

enCORE

OSU Solar Decathlon 2011



PROJECT MANUAL

08.11.2011

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Summary of Changes

As EnCore continues to evolve and develop as the competition nears, so do the construction documents. The following Project Manual has been updated from a previous submission, and reflects the development of the House. A list of updated information in the Project Manual is listed below.

08.11.2011 Submission

All sections of the Project Manual have been updated in accordance with project development and the refinement of all construction drawings and other documents to reflect as built conditions.

Energy Analysis and Results have been updated to reflect comparisons between ASHRAE and Trane TRACE ®700 modeling systems to determine equipment sizing and performance requirements.

Building Specifications have been revised in accordance with material finalization, section additions and substitutions.

05.03.2011 Submission

All sections of the Project Manual have been updated in accordance with project development and the refinement of all construction drawings and other documents.

The Rules Compliance Checklist reflects the expanded construction drawing set.

Structural Calculations demonstrate all load calculations for the House.

Building Specifications have expanded as the project has developed.

The Summary of Reconfigurable Figures illustrates the versatility in the space and operability of building elements.

The Project Manual now includes more bookmarks, allowing for easier navigation through the document.

End of section.

Rules Compliance Checklist

Rule	Description	Content Requirement(s)	Relevant Sheet(s)
4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	0-101
4-2	Construction Equipment	Specifications for heavy machinery	015000
4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	E-102
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	S-503, E-102
4-5	Generators	Specifications for generators	015000
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	P-101, P-102, P-103, P-106, P-201, P-901, P-902, M-102, M-501
4-6	Spill Containment	Specifications for all equipment, containers, and pipes that will contain fluids at any point during the event	220500, 220523, 221116, 221119, 221123, 221316, 221353, 223300, 223301, 224000, 230000, 233713, 238143
4-7	Lot Conditions	Calculations showing that the structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	S-001 Notes, S-501
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	S-501
5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	A-201, A-202
5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	N/A

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	Proj. Manual: Structural Calculations, S-001-S-501
6-2	Finished Square Footage	Drawing(s) showing all information needed by the rules officials to measure the finished square footage electronically	G-101
6-2	Finished Square Footage	Drawing(s) showing all movable components that may increase the finished square footage if operated during contest week	N/A
6-3	Entrance and Exit Routes	Drawing(s) showing the accessible public tour route and the ground surface area that will be covered by organizer-provided walkway material	G-102, G-103
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-102, L-501
7-2	Watering Restrictions	Drawing(s) showing the layout and operation of greywater irrigation systems	P-201, P-601, P-901
8-1	PV Technology Limitations	Specifications for photovoltaic components	263100
8-3	Batteries	Drawing(s) showing the location(s) and quantity of all primary and secondary batteries and stand-alone, PV-powered devices	N/A
8-3	Batteries	Specifications for all primary and secondary batteries and stand-alone, PV-powered devices	N/A
8-4	Desiccant Systems	Drawing(s) describing the operation of the desiccant system - Not a liquid desiccant system	M-101, M-102, M-601
8-4	Desiccant Systems	Specifications for desiccant system components - Not a liquid desiccant system	238419
8-5	Village Grid	Completed interconnection application form	Proj. Manual: page 23
8-5	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	A-113, E-201, E-611

8-5	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	262813, 263100
8-5	Village Grid	One-line electrical diagram	E-612
8-5	Village Grid	Calculation of service/feeder net computed load per NEC 220	E-601
8-5	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	A-101, E-102, E-201
8-5	Village Grid	Elevation(s) showing the meter housing, main utility disconnect, and other service equipment	E-201
9-1	Container Locations	Drawing(s) showing the location of all liquid containers relative to the finished square footage	A-102, I-101, S-101, S-102, 223301, 237113
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	P-101
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	223301, 237113, Liquids delivered with team
9-3	Greywater Reuse	Drawing(s) showing the layout and operation of greywater reuse systems	P-101, P-102
9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	L-101, L-501, P-101, P-201
9-6	Thermal Mass	Drawing(s) showing the locations of liquid-based thermal mass systems	M-101, M-102, M-501
9-6	Thermal Mass	Specifications for components of liquid-based thermal mass systems	237113
9-7	Greywater Heat Recovery	Drawing(s) showing the layout and operation of greywater heat recovery systems	P-101, P-901, P-902

9-8	Water Delivery	Drawing(s) showing the complete sequence of water delivery and distribution events	L-502, P-101
9-8	Water Delivery	Specifications for the containers to which water will be delivered	221119
9-9	Water Removal	Drawing(s) showing the complete sequence of water consolidation and removal events	L-502, P-101
9-9	Water Removal	Specifications for the containers from which water will be removed	221553, S-503
11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	G-103

End of section.

Structural Calculations

GRAVITY DESIGN: FLOOR

LIVE LOAD = 50 PSF

DEAD LOAD = 5 PSF

TOTAL LOAD = 55 PSF

FLOOR BEAMS: WOOD

SPACING = 16" O.C.

LIVE LOAD = 50 PSF X 16/12 = 67 PLF

DEAD LOAD = 5 PSF X 16/12 = 7 PLF

TOTAL LOAD = 74 PLF

$\Delta < L/360$

- IRC TABLE R502.3.1(2) WITH TOTAL LOAD OF 60 PSF SPACING @ 16" O.C.

SPF #2

MAX SPAN 13'-7"; 2 X 10 IS OK.

FLOOR BEAMS: STEEL

BEAM COMPRESSION FLANGE BRACED WITH 2 X 12 ON BOTH SIDES

LONG SIDE: 41'-10 1/4" (MAX SPAN: 8'-7")

- ROOF LOAD = 322 PLF

- WALL LOAD = 88 PFL

- FLOOR LOAD = 387 PLF

- **TOTAL LOAD = 797 PLF**

(LONG SIDE CONTINUED)

$$\text{MOMENT} = wL^2/8$$

$$w = 797 \text{ PLF}$$

$$L = 8'-7''$$

$$M_a = (797 \times 14.67^2)/8 = 7,399 \text{ #-FT}$$

$$M_a = 50 \times 13.2 = 660 \text{ K-in}$$

$$M_n = 7,399 \times 12/1000 = 88.1 \text{ K-in}$$

$$M_a > M_n \Omega$$

$$660/1.67 > 257$$

$$395 > 88.1$$

$$\text{DEFLECTION} = (5wL^4)/(384EI)$$

$$w = 797 \text{ PLF}$$

$$L = 11.335$$

$$E = 29,000$$

$$I = 66.7$$

$$\Delta = (5 \times 797 \times 8.58^4) / (384 \times 29,000 \times 66.7) = .002''$$

$$L/360 = .76''$$

BEAM COMPRESSION FLANGE BRACED WITH 2 X 12 ON EITHER SIDE

SHORT SIDE: 33'-1" (MAX SPAN: 13'-8")

- ROOF LOAD = $40 \text{ PSF} \times 16/12 = 53.3 \text{ PLF}$

- WALL LOAD = $12 \text{ PSF} \times 11' = 132 \text{ PLF}$

- FLOOR LOAD = $60 \text{ PSF} \times 16/12 = 80 \text{ PLF}$

- **TOTAL LOAD = 265.3 PLF**

MOMENT = $wL^2/8$

$w = 265.3 \text{ PLF}$

$L = 6.835$

$M_a = (265.3 \times 6.835^2)/8 = 1.36 \text{ K-in}$

$M_a = 50 \times 13.2 = 660 \text{ K-in}$

$660/1.67 > 1.36$

$395 > 1.36 \text{ K-in}$

DEFLECTION = $(5wL^4)/(384EI)$

$w = 265.3 \text{ PLF}$

$L = 6.835$

$E = 29,000$

$I = 66.7$

$\Delta = (5 \times 265.3 \times 6.835^4) / (384 \times 29,000 \times 66.7) = .01''$

$(13.67 \times 12)/.01 = 16,404 > 360$

END REACTION: $265.3 \times 6.835 = 1.81\text{K}$

ROOF JOISTS

OPEN WEB JOISTS

SPACING = 24" O.C.

LIVE LOAD = 20 PSF

DEAD LOAD = 10 PSF

TOTAL LOAD = 30 PSF

$\Delta < L/360$ @ 15 PSF DEAD LOAD; CLEAR SPAN 13'-7"

-PER MFG TABLE

15 PSF DEAD LOAD

40 PSF LIVE LOAD

$\Delta < L/360$

24" O.C.

PER CRITERIA ABOVE THE FOLLOWING WORKS:

9 1/4" TRUSS WITH 3 X 2 CHORD (USING 11 7/8" FOR DUCT WORK)

MAX SPAN - 14'-3"

1 1/2" BEARING @ EACH END

CONNECTIONS TO RIM JOISTS MADE WITH SIMPSON STRONG-TIE CONNECTORS.

