131	919	110	100'	500'	
2/3	Stranded	6	1.071	862	130	100'	500'	
2/4	Stranded	6	1.195	1100	130	100'	500'	

Note: Ampacities are based on Table 310.16 of the NEC. *Ampacities shown are for general use as specified by the NEC, Section 310.15.

For equipment marked for use at higher temperatures, the conductor ampacity shall be limited to the following per NEC 110.14(C):

60°C when terminated to equipment for circuits rated 100 amperes or less or marked for size 14 AWG through 1 AWG conductor.

75°C when terminated to equipment for circuits rated over 100 amperes or marked for conductors larger than 1 AWG.

90°C for ampacity derating purposes.

When the neutral is considered current-carrying conductor, the ampacity of 4/C cables shall be reduced by a factor of 0.80 per NEC 310.15(B)(2)(a).

Additional conductor sizes are available up to 4/0 AWG. Grounding conductors 8 AWG and larger are stranded.

The above data is approximate and subject to normal manufacturing tolerances.

Standard Conductor Color Coding

Features:

Installation costs reduced by up to 50% over conduit and wire.

Weight of aluminum armor is as much as 45% less than steel.

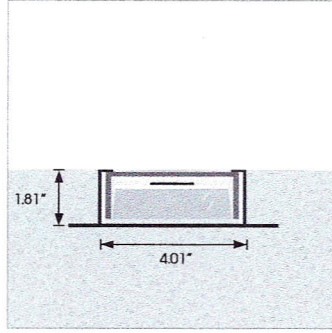
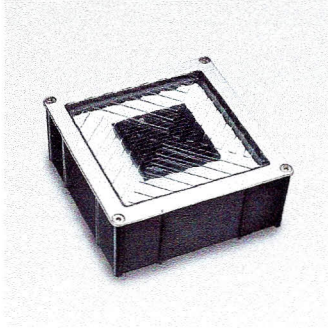
For ease of installation and pulling, cable is reverse wound on reels. Coils are designed to be pulled from the inside.

Number	120/208Y
2	Black/White
3	Black /Red/White
4	Black /Red/Blue/White
Ground	Green

Additional colors available subject to ERQ

Number	277/480Y
2	Brown/Gray
2	Orange/Gray
2	Yellow/Gray
2	Purple/Gray
3	Brown/Yellow/Gray
3	Brown/Orange/Gray
4	Brown/Orange/Yellow/Gray
4	Brown/Yellow/Purple/Gray
Ground	Green





Type :
Project :
Quantity:
Note :

General

Size	Edge length : 4.01" Height : 1.81"
Weight	0.968 lbs
Finish	Brushed / polished stainless steel
Lens	GE super light permeable PC
Housing	SUS304 stainless steel, cast aluminum
Power Storage	Ultracapacitor
Protection Class	IP68

Operational

Switch	Lighting sensitive auto on/off
Operation Time	Minimum 12 hrs (fully charged) 4~8 hrs (overcast)
Full Charge Time	6hrs (direct sunlight)

Environmental

Compressive Strength	9902 lbs / 4456 kgs (minimum)
Operating Temperature	-4F~140F / -20C~60C
Storage Temperature	-13F~176F / -25C~80C
Moisture Protection	IP68

Color	LUX (Average)
White	30
Amber	25
Red	70
Blue	20
Green	60

Ordering Information

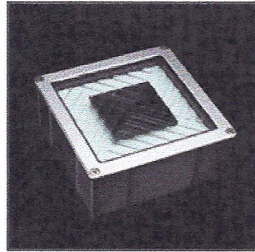
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Model#	LED Color	Finish	Housing
SH-130C (product)	A - Amber	B - Brushed Stainless Steel	H - Housing and Anchor Plate Included
SH-130B (battery sample)	B - Blue	P - Polished Stainless Steel	- - Without Housing and Anchor Plate
	G - Green		
	R - Red		
	W - White		



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What's new

home | products | SH-130C



SH-130C - 4"x4" paver light

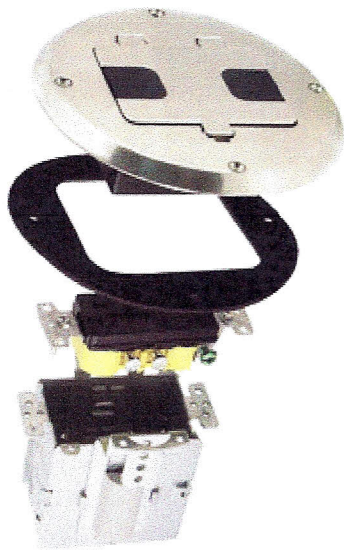
Size	Edge length:4.01" Height: 1.81"
Weight	0.968 lbs
Finish	Brushed / polished stainless steel
Lens	GE super light permeable PC
Housing	SUS304 stainless steel, cast aluminum
Power Storage	Ultracapacitor
Protection class	IP68

- [Specification sheet](#)
- [CAD drawings](#)
- [Photometric file](#)
- [Installation guide](#)

Paver Light Series	Dimension	LED	Lux(avg)	White	Amber	Red	Blue	Green
SH-110	4"x4"	2 pcs		70	65	40	20	75
SH-130C	4"x4"	4 pcs		30	25	70	20	60
SH-140	4"x4"	4 pcs		68	50	25	20	65
SH-170C	6"x6"	8 pcs		35	25	65	25	50
SH-180C	4"x8"	15 pcs		55	40	80	35	90

Lowes

Function Type	Duplex	Contractor Pack	No
NEMA Configuration	5-15	UL Safety Listing	Yes
Material	Plastic	CSA Safety Listing	Yes
Wiring	Side	ETL Safety Listing	No
Miswired Indicator Light	No	Color/Finish Family	Nickel
Package Quantity	1.0	Grade	Residential
RF Compatible	No	Style	Decorator
Watertight	Yes	Configuration	Straight Blade
Wall Plate Included	No	Amps (Amps)	15.0
Tamper Resistant	Yes	Receptacle Voltage	125
Weather Resistant	No	Wiring Type	3-wire grounding
Color/Finish	Nickel Plated		





More saving. More doing.®

Welcome Connie, (Sign Out) Nashville, TN is your

Share Email Print

Quantity: 1

Not Sold Online

Halex 3/8 in. Flexible Duplex Connectors (2-Pack)

Model # 21580 Store SKU # 577337

★★★★★ Be the first to [Write a Review](#)

\$2.36 /BG-Bag



[Zoom View](#)

[CHECK STORE AVAILABILITY](#) Details

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SHOPPERS WHO VIEWED THIS ITEM ALSO VIEWED



3.6 cu. ft. IEC Capacity Top Load Washer in White: ...
\$358.20/Each



Palm Canyon Collection 7-Piece Dining Set
\$674.10/Set



6.5 cu. ft. Super Capacity Electric Dryer in White...
\$349.00/Each

Description

The Halex 3/8 in. Flexible Duplex Connectors (2-Pack) are designed to connect and bond 2 pieces of flexible metal conduit, AC, MC or NM cable to a steel outlet box or other metal enclosure when only 1 knockout is in use. These connectors include Tri-drive headed, zinc-plated steel screws.

- Connects and bonds 2 pieces of conduit
- Made of corrosion-resistant die-cast zinc alloy
- Fits in a standard 1/2 in. knockout
- For indoor use
- Included screws compatible with Phillips, slotted and square screwdrivers
- UL- and CSA listed
- MFG Brand Name : Halex
- MFG Model # : 21580
- MFG Part # : 21580

Specifications

- Application type : Flex
- Assembled Depth (in.) : 1.65 in
- Assembled Height (in.) : 1.30 in
- Assembled Width (in.) : 1.56 in
- CSA Listed : Yes
- Compatible conduit type : RMC
- ETL Listed : No
- Electrical Product Type : Standard Fitting
- Fitting type : Connector
- Indoor/Outdoor : Indoor
- Item Package Type : Bag
- Item Weight : .22860 lb
- Manufacturer Warranty : None
- Material : Zinc
- Paintable/Stainable : No
- Product Depth (in.) : 1.496
- Product Height (in.) : .130
- Product Weight (lb.) : .220
- Product Width (in.) : .650
- Trade size : 3/8
- UL Listed : 1-UL Listed**

More Info

Warranty

For warranty information on this product, please call our Internet Customer Service Center at 1-800-435-4654.

Product Search Description [Advanced Search]

Asterisk (*) may be used as wildcard

[Customers](#) | [Manufacturers](#) | [Services](#) | [Catalogs](#) | [How to Order](#) | [News](#)

Search Terms: +98317711;

Search Results :: 1
Items found

Sort Results by:

View results as Grid : List

Results per page: Previous : Page: of 1 : Next

Select all
Deselect all

[» Click here to open refinement menu «](#)

Top-Level Categories

Boxes & Fittings

Select



Boxes & Fittings > Fittings > Conduit Connectors > Armored/Flex Cable - Straight

Connector, Straight, Insulated, Die Cast Zinc, Trade Size 3/8 Inch, Knockout Size 1/2 Inch, Single Cable Opening, Armored Cable/Flex Metal Conduit/Metal Clad Cable, Cord Size 0.405 To 0.612 Inch, Length 1.41 Inch, Push In Installation, Standard Package 500, Approval UL, Csa, Snap2it Brand [\(Click for Detail View\)](#)



This item is designated by the manufacturer as a 'Green' item

Carton/Package alternatives: 50 Box

Mfr. Name	Mfr. Part #	Graybar Part #
Arlington Industries	38AST	98317711

Select all
Deselect all

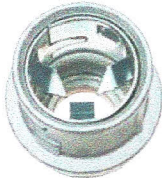
View results as Grid : List

Previous : Page: of 1 : Next

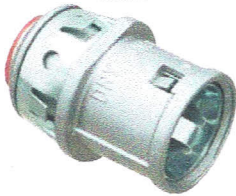


SNAP²IT[®] Connectors

Zinc die-cast. For MC/HCF steel and aluminum cable • AC/HCF steel and aluminum cable • Flexible metal conduit steel and aluminum (regular and reduced wall) • MC cable continuous corrugated aluminum.



38AST



40AST

FOR
**EASIER MC/AC
INSTALLATIONS...**
See
3810AST & 4010AST
on Page E-2

NO TOOLS!

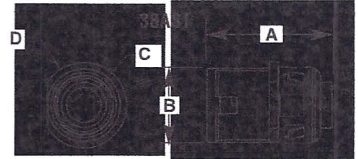
- Safe and fast installations
- Saves about 17 seconds per fitting!
- Competitively priced

CATALOG NUMBER	UPC/DCI/NAED MFG #01 8997	TRADE SIZE	KO SIZE	UNIT PKG	STD PKG	DIM A	DIM B	DIM C	DIM D	CABLE RANGE
38AST*	00070	3/8	1/2	50	500	1.410	.850	.405	1.000	.405-.612
38A*	00038	3/8	1/2	50	500	1.410	.850	.405	1.000	.405-.612
380ST	00381	3/8	1/2	50	500	1.280	.850	.400	1.000	.405-.612
380AST*	00382	3/8	1/2	50	500	1.280	.850	.400	1.000	.405-.612
45AST*	00045	1/2	1/2	50	500	1.660	1.130	.560	1.244	.590-.840

*Provided with insulated throat.



E18304 LR49636



With Insulated Throat and Red Tinted Inside Clip

CATALOG NUMBER	UPC/DCI/NAED MFG #01 8997	TRADE SIZE	KO SIZE	UNIT PKG	STD PKG	DIM A	DIM B	DIM C	DIM D	CABLE RANGE
40AST	00041	3/8	1/2	50	500	1.410	.850	.405	1.000	.485-.612
400AST	40347	3/8	1/2	50	500	1.280	.850	.400	1.000	.485-.612
50AST	72300	1/2	1/2	50	500	1.660	1.130	.560	1.244	.860-.920

Refer to chart on page E-25 for a list of cable types.

Concrete tight when taped.

Flexible metal conduit, CSA listed with anti-short bushing (UL not applicable).

SNAP-TITE[®] and SNAP²IT[®] products have been tested and listed by UL in accordance with UL's ground fault requirements. For additional information see page 6.

PATENTED. ADDITIONAL PATENTS PENDING.



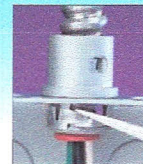
E18304 LR49636

SNAP²IT Connectors are EASY to Install...



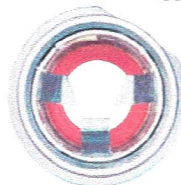
Just snap onto cable and snap into box!

And EASY to Remove...

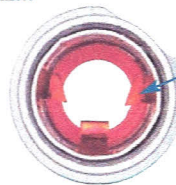


Using a screwdriver, lift the ring and twist off.

COMPARE...



38AST



40AST

RED TINTING means 'OPEN TANG' Design!
It gives you more room inside the fitting for easy insertion of wires.
The redesigned front end makes it easier than ever to snap the fitting into box!

Product Search Description [Advanced Search]

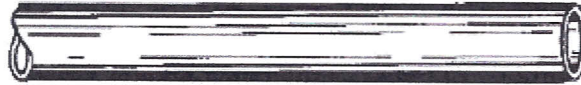
Asterisk () may be used as wildcard*

[Customers](#) [Manufacturers](#) [Services](#) [Catalogs](#) [How to Order](#) [News](#)

Search Terms: 88272942;

Top-Level Categories

Conduit (Metal) 3/4-EMT



COMPLETE SHORT DESCRIPTION

Thin Wall Conduit, Hot Galvanized, Steel, Trade Size 3/4 Inch, Approval UI, Allied Brand, Jacket Material Flo Coat, Type Code Emt

COMPLETE LONG DESCRIPTION

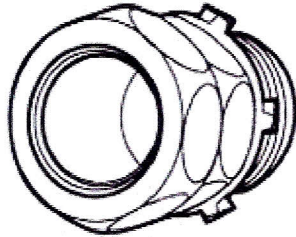
[Catalog Page](#) | [Product Info](#)

Main Information		Attributes
Mfr. Name	Mfr. Part #	Graybar Part #
Conduit (Metal)	3/4-EMT	88272942
Carton/Package alternatives: 100 Bundle		
Must order multiples of 10		

Product Search Description [Advanced Search]*Asterisk (*) may be used as wildcard*[Customers](#)[Manufacturers](#)[Services](#)[Catalogs](#)[How to Order](#)[News](#)

Search Terms: 88073717;

Top-Level Categories

Cooper Crouse-Hinds 651S**COMPLETE SHORT DESCRIPTION**

Connector, Compression Installation, Non Insulated, Steel, Trade Size 3/4 Inch, Concrete Tight, Approval UL, Csa, Standard Package 125, Used On Emt Conduit, Cooper Crouse-Hinds Brand

COMPLETE LONG DESCRIPTION

Thinw all conduit fittings are used to join EMT to a box or enclosure or to couple two ends of EMT conduit. Features: Unique Raised Bump Design Affords Fast, Positive Locking of Compression Nuts; Male Hub Threads-NPSM; Steel Locknuts; Heavy Steel Walls; Zinc-Plated Steel

[Catalog Page](#) | [Product Info](#)**Main Information****Attributes**

Mfr. Name	Mfr. Part #	Graybar Part #
Cooper Crouse-Hinds	651S	88073717

Carton/Package alternatives: 20 Carton

Product Search Description [Advanced Search]

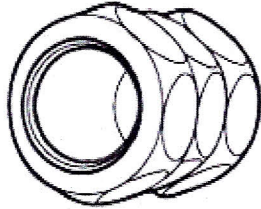
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Search Terms: 88073727;

Top-Level Categories

Cooper Crouse-Hinds 661S



COMPLETE SHORT DESCRIPTION

Coupling, Compression Installation, Steel, Trade Size 3/4 Inch, Concrete Tight, Approval UL, Csa, Standard Package 125, Used On Emt Conduit, Crouse-Hinds Brand

COMPLETE LONG DESCRIPTION

Thinw all conduit fittings are used to join EMT to a box or enclosure or to couple two ends of EMT conduit. Features: Unique Raised Bump Design Affords Fast, Positive Locking of Compression Nuts; Male Hub Threads-NPSM; Steel Locknuts;

Heavy Steel Walls; Zinc-Plated Steel

[Catalog Page](#) | [Product Info](#)

Main Information		Attributes
Mfr. Name	Mfr. Part #	Graybar Part #
Cooper Crouse-Hinds	661S	88073727

Product Search Description [Advanced Search]

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Search Terms: +88073717;

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[Deselect all](#)

[» Click here to open refinement menu «](#)

Top-Level Categories

[Boxes & Fittings](#)

Select



Boxes & Fittings > Fittings > Conduit Connectors > EMT - Straight

Connector, Compression Installation, Non Insulated, Steel, Trade Size 3/4 Inch, Concrete Tight, Approval UI, Csa, Standard Package 125, Used On Emt Conduit, Cooper Crouse-Hinds Brand [\(Click for Detail View\)](#)

Carton/Package alternatives: 20 Carton

Mfr. Name	Mfr. Part #	Graybar Part #
Cooper Crouse-Hinds	651S	88073717

[Select all](#)
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View results as Grid : List

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Product Search Description [Advanced Search]

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Search Terms: +88272936;

Search Results :: 1
Items found

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Top-Level Categories
Conduit, Raceway & Fasteners

Select



Conduit, Raceway & Fasteners > Conduit > Electrical Metallic Tubing (EMT)

Thin Wall Conduit, Hot Galvanized, Steel, Trade Size 1 Inch, Approval UI,

Allied Brand, Jacket Material Flo Coat, Type Code Emt ([Click for Detail View](#))

Must order multiples of 10

Carton/Package alternatives: 100 Bundle

Mfr. Name	Mfr. Part #	Graybar Part #
Conduit (Metal)	1-EMT	88272936

Select all
Deselect all

View results as Grid : List

Previous : Page: of 1 : Next

Product Search Description [Advanced Search]

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Search Terms: +88073718;

Search Results :: 1
Items found

Sort Results by:

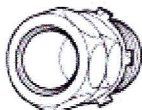
View results as Grid : List

Results per page: Previous : Page: of 1 : Next

Select all
Deselect all

[» Click here to open refinement menu «](#)

Select



Boxes & Fittings > Fittings > Conduit Connectors > EMT - Straight
Connector, Compression Installation, Non Insulated, Steel, Trade Size 1 Inch,
Concrete Tight, Approval UL, Csa, Standard Package 100, Used On Emt Conduit,
Cooper Crouse-Hinds Brand [\(Click for Detail View\)](#)

Carton/Package alternatives: 100 Box

Mfr. Name	Mfr. Part #	Graybar Part #
Cooper Crouse-Hinds	652	88073718

Select all
Deselect all

View results as Grid : List

Previous : Page: of 1 : Next

Product Search Description [Advanced Search]

Asterisk (*) may be used as wildcard

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Search Terms: +99477183;

Search Results :: 1
Items found

Sort Results by:

View results as Grid : List

Results per page: Previous : Page: of 1 : Next

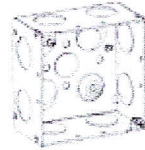
Select all
Deselect all

[» Click here to open refinement menu «](#)

Top-Level Categories

Boxes & Fittings

Select



Boxes & Fittings > Boxes > Standard > Square

Square Box, Height 4 Inch, Width 4 Inch, Depth 2-1/8 Inch, Capacity 30.3 Cu Inch, 16 Knockout(S), Knockout Location (4) Bottom, (12) Side, Knockout Size (2) 1/2 Inch Conduit Bottom, (2) (1/2 Inch - 3/4 Inch) Conduit Eccentric Knockout Bottom, (8) 1/2 Inch Conduit Sides, (4) (1/2 Inch - 3/4 Inch) Conduit Eccentric Knockout Sides, Welded Steel, Standard Package 25, Approval UI 514-A, UI 514-B, UI 514-C, Cooper Crouse-Hinds Brand, Applicable Standard Federal

Specification #w-J-800e, Nema Os-1 ([Click for Detail View](#))

Carton/Package alternatives: 25 Carton

Mfr. Name	Mfr. Part #	Graybar Part #
Cooper Crouse-Hinds	TP403	99477183

Select all
Deselect all

View results as Grid : List

Previous : Page: of 1 : Next

Product Search Description [Advanced Search]

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Search Terms: +88073728;

Search Results :: 1
Items found

Sort Results by:

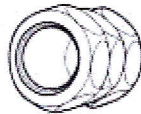
View results as Grid : List

Results per page: Previous : Page: of 1 : Next

Select all
Deselect all

[» Click here to open refinement menu «](#)

Select



Boxes & Fittings > Fittings > Conduit Couplings > EMT > Compression Coupling, Compression Installation, Steel, Trade Size 1 Inch, Concrete Tight, Approval UL, Csa, Standard Package 100, Used On Emt Conduit, Crouse-Hinds Brand [\(Click for Detail View\)](#)

Carton/Package alternatives: 100 Box

Mfr. Name	Mfr. Part #	Graybar Part #
Cooper Crouse-Hinds	662	88073728

Select all
Deselect all

View results as Grid : List

Previous : Page: of 1 : Next

Steel Square Covers

Steel Boxes

COVERS FOR 4" SQUARE BOXES – CUBIC INCH CAPACITY (SEE BELOW)



TP472



TP474



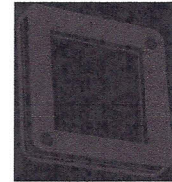
TP478



TP473, TP475, TP476,
TP477, TP479, TP 483



TP850*



TP854*

*For Air Plenum

Product Number	Description	Std. Unit Pkg.	Wt. Lbs. Per 100	Capacity Cu. In.
TP472†	Flat Blank	50	31	—
TP474	Flat Blank, Open With Ears 2¾"	50	21	—
TP478†	Flat with ½", ko	50	31	—
TP473	Raised ¼", Open With Ears 2¾"	50	23	1.3
TP476†	Raised ½", Open With Ears 2¾"	50	26	4.0
TP477	Raised ⅝", Open With Ears 2¾"	50	27	5.0
TP475	Raised ¾", Open With Ears 2¾"	25	31	6.0
TP479	Raised 1", Open With Ears 2¾"	25	34	7.0
TP483	Raised 1¼", Open With Ears 2¾"	25	37	8.5

Air Plenum

TP850*	Flat Blank Gasketed With Captive Screws	25	31	—
TP854*	Flat Ring Double Gasketed	25	12	—

† CSA Certified

ONE DEVICE



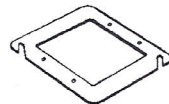
TP480



TP482, TP484, TP486,
TP488, TP489, TP490

Product Number	Description	Std. Unit Pkg.	Wt. Lbs. Per 100	Capacity Cu. In
TP480	Flat	50	20	—
TP482	¼" Raised	50	21	1.8
TP484	½" Raised	50	23	3.5
TP489	⅝" Raised	50	26	4.3
TP486	¾" Raised	50	30	5.5
TP488	1" Raised	50	34	6.8
TP490	1¼" Raised	25	39	8.8

TWO DEVICE



TP494



TP496, TP488, TP499,
TP500, TP501, TP502

Product Number	Description	Std. Unit Pkg.	Wt. Lbs. Per 100	Capacity Cu. In
TP494	Flat	50	12	—
TP496	¼" Raised	50	13	3.0
TP498	½" Raised	50	18	6.0
TP499	⅝" Raised	50	22	8.0
TP500	¾" Raised	50	24	9.0
TP501	1¼" Raised	25	31	14.0
TP502	1" Raised	25	30	11.7

Product Search Description [\[Advanced Search\]](#)

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Search Terms: 90058833;

[Top-Level Categories](#)

Cooper Crouse-Hinds TP472



COMPLETE SHORT DESCRIPTION

Square Box Cover, Flat, Box Size 4 Inch, Blank, Steel, Standard Package 50, Approval Csa, Cooper Crouse-Hinds Brand

COMPLETE LONG DESCRIPTION

[Catalog Page](#) | [Product Info](#)

Main Information		Attributes
Mfr. Name	Mfr. Part #	Graybar Part #
Cooper Crouse-Hinds	TP472	90058833

Carton/Package alternatives: 50 Carton

Armorlite® Type MC Multiple Neutral

Lightweight Aluminum Interlocked Armor. 600 Volts.
Copper Power Conductors. THHN/THWN Insulated Singles.
Multiple Neutral Conductors. Insulated Grounding Conductors.
Sizes 12 AWG and 10 AWG. Rated VW-1.



APPLICATIONS

Southwire Armorlite® Type MC Cable - "Multiple Neutral" is suitable for use as follows:

- Applications affected by harmonics generated from non-linear switching loads, such as computers, variable frequency drives, electrical test equipment, and office equipment.
- Branch, feeder and service power distribution in commercial, industrial, institutional, and multi-residential buildings.
- Power, lighting, control, and signal circuits.
- Fished or embedded in plaster.
- Concealed or exposed installations.
- Environmental air-handling spaces per NEC 300.22 (C).
- Places of Assembly per NEC 518.4 and theaters per NEC 520.5.
- Installation in cable tray and approved raceways.
- Under raised floors for information technology equipment conductors and cables per NEC 645.5(D) & 645.5(D)(2).
- Class I Div. 2, Class II Div 2, & Class III Div. 1 Hazardous Locations.

STANDARDS & REFERENCES

Southwire Armorlite Type MC Cable- "Multiple Neutral" meet or exceed the following

- UL 83
- UL 1569
- UL 1685
- Federal Specification A-A59544 (formerly J-C-30B)
- The National Electrical Code
- Listed for use in UL 1, 2 and 3 Hour Through Penetration Firestop Systems
- Jacketed & Non Jacketed will both pass " UL Test" & "FT4/IEEE 1202" (70,000 Btu/hr) Vertical Cable Tray Flame Test

CONSTRUCTION

Southwire Armorlite® Type MC Cable - "Multiple Neutral" is constructed with solid soft-drawn copper Type THHN/THWN phase conductors, an oversized copper neutral conductor or one neutral per phase, and an insulated copper grounding



greenSpec™
RoHS Compliant



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Armorlite Type MC - Multiple Neutral

conductor. The conductors are cabled together with Mylar binder tape and a marker bearing the print legend. Aluminum interlocking armor is applied over the assembly. The standard PVC Jacket will not meet "Limited Smoke" or "LS" Rating. An optional SOLONON Jacket can be provided for "LS" Rating.

Phase Conductor Size (AWG) / # of Cond.	Solid or Stranded	Neutral Conductor Size (AWG) / # of Cond.**	Grounding Conductor Size (AWG) / # of Cond.	Approx. Weight (lbs./1000)	Approx. Armor O.D. (Inches)	Coil Length (feet)	Reel Length (feet)
12/2	solid	12/2	12/1	155	0.539	250	1000
12/3	solid	12/3	12/1	230	0.611	250	1000
12/4	Solid	12/4	12/1	256	0.647	---	1000
10/2	solid	10/2	10/1	223	0.656	250	1000
10/3	solid	10/3	10/1	369	0.714	250	1000
10/4	solid	10/4	10/1	376	0.668	250	1000
8/4	solid	8/4	8/1	409	0.732	250	1000
12/2	stranded	12/2	12/1	154	0.558	---	1000
12/3	stranded	12/3	12/1	180	0.280	---	1000
12/4	stranded	12/4	12/1	207	0.594	---	1000
10/2	stranded	10/2	10/1	229	0.656	---	1000
10/3	stranded	10/3	10/1	391	0.751	---	1000
10/4	stranded	10/4	10/1	481	0.862	250	1000
8/3	stranded	8/3	8/1	609	0.923	250	1000
6/3	stranded	6/3	6/1	884	1.042	250	1000

**Sizes 8 AWG and larger will be stranded. Note: Consult Section 310.15 of the National Electrical Code, 2008 Edition for ampacities. Data reflects products manufactured with aluminum interlocked armor.



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Armorlite Type MC - Multiple Neutral

Phase Conductor Size (AWG) / # of Cond.	Solid or Stranded	Neutral Conductor Size (AWG) / # of Cond.**	Grounding Conductor Size (AWG) / # of Cond.	Approx. Weight (lbs./1000)	Approx. Armor O.D. (Inches)	Coil Length (feet)	Reel Length (feet)
12/2	solid	12/2	12/2	184	0.574	250	1000
12/3	solid	12/3	12/2	235	0.611	250	1000
12/4	Solid	12/4	12/2	262	0.646	---	1000
12/4	Solid	10/2	12/2	265	0.636	250	1000
12/6	Solid	10/2	12/2	351	0.818	250	1000
10/2	solid	10/2	10/2	329	0.775	250	1000
10/3	solid	10/3	10/2	377	0.714	250	1000
10/4	solid	8/2	10/2	465	0.858	250	1000
10/6	solid	8/2	10/2	522	0.876	---	1000
12/2	stranded	12/2	12/2	189	0.574	---	1000
12/3	stranded	12/3	12/2	244	0.642	---	1000
12/4	stranded	12/3	12/2	272	0.680	---	1000
10/2	stranded	10/2	10/2	364	0.751	---	1000
10/3	stranded	10/3	10/2	391	0.751	---	1000

**Sizes 8 AWG and larger will be stranded. Note: Consult Section 310.15 of the National Electrical Code, 2008 Edition for ampacities. Data reflects products manufactured with aluminum interlocked armor.

FEATURES

- A neutral conductor per phase or multiple oversized neutrals for applications affected by harmonics.
- Reduces installation costs up to 50% over pipe and wire.
- Lightweight aluminum armor--as much as 45% lighter than steel MC Cable.
- UL Classified 1, 2, and 3 hour Through Penetration Firestop Systems: W-J-3037, W-L-3110, W-L-3113, W-L-3117, W-L-3120, W-L-3121, W-L-3160, C-AJ-3115, C-AJ-3140, C-AJ-3142, C-AJ-3145, C-AJ-3173, C-AJ-3202, C-AJ-4065, C-AJ-4066, F-C-3038.
- Cable reverse wound on reel for ease of pulling and installation. When pulling from coils, pull from inside to ensure ease of installation.
- Anti-short bushings are not required for use with MC cable per the NEC and UL

ONLINE CERTIFICATIONS & TOOLS

- UL Online Certification Directory (www.ul.com)
- UL Online Product Guide Info - Metal-Clad Cable (PJAZ) (www.ul.com)



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Product Search Description [Advanced Search]

Asterisk () may be used as wildcard*

[Customers](#) [Manufacturers](#) [Services](#) [Catalogs](#) [How to Order](#) [News](#)

Search Terms: 88321210;

Top-Level Categories

Wire MC ALUM 12/2 250FT COIL



COMPLETE SHORT DESCRIPTION

Armored Cable, Armor Mc - Aluminum, Conductor Size 12 Aw g, No. Of Conductors 2,

Conductor Material Copper, Length 250 Ft

COMPLETE LONG DESCRIPTION

[Product Info](#)

Main Information		Attributes
Mfr. Name	Mfr. Part #	Graybar Part #
Wire	MC ALUM 12/2 250FT COIL	88321210

Carton/Package alternatives: 250 Reel

Thin Wall Conduit Fittings (For EMT Conduit)

- Compression Type Fittings
- Set Screw Type Fittings
- Combination Couplings
- Straight Connectors
- Couplings

Thinwall Fittings

Application:

Thinwall conduit fittings are used:




- to join EMT to a box or enclosure
- to couple two ends of EMT conduit

COMPRESSION TYPE FITTINGS – STEEL

Concrete Tight




Straight Connectors – Insulated

UL File No. E-22132

	Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
	1650	1/2"	50	250	11
	1651	3/4"	25	125	16
	1652	1"	25	100	25
	1653	1 1/4"	10	50	43
	1654	1 1/2"	10	50	54
	1655	2"	5	25	76
	1656	2 1/2"	2	10	190
	1657	3"	1	5	300
	1658	3 1/2"	1	5	330
	1659	4"	1	5	360




Straight Connectors – Non-Insulated

UL File No. E-22132

	Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
	650S	1/2"	50	250	9
	651S	3/4"	25	125	16
	652	1"	25	100	25
	653	1 1/4"	10	50	43
	654	1 1/2"	10	50	54
	655	2"	5	25	76
	656	2 1/2"	2	10	190
	657	3"	1	5	300
	658	3 1/2"	1	5	280
	659	4"	1	5	360

Couplings

UL File No. E-22132





	Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
	660S	1/2"	50	250	12
	661S	3/4"	25	125	18
	662	1"	25	100	27
	663	1 1/4"	10	50	46
	664	1 1/2"	10	50	63
	665	2"	5	25	92
	666	2 1/2"	2	10	250
	667	3"	1	5	410
	668	3 1/2"	1	5	390
	669	4"	1	5	485

SET SCREW TYPE FITTINGS

Concrete Tight

Straight Connectors – Insulated





UL File No. E-22132

	Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
	1450	1/2"	50	250	9
	1451	3/4"	25	100	14
	1452	1"	20	100	23
	1453*	1 1/4"	10	50	46
	1454*	1 1/2"	10	50	50
	1455*	2"	5	25	78
	1456*	2 1/2"	2	10	130
	1457*	3"	1	5	140
	1458*	3 1/2"	1	5	180
	1459*	4"	1	5	225

* Two Tightening Screws

Straight Connectors – Non-Insulated





UL File No. E-22132

	Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
	450S	1/2"	50	250	9
	451	3/4"	25	100	15
	452	1"	20	100	23
	453*	1 1/4"	10	50	46
	454*	1 1/2"	10	50	50
	455*	2"	5	25	77
	456*	2 1/2"	2	10	130
	457*	3"	1	5	140
	458*	3 1/2"	1	5	180
	459*	4"	1	5	225

* Two Tightening Screws

Couplings

UL File No. E-22132

	Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
	460	1/2"	50	250	9
	461	3/4"	25	125	16
	462	1"	20	100	23
	463*	1 1/4"	10	50	42
	464*	1 1/2"	10	50	50
	465*	2"	5	25	77
	466*	2 1/2"	2	10	130
	467*	3"	1	5	140
	468*	3 1/2"	1	5	240
	469*	4"	1	1	250




* Four Tightening Screws

COMBINATION COUPLINGS – STEEL

Concrete Tight

EMT (Compression) to Rigid (Threaded)

UL File No. E-19189

	Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
	690S	1/2"	25	250	9
	691	3/4"	20	200	13
	692	1"	10	100	19

Thin Wall Conduit Fittings (For EMT Conduit)

- Combination Couplings
- 90° Pulling Elbows
- Straps
- Clamps

- Clampbacks/Spacers
- Clamps "Snap-On"
- Nailing Straps

Thinwall Fittings

COMBINATION COUPLINGS – DIE CAST ZINC

EMT (Set Screw) to Flexible Steel (Clamp)

UL File No. E-19189



Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
780DC	1/2"-3/8"	50	500	8



90 DEGREE PULLING ELBOWS – DIE CAST ZINC

Features:

- Supplied threaded and with set screw for use with EMT or rigid conduit
- Removable cover facilitates wire pulling

EMT To Box (also threaded for rigid to box)

UL File No. E-22132



Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
810DC	1/2"	10	100	31
811DC	3/4"	5	50	31



EMT To EMT (also threaded for rigid conduit)

UL File No. E-22132



Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
820DC	1/2"	10	100	28
821DC	3/4"	5	50	35
822DC	1"	5	25	64
823DC	1 1/4"	2	20	66



STRAPS – STEEL GALVANIZED

Two Hole



Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
497-1	1/2"	250	250	2
497-2	3/4"	150	150	3
497-3	1"	100	100	5
497-4	1 1/4"	50	50	8
497-5	1 1/2"	50	50	13
497-6	2"	25	25	14
496-9	2 1/2"	25	25	19
496-10	3"	25	25	23
496-11	3 1/2"	25	25	93
496-12	4"	10	10	108

CLAMPS – MALLEABLE IRON



Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
516	2 1/2"	5	25	104
517	3"	2	10	120
518	3 1/2"	2	10	150
519	4"	2	10	220



CLAMPBACKS/SPACERS – IRON

Application:

- Provides space between conduit and mounting surface



Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
CB1	1/2"	25	250	8
CB2	3/4"	25	250	10
CB3	1"	25	100	12
CB4	1 1/4"	25	100	21
CB5	1 1/2"	25	100	42
CB6	2"	10	50	40
CB7	2 1/2"	10	50	49
CB8	3"	10	50	62
CB9	3 1/2"	10	10	91
CB10	4"	10	10	110
CB11	5"	5	5	135
CB12	6"	5	5	225

CLAMPS "SNAP-ON" – STEEL

Application:

- To support rigid conduit and IMC to mounting surface

Heavy Gauge



Cat. #	Size	Unit Quantity	Standard Package	Weight Lbs. Per 100
200	1/2"	100	500	5
201	3/4"	100	500	6
202	1"	100	500	6
203	1 1/4"	50	250	13
204	1 1/2"	25	100	17
205	2"	25	25	20
206	2 1/2"	25	25	64
207	3"	25	25	71
208	3 1/2"	10	10	120
209	4"	10	10	130

NAILING STRAPS

Application:

- To support rigid conduit and IMC to mounting surface



Cat. #	Conduit Sizes		Unit Quantity	Standard Package	Weight Lbs. Per 100
	EMT	Rigid			
NS-1	1/2"	3/8"	100	1000	2
NS-2	3/4"	1/2"	100	1000	2
NS-3	1"	3/4"	100	1000	3

Search Results

Home > Products Overview > Search Results >

Evaluate

- FAQ's

Design a Solution

- Part Drawings

How to Buy

- Bill of Material
- Favorite Products List
- Locate Distributor

Current refinements (click to remove) Search Tips Within Results

Pan-Ty® Clamp Ties > Text Search: 'PLC2S-S10-C'

Refine By

- RoHS Compliancy St ..
- Product Type
- Material
- Color
- UL Listed (File #E ..
Yes
- Length (In.)
- Length (mm)
- Width (In.)
- Width (mm)
- Cross Section
- Material Flammabil ..
- Max. Bundle Diamet ..
- Max. Bundle Diamet ..
- Min. Loop Tensile ..
- Min. Loop Tensile ..
- Nominal Hole Diame ..
- Nominal Hole Diame ..
- Plenum-Rated

Search Results

2 Records found.

1. [PLC2S-S10-C](#)



<ul style="list-style-type: none"> <input checked="" type="checkbox"/> RoHS Compliancy Status <input checked="" type="checkbox"/> Part Description <input checked="" type="checkbox"/> Product Type <input checked="" type="checkbox"/> Material <input checked="" type="checkbox"/> Color <input checked="" type="checkbox"/> UL Listed (File #E56854) <input checked="" type="checkbox"/> Length (In.) <input checked="" type="checkbox"/> Length (mm) <input checked="" type="checkbox"/> Width (In.) <input checked="" type="checkbox"/> Width (mm) <input checked="" type="checkbox"/> Cross Section <input checked="" type="checkbox"/> Material Flammability Rating <input checked="" type="checkbox"/> Max. Bundle Diameter (In.) <input checked="" type="checkbox"/> Max. Bundle Diameter (mm) <input checked="" type="checkbox"/> Min. Loop Tensile Strength (Lbs.) <input checked="" type="checkbox"/> Min. Loop Tensile Strength (N) <input checked="" type="checkbox"/> Nominal Hole Diameter (In.) <input checked="" type="checkbox"/> Plenum-Rated <input checked="" type="checkbox"/> Min. Order UOM <input checked="" type="checkbox"/> Min. Order Qty. 	<ul style="list-style-type: none"> Compliant Clamp Tie, 7.9", Standard cross section Cable Ties Nylon 6.6 Natural Yes 7.9 201 0.190 4.8 Standard UL 94V-2 1.84 47 50 222 0.200 Yes, for use in plenum or air handling spaces per NEC Sec. 300.22 (C) and (D) PC 100
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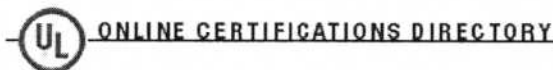
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Related Products

- [Cable Tie Tools – Tool C ..](#)
- [Cable Tie Tools – Instal ..](#)
- [Pneumatic Hand Tools - Tool-Co ..](#)

2. [Part Drawings: Pan-Ty Clamp Tie, SS-2724 \(R18\) - pdf](#)

30076570



DUZX.GuideInfo Communications Cable

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[Page Bottom](#)

Communications Cable

[Guide Information for Electrical Equipment for Use in Ordinary Locations](#)

USE AND INSTALLATION

This category covers communications cable which is a single conductor coaxial cable or a multiple conductor jacketed cable for telephone and other communications circuits for use as described in Article 800 of ANSI/NFPA 70, "National Electrical Code" (NEC).

This cable is used as wiring from a protector to a telephone or other communications equipment within a building, and for use as interconnecting wiring between parts of a communications system.

Except for special locations specifically required by the NEC, communications cable, in general, is not required to be installed in conduit or raceway.

PRODUCT MARKINGS

Communications cable is identified by marking on the surface of the jacket or on a marker tape under the jacket. This marking includes one of the following Type designations:

CM — Indicates cable intended for general use within buildings in accordance with Section 800.154(E)(1) of the NEC. This cable does not spread flame to the top of the tray in the Vertical-Tray Flame Test in [UL 1685](#), "Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables."

CMG — Indicates cable for general use within buildings in accordance with Section 800.154(E)(1) of the NEC. The damage height of this cable does not exceed 4 ft 11 in. when tested in accordance with the CSA FT4 Vertical-Tray Flame Test in [UL 1685](#).

CMP — Indicates cable intended for use within buildings in ducts or plenums or other spaces used for environmental air in accordance with Section 800.154(A) of the NEC. This cable exhibits a maximum peak optical density of 0.5, a maximum average optical density of 0.15, and a maximum flame spread distance of 5 ft, when tested per ANSI/NFPA 262, "Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces."

CMR — Indicates cable intended for use within buildings in vertical shafts in accordance with Section 800.154(B) of the NEC. The flame propagation height of this cable is less than 12 ft when tested per [ANSI/UL 1666](#), "Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts."

CMUC — Indicates cable for undercarpet use in accordance with Section 800.154(E)(6) of the NEC. This cable complies with the VW-1 Flame Test requirements in [ANSI/UL 1581](#), "Reference Standard for Electrical Wires, Cables, and Flexible Cords."

CMX — Indicates cable intended for use within buildings (1) where the wire or cable is enclosed in raceway or noncombustible tubing, or (2) in nonconcealed spaces where the exposed length of wire or cable does not exceed 10 ft, or (3) in one- or two-family or multifamily dwellings when the cable diameter is less than 0.25 in., in accordance with Section 800.154(E) of the NEC. Type CMX cable may be marked "Outdoor" to indicate its suitability for installation outdoors on dwellings. This cable complies with the VW-1 Flame Test requirements in [ANSI/UL 1581](#).