RIM JOISTS

LP LVL JOISTS

SPACING = 24" O.C. SIDE LOADED

$$\Delta < L/360$$

WORST CASE SPAN:

$$E = 2.0 \times 10^6$$

$$B = 1.75''$$

$$D = 14''$$

$$W = 233\text{plf}$$

Snow load: 20 psf

PV: 10 psf

Dead load: 10 psf

Total Load: 40psf

$$W = \text{total load} \times \text{module span}/2 = 233\text{plf}$$

$$L = 18'-0''$$

Deflection:

$$\Delta = 270wl^4/ebd^3 + 28.8wl^2/ebd$$

$$\Delta = ((270 \times 233 \times 18^4)/(2.00 \times 10^6 \times 1.75 \times 14^3)) + ((28.8 \times 233 \times 18^2) / (2.00 \times 10^6 \times 1.75 \times 14)) = .14$$

Allowable Deflection:

$$\Delta = L/360$$

$$\Delta = 18 \times 12/360 = .6$$

.6 > .14 deflection is acceptable.

FLOOR JOIST CONNECTORS

$$R = wL/2 = (60 \text{ PSF} \times 16/12) / 2 = 40 \text{ LB.}$$

- B SERIES JOIST HANGERS MIN 265 LB. UP LIFT & 2425 LB. GRAVITY
- LB28 SIMPSON STRONGTIES OK

ROOF JOIST CONNECTORS

$$.6 \times 20 \text{ PSF} - 19 \text{ PSF} = -7 \text{ PSF}$$

$$-7 \text{ PSF} \times 24/12 \times 14/2 = 98 \text{ LB}$$

- SIMPSON STRONG-TIE CONNECTOR RESISTS 575 RESISTS 575 LB OF UPLIFT FORCE. SEE DRAWINGS FOR CONNECTOR TABLE.

FOUNDATIONS (SEE DRAWINGS FOR DIMS)

FLOOR LOADS:

LIVE LOAD = 50 PSF

DEAD LOAD = 5 PSF

ROOF LOADS:

LIVE LOAD = 20 PSF

DEAD LOAD = 10 PSF

HORIZONTAL LOADS:

TOTAL LOAD = 85 PLF

WALL LOADS:

EXTERIOR LOAD = 12 PSF X 11' = 132 PLF X 130LF = 17,160 LB

INTERIOR LOAD = 10 PSF X 8' = 80 PLF X 40LF = 3,200 LB

TOTAL LOAD = 20,360 LB

TOTAL LOADS:

$85 \times 29.67 \times 33.67 = 84,914 \text{ LB} + 20,360 \text{ LB} = 105,274 \text{ LB}$

WORST CASE PIER:

$85 \times 5.83 \times 8.33 = 4,127 \text{ LB}$

PAD: $(24'' \times 24'') / 144 = 4.00 \text{ SF/PAD} \times 1500 \text{ PSF} = 6000 \text{ LB/PAD}$

NUMBER OF PIERS: $105,274 \text{ LB} / 4127 \text{ LB} = 26 \text{ PIERS}$

WOOD STUDS

- 2 X 6 STUDS @ 24" O.C.; 8'-3"
- CLADDING 1/2" PLYWOOD

PER IRC TABLE R602.3(5)

DESIGN

- HEIGHT > 10'-0" WITH LATERAL SUPPORT
- 24" O.C. SPACING
- SUPPORT ROOF ONLY

PER TABLE

- 10'-0" UNBRACED
- 24" O.C.
- SUPPORT ROOF ONLY

SHEATHING - WALLS

PER IRC TABLE R602.3(3)

- REQUIRES 24/16 RATED, 1/2" THICK @ 24" O.C. STUD SPACING
- REQUIRED OK

SHEATHING - FLOOR & ROOF

PER IRC TABLE R503.2.1.1(2)

- ROOF: 24/16 (MIN 3/8") - TOTAL LOAD 40 PSF
- FLOOR: 24/16 (MIN 7/16") - TOTAL LOAD 50 PSF
- USING 3/4" PLYWOOD FOR BOTH

DECK FOUNDATIONS

LOAD = 100 PSF

SOIL LOAD = 1500 PSF

EXTERIOR PIERS

MODULE: 100 PSF X 4.5 X 5.5 = 2475 LB

2475/4 = 618.75 LB

PAD: 5 X 5/ 144 = .17 SF/PAD

.17 X 1500 = 260 LB (DOES NOT WORK)

PAD: 11.25 X 120/ 144 = 9.38 SF

9.38 X 1500 = 14,062 LB > 2475 LB (OK)

DEFLECTION HEM-FIR 2 X 12

$$\Delta = (5wL^4)/(384EI) = .01''$$

INTERIOR PIERS

2475/2 = 1237.5 LB

PAD: 11.25" X 12"/ 144 = .94 SF

.94 X 1500 = 1406.5 LB > 1237.5 LB

WIND LOADS

Basic Wind Speed	$V_{3s} = 90$ mph
Importance Factor	$I = 1.0$
Exposure Category	B
Velocity Pressure Exposure	$Kz = .9$
Velocity Pressure Exposure	$kh = .85$
Topographic Factor	$Kzt = 1$
Wind Directionality	$Kd = .85$
Gust Effect Factor	$G = .85$
Enclosure Classification	Enclosed
Internal Pressure Coefficient	$GC_{pi} = .18$ $GC_{pi} = -.018$
Wall External Pressure	$C_p = .8$ $C_p = -0.5$ $C_p = -0.7$
Roof External Pressure	$C_p = .3$ $C_p = -0.6$
Velocity Pressure	$q_z = (.00256)(.9)(1)(.85)(90^2)(1)$ $q_z = 15.86$ mph $q_z = (.00256)(.85)(1)(.85)(90^2)(1)$ $q_z = 14.98$ mph
Design Wind Load	$p = qGC_p - q_i(GC_{pi})$ $p = (15.86)(.85)(.8) - (15.86)(-.018)$ $p = 11.07$ psf

WIND LOADS

$$\text{Width}_{ns} = 33'-4''$$

$$\text{Width}_{ew} = 30'-0''$$

$$\text{Height} = 15'-3''$$

$$\begin{aligned} V_{ns} &= (33.33)(15.25)(11.07) \\ &= 5,630 \text{ lbs} \end{aligned}$$

$$\begin{aligned} V_{ew} &= (30)(15.25)(11.07) \\ &= 5,070 \text{ lbs} \end{aligned}$$

$$\begin{aligned} \text{Overhang} &= (9.83)(15.25)(11.07) \\ &= 1,650 \text{ lbs} \end{aligned}$$

WIND CALCULATIONS

PROJECT: enCORE House

DATE 2/23/2011

BUILDING SEGMENTS		ASCE equiv mph
BASIC WINDSPEED	90 mph	110 mph 3 sec gusts
DEGREE OF ROOF SLOPE	4.7636 degrees (from table below)	
ROOF PITCH enter rise	1 in 12	degrees roof pitch
<u>ROOF span</u>	33.25 ft	4.763639 1/12
<u>ROOF WIDTH usually matches wall length ft</u>	30 ft include overhang	9.4623218 2/12
ROOF SF WEIGHT lbs	40 lbs	14.036243 3/12
ROOF OVERHANG	2 ft in span direction	18.417758 4/12
TOTAL ROOF HEIGHT above wall	1.89 ft to peak or high	22.619865 5/12
<u>TOTAL BUILDING HEIGHT to roof peak</u>	12.50 ft	26.565051 6/12
<u>WALL LENGTH long wall</u>	120 ft	30.256436 7/12
<u>WALL HEIGHT</u>	8.25 ft	33.687423 8/12
FASCIA LEADING EDGE	14 in high 35	36.869898 9/12
WALL SF WEIGHT	12 lbs	39.805569 10/12
<u>WALL WEIGHT per long wall</u>	11880 lbs	42.51044 11/12
SLOPE LENGTH to highpoint	20.01 ft	45 12/12
<u>TOTAL ROOF AREA</u>	1,201 sf	
INWARD ROOF AREA	600 sf	23.03 0
<u>TOTAL ROOF WEIGHT</u>	48,025 lbs	enter 1 for hip roof
WALL WINDLOAD AREA per long wall	990 sf	
degree to radians conversion		
4.7636 degrees		
0.08314 radians		
<u>FOOTING</u>	DEPTH ft	0 ft
	WIDTH ft	2 ft
if footing segments	LENGTH ft	1.25 ft
42 total	WT per cf	150 lbs
0.03 ft long ea	totalCF conc	0 cf
0 lbs ea	<u>TOTAL FOOTING WT</u>	0 lbs = 0.00 cy concrete
WALL, FOOTING AND ROOF WT LESS UPLIFT		56,882 lbs
RESULT MUST BE POSITIVE TO PREVENT LIFTING		
TOTAL long WALL, FOOTING AND ROOF WT. 59,905 lbs		

SOIL RESISTANCE (passive)		
coeff	1	friction
	1	ftg count
soil wt	110	pcf
soil cf	0	cf
total wt	0	lbs

TOTAL ROOF UPLIFT leeward	3,023	LIFT = .5 * .00238 * VELsquared * SFarea * CL
TOTAL ROOF PRESSURE windward	3,023 lbs	
WINDWARD ROOF PRESSURE	5 PSF	
LEEWARD ROOF UPLIFT PSF	5 PSF	TRUE

OVERTURNING MOMENT CALCULATIONS (may be based on representative segment of building)	
walls or support columns	roof factors
0 wall pressure PSF	5 uplift roof suction PSF
4 = wall height / 2 = moment arm (centroid)	16.63 = roof span / 2 = moment arm (centroid)
0 = OT coeff = lateral wind psf * (windspeed/120)sqrd	3 uplift suction psf * (windspeed/120)sqrd = OT coeff
0 = OT coeff * L * W * (centroid)	46,968 = OT coeff * L * W * (centroid)
Mot = TOTAL OT MOMENT = 46,968 ft-lbs	ADDED WALL WEIGHT = 0 lbs
3,023 roof download windward LL	0 = number of long walls inc ##
TOTAL lbs = 48,025 walls, roof and footing lbs DL	0 = number of short walls in 150
plus 0 ftg / soil resistance DL	enter wall slab depth ft 0.34 total job con ###
equals 51,048 plus 0 added conc DL	
Mr = 51,048 TOTAL RESISTANCE DL+LL	
surplus lbs = 4,080 = 8.69% safety margin	
surplus value must be positive to prevent overturning	

End of section.