Cable that contains one or more optical fiber members has the suffix "-OF" added to the above.

Cable that complies with the Limited Smoke Requirements specified in [UL 1685](#) is surface marked with the suffix "LS."

Cable marked "Shielded" contains one or more electromagnetic shields.

Cable that complies with the requirements for "Limited Combustible" specified in ANSI/NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems," is surface marked "Limited Combustible."

Listed cable that is additionally marked "Verified (UL) Category 2, 3, 4, 5, 5E, 6 or 6A [including latest draft number if applicable]" or "Verified (UL) Category 3, 4, 5, 5E, 6 or 6A [including latest draft number if applicable] Patch Cable" for stranded conductor cable, has been investigated in accordance with the UL Data Transmission Performance Category Marking Program and is manufactured under an acceptable quality assurance system.

Listed cable that is additionally marked "Verified (UL) Category 6 or 7 NEMA WC66" has been investigated in accordance with NEMA WC66-1999, "Performance Standard for Category 6 and 7 100 Ohm Shielded and Unshielded Twisted Pair Cable." Additionally, this cable has been manufactured under an acceptable quality assurance system.

Listed cable that is additionally marked "Verified In Accordance With [Specification name and/or number]" complies with the requirements of a transmission performance specification referenced and is manufactured under an acceptable quality assurance system.

Communications wire is a single wire or unjacketed multi-conductor assembly of these wires that is intended for use in distributing frames and in cross-connect arrays in accordance with Section 800.154(C) of the NEC. This wire or assembly is marked "cross-connect wire."

ADDITIONAL INFORMATION

For additional information, see Electrical Equipment for Use in Ordinary Locations (AALZ).

REQUIREMENTS

The basic standard used to investigate products in this category is ANSI/UL 444, "Communications Cables."

These products may additionally be Verified to ANSI/TIA-568-C.2 (2009), "Balanced Twisted-Pair Telecommunications Cabling and Components Standards," as noted in the individual Listings.

In addition, the standards used to investigate cable marked "Verified in Accordance with [Specification]" include the applicable Performance Standards.

UL MARK

The UL symbol on the product and the Listing Mark of Underwriters Laboratories Inc. on the attached tag, the reel or the smallest unit container in which the product is packaged is the only method provided by UL to identify products manufactured under its Listing and Follow-Up Service. The Listing Mark for these products includes the UL symbol (as illustrated in the Introduction of this Directory) together with the word "LISTED," a control number, and the product name "Communications Cable."

The Listing Mark for this category requires the use of a holographic label.

Cable that is also Verified to the UL Data Transmission Performance Category Marking Program has the marking "Verified to UL Performance Category Program," along with the UL symbol (as illustrated in the Introduction of this Directory) on the product, or the UL Verification Mark along with the words "Performance Category Program," together with the Listing Mark information on the tag, the reel or the smallest unit container. Cable that is also Verified to another transmission performance specification has the marking "Verified in Accordance with [Specification name and/or number]," along with the UL symbol (as illustrated in the Introduction of this Directory) on the product, or the UL Verification Mark along with the applicable Specification name and/or number together with the Listing Mark information on the tag, the reel or the smallest unit container.

The Verification Mark for this category requires the use of a holographic label.

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Last Updated on 2010-12-20

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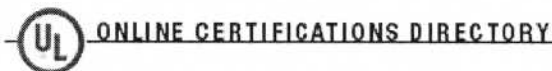
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30075609



DUZX.E106583 Communications Cable

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Communications Cable

[See General Information for Communications Cable](#)

COMTRAN CABLE L L C
330A TURNER ST
SOUTH ATTLEBORO, MA 02703 USA

E106583

Communications cable, Type(s) CM, CMG, CMH, CMP, CMR (60°C, 75°C), CMR-OF, CMX, CMX-Outdoor, CMX-Outdoor-CM, CMX-Outdoor-CMR, Cross-Connect Wire

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PJAZ.GuideInfo Metal-clad Cable

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Metal-clad Cable

[Guide Information for Electrical Equipment for Use in Ordinary Locations](#)

GENERAL

This category covers Type MC metal-clad cable. The cable is rated for use up to 2000 V, and Listed in sizes 18 AWG through 2000 kcmil for copper, 12 AWG through 2000 kcmil for aluminum or copper-clad aluminum, and employs thermoset or thermoplastic insulated conductors. It is intended for installation in accordance with Article 330 of ANSI/NFPA 70, "National Electrical Code" (NEC).

The cable consists of one or more insulated circuit conductors, a grounding path (grounding conductor, metal sheath, or combination thereof) as described below, one or more optional optical fiber members, and an overall metal sheath. The metal sheath is an interlocked metal tape, a corrugated metal tube, or a smooth metal tube. The metal sheath of single-conductor cable is nonferrous. A nonmetallic jacket may be provided under and/or over the metal sheath. Cable with metal armor, rated 2400 to 35,000 V is covered under Medium-voltage Power Cable ([PITY](#)) and is marked "Type MV or MC."

Cable with interlocked armor that has been determined to be suitable for use as a grounding means has interlocked aluminum or steel armor in direct contact with a single, full-sized, bare aluminum grounding/bonding conductor. This cable is marked to indicate that the armor/grounding conductor combination is suitable for ground. The equipment grounding conductor required within all other cable with interlocked armor may be insulated or bare, may be sectioned, and is located in the cable core but not in contact with the armor. Any additional grounding conductors of either design have green insulation. One insulated grounding conductor may be unmarked, one other may have only a yellow stripe and the balance have surface markings that indicate they are additional equipment grounding conductors or isolated grounding conductors.

The sheath of the smooth or corrugated tube Type MC cable or a combination of the sheath and a supplemental bare or unstriped green insulated conductor is suitable for use as the ground path required for equipment grounding. The supplemental grounding conductor may be sectioned. When sectioned, all sections are identical. Each additional green insulated grounding conductor has either a yellow stripe or a surface marking or both to indicate that it is an additional equipment or isolated grounding conductor. Additional grounding conductors, however marked, are not smaller than the required grounding conductor.

PRODUCT MARKINGS

Information regarding temperature rating, voltage rating, cable and conductor Type and AWG size is shown either on a marker tape under the armor or on the surface of a nonmetallic jacket, if used.

Copper-clad aluminum conductors are surface printed "AL (CU-CLAD)" or "Cu-clad Al." Aluminum conductors are surface printed "AL."

Cable employing compact-stranded copper conductors is so identified directly following the conductor size, wherever it appears (surface, tag, carton or reel), by "compact copper." The abbreviations "CMPCT" and "CU" may be used for compact and copper, respectively.

Tags, reels and cartons for products employing compact-stranded copper conductors have the marking: "Terminate with connectors identified for use with compact-stranded copper conductors."

For termination information, see Electrical Equipment for Use in Ordinary Locations ([AALZ](#)).

Cable suitable for use in cable trays, direct sunlight or direct burial application is so marked. Cable marked for direct burial is also considered acceptable for encasement in concrete.

Cable marked "Oil Resistant I" (or "Oil Res I") is suitable for exposure to mineral oil at 60°C. Cable suitable for exposure to mineral oil at 75°C is marked "Oil Resistant II" (or "Oil Res II").

Cable containing one or more optical fiber members is marked "MC-OF."

Cable with a nonmetallic outer jacket that complies with the Limited Smoke Test requirements specified in [UL 1685](#), "Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables," and all unjacketed metal-clad cable may be marked with the suffix "-LS."

Cable with an interlocked armor that is intended as a ground path is marked "armor is grounding path component," and is provided with installation instructions.

Cable intended for use in hazardous (classified) locations, Class I, Division 1, Groups A, B, C and D; Class II, Division 1, Groups E, F and G; Class I, Zone 1, Groups IIA, IIB and IIC in accordance with the NEC, is marked "MC-HL."

ADDITIONAL INFORMATION

For additional information, see Electrical Equipment for Use in Ordinary Locations ([AALZ](#)).

REQUIREMENTS

The basic standard used to investigate products in this category is [ANSI/UL 1569](#), "Metal-Clad Cables."

Cable marked "MC-HL" has been additionally investigated to [ANSI/UL 2225](#), "Cables and Cable Fittings for Use in Hazardous (Classified) Locations."

UL MARK

The Listing Mark of Underwriters Laboratories Inc. on the attached tag, the reel, or the smallest unit container in which the product is packaged, with or without the UL symbol on the product, is the only method provided by UL to identify products manufactured under its Listing and Follow-Up Service. The Listing Mark for these products includes the UL symbol (as illustrated in the Introduction of this Directory) together with the word "LISTED," a control number, and the product name as appropriate: Metal-clad cable that contains copper or copper-clad aluminum conductors has the product name "Metal-clad Cable"; metal-clad cable that contains aluminum conductors has the product name "Metal-clad Aluminum Cable."

See Cable for Use in Hazardous Locations ([PJPP](#)) for Listing Mark requirements for cable marked "MC-HL."

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**PJAZ.E47409
Metal-clad Cable**[Page Bottom](#)**Metal-clad Cable**[See General Information for Metal-clad Cable](#)

NEXANS CANADA INC
670 GZOWSKI ST
PO BOX 1203
FERGUS, ON N1M 2W9 CANADA
[Last Updated](#) on 1996-05-09

E47409

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ZLGR.GuideInfo Thermoplastic-insulated Wire

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[Wire] Thermoplastic-insulated Wire

[See General Information for Wire](#)

USE

This category covers thermoplastic-insulated wire for use in accordance with Article 310 of ANSI/NFPA 70, "National Electrical Code."

PRODUCT TYPES

Thermoplastic-insulated wire is rated 600 V and is designated as follows:

TW — Indicates a single conductor having flame-retardant, moisture-resistant thermoplastic insulation. The wire is rated 60°C wet or dry.

THHN — Indicates a single conductor having flame-retardant and heat-resistant thermoplastic insulation with a jacket of extruded nylon or equivalent material. The wire is rated 90°C dry only.

THW — Indicates a single conductor having flame-retardant, moisture- and heat-resistant thermoplastic insulation. The wire is rated 75°C wet or dry.

THW-2 — Same as THW except that the wire is rated 90°C wet or dry.

THHW — Indicates a single conductor having flame-retardant, moisture- and heat-resistant thermoplastic insulation. The wire is rated 90°C dry and 75°C wet.

THWN — Indicates a single conductor having flame-retardant, moisture- and heat-resistant thermoplastic insulation with a jacket of extruded nylon or equivalent material. The wire is rated 75°C wet or dry. THWN wire suitable for exposure to mineral oil and to liquid gasoline and gasoline vapors at ordinary ambient temperature is marked "Gasoline and Oil Resistant I" if suitable for exposure to mineral oil at 60°C, or "Gasoline and Oil Resistant II" if the compound is suitable for exposure to mineral oil at 75°C. Gasoline resistant wire has been tested at 23°C when immersed in gasoline. It is considered inherently resistant to gasoline vapors within the limits of the temperature rating.

THWN-2 — Same as THWN except that the wire is rated 90°C wet or dry.

FEP — Indicates a single copper conductor having flame-retardant and heat-resistant thermoplastic (fluorinated ethylene propylene) insulation. Type FEP wire is suitable for use at 90°C and lower temperatures in dry locations. It is also suitable for use in dry locations at 200°C and lower temperatures for special applications.

FEPB — Indicates a single copper conductor having flame-retardant and heat-resistant thermoplastic (fluorinated ethylene propylene) insulation with a glass braid. Type FEPB wire is suitable for general use at 90°C and lower temperatures in dry locations. It is also suitable for use in dry locations at 200°C and lower temperatures for special applications.

PFA — Indicates a single copper conductor having flame-retardant and heat-resistant thermoplastic (perfluoroalkoxy) insulation. Type PFA wire is suitable for use at 90°C and lower temperatures in dry locations. It is also suitable for use in dry locations at 200°C and lower for special applications.

PFAH — Indicates a single, nickel or nickel-coated copper conductor having flame-retardant and heat-resistant thermoplastic (perfluoroalkoxy) insulation. The PFAH is suitable for use at 250°C and lower temperatures only for leads within apparatus or within raceways connected to apparatus, in dry locations only.

TFE — Indicates a single, nickel-coated copper or nickel base alloy conductor having flame-retardant and heat-resistant thermoplastic (polytetrafluoroethylene) insulation. Type TFE wire is suitable for use at 250°C and lower temperatures in dry locations as leads within apparatus or within raceways connected to apparatus or as open wiring.

Z — Indicates a single copper conductor having flame-retardant and heat-resistant thermoplastic (ethylene tetrafluoroethylene) insulation. Type Z wire is suitable for use at 90°C and lower temperatures in dry locations. It is also suitable for use in dry locations at 150°C and lower temperatures for special applications.

ZW — Indicates a single copper conductor having flame-retardant and heat-resistant thermoplastic (ethylene tetrafluoroethylene) insulation. Type ZW wire is suitable for use in dry locations at 90°C or wet locations at 75°C. It is also suitable for use in dry locations at 150°C and lower temperatures for special applications.

ZW-2 — Same as ZW except that the wire is rated 90°C wet or dry.

TBS — Indicates a single conductor switchboard wire having thermoplastic insulation and a flame-retardant nonmetallic covering. Type TBS is suitable for use at 90°C and lower temperatures in dry locations.

PRODUCT MARKINGS

Types TW, THW, THW-2, THHN, THHW, THWN, THWN-2, PFA, PFAH and Z in sizes 4 to 1 AWG for grounding conductors only and in sizes 1/0 AWG and larger for circuit and grounding conductors that are marked "Cable Tray Use" or "CT" comply with a vertical-tray cable flame test. Wire so marked may additionally be marked "Sunlight Resistant" indicating compliance with an artificial weathering test.

Types TW, THW, THW-2, THHW, THWN and THWN-2 in all sizes that are marked "Sunlight Resistant" comply with an artificial weathering test.

Wire suitable for exposure to mineral oil is marked "Oil Resistant I" for 60°C oil resistance, or "Oil Resistant II" for 75°C oil resistance, on the surface of the wire. An Oil Resistant marking, by itself, does not include resistance to gasoline or similar light petroleum solvents.

Wire that complies with a special vertical flame test is surface marked "VW-1."

Constructions in this category that comply with a flame and smoke test (as described in [UL 1685](#), "Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables") may have the additional marking "ST1" indicating "Limited Smoke." (Note: The suffix "-LS," added to the Type letters, has also been used to indicate Limited Smoke. Effective November 15, 2004, only "ST1" may be used.)

In place of three of the markings described above, the following multinational markings may be used:

"SR" in place of "Sunlight Resistant"

"PR" in place of "Oil Resistant"

"GR" in place of "Gasoline and Oil Resistant"

Submersible Pump Cable — Indicates multiconductor cable consisting of two or three flat or two to six twisted insulated conductors with or without an overall jacket. The cable is labeled in size 14 AWG to 500 kcmil copper, and 12 AWG to 500 kcmil aluminum or copper-clad aluminum. The cable is tag marked "For Wiring Only Between Equipment Located at Water Well Heads and Motors of Installed Deep-Well Submersible Water Pumps." The insulation is surface marked "Submersible Pump Cable." The cable has not been investigated for direct burial in the earth.

Wire, in sizes mentioned below, may employ copper or aluminum, or copper-clad aluminum conductors. Wire with copper-clad aluminum conductors is surface printed "AL (CU-CLAD)" or "Cu-Clad Al." Wire with aluminum conductors is surface printed "AL."

Wire and cable employing compact-stranded copper conductors is so identified directly following the conductor size, wherever it appears (surface, tag, carton or reel), by "compact copper." The abbreviations "CMPCT" and "CU" may be used for compact and copper, respectively.

Tags, reels and cartons for product employing compact-stranded copper conductors have the marking: "Terminate with connectors identified for use with compact-stranded copper conductors."

SIZE AND CONDUCTOR INFORMATION

Types TW, THW and THW-2 are Listed in sizes 14 AWG to 2000 kcmil copper and 12 AWG to 2000 kcmil aluminum or copper-clad aluminum.

Types THHN, THWN, THWN-2 and THHW are Listed in sizes 14 AWG to 1000 kcmil copper and 12 AWG to 1000 kcmil aluminum or copper-clad aluminum.

Types TA, TBS, PFA, PFAH and Z are Listed in sizes 14 to 4/0 AWG copper and 12 to 4/0 AWG aluminum or copper-clad aluminum.

Types ZW, ZW-2, FEP and FEPB are Listed in sizes 14 to 2 AWG copper and 12 to 2 AWG aluminum or copper-clad aluminum.

ADDITIONAL INFORMATION

For conductor termination information, see Electrical Equipment for Use in Ordinary Locations ([AALZ](#)).

REQUIREMENTS

The basic standard used to investigate products in this category is [UL 83](#), "Thermoplastic-insulated Wires and Cables."

UL MARK

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conductors has the product name "Insulated Wire"; thermoplastic-insulated wire that contains aluminum conductors has the product name "Insulated Aluminum Wire."

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**ZLGR.E194031
Thermoplastic-insulated Wire**[Page Bottom](#)

Thermoplastic-insulated Wire[See General Information for Thermoplastic-insulated Wire](#)**UNITED COPPER INDUSTRIES**

E194031

SUITE 201
2219 S LOOP 288
DENTON, TX 76205 USA

Types THHN, THW, THW-2, THHW, THWN, THWN-2, TW.

Deep well submersible pump cable.[Last Updated](#) on 1999-09-20

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QCIT.E2527 Metallic Outlet Boxes

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Metallic Outlet Boxes

See General Information for Metallic Outlet Boxes

APPLETON ELECTRIC L L C

E2527

9377 W HIGGINS RD
ROSEMONT, IL 60018 USA

Trademark and/or Tradename: "E2527", "'A" in triangle" or "Appleton"

Conduit bodies, threaded for rigid conduit, FM7 unilets, 1-1/4 to 4 in. incl., with or without suffix -SA, Types C, E, L, LB, LL, LR, T, TA, TB, X followed by 4 to 10 incl., followed by 7, with or without suffix -SA; FM7 Unilets, 1/2 to 1 in., Types C, E, L, LB, LL, LR, T, TA, TB, and X, followed by 1 through 3, followed by 7, with or without suffix -SA; FM8 unilets, 1/2 to 4 in. incl., Types C, LB, LL, LR, T, TB, X followed by 1 to 10 incl., 44 or 88, followed by 8, with or without suffix Z0. Suitable for wet locations except with suffix Z0; Form 35 unilets, 1/2 to 2 in. incl., Types TA, TB followed by suffix -A or -M; 1/2 to 4 in. incl., Types C, E, LBD, LF, LL, LR, LRL, T, X followed by suffix -A or -M; 1/2 to 6 in. incl., Type LB followed by suffix -A or -M; Form 85 unilets, 1/2 to 2 incl., Types C, E, LB, LL, LR, T, X followed by suffix -A; PTB-1250, -1251, -1252, -1253, -1272, -1273, -1274, -1275, -1294, -1295, -1296, -1297, PTC-1200, -1201, -1202, -1203, -1211, -1212, -1213, -1214, -1222, -1223, -1224, -1225, -1244, -1245, -1246, -1247, -1812, -1813, -1814, -1815, -1816; threadless for rigid conduit; Form 35 unilets, 1/2 to 1 in. incl., Types C, LB, T followed by suffix -N-M; FM9 unilets, 1/2 to 4 in. incl. Cat Nos. C, LB, LR, LL, T, followed by 19, 29, 39, 49, 59, 69, 789, 889, 989, or 1089. Cat. No. TB, followed by 19, 29, 39, 49, 59, or 69. Cat. No. X, followed by 19, 29, or 39. Suitable for wet locations when used with self-adhesive integral gasketed covers.

Conduit bodies, Mogul Type; Cat. Nos. BC100-A, -100-M, -125-A, -125-M, -150-A, -150-M, -200-A, -200-M, -250-A, -250-M, -300-A, -300-M, -350-A, -350-M, -400-A, -400-M, BLB100-A, -100-M, -125-A, -125-M, -150-A, -150-M, -200-A, -200-M, -250-A, -250-M, -300-A, -300-M, -350-A, -350-M, -400-A, -400-M, BLL100-A, -100-M, -125-A, -125-M, -150-A, -150-M, -200-A, -200-M, BLR100-A, -100-M, -125-A, -125-M, -150-A, -150-M, -200-A, -200-M, BT100-A, -100-M, -125-A, -125-M, -150-A, -150-M, -200-A, -200-M, -250-A, -250-M, -300-A, -300-M, -350-A, -350-M, -400-A, -400-M, BUB100-A, -100-M, -125-A, -125-M, -150-A, -150-M, -200-A, -200-M, -250-A, -250-M, -300-A, -300-M, -350-A, -350-M, -400-A, -400-M, LBDN-250-A, -250-M, -300-A, -300-M, -350-A, -350-M, -400-A, -400-M.

Conduit bodies for electrical metallic tubing, Cat. No. C followed by 50T, 75T, 100T, 125T or 150T, followed by A; Cat. No. LB, LL or LR followed by 50T, 75T, 100T, 125T, 150T or 200T, followed by A; Cat. No. T followed by 50T, 75T or 100T, followed by A.

Conduit bodies for rigid or intermediate metallic conduit, Cat. Nos. C, LB, LL, LR or T followed by 50, 75, 100, 125, 150, 200, 250, 300, 350 or 400, followed by A.

Conduit body, threaded for IMC and rigid, Cat. No. 4S5L1/2DRC.