Detailed Water Budget

Function	Water Use (Gallons)	Calculations		Notes
		Gallons	Events	
Hot Water Draws	320	40	8	
Water Vaporization	2.5	.625	4	
Dishwasher	13.5	2.7	5	
Clothes Washer	68.4	6	11.4	
Vegetation	0	0	0	Using grey water recovery system for irrigation
Fire Protection	300	300	1	May use general storage and waste to supplement
Thermal Storage Tanks	80	80	1	
Testing	0	0	0	See Safety Factor
Initial Systems Fill	5	5	1	
Solar Thermal Collectors	2	2	1	
Aesthetic Purpose	50	50	1	
Radiant Flooring	0	0	0	
Safety Factor	100			
Water Required:	941.4 gallons			

End of section.

Summary of Unlisted Electrical Components

There are no unlisted electrical components.

End of section.

Summary of Reconfigurable Features

Demonstration of Reconfigurable Features for Jury Tours

During the course of public and jury tours, team members will demonstrate multiple reconfigurable features of the Encore home. Each has been outlined below.

Murphy Bed

The Encore home features a manually operated Murphy Bed that is constructed as part of the West Bedroom wall. During public and jury tours, a decathlete will lower and raise the bed to demonstrate the flexibility of the space to all visitors. The operation of this component and the associated details can be viewed in more detail in the Construction Documents. Specific references include elevation 1/A-216.

Sliding Exterior Window Screens

The West side windows of the Encore home are complimented by interacting with the exterior screen of the house. Swinging window screens on the outside of the window allow for control natural light and solar heat gain based on occupant needs. On the South side of the Encore home there are full height sliding exterior wall panels. The three panels cover the windows to again control both natural light and solar heat gain as well as allow for increased privacy. During the public and Jury tours of the home a decathlete will demonstrate the swinging window and sliding screens ease of use as well as how to best optimize their function for specific scenarios and conditions. Specific references to the location of these features include A-211 and A-212.

End of section.

Interconnection Application Form

The Ohio State University : EnCORE
OHIO STATE : Lot 404

PV Systems

Module Manufacturer	Description of Array	DC Rating of Array (sum of the DC ratings)
First Solar	108 77.5 W panels at 12 degree monoslope	8.370kW
Total DC power of array:		8.4 kW (in tenths)

Inverters

Inverter Manufacturer	Model Number	Voltage	Rating (kW)	Quantity
SMA	Sunny Boy 7000	240	8.650	1
Total AC power of inverters:		7 kW (in whole numbers)		

1. One-line electrical schematic : See Construction Documents Sheet E-61
2. Plan view of the lot showing the house, decks, ramps, tour paths, and the service point : See Construction Document Sheet E-103, G-102, G-103
3. Elevation view(s) showing the terminal box (contains the service point). meter, and other service equipment (such as the distribution panel or load center) : See Construction Document Sheet E-201
4. Electrical calculations : See Construction Document Sheet E-601
5. Three-Line electrical schematic : See Construction Document Sheet E-611

End of section.

Energy Analysis Results and Discussion

Introduction

The enCORE house team has created a variety of energy models used to simulate the performance of the structure. The team has also consulted with various industry experts to ensure that the results are not only accurate, but interpreted properly. The Team has used the following five modeling tools: Trane Trace, eQuest, the Passive House Planning Package (PHPP), PVWATTS, and PVSYST. Each simulation provides key information needed for specific design areas and/or allows for comparison of the results of several different simulation methods. The results from each simulation have been key to specifying both the building envelope construction and MEP equipment.

HVAC Equipment Sizing

To determine the final equipment size and performance requirements, the values from ASHRAE calculations and Trane's TRACE® 700 simulation software were used. A comparison of the two results are further elaborated in the following sections. Where the two estimates differed, the more conservative value was chosen so as to provide the most robust system possible.

ASHRAE Peak Load Analysis

All formulas and table values were taken from the 2009 ASHRAE Handbook Fundamentals I-P Edition textbook, specifically Chapter 17: Residential Cooling and Heating Load Calculations. Standard English units were used throughout.

Peak Cooling Load Analysis

Introduction

Values for latitude (40°) and outdoor temperature (91.1°F) were found in tables documenting standard conditions in Columbus, Ohio, while the indoor temperature was assumed to be a standard summer value of 75°F. These conditions yield a temperature difference (Δt) of 16.1°F. The typical daily temperature range (DR) was found to be 24°F.

Opaque Surfaces

The surfaces deemed to be opaque were the roof, walls, floor, and doors. The equation used to determine opaque surface cooling load is given below:

$$q_{opq} = A \times CF_{opq}$$

where A [ft^2] is the component area and CF_{opq} [$Btu/h \cdot ft^2$] is the surface cooling factor for opaque surfaces given below:

$$CF_{opq} = U(OF_t \Delta t + OF_b + OF_r DR)$$

where OF_t , OF_b [$^{\circ}F$], OF_r are opaque-surface cooling factors.

U -factors for the walls, roof, and floor were calculated by adding the R -values of all materials involved and taking the inverse. U -factors for the doors were given by the manufacturer. The cooling factors were determined from Table 7 on page 17.9. The walls were taken to be wood framed with solar exposure, the

roof was taken to be a ceiling/roof assembly, the floor was taken to be over ambient, the East door was taken to be shaded, and the North door was taken to have solar exposure. The ceiling/roof assembly yields the following equation:

$$68.9\alpha_{roof} - 12.6$$

where α_{roof} is solar roof absorptance, which was found in Table 8 on page 17.9, giving a value of 0.3 corresponding to white elastomeric coating. After including this equation, the opaque surface cooling factor coefficients are as follows:

COMPONENT	OF_t	OF_b	OF_r
Wall	1	14.8	-0.36
Roof	1	-8.1	-0.36
Floor	1	0	-0.06
East Door	1	0	-0.36
North Door	1	14.8	-0.36

Transparent Surfaces

The surfaces deemed to be transparent were the windows in the walls and doors. The equation used to determine non-door fenestration is given below:

$$q_{fen} = A \times CF_{fen}$$

Where A [ft^2] is the component area and CF_{fen} [$Btu/h \cdot ft^2$] is the surface cooling factor for transparent surfaces given below:

$$CF_{fen} = U(\Delta t - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$$

where PXI [$Btu/h \cdot ft^2$] is the peak exterior irradiance (including shading modifications), $SHGC$ is the solar heat gain coefficient, IAC is the interior shading attenuation coefficient, and FF_s is the fenestration load factor. U -factors were all given by the manufacturer.

The equation for peak exterior irradiance is given below:

$$PXI = T_x [E_t + (1 - F_{shd})E_D]$$

Where E_t, E_d, E_D [$Btu/h \cdot ft^2$] are the peak total, diffuse, and direct irradiance respectively, T_x is the transmission of exterior attachment, and F_{shd} is the fraction of fenestration shaded by permanent overhangs, fins, or environmental obstacles.

The visible transmittance of all windows were given by the manufacturer. The peak irradiance values (shown below) were determined from Table 10 on page 17.9 and were based on cardinal direction and latitude:

COMPONENT	E_D	E_d	E_t
North Windows	26	27	53
South Windows	90	65	155
East Windows	178	60	237
West Windows	178	60	237
East Door Window	178	60	237
North Door Window	26	27	53

The fraction of fenestration shaded by overhangs was determined by the following equation:

$$F_{shd} = \min \left[1, \max \left(0, \frac{SLF \times D_{oh} - X_{oh}}{h} \right) \right]$$

where SLF is the shade line factor, D_{oh} [ft] is the depth of the overhang, X_{oh} [ft] is the vertical distance from top of fenestration to overhang, and h [ft] is the height of the fenestration.

The shade line factors (shown below) were determined from Table 12 on page 17.10, based on cardinal direction and latitude:

COMPONENT	SLF
North Windows	1.7
South Windows	3.3
East Windows	1.1
West Windows	1.1
East Door Window	1.1
North Door Window	1.7

The depth of overhang depended on location. The east side of the house has a 15ft overhang, the south side has a 3ft overhang, and all other sides were approximated as having no overhang. Since the vertical distance between the overhang and the wall windows varies somewhat throughout each wall, an average value of 3ft was used to approximate the total effect of the overhang. Similarly, since the height of each window varies, an average value of 6ft was used. The height of each door window is 3ft and the distance between the top of the window and the overhang is 3ft. These values yield a fraction of fenestration of 1 for all components under an overhang.