Conduit boxes+, Cat. Nos. WYF040403#, WYF040404#, WYF060403#, WYF060404#, WYF080403#, WYH040402#, WYH040404#, WYH060403#, WYH060404#, WYL040403#, WYL040404#, WYL050503#, WYLO60403#, WYLO60404#, WYLO80403#, WYR040403#, WYR040404#, WYR060403#, WYR060404#, WYR080403#, WYS040402#, WYS040403#, WYS040404#, WYS050503#, WYS060403#, WYS060404#, WYS060602#, WYS080403#, WYU040402#, WYU040403#, WYU040404#, WYU060403#, WYU060404#, WYW050503#, WYW060403#, WYW060404#, WYW080403# with or without suffixes A or B.

Covers for conduit bodies, Cat. Nos. K50, K50-A, K50-CA, -CM, K75, K75-A, K75-CA, -CM, K100, K100-A, -CA, -CM, K200, K200-A, -CA, -CM, K500, K500-A, K600, K600-A, K125150, K125150-A, -CA, -CM, K250300, K250300-A, -CA, -CM, K350400, K350400-A, -CA, -CM, KCG50, -75, KVS75-A, -100-A, KWD50-A, MK-100-CM, -125-CM, -150-CM, -200-CM, -250-CM, -300-CM, -350-CM, -400-CM; Cat. No. 1 to 6 incl., 8 or 9 followed by 70, with or without suffix G or IG, with or without suffix F, FIG or FG, with or without suffix -SA. Suitable for wet locations; Cat. No. 1 to 6 incl., 8 or 9 followed by 80, followed by F, FIG, FG or I G, F may be with or without suffix Z0. Suitable for wet location except with suffix Z0; FM9 series Cat. No. 190, 290, 390, 490, 590, 690, 889 or 989 with or without suffix G or IG. Covers with suffix G or IG suitable for wet locations.

Covers for flush device boxes, Cat. Nos. 180-A, -T, -W, -X, 2510, 2520, 2538, 2539, 2540, 2555, 2594, 8377; malleable iron or aluminum Cat. Nos. FSK-1B, -1B-C, -1DR, -1DR-C, -1J, -1J-C, -1PB, -1PBS, -1R-Q, -1R-T, -1R-W, -1R-X, -1R-Y, -1R-Z, -1TS, -1TS-C, -1TSG, -1TSG-C, -1V, -1VDR, -1VR, -1VRG-23, -1VRG-223, -1VS, -1VTS, -1WD-3, -4B-CM, -10R, with or without suffix A for aluminum; steel or aluminum Cat. Nos. FSK-2B, -2B-CA, -2B-CM, -2DR, -2R-L, -2R-M, -2R-Q, -2R-T, -2R-W, -2RS-K, -2TS, -2VTS, -3B, -3B-CM, -3TS, -3VTS, with or without suffix A for aluminum steel only Cat. Nos. FSK-4TS, GSK-50-5, GSK-BC-5.

Covers for outlet boxes, Cat. Nos. 2GC-75, 3GC-75, 4GC-75, 5GC-75, 6GC-75, 7GC-75, 8GC-75, 2520, 8301-A, 8320, 8360, 8361, 8363, 8364, 8365, 8365N, 8367, 8368, 8369, 8371, 8371N, 8373, 8373N, 8375, 8375N, 8377, 8378, 8379, 8381, 8391N, 8401, 8403, 8409, 8409-A, -D,

8413, 8419-LR, 8420-LR, 8461, 8461-A, -B, -C, -D, -E, 8465, -P, 8466, 8466-A, 8468, 8468-A, -B, -C, -F, -WB, 8469, 8469-A, -B, 8470, 8470-A, -B, -C, -F, -WB, 8474, 8475, 8484B, 8484BN, 8485, 8485-A, 846-50, -75, -100, -125, -150, -200, 856-100, -125, -150, -200, 857-100, -150, -200, 8486A, -D, -E, -F, 847-50, -75, -100, -125, -150, -200, 8487, 8487-K, -P, 8488, 8488-A, 8489, 8490, 8491, 8492, 8493, 8493N, 8494, 8495, 8496, 8497, 8498, 8499, 11362, GSK-BC-20, JBK-B, JBK-1BCA, OCP, OCP-3/8, JIC-C. Suitable for damp and wet locations, Cat. Nos. FSK-WRD, -WR1, -WR2, -WT2. Suitable for wet location with cover closed, Cat. Nos. FSK-C, -WGF1.

Cat. Nos. 8436R, 8438R, 8456R, 8458R with or without prefix OB; Cat. Nos. 11355, 11360, 11362.

Extension rings, Cat. Nos. 3-OE-1/2, -3/4, 4-OE-1/2, -3/4, 4-OE-SPL, 4-OED-1/2, -3/4, -1, 4-OES, 4-SE-1/2, -3/4, 4SES, 4S-SBE-SPL, 4-SJDE-1/2, -1/2-3/4, -1, 4-SJE-1/2, -3/4, 4SL-1/2, 4SLES, 4-SSLE-1/2 Ext-50, -75, -100, 184E, WE-1, -2, WEFX-50, -75, WERX-50, -75.

Fixture support covers for outlet boxes, Cat. Nos. JBK-50, -50A, -75, -75A.

Flush device cover plates, Cat. Nos. WAD, WCB-1, -14, -24, WCBR, WCT-1, -113, -115, WHD1, -1RV, WHG1, WHS1, -1RV, WVD1, -1RV, WVDDL2, WVDL1, WVDG2, WVGG2, WVP-21L1, -141, -161, -171, -211, , WVSD2, WVSG2, WVS1, WVSS2, WVSSL2, WVTT-2, -213, -215, -220.

Flush device boxes, malleable iron or aluminum; Cat. Nos. FD-1, -50, -75, -100, FD-1-50L, -75L, FD-2-50, -75, -100, FD-3-75, -100, FDA-1-50, -75, FDC-1-50, -50L, -75, -75L, -100, FDCA-1-75, FDCC-1-50, -75, -100, FDCT-1-50, -75, -100, FDD-2-75, -100, FDD-3-100, FDL-1-50, -75, FDLA-1-75, -100, FDR-1-50, -75, FDS-1-50, -75, -100, FDS-2-75, FDS-3-75, FDT-1-50, -75, -100, FDX-1-50, -75, -100, FS-1-50, -50L, -75, -75L, -100, FS-1D-50, -75, FS-1EXT, FS-2-50, -75, -100, FS-2EXT, FS-2T-50, -75, FS-3-75, -100, FSA-1-50, -75, FSC-1-50, -50L, -75, -75L, -100, FSC-1D-50, -75, FSC-2-50, -75, -100, FSC-2T-50, -75, FSCA-1-50, -75, FSCC-1-50, -75, FSCD-1-50, -75, FSCT-1-50, -75, -100, FSD-2-75, FSL-1-50, -75, FSLA-1-50, -75, FSR-1-50, FSR-1-75, FSS-1-50, -75, FSS-2-50, -75, -100, FSS-3-75, FST-1-50, -75, FSX-1-50, -75 with or without suffix A for aluminum; Cat. Nos. SEH-50, -75, SEHC-50, -75, SEHL-50, -75, SEHT-50, -75, SEHX-50, -75.

Flush device boxes, Cat. Nos. 4CSV-1/2, 4CSX-1/2PL, 4SSLV-1/2, 4SSLX-1/2PL, 18LES, -TW, 94, 111, 111-HB, -LE, -NL, -VB, 132AP-1/2, 132APFB-SPL, 132AP-SPL, 133AP-1/2, 134APFB-1/2, 173-FVB, 180 1/2, 181-1/2, 222, 222-HB, -LE, -NL, -OW, -VB, -VB-PL, 225, 333, 333-D, -DLE, -LE, -NL, -VB, 335, 336, 778, DWG77657, M4-250, -350, MW1-350, -550, -750, WDK-210, -250, WDM-110, -150, -175, WDP-250, -275, WDX-150, -175, WSK-250, -275, WSL-150, -175, -250, -275, WSM-110, -150, -175, -210, -250, -275, WSP-150, -175, -250, -275, WSR-250, -275, WST-250; for masonry walls, Cat. Nos. M1, M2, M3, M4, M5 followed by suffixes -250 or -350; with clamps for nonmetallic sheathed cable and flexible nonmetallic tubing, Cat. Nos. 16LE, -LE-VB, -LES, -LESN, 18LES, -LESN, -LESNX, 44, 44-LE, -LR, -NL, -VB, 95, 383, 384, 384-D, -DNL, -DLE, -DVB-PL, -DW-PL, -HB, -LE, -LES, -LES-VB, -LESN, -LR, -NL, -OW, -VB, -VB-PL, -VB-PL2G, 385-LES, -LESN, 388, 388-DW, 388-HB, 388-LE, 388-LES, 388-LESN, 388-NL, 388-LR, 388-VB, 388-VB-PL2G, 389, 389-VB, 999-OB; with receptacle, Cat. No. 1460; with clamps for armored cable, flexible steel conduit, nonmetallic sheathed cable and flexible nonmetallic tubing, Cat. Nos. 4SBB, 171F, 173F, -FHB, -FNL, -FVB, -LE, 174F, -VB-PL, 175F, 175FVB, 571L; blank bodies for drilling and tapping, Cat. Nos. FDB-1L, -2L, -2GL, -3L, -3GL; blank bodies for brazed hubs, Cat. Nos. FD-1L, -2G, -2GL, -2L, -3G, -3GL, -36L, -3L, -4G, -4GL, -4L, FS-1GL, -2G, -2GL, -3G, -3GL, -4G, -4GL.

Metallic outlet boxes for ceiling fan and light fixture support products, Models FFS4CL, FFS4CLNBH, FFS561L, FFS561LD, FFS561LDVBNW, FFS561LDNBH, FFS561LNBH, FFS561LOBH, FFS561LDOBH.

Metallic outlet box covers, Models 2GC75N, 8GC75N.

Metallic outlet boxes for conduit use, Models 3G5075S, 4G5075S, 5G5075S, 6G5075S, 7G5075S.

Multigang switch boxes, Models 2G5075S, 8G5075S, LVP-1N.

Outlet box covers, Models 3GC75N, 4GC75N, 5GC75N, 6GC75N, 7GC75N.

Outlet boxes, Cat. Nos. 2G, 2G-50, 2G-75, 2G-5075, 3G, 3G-50, 3G-75, 3G-5075, 3-O-1/2, -3/4, 4CL, 4CS-1/2, -3/4, 4CSE-1/2, 4CS-1/2-C, 4-CSL-1/2, 4G, 4G-5075, 4-O-1/2, -3/4, 4-O-SPL, 4-OD-1/2, -3/4, -1, 4-OD-SPL, 4-OJB-1/2, 4-OVB-1/2, 4S-1/2, 4S-3/4, 4S-1/2-DR, -1/2-SB2-1/2, -1/2-SB3-5/8, -3/4-DR, 4SAB-1/2, 4SAB-EK, 4SAB-SPL, 4SAD-SPL, 4-SB-1/2, 4SB-EK, 4-SB-SP, 4SBB, 4SD-1/2, -3/4, -1, 4SD-SPL, 4SD-EK, 4SDVB-EK-PL, 4SDVB-1/2-PL, 4SDVB-SPL-PL, 4S-EK, 4SJ-1/2, -3/4, -SPL, 4SJD-EK, 4SJD-EK-VB, 4SJ-EK, 4SJD-SPL, -1/2, -3/4, -1, -3/4-1, -1-1/4, -1-VB, -SPL-JB, -VB, 4SL-1/2, 4SOB-1/2, 4SOB-EK, 4SP, 4SP-D, 4SP-JD, 4SP-DR, 4SR-SB2-1/2, -SB3-5/8, 4S-SPL-DR, 4S-SPL, -SPL-SB2-1/2, -SPL-SB3-5/8, 4SS, 4SSBE-SPL, 4SSL-1/2, -1/2-DR, -3/4, -3/4-DR, -1, 4SSL-1/2DR-C, 4SSLD-1/2, 4SSLS-1/2, 4SSLX-1/2, 4SSLX-NL, -PL, 4SVB-1/2, 4SVB-1/2-PL, 4SVB-EK-PL, 4SVB-SPL, -SPL-PL, 4SX, 4SXAB-EK, 4SXB-EK-PL, 4SXB-PL, 4SX-SB2-1/2, -SB3-5/8, 4SXAB, 4SXVB, 4SXVB-PL, 5G, 5G-5075, 6G, 6G-5075, 40LK, 40VB-1/2, 133APFB-1/2, GSU-20, -100, JBDX-50, -50L, -75, -75L, -100, -100L, JBLX-50L, -50LA, -75L, -75LA, -100L, -100LA, JBX-50, -50L, -50LA, -75, -75L, -75LA, -100, -100L, JIC-1, -B, -H50, -H75, -S50, -S75, WVP-17L2, -21L2, -26L2, WRX-50, -50C, -75, -75C; concrete, Cat. Nos. OCR-1-1/2, -2, -2 1/2, -3, -3 1/2, -4; with clamps for armored cable, Cat. Nos. 551-L, -L-JB; with clamps for armored cable and flexible steel conduit, Cat. Nos. 4SBB, 4SXAB; with clamps for nonmetallic sheathed cable and flexible nonmetallic tubing, Cat. Nos. 4SR, 4SRAB, 4SRAB-EK, 4SR-EK, 4SRB-EK, 4SRB, 4SR-EK, 4SRD, 4SRDVB, 4SRDVB-PL, 4SROB-1/2, 4SROB-EK, 4-SRVB, 4SRVB-EK-PL, 4SRVB-PL, 4SXSD.

4SXSDVB-PL, 4SX-EK, 4SXVB-EK-PL, 510-LC, 560-L, -LVB, -LXE, 561-L, -LD, -LDJB, -LJB, -LVB, -LXE, -N, 563-L, 520119-1, -2; with clamps for armored cable flexible steel conduit, nonmetallic sheathed cable and flexible nonmetallic tubing, Cat. No. 571-L; with box supports, Cat. Nos. SX-115-40-1/2, SX-115-551L, -561L.

Note: All catalog numbers may include prefix "APP".

Cat. Nos. 4S 1/2, 4S 3/4 DR, 4S EK, 4S SPL, 4S-3/4, 4S-1/2-DR, 4S-SPL-DR, 4SL-1/2, 4SAB-EK, 4SOB-EK, 4SVB-3/4-PL, 4SD-SPL, 4SVB-EK-PL, 4SD-EK, 4SDVB-EK-PL, 4SJD-EK, 4SJD-EK-VB, 4SJ-EK, 4SJD-3/4-1, 4OVB-1/2, 4-O-1/2, 4-O-3/4, 4-O-SPL, 4-OD-1/2, 4-OD-3/4, 4-OD-SPL, 4-SJ-3/4, 4-SJD-3/4, 4-SJD-1, 4-SJD-1-1/4, 4-SJD-1-VB, 8403, 8465, 8487, 8495. Cat. Nos. may be followed by the suffix -RD to indicate a coat of red paint:

All boxes may be followed by suffix -P to indicate the addition of a 10 in. "pigtail" grounding wire.

Wet locations (rain tight).

+ Conduit bodies and conduit boxes having threaded hubs for attachment to threaded rigid conduit are considered rain tight when used in conjunction with gasketed covers.

Last Updated on 2010-10-05

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Phone (800) 611-7277 / Fax (315) 468-6296
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CERTIFICATE OF COMPLIANCE – UL and CSA

WPB332

Active



Extended Catalog Number : WPB332
Description : WP BOX 2G 3 HOLE 3/4

Manufactured or Purchased : Purchased UPC Code : 78500711652.00 Current Catalog Page :	Primary Point of Manufacture : PR Minimum Order Quantity : 5.00 Standard Package Quantity : 5.00 Unit Of Measure : EA
--	--

Sales Category : 20 - RESIDENTIAL
Product Segment : 26 - WEATHERPROOF
Product Group : 772 - OUTDOOR BOXES N271022121105413
Cornerstone Family : O008 - WEATHERPROOF
PLM : Tom Roy Ext: 8021

Engineering Information :

UL File # : E143223
UL Volume : ML
UL Section :
CSA File # : 17695
Federal Spec ID :
Drawing Number : 8913

Michael J. Gaines, Technical Support
Pass & Seymour Legrand
April, 28, 2011



QCRV.E165702 Outlet Bushings and Fittings

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Outlet Bushings and Fittings

[See General Information for Outlet Bushings and Fittings](#)

ERICO INTERNATIONAL CORP

E165702

34600 SOLON RD
SOLON, OH 44139 USA

CADDY® ERICO®

Trademark and/or Tradename: "CADDY®", "ERICO®",

Box / device leveler device, Cat. No. RLC.

Box hanger assemblies, Cat. Nos. 510HD, 512HD, 512HDTC, 512HDXT, 51212.

Box hanger clip, Cat. No. BHC.

Box mounting clips, Cat. Nos. TSGLDR1, TSGLDR1TC.

Box to strut clips, Cat. Nos. MFA4I, MFA625.

Box to T-Grid support, Cat. No. 4ACS.

Extension bracket, Cat. No. TEB6XT.

Fan brace kits, Cat. Nos. 512HDFM35, 512HDFM70.

Far side box supports, Cat. Nos. 760, J1A2.5, -3.5, -4, -6.

Old work box mounts, Cat. Nos. DSI2, DSI2A.

Outlet box supports, Cat. Nos. FMBS16, FMBS18, H4, H6, H23, H46, HS3, TH234.

Outlet box mounting brackets, Cat. Nos. MEB1, RBS-16, RBS-24, TEB23, TEBS1624, TEB4, TSRBS1625.

Screw gun brackets, Cat. Nos. SGB16A, -24A, TSGB16, TSGB24, TSGB1624.

Snap on box support, Cat. No. MSF.

All models may or may not be provided with an additional suffix of "Rxx" where xx is a number indicating package quantity.

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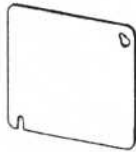
An independent organization working for a safer world with integrity, precision and knowledge.



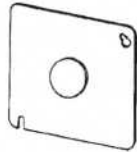
4" Square Covers

Flat Covers and Single Device – Plaster Rings/Mud Rings

Third Party Certification:



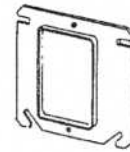
8465
Blank



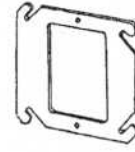
8474
1/2" KO



8465P
Plenum box cover
with gasket and screws



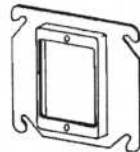
8468WB
1/4" Raised



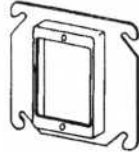
8468F
Flat



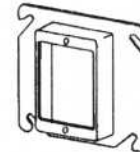
8468B
1/4" Raised



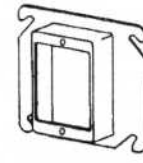
8468A
1/2" Raised



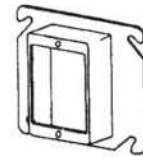
8468C
3/4" Raised



8468
1/2" Raised



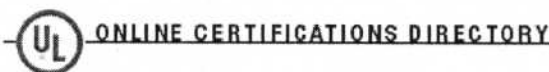
8466A
1" Raised



8466
1 1/4" Raised

Catalog Number (Universal No.)	Depth (inches)	Wiring Cubic Inch Capacity	Description	Wt. Lbs. Per 100	Std. Pkg.
Flat Covers					
8465 ◊ (52C1)	Flat	--	Blank	32.0	50
8474 (52C6)	Flat	--	1/2" KO	32.0	50
8465P	Flat	--	Blank Plenum Box Cover Gasketed with Two Captive Screws	35.0	50
Single Device					
8468WB (52C36)	1/4	1.5	Single Device	22.0	50
8468F (52C-0)	Flat	0	Single Device	21.0	50
8468B (52C62)	1/4	2.0	Single Device	23.0	25
8468A (52C13)	1/2	3.5	Single Device - Drawn	28.0	25
8468C (52C14-3/4)	3/4	4.5	Single Device - Drawn	28.0	50
8468 (52C14)	1/2	5.5	Single Device - Drawn	32.0	25
8466A (52C15)	1	7.5	Single Device - Drawn	36.0	25
8466 (52C16)	1 1/4	9.5	Single Device - Drawn	40.0	25

◊ Red Box available on FF37



QCIT.E23156 Metallic Outlet Boxes

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Metallic Outlet Boxes

[See General Information for Metallic Outlet Boxes](#)

COOPER CROUSE-HINDS

E23156

WOLF & 7TH NORTH ST
PO BOX 4999
SYRACUSE, NY 13221 USA

Flush device cover plates, Models 13641 thru 13646.