The solar heat gain coefficients were all given by the manufacturer. Our initial calculations assumed every window contained the same $SHGC$ value, but this resulted in higher than anticipated peak loads. After working closely with the company Serious Materials, windows with different $SHGC$ values were selected based on their location in order to optimize energy efficiency.

The interior attenuation coefficients were found using the following equation:

$$IAC = 1 + F_{cl}(IAC_{cl} - 1)$$

where F_{cl} is the shade fraction closed (0 to 1) and IAC_{cl} is the interior attenuation coefficient of fully closed configuration.

To get a high estimate, the shade fraction was assumed to be 1. The IAC_{cl} values, obtained from Table 14 on page 17.10, assumed the interior attenuation devices were Low-e low-solar medium blinds, and yield a value of 0.88. These blinds were applied to all wall windows, while the door windows were left with no interior attenuation.

The fenestration solar load factors (shown below), found in Table 13 on page 17.10, were based on cardinal direction assuming a single family detached configuration:

Component	FF_s
North Windows	0.44
South Windows	0.47
East Windows	0.31
West Windows	0.56
East Door Window	0.31
North Door Window	0.44

Ventilation

The peak load due to natural ventilation was determined assuming an air exchange rate (ACH) of 0.2 changes/h. The equation used to calculate heat load due to ventilation/infiltration is shown below:

$$q_{vi} = C_s [Q_{vi} + (1 - \varepsilon_s) Q_{bal}] \Delta t$$

where C_s is the air sensible heat factor [$Btu/f \cdot ^\circ F \cdot cfm$], ε_s is the HRV/ERV sensible effectiveness, Q_{vi} is the combined infiltration/ventilation flow rate [cfm], and Q_{bal} is the balanced ventilation flow rate via HRV/ERV equipment [cfm].

ε_s was given by the manufacturer as 0.56. C_s is elevation dependant. Since sea level was assumed, this yields an air sensible heat factor of 1.1 $Btu/f \cdot ^\circ F \cdot cfm$.

Balanced and unbalanced airflow rates were taken to be:

$$Q_{bal} = \min(Q_{sup}, Q_{exh})$$

$$Q_{unbal} = \max(Q_{sup}, Q_{exh}) - Q_{bal}$$

where Q_{sup} is the total ventilation supply airflow rate [cfm] and Q_{exh} is the total ventilation exhaust airflow rate [cfm]. Since both Q_{sup} and Q_{exh} are approximately 60 cfm , Q_{bal} was taken to be 60 cfm and Q_{unbal} was assumed to be negligible.

Using the assumed air exchange rate and assuming Q_{unbal} is negligible yields the following equation for the combined infiltration/ventilation flow rate:

$$Q_{vi} = ACH \left(\frac{V}{60} \right)$$

where V is the building volume [ft^3]. With an approximate volume of 7500 ft^3 the infiltration/ventilation flow rate is taken to be 25 cfm .

Other Heat Sources

Other heat sources include occupants, lighting, and additional equipment. The house is designed for a maximum of 3 occupants, and each occupant is assumed to generate heat at a rate of 250 *Btu/h*. The lighting in the house generates approximately 300W of power, corresponding to a heat generation of 1024 *Btu/h*. All the other equipment in the house (e.g. television, kitchen appliances, computer, etc) are assumed to collectively output 1000W of power, corresponding to an additional 3413 *Btu/h* generated inside the house.

Peak Cooling Load

After adding the load required by each component, the peak cooling load is estimated to be 8165 *Btu/h* when using standard ASHRAE calculations.

Peak Cooling Load Calculations

Designed for Indoor Temperature of 75°F and Outdoor Temperature of 91.1°F

Unit Standard

MEASUREMENT	UNITS
distance	feet
temperature	°F
heat	Btu
time	hour

Given Parameters

ITEM	VALUE
ΔT (°F)	16.1
Daily Range (°F)	24
Latitude (deg)	40

R-Values

COMPONENT	VALUE
Wall	40
Roof	64
Floor	54

Opaque Surfaces

COMPONENT	q	U	AREA	CF	OF_t	OF_b	OF_r	a_roof
Wall	555.39	0.03	998	0.56	1	14.8	-0.36	
Roof	480.41	0.0156	1535	0.31	1	12.57	-0.36	0.3
Floor	263.61	0.02	971	0.27	1	0	-0.06	
East Door	12.31	0.10	16.5	0.75	1	0	-0.36	
North Door	36.73	0.10	16.5	2.23	1	14.8	-0.36	

Transparent Surfaces

COMPONENT	q	U	AREA	CF	E_D	E_d2	E_t	F_shd	SLF	D_oh	X_oh	h
North Windows	79.78	0.15	41.9	1.90	26	27	53	0	1.7	0	2	6
South Windows	259.19	0.11	104	2.49	90	65	155	1	3.3	3	2	6
East Windows	263.54	0.18	97.2	2.71	178	60	237	1	1.1	15	2	6
West Windows	100.06	0.15	13.7	7.30	178	60	237	0	1.1	0	2	6
East Door Window	8.04	0.2	4.5	1.79	178	60	237	1	1.1	15	3	3
North Door Window	8.92	0.2	4.5	1.98	26	27	53	0	1.7	0	3	3

COMPONENT (cont'd)	T_x	PXI	SHGC	F_cl	IAC_cl	IAC	FF_s
North Windows	0.31	16.43	0.18	1	0.88	0.88	0.44
South Windows	0.36	23.4	0.2	1	0.88	0.88	0.47
East Windows	0.44	26.40	0.25	1	0.88	0.88	0.31
West Windows	0.31	73.78	0.18	1	0.88	0.88	0.56
East Door Window	0.26	15.60	0.16	0	0	1	0.31
North Door Window	0.26	13.78	0.16	0	0	1	0.44

Other Heat Sources

ITEM	VALUE	q
Occupants	3	750
Lighting	300W	1024
Equipment	1000W	3413

Ventilation

Cs	Qvi	eff	Qb	q
1.1	25	0.56	60	910.29

Peak Cooling Load **8165.26**

Peak Heating Load Analysis

Introduction

Values for latitude (40°) and outdoor temperature (3.2°F) were found in tables documenting standard conditions in Columbus, Ohio, and the indoor temperature was assumed to be a standard winter value of 68°F. These conditions yield a temperature difference (Δt) of 64.8°F.

Opaque Surfaces

The equation used to determine peak heating load is given below:

$$q = A \times HF$$

where A [ft^2] is the component area and HF is the heating load factor given below:

$$HF = U\Delta t$$

U -factors for the walls, roof, and floor were calculated by adding the R -values of all materials involved and taking the inverse. U -factors for the doors and windows were given by the manufacturer.

Ventilation

The calculation for peak load due to ventilation and infiltration was derived the same as for the cooling case (see above).

Other Heat Sources

To get a maximum estimate for the peak heating load, all surfaces were deemed to be opaque and there was assumed to be no heat generation by sources within the building envelope such as occupants or electronic equipment.

Peak Heating Load

After adding the load required by each component, the peak heating load is estimated to be 10814 *Btu/h* when using standard ASHRAE calculations.

Peak Heating Load Calculations

Designed for Indoor Temperature of 68°F and Outdoor Temperature of 3.2°F

Unit Standard

MEASUREMENT	UNITS
distance	feet
temperature	°F
heat	Btu
time	hour

Given Parameters

ITEM	VALUE
ΔT (°F)	64.8

R-Values

COMPONENT	VALUE
Wall	40
Roof	64
Floor	54

Opaque Surfaces

COMPONENT	q	U	AREA	HF
Wall	1684.80	0.03	1040	1.62
Roof	1554.19	0.0156	1535	1.01
Floor	1165.20	0.02	971	1.20
North Windows	407.27	0.15	41.9	9.72
South Windows	741.31	0.11	104	7.13
East Windows	1133.74	0.18	97.2	11.66
West Windows	133.16	0.15	13.7	9.72
East Door	106.92	0.1	16.5	6.48
East Door Window	58.32	0.2	4.5	12.96
North Door	106.92	0.1	16.5	6.48
North Door Window	58.32	0.2	4.5	12.96

Other Heat Sources

ITEM	VALUE	q
Occupants	0	0
Lighting	0	0
Equipment	0	0

Ventilation

Cs	Qvi	eff	Qb	q
1.1	25	0.56	60	3663.79

Peak Heating Load 10813.94

Trane TRACE ® 700 Modeling

The Trane Trace software package is widely used in industry to size HVAC equipment. The program offers eight different simulation methods. Furthermore, it includes an 8760 hour simulation option which greatly improves the accuracy of the results. While the Team has examined enCORE House with simulations for both Washington DC and Columbus, Ohio, only the results for Columbus will be presented here. The purpose of this decision is two-fold. First the team wishes to design the house for long term use and sustainable operation in central Ohio; the house will only be in Washington DC for about a month out of its life. Furthermore, the climates in Washington DC and Columbus, Ohio are relatively similar. A house that performs well in Columbus will also perform well in Washington DC.