Flush device boxes, Cat. Nos. TP112, TP114, TP126, TP128, TP130, TP131, TP132, TP214, TP216, TP218, TP218SW, TP220, TP222, TP224, TP247, TP248, TP250, TP252, TP253, TP254, TP588, TP591, TP594, TP596, TP598, TP604, TP604 UST, TP605, TP606, TP629, TP641, TP874, may be followed by -PF designating ground lead provided.

with clamps for armored and metal clad interlocking steel cable, Cat. Nos. TP106, TP120, TP121, TP123, TP124, TP178, TP179, TP180, TP183, TP184, TP185, TP197, TP213, TP244, TP246, TP249, TP666, TP668, TP670, may be followed by -PF designating ground lead provided.

with clamps for nonmetallic sheathed cable, Cat. Nos. TP161, TP162, TP162SW, TP163, TP164, TP170, TP171, TP172, TP177, TP660, TP662, TP664, TP672, TP674, TP676, TP678, TP680, may be followed by -PF designating ground lead provided.

with clamps for nonmetallic sheathed cable and flexible nonmetallic sheathed tubing, Cat. Nos. TP100, TP104, TP110, TP116, TP118, TP134, TP135, TP137, TP138, TP140, TP144, TP146, TP148, TP149, TP158, TP165, TP174, TP175, TP188, TP196, TP198, TP190, TP206, TP210, TP236, TP238, TP239, TP240, TP242, TP243, may be followed by -PF designating ground lead provided.

with rigid or intermediate conduit, Models TP13160 thru TP13166, TP13680 thru TP13699, TP13715 thru TP13720, TP13725 thru TP13730, TP13735 thru TP13740, TP13745 thru TP13750, TP13755 thru TP13804, TP13810 thru TP13829, TP13840 thru TP13849, TP13860 thru TP13869, may be followed by -PF designating ground lead provided.

Flush device cover plates, Cat. Nos. BP-10, BP20, GFI-H, GFI-V, GFI-22V, GFI-25V, PO30-50, RP-4, RP-5, RP-22, RP-44, RP-45, RPG-45, RV-5, TP608, TP610, TP612, TP613, TP614, TP616, TP618, TP7202, TP7207, TP7208, TP7209, TP7229, TP7230, TS-1, TS-20, TWL-20, WT-1.

Gang box covers, Cat. Nos. TP632, TP653, TP655, TP657, TP661, TP667, TP802, TP803, TP804, TP805, TP806.

Masonry boxes, Cat. Nos. TP633, TP637, TP638, TP671, TP675, TP679, TP681, TP682, TP683, TP684, TP685, TP686, TP687, TP688, TP689, TP690, TP691, TP692, TP693, TP694, TP695, TP696, TP697, TP698, TP699, may be followed by -PF designating ground lead provided.

Outlet boxes, Cat. Nos. TP256, TP257, TP269, TP273, TP274, TP276, TP278, TP280, TP282, TP290, TP292, TP292, TP293, TP294, TP295, TP298, TP320, TP339, TP356, TP396, TP403, TP403RED, TP404, TP404PF, TP404RED, TP408, TP410, TP412, TP414, TP414RED, TP415, TP420, TP423, TP423RED, TP425, TP430, TP432, TP433, TP434, TP434RED, TP436, TP438, TP438PF, TP467, TP469, TP451, TP451PF, TP451RED, TP548, TP549, TP552, TP553, TP554, TP555, TP556, TP556PF, TP556RED, TP557, TP558, TP559, TP560, TP561; TP563, TP602-W, TP620+, TP630, TP622+, TP628+, TP631, TP640, TP647, TP704, TP7154, TP870, TP871, TP872, TP873, TP50BPF, TP40BDPF, TP40BPF, TP40S, TP40SPF, TP40D, TP40DPF, may be followed by -PF designating ground lead provided.

with clamps for armored cable and metal clad interlocking steel cable, Cat. Nos. TP310, TP312, TP314, TP317, TP338, TP338PF, TP431, TP431PF, TP440, TP454, TP454PF, TP456, TP456PF, TP459, TP461, may be followed by -PF designating ground lead provided.

with clamps for nonmetallic sheathed cable and flexible nonmetallic sheathed tubing, Cat. Nos. TP118, TP259, TP260, TP262, TP264, TP266, TP267, TP288, TP298, TP300, TP302, TP304, TP306, TP308, TP318, TP432, TP434, TP437, TP444, TP446, TP449, TP450, TP451, TP452, TP459, TP461, may be followed by -PF designating ground lead provided.

with bar hanger and clamps for nonmetallic sheathed cable and nonmetallic flexible tubing, Cat. Nos. TP377, TP378, TP386, may be followed by -PF designating ground lead provided.

with bar hanger and clamps for armored cable and metal clad interlocking steel cable, Cat. Nos. TP367, TP367PF, TP369, may be followed by -PF designating ground lead provided.

with support brackets, Cat. Nos. TP403SSB, TP404SSB, TP404SSBPF, TP431SSB, TP444SSB, TP450SSB and TP454SSB and TP563SSB, may be

followed by -PF designating ground lead provided.

Cat. Nos. TP454SSB12-6, TP431SSB12-6, may be followed by -PF designating ground lead provided.

with covers, grounding leads and support brackets, Cat. Nos. TP489403PF, TP499403PF, BB423-1104D, BB423-1104, BB423-2104D and BB423-2104, may be followed by -PF designating ground lead provided.

Outlet box covers, Cat. Nos. TP270, TP272, TP322, TP323, TP326, TP328, TP329, TP330, TP331, TP332, TP333, TP335, TP337, TP472, TP472RED, TP474, TP473, TP475, TP476, TP477, TP478, TP479, TP480, TP482, TP483, TP484, TP486, TP487, TP488, TP489, TP490, TP494, TP496, TP498, TP499, TP500, TP502, TP503, TP504, TP506, TP507, TP508, TP509, TP510, TP511, TP512, TP513, TP514, TP515, TP516, TP517, TP518, TP519, TP520, TP522, TP526, TP528, TP529, TP530, TP531, TP532, TP534, TP536, TP538, TP540, TP541, TP543, TP568, TP568RED, TP570, TP572, TP576, TP580, TP582, TP584, TP586, TP587, TP589, TP593, TP648, TP649, TP652.

Extension rings, Cat. Nos. TP258, TP284, TP286, TP422, TP424, TP426, TP428, TP428RED, TP430, TP432, TP433, TP436, TP443, TP550, TP551, TP564, TP564RED, TP565, TP566, TP600, TP623, TP624, TP635, TP636, TP643, TP644.

Outlet boxes for ceiling suspended fans, Cat. No. TP275, may be followed by -PF designating ground lead provided.

with clamps for nonmetallic sheathed cable and nonmetallic flexible tubing, Cat. No. TP301, may be followed by -PF designating ground lead provided.

Outlet box support covers, Cat. Nos. TP30000, TP31000, TP32000, TP35000, TP36000, TP37000.

Outlet box support covers-outlet box combinations, Cat. Nos. TP30XXX, TP31XXX, TP32XXX, TP35XXX, TP36XXX, TP37XXX where XXX may be numbers 403PF, 404, 404PF, 405, 408, 410, 411, 412, 414, 415, 422, 424, 426, 428, 430, 431, 431PF, 432, 433, 434, 436, 438, 444, 450, 454, 454PF. These numbers represent outlet boxes supplied with the covers; Model TP538454PF, may be followed by -PF designating ground lead provided.

Metallic outlet boxes for conduit use, Cat. Nos. TP404, TP423, TP425, TP403, TP403PF, TP432, may be followed by -PF designating ground lead provided.

+ Concrete tight.

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OANZ.E129200 Insulating Tape

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Insulating Tape

[See General Information for Insulating Tape](#)

3M COMPANY ELECTRICAL MARKETS DIV (EMD)
3M AUSTIN CENTER
6801 RIVER PLACE BLVD
AUSTIN, TX 78726 USA

E129200

Trademark and/or Tradename: "Tartan"



For use as sole insulation: Thermoplastic tapes, Cat. Nos. 15, 22, 33, 33+*, 35[b], 37, 80T*, 88, 600, 601, 700*, 701, 710@, 710W*, 711, "777*", 1712*, 1750*, 2150, 2155, "Auto-Pak*", "Highland*", "Hyflex*", "Super 33", "Super 33+" Black[+], "Super 88", "Tartan 2155", "Temflex 80T*", "Temflex 1776*", "Temflex 1712", "Temflex 1715", "Temflex 1750", "Temflex 2150".

Cat. Nos. 1400[a]#, 1400C[a]#, 1510-10#.

Cat. Nos. Temflex 1700[+], Temflex 1700P[+], Temflex 1700C[+], Tartan 1710[+].

Cat. Nos. 790#, 1700C#, 1700P#, 1701#, 1710#, 1400#, 1400C#, 1510-10# , 2535-Blue#, 2535-Brown#, 2535-Green#, 2535-Orange#, 2535-Red#, 2535-Violet#, 2535-Yellow#, 2535-White#.

Cat. No. "Temflex 1780*"

[+] Complies with "Flame Retardant" and/or "Cold Resistant" and/or "Sunlight Resistant" requirements when so marked.

*Complies with Flame Retardant and/or Cold Resistant requirements when so marked.

#Complies with Flame Retardant requirements when so marked.

[a] All colors except clear comply with Flame-Retardant and Cold Resistance requirements when so marked. Only white color, in the 0.180 mm thickness, complies with the Sunlight Resistance requirements when so marked.

[b] Complies with Flame-Retardant requirements for gray and red ; Cold Resistance requirements for gray, white and red; Sunlight Resistant requirements for white when so marked.

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ZODZ2.E116841 Positioning Devices - Component

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Positioning Devices - Component

[See General Information for Positioning Devices - Component](#)

3M COMPANY ELECTRICAL MARKETS DIV (EMD)

E116841

3M AUSTIN CENTER
6801 RIVER PLACE BLVD
AUSTIN, TX 78726 USA

Cable ties, Part Nos. 0709488, 0709490, 0709492, 0709494, 53174, 53198, 53199, 53200, 53201, 53202, 53225, 53293, 53294, for use at temperatures not exceeding 85C, all colors.

Part Nos. 53168, 53170, 53172, 53176, 53208, 53210, 53212, 53219, 53221, 53223, 53313, 53314, 53315, 53316, 53318, 53319, for use at temperatures not exceeding 70C, all colors.

Part Nos. 53169, 73171, 53173, 53220, 53222, 53224, 53295, 53296, 53320, 53321, for use at temperatures not exceeding 65C, black color only.

Part Nos. 53178, 53180, 53182, 53184, 53186, 53188, 53189, 53190, 53203, 53204, 53205, 53206, 53207, 53211, 53213, 53227, 53293, 53294, 53295, 53296, 53297, for use at temperatures not exceeding 85C, all colors.

Part Nos. 0709489, 0709493, 0709498, 0709499, 0709491, 53175, 53177, 53179, 53181, 53183, 53185, 53187, 53226, for use at temperatures not exceeding 85C, black color only.

Part Nos. 06200, -201, -202, -205, -207, 06224, 06248, -270, -271, -274, -275, -277, 53172, 53173, 53175, 53223, 53224, 53226, 53174, 53225, 53185, 53184, White color only, for use in temperature not exceeding 75C; Part Nos. 06226, 06232, 06250, 06256, 06203, 06273, 06227, 06251, 06204, 06228, 06252, 06243, 06240, 06264, 06267, 06272, Black color only, for use in temperature not exceeding 85C; Part Nos. 06225, 06249, 06206, 06229, 53228, 53227, 53187, 53186.

Mounting cable ties, Part Nos. 06232, 06234, 06243, 06256, 06258, 06267; acceptable for indoor use at temperatures not to exceed 85 degrees C.

Part Nos. 06205 and 06275; acceptable for outdoor use at temperatures not to exceed 85 degrees C.

(#)-Manufactured from a material which has been subjected to one or more of the following tests: Ultraviolet Light, Water Exposure or Immersion in accordance with UL746C, where the acceptability for outdoor use is to be determined by UL.

Marking: Company name and part or catalog designation on the part or on the smallest unit package in which the component is shipped.

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ZODZ2.GuideInfo Positioning Devices - Component

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Positioning Devices - Component

The devices covered under this category are incomplete in certain constructional features or restricted in performance capabilities and are intended for use as components of complete equipment submitted for investigation rather than for direct separate installation in the field. THE FINAL ACCEPTANCE OF THE COMPONENT IS DEPENDENT UPON ITS INSTALLATION AND USE IN COMPLETE EQUIPMENT SUBMITTED TO UNDERWRITERS LABORATORIES INC.

GENERAL

This category covers bundling devices, cable straps, wiring ducts, etc., which provide mechanical means for holding or routing conductors within equipment.

Investigation generally includes flammability, elevated temperature exposure and mechanical property considerations.

REQUIREMENTS

The basic standard used to investigate products in this category is [UL 1565](#), "Positioning Devices."

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QEUY2.E8741
Panelboard and Switchboard Accessories - Component

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Panelboard and Switchboard Accessories - Component

[See General Information for Panelboard and Switchboard Accessories - Component](#)

EATON

E8741

EATON BLDG
 1725 1200TH AVE
 LINCOLN, IL 62656 USA

Panelboard interiors, Cat. Nos. 81-11040X, 81-25582D, 81-25577-3D.

Cat. Nos. PB424CHH2251NGP, PB424ML2251NGP, PB424CC2251NGP.

Cat. Nos. EE1483S08AX, -08CX, EE1483T12AX, -12CX.

CH12L125INT, CH12L200INT, CH12L3125INT, CH16L125INT, CH16L200INT, CH18L3125INT, CH24L125INT, CH24L225INT, CH24L3125INT, CH24L3225INT, CH30L3150INT, CH30L3225INT, CH32L225INT, CH42L225INT, CH42L3225INT, CH30B3200INT, CH6L3125INTSR, CH12L3225INTSR.

Cat. No. CH9MB270.

Cat. Nos. 24INT70B, 24INT125B, 48INT125B, 612INT125B, 816INT125B, CH2L70INT, CH2L125INT, CH4L125INT, CH6L3125INT, CH8L125INT, ML3100B.

Sub-feed devices Cat. Nos. CHB9SF2125, -3125, CH9SF2125, -3125.

Breaker mounting panels, Cat. Nos. CHB9H1, CHB9H2125, -3100, CHB9L1, CHB9L250, -350.

Mounting tab, Cat. No. CHB9F10.

Tie plates, Cat. Nos. CHB9T2, -T3.

Marking: Company name and catalog designation.

[Last Updated](#) on 2007-03-19

CH9GP21
 CH9GP13
 (SEE FOLLOWING PAGE)
 FOR ACCESSORIES

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QEUY2.GuideInfo Panelboard and Switchboard Accessories - Component

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Panelboard and Switchboard Accessories - Component

The devices covered under this category are incomplete in certain constructional features or restricted in performance capabilities and are intended for use as components of complete equipment submitted for investigation rather than for direct separate installation in the field. THE FINAL ACCEPTANCE OF THE COMPONENT IS DEPENDENT UPON ITS INSTALLATION AND USE IN COMPLETE EQUIPMENT SUBMITTED TO UNDERWRITERS LABORATORIES INC.

USE

This category covers incomplete panelboard assemblies, such as panelboard interiors. Also covered under this category are accessories intended for use with panelboards or switchboards, such as branch circuit buses for circuit breakers and switches, insulators, anti-turn devices, neutral assemblies, bonding kits, equipment grounding bars, barrier kits, back-fed unit hold-down kits, transfer kits for optional standby power systems, and the like.

CONDITIONS OF ACCEPTABILITY

Consideration is to be given to the Conditions of Acceptability specified in the individual Reports when these components are employed in the end-use equipment.

RELATED PRODUCTS

Accessories intended for use specifically with circuit breakers are covered under Circuit Breaker Accessories ([DIHS2](#)).

REQUIREMENTS

The basic standards used to investigate products in this category are [ANSI/UL 67](#), "Panelboards," and [ANSI/UL 891](#), "Switchboards."

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Steel City[®]



T&B Catalog Number: TC112A
UPC Number: 78599102496
Description: 3/4" Compression Connector, Steel-Zinc Plated, Concrete tight. For use with EMT Conduit.
Status: Active

Features

- Concrete Tight

General

-Trade Size (inches) 3/4
-Material Steel
-Finish Zinc Plated
-Connection Type Compression

Packaging

-T&B Order Multiple 50
-T&B Inner Pack 50
-Package in Units 250
-T&B Sold in UOM Each
-T&B Weight Per UOM 15.92 lbs. per 100

Application Support

-Product Selector sg_emt_steel_couple_conn

Certifications

-RoHS Compliance Yes

Certifications



File Nbr:

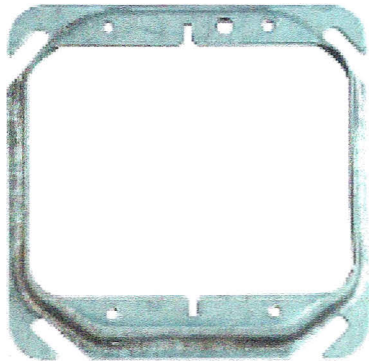
E 16592

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Monday-Friday
Phone: (888) 862-3289
Fax: (901) 252-1321
Email:techsupport@tnb.com



Steel City

T&B Catalog Number: 52C17-25
UPC Number: 78599113895
Description: 4" Pre-galvanized steel square box device cover, 1/2" raised, 6.3 cu.in. For use with two devices.
Status: Active

General

-Material	Steel
-Finish	Galvanized
-Volume (cu.in.)	6.3

Dimension Information

-Size (inches)	4
-Raised (inches)	1/2
-Number of Devices	Two

Packaging

-Package in Units	25
-T&B Sold in UOM	Each
-T&B Weight Per UOM	18.4 lbs. per 100

Application Support

-Product Overview	Available on Website
-NEC Article 314 - Boxes and Fittings	Available on Website
-Product Brochure-Pre-Assemblies & Pre-Assemblies Labor Saving Calculator	Available on Website

Certifications

-RoHS Compliance	No
------------------	----

Certifications



File Nbr:
E 2969

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Steel City®

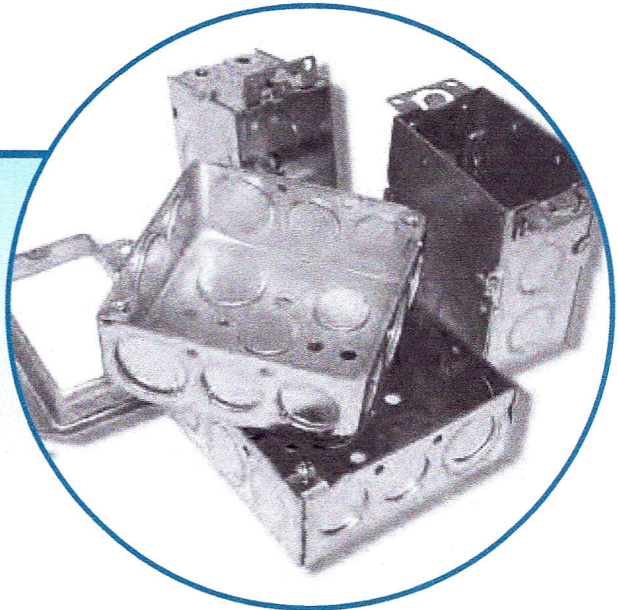
Overview

Steel City® Metallic Boxes & Covers

Steel City® is the industry leading product line of metallic switch and outlet boxes used in electrical construction. Since 1904, Steel City® products have symbolized the highest quality standards in manufacturing and innovative design, with one of the most complete offerings available.

Steel City® products are known for their simple improvements, such as being the first box offering to standardize combination slotted/phillips screws on all boxes. Thomas & Betts is also recognized as a leader in design innovation, as in our new metal stud bracket.

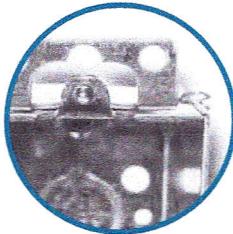
Thomas & Betts continues to listen to contractors and responds to their ever-changing needs. Contact a T&B distributor nearest you to select the right Steel City® product for your requirements.



Advantages of Steel City® Boxes & Covers

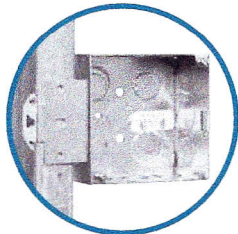
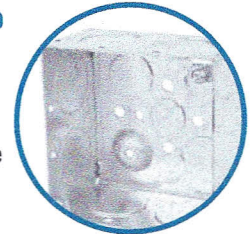
Notched Ears on Switch Boxes

- Steel City® Switch Boxes feature a longer ear and a special notch. This provides clearance for the screws that are used to attach wall plates to GFCI or rocker-type light switches



Raised Ground Screw Bump in 4" Square, 4 1/6" and Utility Boxes

- Quicker surface mounting by eliminating the need to remove the portion of the screw that threads through the back of the box
- Allows for improved repositioning of grounding conductor
- Ground bump standard in 2 1/2" boxes
- Ground bump optional in 1 1/2" boxes

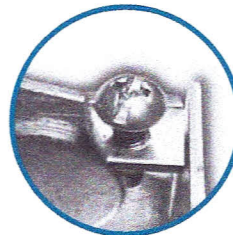
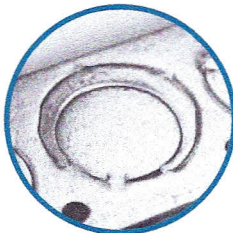


MS Bracket Boxes

- Mounts without the use of screws
- Mounts to the open or closed side of the stud
- Works on stud depths up to 4"

Eccentric Knockouts on Square Boxes

- Provide better contact with conduit fitting and locknut to the box, improve grounding path, stronger than 3/4" knockout
- Available in all four standard size square boxes
- Improved 3/4" knockout position on square boxes
- Less labor required to install 3/4" conduit to box



Pre-Installed Screws are Packaged in Raised Position

- Eliminates extra step of having to back out the screw during cover installation

Steel City® switch and outlet boxes are protected from rust and corrosion by zinc-galvanizing. All clamps and other component parts are electrogalvanized separately, before assembly in the box, to ensure corrosion protection of every surface. Steel City® galvanized finish meets the requirements of Underwriters Laboratories, Inc. and Federal Specifications.

Thomas & Betts

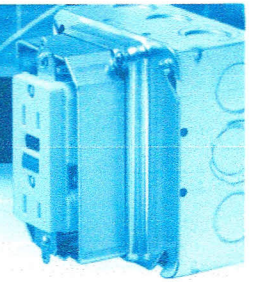
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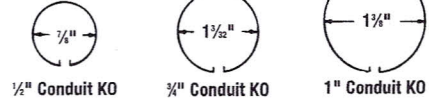


Guide to Steel City® Knockouts, Pryouts, Ears, Brackets and Clamps

Knockouts and Pryouts

Steel City® conduit KO's have standard trade size dimensions. KO's are uniform and true for attachment of cable or conduit connectors. Pryouts for cable entrance are slotted — a twist with a screwdriver removes them. KO's and Pryouts are precision stamped to permit easy removal, but remain sufficiently strong and sturdy when not removed.

Knockouts



Outlet Box Ears

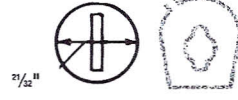
Mounting ears support the box independent of the electrical system attachments. Switch boxes have a fixed ear for old work installations. Ears for plaster are set 1/8" forward of the box face in position for old work (modernization), except where specifically noted.

Eccentric Knockouts



Combination 1/2" & 3/4" Knockout

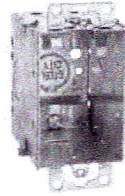
Pryouts



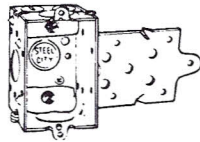
Cable Pryouts always in Pairs.

Tapped Holes for Grounding

All Steel City® boxes have a 10-32 tapped hole in the bottom of the box for attaching separate ground wire.

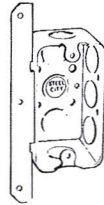


Brackets



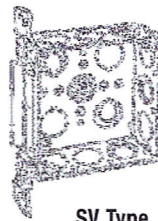
S or B Type

Mounts to face of stud. Used on switch, handy or square boxes. 2" long x 2 1/4" wide



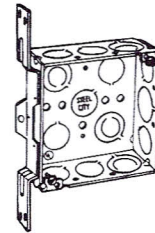
T Type

Positions handy box against the face and side of stud. 5 1/2" long x 1 1/4" wide



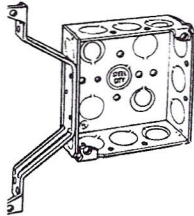
SV Type

Mounts box to side of stud with positioning spikes. 7 7/8" long x 1" wide x 3/8" offset



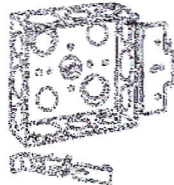
CV Type (Outlet Boxes)

Mounts to flat side of metal studs or wood studs. 7 7/8" long x 1" wide x 3/8" offset



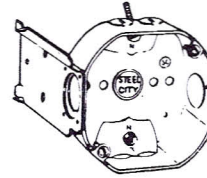
DV Type

Mounts box offset from stud 1 1/2". 6 13/16" long x 1" wide x 1 1/2" offset



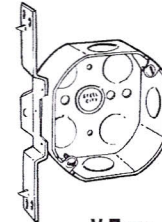
MS Type (For Metal Studs)

Mounts to any depth of metal stud, open or closed side. 2 1/2" long x 1 1/8" wide x 3/8" offset
Far side support to 4" only



L Type

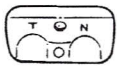
Used to mount octagon boxes. 2 5/8" long x 3 3/8" wide x 1/4" offset



V Type

Mounts to flat side of stud. 7 7/8" long x 1" wide x 3/8" offset

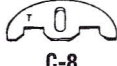
Clamps



C-1



C-5



C-8 (Loom only)



C-3

For Armored Cable



C-10

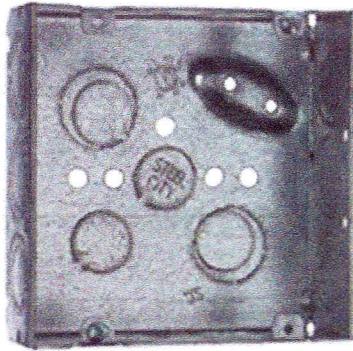
For Non-Metallic Sheathed Cable and Non-Metallic Tubing (Loom)

UNDERWRITERS LABORATORIES INC. and CANADIAN STANDARDS ASSOCIATION file numbers for individual items available upon request. *Products listed in this catalog are subject to alteration or discontinuation without prior notice.*

Listing Information for Armored Cable Clamp — Type C-3

Armored Cable (BX) — Steel	Sizes 14-2 through 10-3	MCAP™ — Aluminum*	.370—.580
Armored Cable (BX) — Aluminum	Sizes 14-2 through 10-3	Flex Metal Conduit — Steel	1/8" Trade Size
MC Interlocked (MCI) — Steel	.449—.570 Diameter	Flex Metal Conduit — Aluminum	3/8" Trade Size
MC Interlocked (MCI) — Aluminum	.476—.606 Diameter	C-3 Clamp Acceptable for Grounding	
MC Corrugated (MCC) — Aluminum	.375—.515 Diameter		

* MCAP™ is a trademark of Southwire Company



Steel City

T&B Catalog Number: 521711234E
UPC Number: 78599116711
Description: 4" Pre-galvanized steel square box, 2-1/8" deep, 30.3 cuin. Welded construction with 1/2" & 3/4" eccentric knockouts and ground bump. For use with conduit.
Status: Active

General

-Material	Steel
-Finish	Galvanized
-Volume (cu.in.)	30.3
-Construction Type	Welded
-Ground Bump	Yes
-Knockouts-Each Side (Conduit)	(2) - 1/2", (1) - 1/2" & 3/4" E
-Knockouts-Each End (Conduit)	(2) - 1/2", (1) - 1/2" & 3/4" E
-Knockouts-Bottom (Conduit)	(3) - 1/2", (2) - 1/2" & 3/4" E

Dimension Information

-Size (inches)	4
-Depth (inches)	2 1/8

Packaging

-Package in Units	50
-T&B Sold in UOM	Each
-T&B Weight Per UOM	86.7 lbs. per 100

Application Support

-Product Overview	Available on Website
-NEC Article 314 - Boxes and Fittings	Available on Website
-Product Brochure-Pre-Assemblies & Pre-Assemblies	Available on Website
-Pre-Assemblies Labor Saving Calculator	Available on Website

Certifications

-RoHS Compliance	No
------------------	----

Certifications



File Nbr:
E 2969

For further technical assistance, please contact us...

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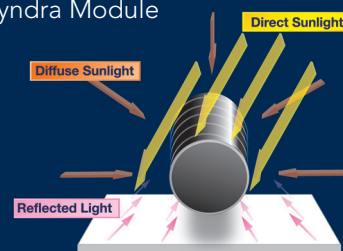
SOLYNDRA[®]

100 SERIES

Solar photovoltaic systems comprised of panels and mounting hardware for low slope, commercial rooftops.

Proprietary cylindrical modules optimize the collection of sunlight and enable Solyndra panels to achieve the highest rooftop coverage without the need for costly mounting hardware or rooftop penetrations. By significantly reducing installation costs and increasing the electricity generated per rooftop, Solyndra delivers electricity at low cost per kilowatt hour.

Solyndra Module



Maximize roof coverage with no need for tilting and spacing.

Greater coverage means more solar electricity per rooftop per year

Fast, simple, and economical installation

Lightweight and self-ballasting

No penetrations or attachments required

Product Specifications*

100 SERIES

Electrical Data

Measured at Standard Test Conditions (STC) irradiance of 1000 W/m², air mass 1.5, and cell temperature 25° C

Model Number		SL-001-150	SL-001-157	SL-001-165	SL-001-173	SL-001-182	SL-001-191	SL-001-200 Release Date TBD
PowerRating (P _{mp})	Wp	150 Wp	157 Wp	165 Wp	173 Wp	182 Wp	191 Wp	200 Wp
Power Tolerance (%)	%/Wp	+4, -5	+/-4	+/-4	+/-4	+/-4	+/-4	+/-4
V _{mp} (Voltage at Maximum Power)	Volts	65.7 V	67.5 V	69.6 V	71.7 V	73.9 V	76.1 V	78.3 V
I _{mp} (Current at Maximum Power)	Amps	2.28 A	2.33 A	2.37 A	2.41 A	2.46 A	2.51 A	2.55 A
V _{oc} (Open Circuit Voltage)	Volts	91.4 V	92.5 V	93.9 V	95.2 V	96.7 V	98.2 V	99.7 V
I _{sc} (Short Circuit Current)	Amps	2.72 A	2.73 A	2.74 A	2.75 A	2.76 A	2.77 A	2.78 A
Temp. Coefficient of V _{oc}	%/°C	-0.29						
Temp. Coefficient of I _{sc}	%/°C	-0.02						
Temp. Coefficient of Power	%/°C	-0.38						

System Information

Cell type	Cylindrical CIGS
Maximum System Voltage	Universal design: 1000V (IEC) & 600V (UL) systems
Dimensions	Panel: 1.82 m x 1.08 m x 0.05 m Height: 0.3 m to top of panel on mounts
Mounts	Non-penetrating, powder-coated aluminum
Connectors	4 Tyco Solarlok; 0.20 m cable
Series Fuse Rating	23 Amps
Roof Load	16 kg/m ² (3.3 lb/ft ²) panel and mounts
Panel Weight	31 kg (68 lb) without mounts
Snow Load Maximum	2,400 Pa (50.1 lb/ft ²)
Hailstone Impact	25 mm, 7.53 g at 23 m/s per IEC 61646
Wind Performance	208 km/h (130 mph) maximum Self-ballasting with no attachments
Operating and Storage Temp	-40°C to +85°C
Normal Operating Cell Temperature (NOCT)	41.7°C at 800 W/m ² , Temp = 20°C, Wind = 1m/s
Certifications/Listings	UL1703, IEC 61646, CEC listing IEC 61730, CE Mark, Fire Class C Application Class A per IEC 61730-2
Warranty	25 year limited power warranty 5 year limited product warranty



Solyndra's panels come with all of the mounts, grounding connectors, lateral clips, and fasteners required to build a standard array.

Headquarters	Regional Support Contacts
Solyndra LLC 47488 Kato Road Fremont CA 94538 USA	Belgium 0800 50735 customersupportbe@solyndra.com
	EMEA 353 61 79 1124 customersupporteu@solyndra.com
	France 0800 942896 customersupportfr@solyndra.com
	Germany 0800 0004366 customersupportde@solyndra.com
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*PRODUCT SPECIFICATIONS ARE ONLY VALID WHEN USING THE PRODUCT IN ACCORDANCE WITH SOLYNDRA'S DESIGN AND INSTALLATION GUIDELINES USING SOLYNDRA SUPPLIED MOUNTS AND INTERCONNECTING HARDWARE. PRODUCT SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

SOLYNDRA[®]
The new shape of solar™

Revision: 9 / Released: 2011-04-01
Part: 0920-30081-009

Xantrex GT Series Grid Tie Solar Inverters



The Xantrex Grid Tie Solar Inverter (GT Series) is designed to convert photovoltaic (PV) electricity produced by solar modules into utility-grade power that can be used by the home or sold to the local electrical utility. Offering high efficiency (up to 96.0%), clean aesthetics, high reliability, and a low installed cost, through ease of installation and integrated features, the GT Series is a proven, high-frequency design in a compact enclosure.

The GT Series may be installed as a single inverter, for a single PV array, or in a multiple-inverter configuration for large PV arrays.

Technology

- ▶ An NEC compliant, integrated DC/AC disconnect, standard in the GT Series, eliminates the need for external DC (PV) disconnects, and in some jurisdictions, AC disconnects
- ▶ Large heat-sink offers extraordinary heat dispersion without the need for a cooling fan
- ▶ Liquid crystal display (LCD) provides instantaneous information – power level, daily and lifetime energy production, PV array voltage and current, utility voltage and frequency, time online "selling", fault messages, and installer-customized screens
- ▶ LCD vibration sensor allows the tap of a finger to turn backlight on and to cycle through display screens
- ▶ Free PC software for remote monitoring and system troubleshooting available online

Installation

- ▶ Flexible module selection and sizing due to wide PV input MPPT tracking voltage range
- ▶ Lightweight and versatile mounting bracket
- ▶ Easy access DC (photovoltaic) and AC (utility) terminal block simplifies wiring
- ▶ Rugged NEMA 3R inverter enclosure allows reliable indoor and outdoor installations

Performance

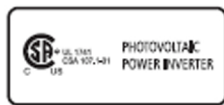
- ▶ Best-in-class efficiency to maximize solar system return on investment
- ▶ Accurate MPPT tracking ensures maximum energy harvest under any conditions
- ▶ FCC Part B compliance provides less external electronic interference

Serviceability

- ▶ 10-year standard warranty
- ▶ Sealed inverter enclosure can be quickly separated from the wiring box allowing DC/AC connections to remain intact in the unlikely event the inverter needs to be serviced



Standard
10-year
warranty



Xantrex Technology Inc.
Customer Service/Technical Support
customerservice@xantrex.com
Toll free: 1-800-670-0707

www.xantrex.com

Xantrex GT Series Grid Tie Solar Inverters

Models	GT5.0		GT4.0N		GT3.3N		GT2.8	
Output	240 V	208 V	240 V	208 V	240 V	208 V	240 V	208 V
Max. AC power output	5000 W	4500 W	4000 W	3800 W	3300 W	3100 W	2800 W	2700 W
AC output voltage (nominal)	240 V	208 V	240 V	208 V	240 V	208 V	240 V	208 V
AC output voltage range	211-264 Vac	183-229 Vac	211-264 Vac	183-229 Vac	211-264 Vac	183-229 Vac	211-264 Vac	183-229 Vac
AC frequency (nominal)	60 Hz							
AC frequency range	59.3 - 60.5 Hz							
Startup current	0 Aac							
Max. continuous output current	21 A	22 A	16.7 A	18.3 A	13.8 A	14.9 A	11.7 A	13.0 A
Max. output over-current protection	30 A		25 A		20 A		15 A	
Max. output over-current protection	30 Arms		25 Arms		20 Arms		15 Arms	
Max. utility backfeed current	0 A							
Total harmonic distortion (THD)	< 3 %		-		< 5 %		-	
Power factor	> 0.99 % (at rated power), > 0.95 % (full power range)							
Utility monitoring, islanding protection	UL1741-2005 / IEEE 1547							
Output characteristics	Current Source							
Output current waveform	True sine wave							
Max. array open-circuit voltage	600 Vdc							
MPPT voltage range (CEC & CSA)	240 - 550 Vdc		240 - 480 Vdc		200 - 400 Vdc		195 - 550 Vdc	
MPPT operating range	Low: 235 Vdc / High: 550 Vdc		Low: 235 Vdc / High: 550 Vdc		Low: 200 Vdc / High: 550 Vdc Vdc		Low: 193 Vdc / High: 550 Vdc	
Max. input current	22.0 Adc	20.0 Adc	18.0 Adc	17.0 Adc	17.5 Adc	16.5 Adc	15.4 Adc	14.9 Adc
Max. array short-circuit current	24.0 Adc							
Reverse-polarity protection	Short-circuit diode							
Ground-fault protection	GF detection, IDIF > 1 A							
Max. inverter efficiency	95.9%	95.5%	96.0%	95.7%	95.9%	95.6%	95.0%	94.6%
CEC efficiency	95.5%	95.0%	95.5%	95.0%	95.5%	95.0%	94.0%	93.5%
Night-time power consumption	1 W							
Operating temperature range	-13°F to +149°F (-25°C to +65°C)							
Enclosure type	NEMA 3R (outdoor rated)							
Inverter weight	58.0 lb (25.8 kg)		58.0 lb (25.8 kg)		49.0 lb (22.2 kg)		49.0 lb (22.2 kg)	
Shipping weight	65.0 lb (27.2 kg)		65.0 lb (27.2 kg)		57.0 lb (25.9 kg)		57.0 lb (25.9 kg)	
Inverter dimensions (H x W x D)	28 1/2 x 16 x 5 3/4" (724 x 403 x 145 mm)							
Shipping dimensions (H x W x D)	34 x 20 1/2 x 10 5/16" (866 x 518 x 262 mm)							
Mounting	Wall mount (mounting bracket included)							
Input and output terminal	AC and DC terminals accept wires sizes of #14 to #6 AWG							
PV / Utility disconnect	Eliminates need for external PV (DC) disconnect. Complies with NEC requirements							
Cooling	Convection cooled, fan not required							
Display	Backlit, two-line, 16-character liquid crystal display provides instantaneous power, daily and lifetime energy production, PV array voltage and current, utility voltage and frequency, time online "selling", fault messages, and installer-customizable screens							
Communications	Integrated RS232 and Xantrex™ RM5 communication ports							
Wiring box	PV, utility, ground, and communications connections. The inverter can be separated from the wiring box							
Warranty	10-year standard							
Model name (negative ground)	GT5.0-NA-240/208 UL-05		GT4.0N-NA-240/208 UL-05		GT3.3N-NA-240/208 UL-05		GT2.8-NA-240/208 UL-05	
Part number (negative ground)	864-1009		864-1008		864-1006		864-1001	
	Positive ground inverters are also available							

Specifications subject to change without notice.

<http://www.wholesalesolar.com/inverters.html>

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DHD3014UC

Specialty Ventilation
30" Downdraft

- ▶ Overview
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General Properties

SKU: DHD3014UC
Material: Stainless steel
Motor location: External
Operating Mode: Convertable: Ducted / Recirculating
Current (A): 10 A
Volts (V): 120 V
Frequency (Hz): 60 Hz
Approval certificates: CSA, UL
Plug type: 120V-3 prong
Remote control: No
Number of motors: 0 No.
Number of speed settings: 3-stage
Number of lights: 0 No.
Total power of the lamps (W): 0 W
Silence level (dBA): 0 dB
No-return airflow flap: No
Grease filter material: Metal grease filter
Grease filter type: Multilayer cassette
Overall appliance dimensions (HxWxD) (in): / x 31 " x 3 3/4 " "
Product packaging dimensions (HxWxD) (in): 7.48 x 32.67 x 27.16 "
Vertical rise height: 13" "
Net weight (lbs): 37 lbs
Gross weight (lbs): 41 lbs
Diameter of air duct (in) back: 10 "
Required accessories: Blower
UPC code: 825225865810
SERIES: 800 Series

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GE Profile Advantium® 120 Above-the-Cooktop Oven



Model# PSA1201RSS



- Speedcook Technology - Cooks up to 4 times faster than a conventional oven
- 4 Ovens In 1 To Meet Your Cooking Needs - Speedcook, True European Convection, Warming/Proofing, Sensor Microwave
- - Optimizes cook time for consistent results
- - Saves valuable time by eliminating preheating
- - Over 175 preprogrammed recipes
- - 2 full-width oven racks for multi-level cooking

FEATURES

Control Type	Glass Touch Controls; Dial
Cooking Modes	Speedcook; Microwave Convection Bake Broil Warm Proof Toast
Cooking Technology	Advantium
Style	Above-the-Cooktop
Cooktop Lighting	Bright/Night/Off Auto Night Light
Defrost Type	Auto / Time / Food / Quick Defrost
Exhaust Fan	Hi/Med/Low/Off
Intake Air/Grease Filter	Yes
Interior Oven Light	Yes
Power Levels	1-10
Program Cooking	Over 175 Programmed Menu Items
Turntable	Glass
Turntable Size (in.)	13.6
Microwave Cooking Controls	Time Cook I & II Melt Soften Defrost by Food Type Defrost by Weight Defrost by Time Simmer
Microwave Sensor Cooking Controls	Popcorn Potatoes Reheat Vegetables Ground Meat Rice Soup Cook By: Beverage Cook By: Reheat Cook By: Bacon Cook By: Eggs
Control Features	Add Time - Dial Clear/Off Clock Cooking Complete Reminder Delay Start Display On/Off Help Pad Timer (On/Off) Reminder (24 Hr.) Repeat Last Start/Pause Demo Mode My Recipes - Up to 30
Microwave Oven Interior	Stainless Steel
Microwave Watts (IEC-705)	925.0

GE Profile Advantium® 120 Above-the-Cooktop Oven



Model# PSA1201RSS

APPROXIMATE DIMENSIONS (HxDxW)

- 16 7/16 in x 15 3/8 in x 29 15/16 in

CAPACITY

- Total Capacity (cubic feet) 1.7 cu ft
- Exhaust Capacity 300.0 ft³/min

WARRANTY

- Parts Warranty - Limited 1-year entire appliance
Limited 5-year magnetron tube
- Labor Warranty - Limited 1-year entire appliance
- Warranty Notes - See written warranty for full details

Have more questions? Please contact 1-800-626-2005

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DHG601DUC

600 CFM Internal Blower

- ▶ Overview
- ▶ Technical specs
- ▶ Additional documents



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General Properties

SKU: DHG601DUC
Material: Lacquered
Motor location: External
Operating Mode: Ducted
Watts (W): 530 W
Volts (V): 120 V
Frequency (Hz): 60 Hz
Approval certificates: ETL
Plug type: 120V-3 prong
Remote control: No
Number of motors: 1 No.
Number of lights: 0 No.
Total power of the lamps (W): 0 W
Silence level (dBA): 0 dB
No-return airflow flap: No
Overall appliance dimensions (HxWxD) (in): 15 1/8" / x 14 3/8 " x 6 3/4 " *
Product packaging dimensions (HxWxD) (in): 8.66 x 17.32 x 15.74 "
Net weight (lbs): 10 lbs
Gross weight (lbs): 18 lbs
Maximum CFM: 600 Cu Ft mi
Discharge direction: downward
Diameter of air duct (in) top: 10 "
Diameter of air duct (in) back: 6 "
Required accessories: Blower
UPC code: 825225837732
SERIES: Accessory