In order to facilitate the replication of the most important parameters of the house in Trane Trace it was necessary to make several simplifications. The butterfly roof of the house was simplified to be constrained to a height equal to the maximum height of the three modules which make up the house. Furthermore, no separate thermal zones were incorporated. The parameters of the design are such that the modeling team anticipates that each separate zone of the house is able to freely exchange heat with any other adjacent section. The square footage of the house is small enough that zoning is inefficient and likely ineffective. To compensate for the lack of interior walls in the model a thermal mass has been added which simulates the influence of interior wall's.

Another important feature of the Trane Trace model is that the team created unique wall, floor, and ceiling construction details to simulate enCORE house's super insulated building envelope. While, the materials used in each typical section are not exotic or unusual the assembly and thicknesses of the sections are. The thermal resistances specified for each section are all above R-45, far outstripping any conventional options offered in Trane Trace.

It is also worth mentioning fenestration parameters for the modeling. Just as for the other high performance elements and sections of the house, the products specified in the construction documents are not available as a standard window types in Trane Trace. The team obtained several NFRC (National Fenestration Rating Council) specifications for triple glazed, argon filled, insulated fiberglass windows, and an average of these values was then entered into the simulation to generate a new window type.

Trane Trace Results

The following are the results for the peak heating and cooling loads for the current state of the design.

System Checksums By Trane

System - 001

Bypass VAV

COOLING COIL PEAK				CLG SPACE PEAK		HEATING COIL PEAK			TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 14		Mo/Hr: 9 / 10		Mo/Hr: Heating Design					
Outside Air:		OADB/WB/HR: 91 / 77 / 121		OADB: 73		OADB: 17					
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak Space Sens	Coil Peak Tot Sens	Percent Of Total (%)	SADB	Cooling	Heating
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h				
Envelope Loads						Envelope Loads					
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0	57.7	57.7	72.5
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0	72.5	72.5	72.5
Roof Cond	201	0	201	1	-12	Roof Cond	-791	-791	73.2	73.2	58.5
Glass Solar	2,725	0	2,725	19	5,621	Glass Solar	0	0	74.7	74.7	54.7
Glass Cond	659	0	659	5	0	Glass Cond	-2,057	-2,057	0.1	0.1	0.0
Wall Cond	644	0	644	4	87	Wall Cond	-1,329	-1,329	0.1	0.1	0.0
Partition	0	0	0	0	0	Partition	0	0	0.3	0.3	0.0
Exposed Floor	65	0	65	0	-67	Exposed Floor	-624	-624			
Infiltration	0	0	0	0	0	Infiltration	0	0			
Sub Total ==>	4,293	0	4,293	30	5,629	53	Sub Total ==>	-4,801	-4,801	72.26	
Internal Loads						Internal Loads					
Lights	512	512	1,024	7	512	5	Lights	0	0	0.00	
People	1,575	0	1,575	11	1,103	10	People	0	0	0.00	
Misc	3,413	0	3,413	24	3,413	32	Misc	0	0	0.00	
Sub Total ==>	5,500	512	6,012	42	5,027	47	Sub Total ==>	0	0	0.00	
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0	0.00	
Ventilation Load	0	0	3,796	27	0	0	Ventilation Load	0	-3,712	55.87	
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0	
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	0	0	0.00	
Ov/Undr Sizing	-71	0	-71	0	0	0	Exhaust Heat	1,869	-28.12		
Exhaust Heat	0	-48	-48	0	0	0	OA Preheat Diff.	0	0	0.00	
Sup. Fan Heat	0	0	325	2	0	0	RA Preheat Diff.	0	0	0.00	
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00	
Duct Heat Pkup	0	0	0	0	0	0					
Reheat at Design	0	0	0	0	0	0					
Grand Total ==>	9,722	464	14,307	100.00	10,657	100.00	Grand Total ==>	-4,801	-6,645	100.00	

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR		Leave DB/WB/HR		Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg				
ton	MBh	cfm	°F	°F	°F	°F		ft²	(%)	MBh	cfm	°F	°F				
Main Clg	1.2	14.3	645.2	74.7	62.6	65.4	912	0	0	Main Htg	-4.8	0.0	0.0	0.0			
Aux Clg	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	Aux Htg	0.0	0	0	0			
Opt Vent	0.0	0.0	0.0	0.0	0.0	0.0	579	0	0	Preheat	-1.8	645	55	57			
Total	1.2	14.3					912	257	21	Humidif	0.0	0	0.0	0.0			
										Opt Vent	0.0	0	0.0	0.0			
										Total	-6.6						

Project Name: OSU Solar Decathlon
Dataset Name: C:\DOCUMENTS AND SETTINGS\OSU\DESKTOP\OSU-SD-2011\SD.TRC

TRACE® 700 v6.1.3 calculated at 12:23 PM on 08/11/2011
Alternative - 1 System Checksums Report Page 1 of 2

Design Cooling Load Summary

By Trane
OSU Solar Decathlon
Columbus, OH

System - System - 001

Type - Bypass VAV

Coil Location - System

Coil Peak Calculation Time: July, hour 14
Ambient DB/WB/HR: 91 / 77 / 121

COOLING COIL LOAD INFORMATION

COOLING COIL SELECTION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	2,725		2,725	19.0 %
Glass Transmission	659		659	4.6 %
Wall Transmission	644		644	4.5 %
Roof Transmission	201		201	1.4 %
Floor Transmission	65		65	0.5 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	512		512	3.6 %
People	1,103	473	1,575	11.0 %
Misc. Equipment Loads	3,413	0	3,413	23.9 %
Cooling Infiltration	0	0	0	0.0 %
Sub-Total ==>	9,320	473	9,793	68.4 %
Ventilation Load	1,204	2,592	3,796	26.5 %
Exhaust Heat	-48	0	-48	-0.3 %
Supply Fan Load	325		325	2.3 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	0		0	0.0 %
Roof Load to Plenum	0		0	0.0 %
Lighting Load to Plenum	512		512	3.6 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenum	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	-71		-71	-0.5 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	11,243	3,064	14,307	100.0 %

Coil Selection Parameters	
Coil Entering Air (DB / WB)	74.7 / 62.6 °F
Coil Entering Humidity Ratio	65.36 gr/lb
Coil Leaving Air (DB / WB)	57.2 / 55.1 °F
Coil Leaving Humidity Ratio	61.55 gr/lb
Coil Sensible Load	11.24 MBh
Coil Total Load	14.31 MBh
Cooling Supply Air Temperature	57.68 °F
Total Cooling Airflow	645.18 cfm
Resulting Room Relative Humidity	49.86 %

General Engineering Checks

Total Cooling Load	1.2 ton
Area / Load	764.94 ft ² /ton
Total Floor Area	912 ft ²
Cooling Airflow	0.71 cfm/ft ²
Airflow / Load	541.15 cfm/ton
Percent Outdoor Air	9.3 %
Cooling Load Methodology	TETD-TA1

PEAK COOLING LOADS
MAIN SYSTEM
By Trane

System	Zone	Room	Floor Area ft ²	SPACE							COIL								
				Peak Time	OA Condition		Room Dry Bulb °F	Supply Dry Bulb °F	Space Air Flow cfm	Space Sensible Load Btu/h	Space Latent Load Btu/h	Peak Time	OA Condition		Supply Dry Bulb °F	Coil Airflow cfm	Coil Sensible Load Btu/h	Coil Latent Load Btu/h	
					DB °F	WB °F							DB °F	WB °F					
Alternative 1																			
		Room - 001	Peak	912	9/10	73	65	72.5	57.7	645	10,657	473	7/14	91	77	57.7	645	11,243	3,064
System - 001			Peak	912		73	65	72.5	57.7	645	10,657	473		91	77	57.7	645	11,172	3,064
System - 001			Block	912	9/10	73	65	72.5	57.7	645	10,657	473	7/14	91	77	57.7	645	11,243	3,064
Alternative 2																			
		Room - 001	Peak	912	7/17	89	76	72.5	56.9	981	17,037	473	7/17	89	76	56.9	981	18,161	2,770
System - 001			Peak	912		89	76	72.5	56.9	981	17,037	473		89	76	56.9	981	18,161	2,770
System - 001			Block	912	7/17	89	76	72.5	56.9	981	17,037	473	7/17	89	76	56.9	981	18,161	2,770

PEAK HEATING LOADS
MAIN SYSTEM
By Trane

Peak Time	OA Condition	
	DB °F	WB °F
Htg Design	17	12

System	Zone	Room	Block or Peak	Floor Area ft ²	SPACE				COIL		
					Room Dry Bulb °F	Supply Dry Bulb °F	Space Air Flow cfm	Space Sensible Load Btu/h	Supply Dry Bulb °F	Coil Air Flow cfm	Coil Sensible Load Btu/h
Alternative 1											
		Room - 001	Peak	912	72.5	72.5	0	-4,801	72.5	0	-4,801
System - 001			Peak	912	72.5	72.5	0	-4,801	72.5	0	-4,801
System - 001			Block	912	72.5	72.5	0	-4,801	72.5	0	-4,801
Alternative 2											
		Room - 001	Peak	912	72.5	72.5	0	-6,004	72.5	0	-6,004
System - 001			Peak	912	72.5	72.5	0	-6,004	72.5	0	-6,004
System - 001			Block	912	72.5	72.5	0	-6,004	72.5	0	-6,004

ASHRAE Calculation / Trane TRACE®700 Simulation Comparison

Peak load calculations were found using both ASHRAE calculations as well as Trane's TRACE® 700 energy simulation software. Using two methods not only provided a very detailed estimate of heating and cooling loads, but also served as an inherent check on the calculated values.

The peak cooling load estimated from the TRACE® 700 simulation software ended up being about 1.75 times higher than the value obtained from the ASHRAE calculations. This most likely resulted from the simplifications that needed to be made to the system in order to run the TRACE® 700 simulation. This was due to the fact that the software was designed exclusively for analysis of commercial structures, not residential homes. For example, the house was approximated as a rectangular box instead of containing multiple roof slopes, the occupants were modeled as working adults instead of a mix of at-home children and adults, and ventilated air was assumed to be ambient temperature.

When comparing specific sources of peak loads, it was found that solar gains, occupancy and ventilation load were the main sources of divergence between the ASHRAE and TRACE® 700 calculations. In all cases, the TRACE® 700 calculations were significantly higher.

Photovoltaics

Schematic Design Phase

A variety of software programs were used to optimize the design of the photovoltaic array with respect to output, cost, and aesthetics. The team has developed a Excel Spreadsheet which simulates tradeoffs associated with adjusting the angle of the photovoltaic array. The upper limit of this calculation is clearly determined by the allowable solar envelope for the Competition. All the same, the main purpose of the spreadsheet is to improve synergy between array performance and building integrated architectural design. EnCORE House attempts to strike a distinct balance between aesthetics and performance while compromising on neither. Managing the integration of the photovoltaic system from the very beginning of the schematic design phase is essential to the success of the project.

Design and Construction Documents Phases

In order to generate the data necessary to examine the team's PV decisions the enCORE modeling team used PVWatts, a free online application that is able to evaluate PV arrays for site-specific solar insolation data. The array performance predictions from PVWatts are then transferred to a spreadsheet and compared with the Team's expected electricity usage. In this way it can be estimated whether the house will maintain net-zero energy usage not only for the duration of the competition but also over the course of a year. Fine-tuning the array design will be accomplished with the assistance of other solar array design modeling software such as PVsyst.

Building Envelope Design

eQuest

With the initial equipment sizing determined by using the Trane Trace software the Team explored two other modeling programs to make building envelope decisions which effect energy efficiency. One such program, eQuest, offers a convenient user interface and is also free. By creating a base model of the EnCORE House in eQuest it was possible to examine net changes in performance relative to energy efficiency measures. One tradeoff examined was the net change in cooling load in relations to the amount of rigid insulation on the exterior walls. Initially, the Team specified 4" of continuous extruded polystyrene insulation on the exterior. However, considerations for mounting the rain screen and concerns over the cost motivated energy analysis in eQuest. The results of the simulation showed that peak cooling loads change by less than 3% for 2" versus 4" of exterior rigid foam. This information allowed the Team to specify 2" of continuous extruded polystyrene without compromising the ability of the HVAC equipment to meet peak loads.

Passive House Planning Package

The Passive House Planning Package (PHPP) will also be employed in the verification and commissioning phase of the project. A model generated by this software is necessary to achieve certification from the Passive House Institute. The team intends to benchmark the performance of enCORE house against other passive house projects. The main advantage of using PHPP is greater flexibility in specifying windows. The team hopes that PHPP will allow for more accurate analysis of its triple pane fiberglass windows. As windows represent a major construction cost, PHPP will help the team to justify decisions which may strongly affect the outcome of the affordability contest.

End of section.

Construction Specifications

Division 01 - General Requirements

- 01 10 00 Summary
- 01 50 00 Temporary Facilities and Controls
- 01 74 19 Construction Waste Management and Disposal
- 01 81 13 Sustainable Design Requirements
- 01 90 00 Information Requirements for Passive House Design and Construction
- 01 90 01 Advanced Framing

Division 04 – Masonry

- 04 20 00 Unit Masonry

Division 05 – Metals

- 05 12 00 Structural Steel Framing
- 05 40 00 Cold-Formed Metal Framing
- 05 50 00 Metal Fabrication
- 05 52 00 Metal Railings

Division 06 – Wood, Plastics, and Composites

- 06 10 00 Rough Carpentry
- 06 16 00 Sheathing
- 06 17 00 Shop Fabricated Structural Wood
- 06 17 53 Shop Fabricated Wood Trusses
- 06 20 00 Finish Carpentry
- 06 73 00 Composite Decking

Division 07 – Thermal and Moisture Protection

- 07 21 00 Thermal Insulation
- 07 46 00 Siding
- 07 53 23 Ketone Ethylene Ester (KEE) Roofing
- 07 62 00 Sheet Metal Flashing and Trim
- 07 71 00 Roof Specialties

07 72 00 Roof Accessories

07 92 00 Joint Sealants

Division 08 – Openings

08 16 73 Fiberglass Doors

08 32 19 Interior Sliding Doors

08 54 13 Fiberglass Windows

08 84 00 Plastic Glazing

08 90 00 Louvers and Vents

Division 09 – Finishes

09 22 16 Non-Structural Metal Framing

09 29 00 Gypsum Board

09 30 00 Tiling

09 64 00 Wood Flooring

09 91 00 Painting

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10 28 00 Toilet, Bath, and Laundry Accessories

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- 25 11 00 Home Automation and Control System (HACS)**

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26 41 13 Lightning Protection for Structures

26 50 00 Lighting

Division 28 – Electronic Safety and Security

28 31 00 Fire Detection and Alarm

Division 32 – Exterior Improvements

32 71 00 Bioremediation

32 93 00 Plants

Division 33 – Utilities

33 47 13 Pond Liner



Division 01

General Requirements

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 PROJECT INFORMATION

A. Project: encore – The 2011 OSU Solar Decathlon House

1. Project Location:

The Ohio State University Campus, Columbus, Ohio.

College of Food, Agricultural, and Environmental Sciences
100 Agricultural Administration Building
2121 Fyffe Road, Columbus, OH 43210
Phone: 614-292-6891

B. Owner: The Ohio State University

C. Architect: The Knowlton School of Architecture. Keoni Fleming (Advisor).

D. Contractor: The Ohio State University Solar Decathlon Team. Steven Winter (Advisor).

E. The Work consists of construction of a 1 story, 35' x 40' house with exterior decks per the referenced drawings and specifications. The house is a light wood frame, constructed in three modules on mobile steel trailers that can be separated for transport following completion of construction.

1.2 WORK RESTRICTIONS

A. Contractor's Use of Premises: During construction, Contractor will have full use of the 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. 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.

C. The site gate must remain closed during construction to keep onlookers from entering the site, and to keep Motown, Steve Winter's black Labrador retriever, from escaping.

D. Work must be completed in accordance with the Solar Decathlon Work Safety Plan, which sets forth requirements for safe construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 015000 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Electric Power: Available from a portable generator provided by the contractor. 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

2.1 EQUIPMENT

- A. Generators:
 - 1. EU 3000i Watt 120 Honda Generator
 - a. <http://www.hondapowerequipment.com/products/modeldetail.aspx?page=modeldetail§ion=P2GG&modelName=EU3000i%20Handi&modelid=EU3000iHAN>
 - 2. Noise Level: 49 – 59db
- B. Lighting
 - 1. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

PART 3 - EXECUTION

3.1 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

3.2 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 a permanent facility, or no later than Substantial Completion.

END OF SECTION 015000

SECTION 017419 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Performance Requirements: Achieve end-of-Project rates for salvage/recycling of 75.

1.2 SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for commencement of the Work.
- B. Waste Reduction Progress Reports: Submit concurrent with each Application for Payment. Include total quantity of waste, total quantity of waste salvaged and recycled, and percentage of total waste salvaged and recycled.
- C. Records of Donations and Sales: N/A
- D. Recycling and Processing Facility Records: Receipts and invoices.
- E. Landfill and Incinerator Disposal Records: N/A.
- F. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Administrative Requirements." Review methods and procedures related to waste management.
- G. Waste Management Plan: Develop a waste management plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
 - 1. Salvaged Materials for Reuse: Reusable wood and metal products.
 - 2. Salvaged Materials for Sale: N/A.
 - 3. Salvaged Materials for Donation: N/A.
 - 4. Recycled Materials: The Ohio State University, Facilities Operation and Development, Enarson Hall 154 W 12th Avenue, 614-292-1528.
 - 5. Cost/Revenue Analysis: N/A.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
- C. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

3.2 SALVAGING DEMOLITION WASTE

- A. N/A

3.3 RECYCLING WASTE

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
 - 5. Clean and stack undamaged, whole masonry units on wood pallets.
- C. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- D. Metals: Separate metals by type.
- E. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- F. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- G. Conduit: Reduce conduit to straight lengths and store by type and size.