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DHDRM36UC

Downdraft Recirculation Module

- ▶ Overview
- ▶ Technical specs
- ▶ Additional documents



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General Properties

Product group: Hood
 Brand: Bosch
 Product name / series name: product line supplement cooker hood
 SKU: DHDRM36UC
 EAN code: 4242002495118
 Dimensions of the packed product (HxWxD): 220 x 880 x 610 cm
 Net weight (kg): 8.28 kg
 Gross weight (kg): 10.20 kg
 Quantity per packing unit: 0
 Standard number of units per pallet: 8
 EAN Barcode: !2E20AC-ejfbbi!
 UPC code: 825,225,866,404

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SHV43P13UC

Dishwasher
24" Integra 300 series

- ▶ Overview
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- ▶ Additional documents



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- Accessories**
- ▶ SMZ5002UC
 - ▶ SGZ1052UC
 - ▶ SGZ1010UC

General Properties
Product group: Dishwasher
Brand: Bosch
SKU: SHV43P13UC
Installation Type: Full Integrated
Panel ready: No, only as accessory
Tub material: Stainless steel
Concealed heating element: Yes
Watts (W): 1400 W
Current (A): 12 A
Volts (V): 120 V
Frequency (Hz): 60 Hz
Approval certificates: CSA, UL
Power cord length (cm): 0.0 cm
Plug type: Fixed connection
Length inlet hose (cm): 0 cm
Length outlet hose (cm): 178 cm
Adjustable feet: Yes
Overall appliance dimensions (HxWxD) (mm): 862 x 598 x 550 mm
Product packaging dimensions (HxWxD) (mm): 920 x 670 x 660 mm
Required cutout size (HxWxD) (mm): 860 x 610 x 610 mm
Net weight (kg): 45.00 kg
Gross weight (kg): 51.00 kg
Number of place settings: 14
Total annual water consumption (l): 0 l
Number of wash cycles: 4
Leak Protection System: Aqua Stop
Water softener: No
Start delay time max (h): 0 h
Display: No
ChildLock: No
INTERIOR_LIGHT_DISH: No
Adjustable upper rack: Single
Glass protection: No
Top basket type: 300
Bottom basket type: 300
Business field: E32

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Display: No
ChildLock: No
INTERIOR_LIGHT_DISH: No
Adjustable upper rack: Single
Glass protection: No
Top basket type: 300
Bottom basket type: 300
Business field: E32
Program 1: Power Scrub Plus US
Program 2: Auto US
Program 3: Regular US
Program 4: Quick Wash US
Silence level (dBA): 50 dB
Load Sensor: No
Variable spray pressure: No
Energy Star® qualified: Yes
Total annual energy consumption (kWh): 259 kWh
Number of Options: 1
Flip tines in upper rack: 1
Fine Cutlery and Silver Tray: No
Flip tines in lower rack: 1
Mezzanine Rack: No
Silverware Basket: Standard
Extra-tall item sprinkler: No
LED: Yes
Multi-Function LED: No
Multi-function text LCD: No
Sanitized indicator light: Yes
Tub type: TallTub
Triple Filtration System: Yes
Five-Level Wash: Yes
NSF Certified: Yes
Required cutout size (HxWxD) (in): 33 15/16" - 35" x 24 " x 24 " *
Overall appliance dimensions (HxWxD) (in): 33 7/8 " x 23 9/16 " x 21 3/4 " *
ADA Compliant: No
Product packaging dimensions (HxWxD) (in): 36 5/8" x 26 3/8" x 26" *
Net weight (lbs): 100 lbs
Gross weight (lbs): 111 lbs
Length outlet hose (in): 90 1/2 "
UPC code: 825,225,880,127
Additional operational options: half load
3rd Rack: no
Shelf Racks in Top Basket: 2 No.
Bottom basket Inserts: 0
Upper rack cup shelf: 2
Included accessories 2: 2 small item clips
SERIES: 300
Interior light: No



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Sun Frost Refrigerator/Freezer Single Compressor Custom Designed

Model: RF12

Product Preferences

► **CLICK dropdown arrow in selection boxes to configure product and determine total cost.**



Base Price: \$2,179.00

- Color:
[Dropdown menu]
- Hinges:
[Dropdown menu]
- Laminate brand name, color name and color number [optional]:
[Dropdown menu]
- Model number:
[Dropdown menu]
- Optional Base Cabinet:
[Dropdown menu]
- Shipping Zone*:
[Dropdown menu]
- Voltage:
[Dropdown menu]

Item Total \$2,179.00

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Product Description



The world's most elegant
and efficient Refrigerators!
Single Compressor
Refrigerator/Freezer

SunFrost Refrigerator/Freezer Single Compressor Model RF12

The world's most elegant refrigerators are also the most efficient!

Along with energy efficiency, the SUN FROST offers other advantages not found in conventional refrigerators, including food-saving high-humidity storage, quiet operation and an easy to clean interior.

With its clean, uninterrupted lines and choice of more than 100 colors and numerous natural wood finishes, the custom-built SUN FROST refrigerator adds elegance to every kitchen.

For the past 19 years, Sun Frost refrigerators/freezers have been used in over 50 countries and have an excellent track record. Sun Frost units are ruggedly constructed and will provide many years of reliable operation, even in the harshest environments.

The Sun Frost RF12 is a single compressor refrigerator freezer with a passive [no fans] cooling system. For convenience it is typically mounted on a 24" high cabinet. The matching cabinet made by Sun Frost has two large side-by-side drawers.

Product Applications:

- Residential Kitchens
- Can run by photovoltaic or utility power
- Can run directly from battery, no generator necessary
- Boats, RVs, conversion buses. No need to level refrigerator

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Manufacturer Info

- Other products

Installations



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- and vibration will not affect its operation.

Solar Photovoltaic Power:

In an energy-efficient home powered by photovoltaics or other low-output energy sources, refrigeration is typically the largest consumer of electricity. But the super-efficient SUN FROST refrigerator makes these alternative technologies both feasible and affordable.

The cost of a solar power system is typically more than the cost of a refrigerator, so efficiency is of prime importance in reducing system costs. As a result of the extremely low energy consumption of Sun Frost units, the cost of a power system will be drastically reduced.

Utility Power:

In a home using utility power, SUN FROST normally cuts energy consumption by 80%

Product Features:

- Rustproof cabinet and hardware [made of wood]
- Unexposed evaporator - cannot be punctured during defrosting
- All copper cooling system prevents corrosion
- Condenser is easy to clean and minimally affected by dust/cobwebs
- Convenient front loading storage - contents don't need to be piled up
- Tested & approved by the World Health Organization (RFVB-134a)
- One-piece liners make cleaning and defrosting easier
- High humidity storage conditions resulting in longer food storage
- Quiet operations
- Generates less heat keeping kitchens cooler during the hot summer
- Standard laminate color is white
- A wide variety of custom laminates and wood veneers are available
- [scroll to the bottom of the page for details]



Product Highlights:

Efficiency - Plus

The Sun Frost refrigerator employs an array of design innovations to achieve its exceptionally low energy consumption. The cooling system on the Sun Frost is top mounted. This configuration reduces energy consumption several ways. The heat generated by the compressor and condenser (black coils on the back of many refrigerators) does not re-enter the refrigerator and also with a cooler running condenser, the efficiency of the cooling system is increased.

Quiet Operation

Because of the efficient design of the Sun Frost, the compressors used run less often, are much smaller and produce correspondingly less noise than those found on a conventional refrigerator. These features make the Sun Frost much quieter than a conventional AC refrigerator.

Simple Defrost System

Defrosting a Sun Frost is a simple process. Frost build-up in the Sun Frost freezer is very slow because there is no air circulating between the freezer and refrigerator sections. The ice that forms in the freezer collects primarily on the ceiling. When defrosting the freezer section, the contents of the freezer may be transferred to the refrigerator section so they remain frozen. After the refrigerator has been turned off for about twenty minutes, the ice is easily removed in large pieces. There is no mop-up because the ice does not need to be melted, only separated from the flat ceiling.

Superior Storage Conditions

Sun Frost refrigerators keep food fresher by maintaining high humidity. This prevents freezer burn and wilting caused by water loss in food. Since there is minimal water loss in foods stored in a Sun Frost, foods often last two to three times longer than in conventional refrigerators. In typical refrigerators, water, which is part of stored food, is transformed into ice on the freezer's cooling coils. This process results in the dehydration of fruits and vegetables, increases energy consumption, and accelerates frost build-up. In a conventional refrigerator, high humidity is achieved by storing food in airtight containers, which creates high humidity conditions, but cuts off the food's oxygen supply. Without oxygen, plant cells break down more rapidly, which decreases shelf life. The Sun Frost allows you to store food in breathable containers, such as paper bags, often more than doubling storage life.

Reliable

The cooling system of the Sun Frost refrigerator contains a minimal number of moving parts. Both the DC and AC compressors incorporate highly reliable, hermetically sealed, brushless motors. The efficient thermal design of Sun Frost refrigerators also contributes to their reliability. The top-mounted cooling system runs at a lower temperature than most, which prolongs the life of the system's lubricants and reduces mechanical strain on the compressor. The cooling system should provide well over 15 years of trouble-free operation.

Cooler Summer Kitchen

During the summer, a typical refrigerator adds as much heat to your kitchen as a 1000 watt heater running four hours per day! The energy needed by your air conditioner to remove this excess heat will be about half the energy consumed by your refrigerator. Increasing the cost of running your refrigerator by an additional 50%. By producing much less waste heat than a conventional refrigerator, a Sun Frost makes your kitchen more comfortable and reduces the cost of air-conditioning your home.

More Sensible use of Kitchen Space

Sun Frost refrigerators are designed to be mounted on a cabinet. With the refrigerator raised, all stored food will then be at a convenient height. In addition, a cabinet beneath the refrigerator provides much more accessible storage space than a ceiling mounted cabinet. The cabinet could be built by the homeowner to match other kitchen cabinets or supplied by Sun Frost. Sun Frost manufactures a 24-inch high cabinet for the Sun Frost RF12. Each cabinet has two large side-by-side drawers. A Sun Frost refrigerator can be placed against a wall, minimizing floor area utilized. It will not have to be moved for either cleaning or servicing.

Custom Styling and Finishes

Each custom built Sun Frost refrigerator is available in more than 100 colors of high-pressure laminate, many natural wood finishes and now a new stainless steel design.

Rugged Design

All Sun Frost refrigerators are completely rust-proof. The spacious interior, made from sturdy fiberglass-reinforced plastic, is exceptionally easy to clean, with no exposed ducts, tubing or inaccessible corners. The adjustable door shelves can accommodate half-gallon beverage containers, while adjustable glass shelves line the refrigerator section.

Reliability

Sun Frost refrigerators have proved themselves reliable. Over the past 12 years they have been installed in over 50 developing countries and have held up under the harshest conditions. For critical applications, far from supporting infrastructure, from Borneo to Botswana, Sun Frost refrigerators have delivered consistently dependable performance day in and day out.

HELP » [Contact Customer Support](#)

- Toll-Free help line offering product info and ordering support
- Online e-mail technical and installation support
- Product cost-of-operation evaluations and comparisons

Product Specifications:**Sun Frost Refrigerator Energy Usage**

RF12**	Refrigerator - Freezer
Daily Energy Use amp hrs @ 12 VDC / kwh @ 110 VAC	at 70°F 21°C: 24 amp-hrs / .29 kWh at 90°F 32°C: 39 amp-hrs / .47 kWh
Height	49.5"
Width	34.5"
Depth	27.75"
Shipping Weigth	230 lbs [export add 40 lbs]
Shipping Volume	36 C.F

R12** : ENERGY STAR® qualified models.

Voltage: All models are available in 12 volt DC, 24 volt DC, 110AC, or 220AC. Listed energy consumptions are for 12 volt units and 110AC; 24 volt units use half the listed amp hours. KWHs are listed for AC units.

Clearance:

- The doors are mounted on a continuous stainless steel piano-style hinge. It is important to allow an additional 3.75" width on the hinge
- side for the door to open.
- All units require minimum 6" clearance above the unit to allow for heat ventilation.
- **PLEASE NOTE:** Oak veneers add a quarter of an inch to overall exterior dimensions, all other wood veneers add a half an inch
- For more information download
- * [Sun Frost Refrigerator/Freezer/Cabinet Clearance](#) Pdf Format

Colors:

- A wide variety of custom laminates and wood veneers are available.
- Standard laminate color is white.

SUN FROST Custom Color Choices

Sun Frost refrigerators, freezers, and matching cabinets come standard with a white laminate finish or you may choose from a variety of color and wood choices available:

Colors: You can select from any of the matte finish laminate colors from Wilsonart, Formica, or Nevamar brands, including textures. Please note that we are unable to work with glossy laminates because they are less scratch-resistant and durable than matte finishes. Although these companies provide printed brochures with all of their color choices, it is not recommended that the customer make a final color decision based on printed charts as printed colors often vary from the true laminate material. A final decision should be made using actual color samples from a "chip board." A chip board can usually be found at a local building supply, cabinet/countertop shop, paint or hardware store. At the time you place your order, Sun Frost will need the brand name, color name, and color number of the laminate chosen. There are hundreds of colors to choose from to match any decor you can dream of!

Wood: We can use most readily available wood species [no rare or exotic species]. Our wood finishes are generally a veneer plywood or MDF core panel. We do not apply any finished coating or stain to our woods, allowing the customer to match existing cabinetry or finish as desired. The most common wood finishes are oak, knotty pine, cherry, hickory, walnut, and maple. Please call us for other wood types.

Stainless Steel: We now offer stainless steel and faux stainless steel

options. The first consists of a high-pressure laminate backer with an overlay of real stainless steel. Because of the high cost of this material, we cover the front of the refrigerator with stainless steel, and cover the sides of the unit in black laminate. As a less expensive option, Wilsonart offers a faux stainless steel laminate that is very popular. Call for details and pricing.

Unfinished: We can also ship our refrigerators, freezers, and base cabinets "unfinished" with just bare plywood [no laminate or veneer]. The aluminum door handle[s] and trim is included but not installed on "unfinished" products. The customer can apply his or her own finish material. Many interesting finishes have been applied by our do-it-yourself customers including corkboard, metals, and woven rattan materials.

Interior Dimensions

	RF12	Freezer	Refrigerator	Total Volume
Height		6.5	24	-
Width		26	28	-
Depth		21	20.75	-
Volume [CF]		2.05	8.07	10.1
Volume [Liters]		58.2	228.5	286.7

VIEW > [Electrical Specifications](#) [PDF Format]

SunFrost Refrigerator/Freezer Cabinet

We recommend using a cabinet below your Sun Frost refrigerator/freezer to elevate the refrigerator to a more convenient height, while providing storage room for dry goods. A cabinet 12" to 16" high works well with our RF16 or RF19 models. For our RF12, we recommend a cabinet 18" to 24" high. Our 4 cubic foot and 10 cubic foot models can be placed on top of existing cabinets, or at a height of about 36".

Sun Frost offers 13" and 24" high cabinets with two side-by-side sliding drawers, which can be made in laminates or woods to match your refrigerator. We also offer a 4" stand for areas in which there is not enough overhead space to install a full cabinet. The 4" stand is open in the front and creates a kick space under the refrigerator.

If you choose to build your own cabinet, it should be constructed of a minimum 3/4" plywood for sufficient strength.

Base Cabinet Dimensions

Model	4" Stand	13" Cab	24" Cab
Height	4"	13"	24"
Width	34.5"	34.5"	34.5"
Depth	27.75"	27.75"	27.75"
Weight (lbs.)	25	60	125

Base Cabinet Crated Dimensions

Height	6"	16"	31"
Width	37"	37"	37"
Depth	30"	30"	30"
Volume	3.9	10.3	16.7

Product Warranty:

VIEW > [Warranty](#) [PDF Format]

Product Manufacturer: Sun Frost

Note: All Sun Frost refrigerators are custom made and shipped directly from the factory. They are non-returnable & non-refundable - all sales are final.

*Shipping Cost

Shipping amounts may vary due to fluctuations in the transportation industry. Final shipping costs may need to be adjusted during order processing. If there is a change in the total shipping cost you will be contacted for approval before the order is finalized.

Delivery Information:

Refrigerators are packaged and shipped to fulfill each customer's specific requirements. Please allow 6 to 11 weeks for orders to be processed and the unit to be boxed and secured to a shipping pallet, plus standard transportation delivery time.

Important Note: To assure large quantity and/or time-critical deliveries, please call for current product availability status and for a guarantee on delivery agreement.

[Reviews](#)

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*Signature required to process



Product List and Energy Usage:

Refrigerators & Freezers	Model	Description	Daily Energy Use (amp hrs @ 12 VDC / kwh @ 110 VAC)		Dimensions (see clearances below)			Shipping (export add 40 lbs.)	
			at 70°F 21°C	at 90°F 32°C	Height	Width	Depth	Weight	Volume
RF19*	Half Refrigerator/Half Freezer	62 amp-hrs .77 kWh	82 amp-hrs 1.02 kWh	66"	34.5"	27.75"	320 lb.	46 C.F	
R19^	Refrigerator Only	28 amp-hrs .33 kWh	47 amp-hrs .56 kWh	66"	34.5"	27.75"	310 lb.	46 C.F	
F19	Freezer Only	100 amp-hrs 1.25 kWh	130 amp-hrs 1.63 kWh	66"	34.5"	27.75"	320 lb.	46 C.F	
RF16^	Refrigerator-Freezer	40 amp-hrs .48 kWh	58 amp-hrs .70 kWh	62.5"	34.5"	27.75"	300 lb.	44 C.F	
RF12^	Refrigerator-Freezer	24 amp-hrs .29 kWh	39 amp-hrs .47 kWh	49.5"	34.5"	27.75"	230 lb.	36 C.F	
R10	Refrigerator Only	13 amp-hrs .17 kWh	23 amp-hrs .28 kWh	43.5"	34.5"	27.75"	215 lb.	32 C.F	
F10	Freezer Only	55 amp-hrs .69 kWh	70 amp-hrs .88 kWh	43.5"	34.5"	27.75"	215 lb.	32 C.F	
RF4	Refrigerator w/ ice tray	12 amp-hrs .14 kWh	18 amp-hrs .21 kWh	31.5"	34.5"	27.75"	160 lb.	23 C.F	
R4	Refrigerator Only	8 amp-hrs .10 kWh	12 amp-hrs .14 kWh	31.5"	34.5"	27.75"	160 lb.	23 C.F	
F4	Freezer Only	28 amp-hrs .35 kWh	36 amp-hrs .45 kWh	31.5"	34.5"	27.75"	160 lb.	23 C.F	
RFVB134a+	Vaccine Storage Unit	14 amp-hrs .17 kWh	23 amp-hrs .28 kWh	31.5"	34.5"	27.75"	200 lb.	27 C.F	

Voltage: All models are available in 12 volt DC, 24 volt DC, 110AC, or 220AC. Listed energy consumptions are for 12 volt units and 110AC; 24 volt units use half the listed amp hours. KWHs are listed for AC units.

Colors: A wide variety of custom laminates and wood veneers are available (see below). Standard laminate color is white.

Follow these links for more info about laminates and veneers: www.formica.com • www.wilsonart.com • www.nevamar.com

Clearance: The doors are mounted on a continuous stainless steel piano-style hinge. **It is important to allow an additional 3.75" width on the hinge side for the door to open.** All units require minimum 6" clearance above the unit to allow for heat ventilation. Also, PLEASE NOTE: Oak veneers add a quarter of an inch to overall exterior dimensions, all other wood veneers add a half an inch.

* Model RF19: Choice of Freezer on top or bottom.

^ Models R19, RF16 and RF12: ENERGY STAR® qualified models.

+ Model RFVB: Crated for export.

Interior Dimensions:

Model	Freezer				Refrigerator				Total Volume			
	Dimensions (inches)			Volume	Dimensions (inches)			Volume	CF	Liters		
	Height	Width	Depth	CF	Liters	Height	Width	Depth	CF	Liters	CF	Liters
RF19	24	28	20.75	8.07	228.5	24	28	20.75	8.07	228.5	16.1	457
R19*	24	28	20.75	8.07	228.5	24	28	20.75	8.07	228.5	16.1	457
F19*	24	28	20.75	8.07	228.5	24	28	20.75	8.07	228.5	16.1	457
RF16+	13	26	20	3.91	110.8	31	28	20.75	10.4	295.2	14.3	406



RF12	6.5	26	21	2.05	58.2	24	28	20.75	8.07	228.5	10.1	286.7
R10	NA	NA	NA	NA	NA	28	27.5	20.5	9.13	258.7	9.13	258.7
F10	28	27.5	20.5	9.13	258.7	NA	NA	NA	NA	NA	9.13	258.7
RFVB	4	26	20	1.2	34.1	6	26	20	1.8	51.1	3.0	85.2
RF4	2.25	26	20	.68	19.2	10.5	26	20	3.16	89.5	3.84	108.7
R4	NA	NA	NA	NA	NA	13	26	20	3.91	110.7	3.91	110.8
F4	13	26	20	3.91	110.8	NA	NA	NA	NA	NA	3.91	110.8

* Unit has two equal size compartments – both refrigerator for R19, both freezer for F19.
+ RF16 has the largest refrigerator compartment.