3.4 DISPOSAL OF WASTE

- A. Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

B. Do not burn waste materials.

END OF SECTION 017419

SECTION 018113 – SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Definitions:

1. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
2. Recycled Content: The recycled content shall be determined by weight.
 - a. "Post-consumer" material is defined as waste material generated by end users of the product, which can no longer be used for its intended purpose.
 - b. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as scrap generated in a process that is reclaimed in the same process that generated it.

B. Submittals:

1. List of proposed materials with recycled content. Indicate post-consumer recycled content and pre-consumer recycled content for each product. Submit within 60 days of date established for commencement of the Work.
2. List of proposed regional materials. Submit within 60 days of date established for commencement of the Work.
3. List of proposed certified wood products. Submit within 60 days of date established for commencement of the Work.
4. Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Recycled Content of Materials: Provide building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 10 percent of cost of materials used for Project.
 1. Do not include mechanical and electrical components in the calculation.
- B. Regional Materials: Provide 10 percent of building materials (by cost) that are regional materials.

2.2 LOW-EMITTING MATERIALS

- A. Use adhesives and sealants that comply with the following limits for VOC content:
1. Wood Glues: 30 g/L.
 2. Subfloor Adhesives: 50 g/L.
 3. Multipurpose Construction Adhesives: 70 g/L.
 4. Contact Adhesive: 80 g/L.
 5. Structural Glazing Adhesives: 100 g/L.
 6. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, PTFE, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
 7. Plastic Cement Welding Compounds: 350 g/L.
 8. PVC Welding Compounds: 510 g/L.
 9. Adhesive Primer for Plastic: 650 g/L.
 10. Other Adhesives: 250 g/L.
 11. Architectural Sealants: 250 g/L.
 12. Single-Ply Roof Membrane Sealants: 450 g/L.
 13. Other Sealants: 420 g/L.
 14. Sealant Primers for Nonporous Substrates: 250 g/L.
- B. Use interior paints and coatings that comply with the following limits for VOC content:
1. Flat Paints and Coatings: 50 g/L.
 2. Nonflat Paints, Coatings: 150 g/L.
 3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 4. Clear Wood Finishes, Varnishes: 350 g/L.
 5. Stains: 250 g/L.
 6. Primers, Sealers, and Undercoaters: 200 g/L.
- C. Do not use composite wood or agrifiber products or adhesives that contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 REFRIGERANT REMOVAL

- A. N/A

3.2 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

- A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Facilities and Controls," install filter media having a MERV 8

according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.

2. Replace all air filters immediately prior to occupancy.

END OF SECTION 018113

SECTION 019000 – GENERAL INFORMATION / REQUIREMENTS FOR PASSIVE HOUSE DESIGN AND CONSTRUCTION.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements and procedures for building to passive house institute standards including but not limited to the following.
1. Insulation
 2. Thermal Bridging
 3. Air tightness
 4. Ventilation and heat recovery
 5. Triple pane windows
- B. Related Requirements:
1. Specification sections referred to in this section.
 - a. Advanced Framing; See Spec section 019001 Advanced Framing
 - b. Rigid Insulation: See Spec section 072100 Thermal insulation
 - c. Spray Foam Insulation: See Spec Section 072100 Thermal Insulation
 - d. Sealants: See spec section 079200 Joint Sealants
 - e. Window installation: See Spec section: 085413 Fiberglass Windows
 - f. Expansion joint Insulation: See Spec section 072100 Thermal Insulation
 - g. Door hardware: See spec section 087100 Door hardware
 2. Typical insulation values for a passive house
 - a. Walls / roofs and slab to ground: 0.10 to 0.15 W/(m²K)
 - b. Windows: less than 0.8 W/(m²K)

1.2 DEFINITIONS

- A. Passive House: A very well-insulated, virtually air-tight building that is primarily heated by passive solar gain and by internal gains from people, electrical equipment, etc. An energy recovery ventilator provides a constant, balanced fresh air supply. The result is an impressive system that not only saves up to 90% of space heating costs, but also provides a uniquely terrific indoor air quality.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Typical thickness needed for achieve a u-value of 0.13 for particular insulating building materials.

1. Typical Insulation Material - 0.30 m
2. Highly insulation material – 0.188 m
3. Non-porous super insulation (normal pressure) – 0.113m
4. Vacuum insulation (silica) - .060 m
5. Vacuum insulation (high vacuum) - .015 m

B. Typical U-values for window construction.

1. Single pane: 5.60 W/(m²K)
2. Double pane: 2.80 W/(m²K)
3. Double low-e, Ar: 1.20 W/(m²K)
4. Triple low-e, Ar: .65W/(m²K)

PART 3 - EXECUTION

3.1 GENERAL REQUIERMENTS

- A. Throughout the project particular attention must be paid to specific details of construction. Some of the areas for concern are as follows.

B. WALL CONSTRUCTION

1. Rain screen construction: Throughout the wall construction various penetrations in the insulation and the wall itself will occur. This can cause the moisture barrier to become ineffective as well as allow for thermal bridging to occur. Contractor is to coordinate and make clear the need for air tight construction. Penetrations in the exterior wall must be thermally broken and sealed air / water tight.
2. Continuous insulation though wall connections to roof and floor must be achieved. Notify designer of any obstructions in wall to floor construction, and wall to roof construction that may hinder the insulations ability to be continuous.
3. Install insulation to fill voids completely, any gaps between insulation materials will hinder walls ability to insulate properly. All Joints of exterior rigid insulation are to be fully sealed in order to achieve a moisture tight barrier.
4. Wall sill seal must be installed continuously along the connection of the floor to the wall.

C. ROOF CONSTRUCTION

1. The roof must be sufficiently insulated to achieve the standards of passive house. The same conditions that apply to the walls apply to the roof.

D. WINDOW INSTALLATION

1. All rough openings for windows are to be fully taped and sealed weather tight. Sill plate backing dam must be provided in rough opening to create a sloped surface toward the exterior of the building to prevent water building up.
2. All gaps between rough openings and window frame are to be sealed with spray foam insulation.

E. EXPANSION JOINT INSULATION

1. In the case of the Encore home the use of expansion joints will be used to connect the modules of the house. All expansion and control joints must have continuous gaskets at all seams and covered with a flexible insulation material to achieve required U-value and air tightness of the floor, wall or roof
2. Expansion joint covers are to be thermally broken.

F. EXTERIOR DOOR OPENINGS

1. Continuous gaskets must be used at all edges of the frame to achieve a tight seal. Seals / gaskets on the door bottom must be able to form an air tight seal with the threshold. Provide raised thresholds as necessary per ADA standards or as indicated on the drawings and in door hardware schedule.

PART 4 - REFERENCE MATERIAL

4.1 Sources for further information on Passive House design

1. <http://www.passivehouse.us>
2. <http://www.passivhaustagung.de>

END OF SECTION 019000

SECTION 019001 – ADVANCED FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general guidelines for design and construction using advanced framing techniques.
- B. Related Requirements:
 - 1. Specification sections referred to in this section.
 - a. Rough Carpentry: See Spec section 061000 Thermal Insulation
 - b. Sheathing: See Spec Section 061600 Sheathing

1.2 DEFINITIONS

- A. Advanced Framing: Refers to a variety of framing techniques designed to reduce the amount of lumber used and waste generated in the construction of a wood-framed house. This technique also allows for better insulated walls through the use of 2x6 stud framing and by reducing the amount of wood used in wall construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 ADVANCED FRAMING DESIGN CONSIDERATIONS

- A. TWO FOOT MODULE
 - 1. Design building length, width, and roof pitch in 2-foot increments to make the best use of common sheet good sizes. This technique will reduce material use, labor, and waste, as many products come in multiples of 2 feet. For example, with proper planning, the entire cutoff from a center cut sheet of plywood can be used elsewhere, eliminating the need for an additional cut and reducing scrap. When planning the roof, remember to allow space for a ridge vent if one is used.
- B. IN-LINE FRAMING
 - 1. Align floor, wall, and roof framing members directly above or below one another so that loads are transferred directly downward. With in-line framing, double top plates can be eliminated because the load is distributed evenly through the top plate. Using this method, studs that are 24 inch on-center are placed directly below roof trusses spaced 24 inches on-center.

C. WINDOW AND DOOR LAYOUT

1. Align at least one side of each window and door in line with an existing stud and attach the other side with a metal hanger. Windows with rough openings of 22½ inches can fit between studs that are spaced 24 inches on center. When this size window is used in conjunction with inline framing, headers are not necessary because no studs need to be cut.

3.2 WALL CONSTRUCTION

A. Stud Spacing:

1. Where allowable by code place studs at 24" on center.

B. Structural Headers:

1. Properly size headers per the ICC table 602.6. or as specified by structural.
2. Do not use headers in non-bearing unless noted otherwise.
3. Scrap rigid insulation spacer in place of plywood or OSB

- a. Scrap insulation must be continuous piece free of cracks and major surface deformations.

C. Jacks (shoulder studs / cripples)

1. Support structural headers with metal hangers eliminating need for jack studs.
2. Use 2x2 nailer at jamb studs for siding attachment when nailable sheathing is not used.

D. Outside and Inside Corners

1. Corners are to be constructed using two stud methods – refer to drawing details.
 - a. Drywall Clips / gypsum backer
 - 1) Use drywall clips for inside gypsum corners. Position clips above the level of wall base trim installation.
 - 2) Install first drywall sheet against side with clip or backer.