Refrigerator and Freezer Crated Dimensions:

Model	Height	Width	Depth	CF	CM
19's	72"	37"	30"	46	1.31
16's	69"	37"	30"	44	1.25
12's	56"	37"	30"	36	1.02
10's	50"	37"	30"	32	0.91
4's	36"	37"	30"	23	0.65
RFVB*	37"	39"	31"	27	0.76

*Crated for Export

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Questions? Please call Sun Frost at 707-822-9095

GE® 4.0 Cu.Ft. Capacity Electric Dryer



Model# DCVH480EKWW



- 4.0 cu. ft. large stainless steel basket - Handles a king-size comforter or 24 full-size bath towels with ease
- 5 heat selections - Offer enhanced drying performance and fabric care
- Sensor Dry™ - Continually monitors moisture content to help prevent clothing wear and tear
- Stainless steel drum interior - Smooth stainless interior helps prevent rust and protect clothes
- Multiple dry cycles - Deliver optimal drying results
- Delay Start - Lets you do the laundry on your terms
- Antibacterial Option - Certified by the NSF® to reduce up to 99.9% of certain types of bacteria
- Extended tumble plus - Tumble clothes without heat to help prevent creasing and wrinkling
- Speed Dry - Delivers ready-to-go results in minutes

FEATURES

Temperature Options	High/Medium/Low/Extra Low/No Heat
Control Type	Electronic Pushbutton w/ LED Count Down LED
Custom Cycles	20
Heat Selections	5
Moisture Sensor	Sensor Dry™
Speed Dry	Yes
Style	Free-Standing
Dual Thermistors	Yes
Additional Cycles	Mixed Load Dewrinkle Air Fluff Active Wear Timed Dry Warm Up Antibacterial Damp Dry Extended Tumble
Delicates Cycle	Yes
Optional Dryness Levels	Very Dry More Dry Dry Less Dry Damp Sensor Damp Dry
Timed Dry	120 Minutes
Tumble Drying	Yes
Wrinkle Free Cycle	Yes
Cottons Cycle	Yes
Number of Cycles	Multiple
Easy Care Cycle	Wrinkle Free
Drum Type	Stainless Steel
Fuel Type	Electric
Leveling System	Adjustable Leveling Legs
Additional Dryer Features	Interior Light Lint Filter with Reminder
Dryer Control Features	LED Cycle Status Lights Cycle Countdown Clean Lint Filter Reminder Light Delay Start - Up to 18 hours Damp Dry Signal

Have more questions? Please contact 1-800-626-2005

GE® 4.0 Cu.Ft. Capacity Electric Dryer



Model# DCVH480EKWW

APPROXIMATE DIMENSIONS (HxDxW)

- 33 3/8 in x 25 11/16 in x 23 1/2 in

CAPACITY

- Total Capacity (cubic feet) 4.0 cu ft

WARRANTY

- Labor Warranty - Limited 1-year entire appliance
- Parts Warranty - Limited 1-year entire appliance
- Warranty Notes - See written warranty for full details

Have more questions? Please contact 1-800-626-2005

GE® 2.6 IEC Cu. Ft. Frontload Washer



Model# WCVH4800KWW



- ENERGY STAR® Qualified - Meets or exceeds federal guidelines for energy efficiency for year-round energy and money savings
- HydroMotion™ wash action - Reversing wash action offers great cleaning performance with gentle wash motion
- HydroHeater™ - Increases wash temperature to reduce bacteria and provide better cleaning for the really tough stains
- 5 wash/spin speed combinations - Washer alternates speeds for great clothes care
- Multiple wash cycles - Choose from various wash actions for optimal cleaning and clothes care
- 5 wash/rinse temperatures with Sanitize - Multiple settings and a Sanitize wash offer a greater degree of control over fabric cleaning and care
- Automatic water levels - Reduce water waste per cycle by filling only enough water to match the load size
- Delay Start up to 18 hours - Set the washer or dryer to begin cycles anytime in the next 18 hours

FEATURES

Washer Cycles	Speed Wash Drain and Spin 2nd Rinse Active Wear Rinse and Spin
Dispenser	Detergent (Liquid/Powder) Fabric Softener Bleach
Control Type	Electronic Pushbutton w/ LED Count Down LED
Custom Cycles	1
Wash/Rinse Temperatures	5 with Sanitize
Wash/Spin Speed Combinations	5
Washer Control Features	LED Cycle Status Lights Cycle Countdown Child Lock Delay Start - Up to 18 hours End-of-Cycle Signal
Water Levels	Automatic
Specialty Cycles	BasketClean™
Whites Cycle	Heavy Duty
Colors Cycle	Normal
Adaptive Capabilities	Load Size
Cottons Cycle	Yes
Delicates Cycle	Yes
Number of Cycles	Multiple
Style	Front-Loading
Wash Basket Type	Stainless Steel
Water Temp System	PerfecTemp™
Easy Care Cycle	Wrinkle Free
Handwash Cycle	Yes
Optional Soil Levels	Extra Heavy Heavy Normal Light Extra Light
Additional Washer Features	AutoBalance™ Suspension System Fill and Drain Hoses Included HydroHeater™ HydroMotion™
Leveling System	Adjustable Leveling Legs
Maximum Spin Speed	1400 RPM

Have more questions? Please contact 1-800-626-2005

GE® 2.6 IEC Cu. Ft. Frontload Washer



Model# WCVH4800KWW

APPROXIMATE DIMENSIONS (HxDxW)

- 33 5/16 in x 26 5/8 in x 23 1/2 in

CAPACITY

- Total Capacity (cubic feet) 2.6 cu ft

Claims & Certifications

- ENERGY STAR® Qualified
- CEE Tier III

WARRANTY

- Labor Warranty - Limited 1-year entire appliance
- Parts Warranty - Limited 1-year entire appliance
- Warranty Notes - See written warranty for full details

Have more questions? Please contact 1-800-626-2005

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Product

The Charming

The Charming Spinner spin dries and energy while doing your laundry your normal spin cycle in the according to the easy to understand turn the handle and let the spinner its full speed of 3200 rpm, then residue from your clothes with drain spout, turn the handle to stop the spin dryer. Remove the clothes, whether you use the green experiment to find out how much.

Since the Charming Spinner is made of high quality materials, it will rarely need service. If you need a replacement part, we offer a full, one year warranty on parts and labor.

[View Charming Spinner spin dryer technical information.](#)

Charming Spinner technical information Close

Model	C-61005
Rated voltage	110-120 volts
Rated frequency	60 Hz
Rated power	780-305 watts
Dry capacity	12 lbs.
Rotating speed	3200 rpm
Net weight of unit	23 lbs.
Height of unit	26 inches
Diameter	13.7 inches
Shock protection	Class 1
Standards	EN 60335-1 EN 60335-2-4
Use	domestic
Unit construction	.7mm stainless steel, plastic
Height of drain spout	5 1/2 Inches
length of electrical chord	82 Inches
Water removed	50-90%, depending on fabric type

[Order Spinner](#)



[View Charming Spinner technical information](#)

No special installation required

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50 Gallon HD Rectangular Flat Bottom Utility Tank



CRMI Rectangular Flat Bottom Utility Tanks

Rectangular Flat Bottom Utility Tanks are ideal for Pressure-Washing and deicing applications including numerous farming containment needs, from farm chemicals to potable water.

Tank features an 8" vented-Lid and one 2" drain fitting.

Tank includes molded-in grooves for stability and easy tie-down.

Tanks are manufactured from medium-density polyethylene with U.V. inhibitors and designed for containment of liquids of up to 2.0 specific gravity.

Tanks are very durable, yet lightweight; easy to install and clean.

Part Number: CRMI-50RT

Heavy Duty (2.0 S.G.)

Capacity: 50 Gallons

Size: 20"L x 48"W x 14.5"H

Weight: 25 lbs.

Ships From: ID

[View Technical Drawing](#) | [Freight Calculator](#)

Online Price: \$109.99

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Any questions or comments please mail to info@tank-depot.com



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500 Gallon HD Rectangular Flat Bottom Utility Tank



CRMI Rectangular Flat Bottom Utility Tanks

Rectangular Flat Bottom Utility Tanks are ideal for Pressure-Washing and deicing applications including numerous farming containment needs, from farm chemicals to potable water.

Tank features an 8" vented-Lid and one 2" drain fitting.

Tank includes molded-in grooves for stability and easy tie-down.

Tanks are manufactured from medium-density polyethylene with U.V. inhibitors and designed for containment of liquids of up to 2.0 specific gravity.

Tanks are very durable, yet lightweight; easy to install and clean.



Part Number: CRMI-500RT

Heavy Duty (2.0 S.G.)

Capacity: 500 Gallons

Size: 92"L x 48"W x 29"H

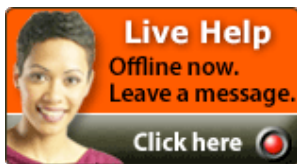
Weight: 185 lbs.

Ships From: ID

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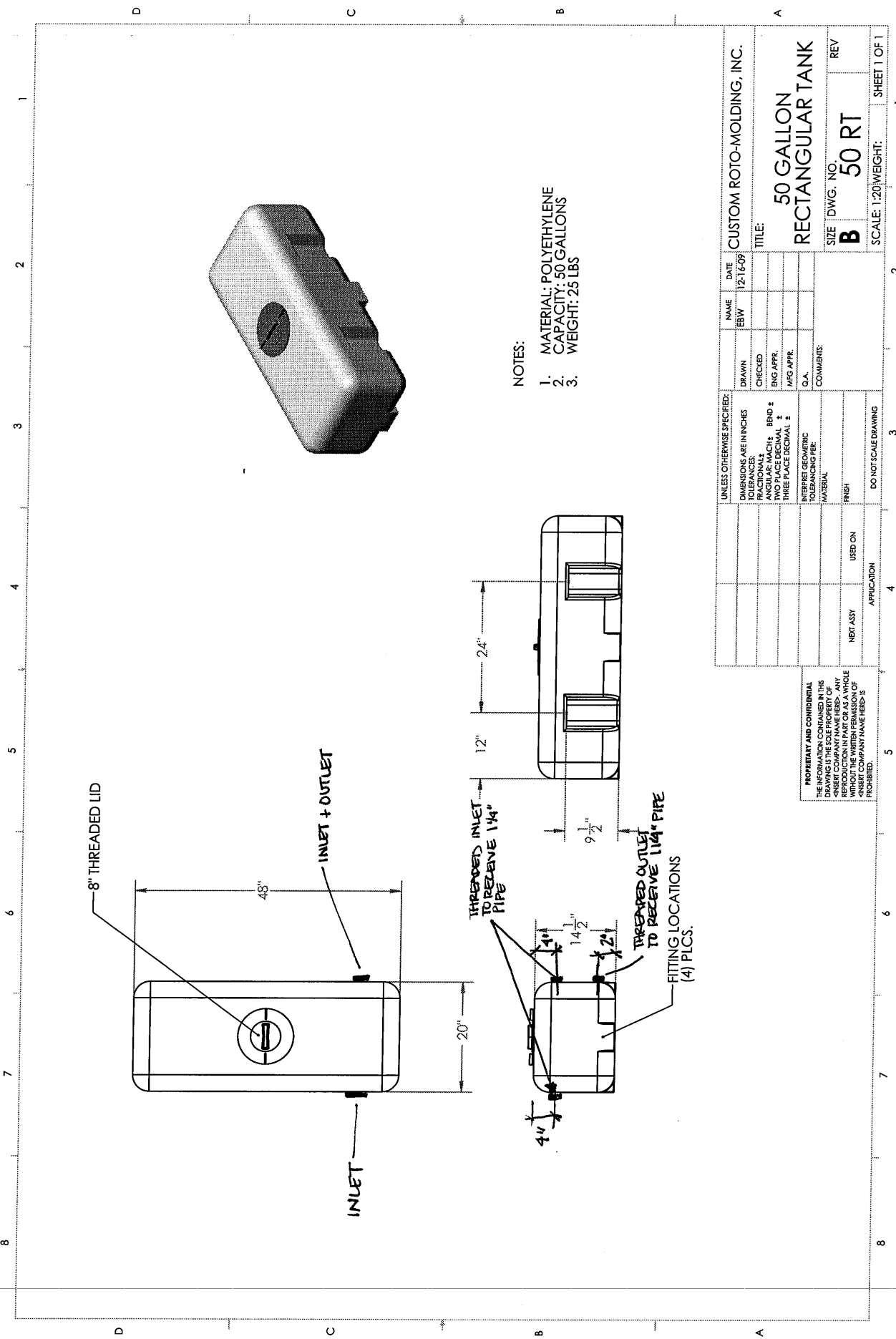
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2-14 00 FACILITY STORM DRAINAGE



- NOTES:
1. MATERIAL: POLYETHYLENE
 2. CAPACITY: 50 GALLONS
 3. WEIGHT: 25 LBS

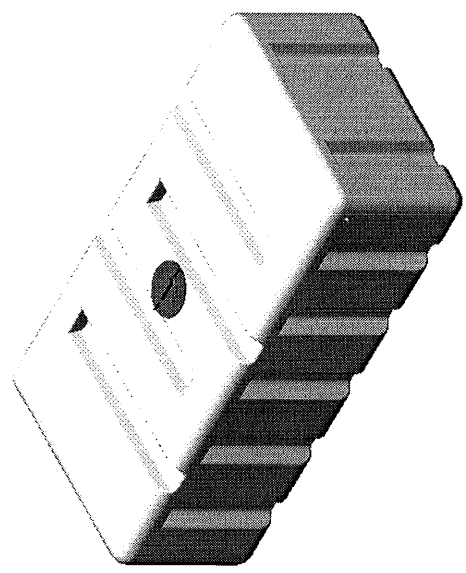
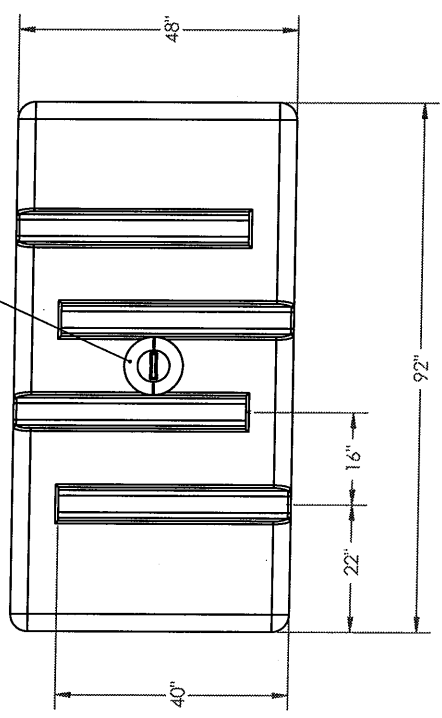
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UNLESS OTHERWISE SPECIFIED:		NAME	DATE	CUSTOM ROTO-MOLDING, INC.	
DIMENSIONS ARE IN INCHES	DRAWN	EBW	12-16-09	TITLE:	
FRACTIONALS	CHECKED			50 GALLON	
TWO PLACE DECIMAL	ENG APPR.			RECTANGULAR TANK	
THREE PLACE DECIMAL	MFG APPR.			SIZE	DWG. NO.
INTERPRET GEOMETRIC TOLERANCING PER MATERIAL	G.A.			B	50 RT
FINISH	COMMENTS:			SCALE:	1:20 WEIGHT:
DO NOT SCALE DRAWING					SHEET 1 OF 1
NEXT ASST	USED ON				
APPLICATION					

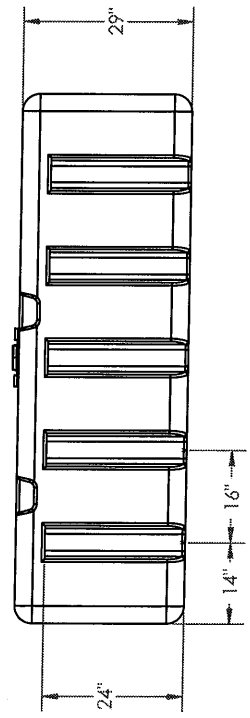
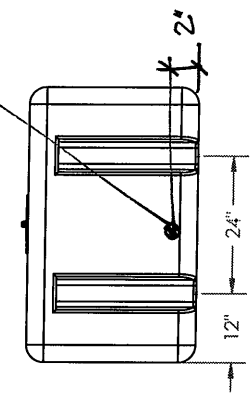
LL1200 FACILITY ROTABLE-WIPERS STORAGE TANKS

1 2 3 4 5 6 7 8

8" THREADED LID
LID MAY BE REPOSITIONED TO FIT
APPLICATION



THREADED INLET TO
RECEIVE 1" PIPE



NOTES:

1. MATERIAL: POLYETHYLENE
2. CAPACITY: 500 GALLONS
3. WEIGHT: 185 LBS.

DRAWN		NAME	DATE	CUSTOM ROTO-MOLDING TITLE:
CHECKED		EBW	9-25-09	
ENG APPR.				
MFG APPR.				
Q.A.		COMMENTS:		SIZE DWG. NO
INTERPRET GEOMETRIC TOLERANCING PER MATERIAL				B 500 RT
FINISH				SCALE: 1:20 WEIGHT:
DO NOT SCALE DRAWING				SHEET 1 OF 1
NEXT ASY		USED ON		
APPLICATION				

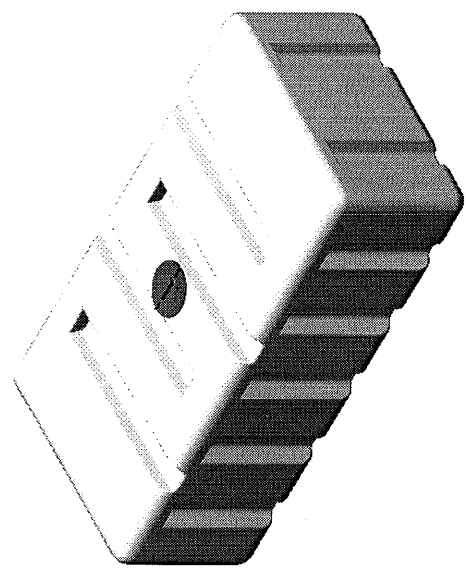
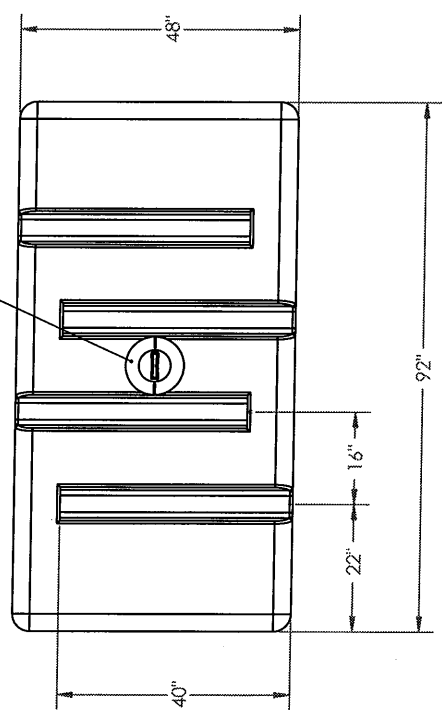
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1 2 3 4 5 6 7 8

22-13-33 FACILITY SEPTIC TANKS

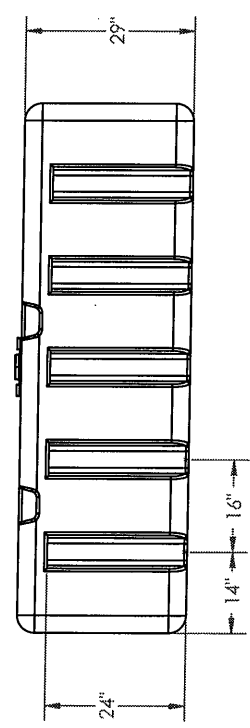
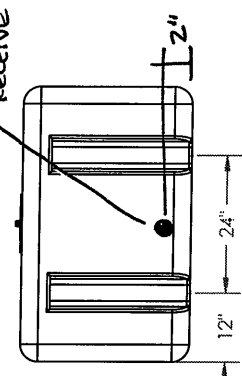
1 2 3 4 5 6 7 8

8" THREADED LID
LID MAY BE REPOSITIONED TO FIT
APPLICATION



THREADED INLET TO
RECEIVE 3" PIPE NOTES:

1. MATERIAL: POLYETHYLENE
2. CAPACITY: 500 GALLONS
3. WEIGHT: 185 LBS.



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	CUSTOM ROTO-MOLDING	
DIMENSIONS ARE IN INCHES	TO FRACTIONS	EBW	9-25-09	TITLE:	
FRACTIONAL 1/2	ANGULAR: MACH 1/2	DRAWN		500 GALLON	
THREE PLACE DECIMAL 1/16	TOLERANCE PER	CHECKED		RECTANGULAR TANK	
INTERPRET GEOMETRIC TOLERANCING PER	MATERIAL	ENG APPR		SIZE DWG. NO	REV
		MFG APPR		B	500 RT
		Q.A.		SCALE: 1:20	WEIGHT:
		COMMENTS:			SHEET 1 OF 1
		FINISH			
		DO NOT SCALE DRAWING			
		APPLICATION			
		USED ON			
		NEXT ASY			

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