E. Partition Connection to Exterior walls (T-walls)

1. Install using "ladder blocks", Drywall clips or full length 2x6 or 1x6 behind the first partition stud.

F. Single Top Plate

1. Used with inline framing
2. Tie top plate at joints, corners and wall intersections with 3x6 inch, 20 gauge galvanized steel plates nailed using three 8d nails each side. Or as specified on structural drawings.
3. When using single top plate construction use 94 ¼ inch long studs to reduce most amount of waste.

PART 4 - REFERENCE MATERIAL

4.1 Sources for further information on advanced framing

1. Energy Efficiency and Renewable Energy Clearinghouse (EREC) 1-800-DOE-3732
http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/26449.pdf
2. Builder's Guide Energy Efficient Building Association, Inc. 651-268-7585
www.eeba.org

END OF SECTION 019001



Division 04

Masonry

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete masonry units (CMU's).

1.2 SECTION REQUIREMENTS

- A. Submittals: None Required
- B. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Regional Materials: CMUs shall be manufactured within 500 miles (800 km) of Project site from aggregates that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
- C. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength where indicated.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. ACM Chemistries; RainBloc.
 - b. BASF Aktiengesellschaft; Rheopel Plus.
 - c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.
- D. CMUs: ASTM C 90.
- 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3050 psi (21.0 MPa).
 - 2. Density Classification: Normal weight

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

END OF SECTION 042000



Division 05

Metals

SECTION 051200 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A
- B. Comply with applicable provisions of the following:
 - 1. AISC 303.
 - 2. AISC 341 and AISC 341s1.
 - 3. AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL

- A. W-Shapes: ASTM A 992/A 992M.
- B. Hollow structural sections: ASTM A 500 / A500M structural tubing.

2.2 ACCESSORIES

- A. High-Strength Bolts, Nuts, and Washers: Type 1, heavy-hex steel structural bolts.
- B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
- C. 16 inch x 16 inch ABS pads.

2.3 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible.
- B. Weld Connections: Comply with AWS D1.1/D1.1M N/A
- C. Shop Priming: Prepare surfaces according to SSPC-SP 2, Shop prime steel to a dry film thickness of at least 1.5 mils (0.038 mm).

PART 3 - EXECUTION

3.1 ERECTION

- A. Structural Steel frames are built to be transportable.
- 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. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
- D. Assemble scaffolding per manufacturers written instructions.

END OF SECTION 051200

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements.

2.2 PERFORMANCE REQUIREMENTS

- A. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.4 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, un-punched, with straight flanges, and matching minimum base-metal thickness of steel studs.
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, un-punched, with stiffened flanges.

2.5 EXTERIOR FURRING STRIPS

- A. PrimeWall Resilient Channel, *RC2-NH-30*- <http://www.steelnetwork.com/Products>
 - 1. 25 gauge galvanized steel ASTM A653 G90. Roll formed and stamped into 2.25 inch width U bar.

2.6 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.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- E. 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.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
- C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
- B. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- C. Install insulation, specified in Section 072100 "Thermal Insulation," 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.

3.2 LOAD-BEARING WALL INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends
- B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch (3 mm) between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
- G. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
- H. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- I. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

END OF SECTION 054000

SECTION 055000 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A.

PART 2 - PRODUCTS

2.1 METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.

2.2 FABRICATION

- A. Welding: Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. At exposed connections, finish welds and surfaces smooth with contour of welded surface matching those adjacent.
- B. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

2.3 STEEL AND IRON FINISHES

- A. Prepare uncoated ferrous metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning," and paint with a fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack.
- B. Fit exposed connections accurately together to form hairline joints.

END OF SECTION 055000

SECTION 055200 – METAL RAILINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A

PART 2 - PRODUCTS

2.1 RAILING SYSTEMS

- A. Provide railings capable of withstanding a uniform load of 50 lbf/ ft. (0.73 kN/m) and a concentrated load of 200 lbf (0.89 kN) applied to handrails and top rails of guards in any direction. Uniform and concentrated loads need not be assumed to act concurrently.
- B. Provide railing infill capable of withstanding a concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m). Infill load and other railing loads need not be assumed to act concurrently.

2.2 METALS

- A. Aluminum, Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
- B. Aluminum Castings: ASTM B 26/B 26M, Alloy A356.0-T6.
- C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 OTHER MATERIALS

- A. N/A

2.4 FABRICATION

- A. Assemble railing systems in shop to the greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Form changes in direction of railing members by use of prefabricated fittings.
- C. Fabricate railing systems and handrails for connecting members with concealed mechanical fasteners and fittings.

- D. Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect handrail and railing members to other construction.
- E. Provide wall returns at ends of wall-mounted handrails.

2.5 FINISHES

- A. Aluminum Railings: Class I, clear anodic finish; AA-M12C22A41; complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fit exposed connections accurately together to form tight, hairline joints.
- B. Set railings accurately in location, alignment, and elevation and free of rack.
- C. Attach handrails to wall with wall brackets.

END OF SECTION 055200



Division 06

Woods, Plastics, and Composites

SECTION 061000 – ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: None Required

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: Provide dressed lumber, S4S, marked with grade stamp of inspection agency.
- B. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

2.2 TREATED MATERIALS

- A. Preservative-Treated Materials: AWPA C2
 1. Use treatment containing no arsenic or chromium.
 2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
 3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- B. Provide preservative-treated materials for all rough carpentry.
- C. Fire-Retardant-Treated Materials: N/A

2.3 LUMBER

- A. Dimension Lumber:
 1. Maximum Moisture Content: 15 percent.
 2. Framing Other Than Non-Load-Bearing Interior Partitions: No. 2
 3. Exposed Framing: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 - a. Species: As specified for framing other than non-load-bearing interior partitions.

- b. Grade: No. 2.
- 4. Maximum Moisture Content: 20 percent.

2.4 ENGINEERED WOOD PRODUCTS

- A. Engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be demonstrated by comprehensive testing.

2.5 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: Plywood, fire-retardant treated, not less than 1/2-inch (13-mm).

2.6 MISCELLANEOUS PRODUCTS

- A. Fasteners: Size and type indicated. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 - 1. Bolts: Steel bolts complying with ASTM A 307.
- B. Metal Framing Anchors: Structural capacity, type, and size indicated.
 - 1. Use anchors made from hot-dip galvanized steel complying with ASTM A 653/A 653M, G60 (Z180) coating designation for interior locations where stainless steel is not indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Securely attach rough carpentry to substrates, complying with the following:
 - 1. CABO NER-272 for power-driven fasteners.

END OF SECTION 061000

SECTION 061600 – SHEATHING (ZIP SYSTEM)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Combination wall sheathing, water-resistive barrier, and air barrier.
2. Roof sheathing
3. Subflooring
4. Self-adhering flexible flashing

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for plywood backing panels.
2. Section 072500 "Weather Barriers" for water-resistive barrier applied over wall sheathing.
3. Section 072700 "Air Barriers"

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. For panels with integral water resistive barrier, include data on air-/moisture-infiltration protection based on testing according to referenced standards.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Capable of demonstrating that all wood procurement operations are conducted in accordance with procedures and policies of the Sustainable Forestry Initiative (SFI) Program.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Outdoor Storage: Comply with manufacturer's recommendations

1. Set panel bundles on supports to keep off ground.
2. Cover panels loosely with waterproof protective material.
3. Anchor covers on top of stack, but keep away from sides and bottom to assure adequate air circulation.
4. When high moisture conditions exist, cut banding on panel stack to prevent edge damage.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sheathing system that fail due to manufacturing defects within specified warranty period.
 - 1. For subflooring and roof and wall sheathing applications, manufacturer shall warrant that the panels will not delaminate nor require sanding due to moisture absorption during installation within 300 days of purchase.
 - 2. System Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

2.2 WOOD PANEL PRODUCTS

- A. Oriented Strand Board: DOC PS 2.
- B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- C. Factory mark panels to indicate compliance with applicable standard.

2.3 COMBINATION WALL SHEATHING, WATER-RESISTIVE BARRIER, AND AIR BARRIER

- A. Oriented-Strand-Board Wall Sheathing: With integral water-resistive barrier, Exposure 1 sheathing. <http://www.zipsystem.com/zip-system/wall.aspx>
 - 1. Acceptable manufacturer: Huber Engineered Woods LLC; ZIP System Wall Sheathing.
 - 2. Span Rating and Nominal Thickness: Not less than Wall-24; 7/16 inch (11.1 mm)
 - 3. Edge Profile: Self-spacing profile.
 - 4. Provide fastening guide on top panel surface with pre-spaced fastening symbols for 16-inches (406 mm) and 24-inches (610 mm) on centers spacings.
 - 5. Performance Standard: DOC PS2 and ICC-ES ESR-1474. Factory laminated integral water-resistive barrier facer.
 - 7. Perm Rating of Integral Water-Resistive Barrier: 12-16 perms.

8. Assembly maximum air leakage of 0.0072 cfm/sq. ft. (0.037 L/s x sq. *m) infiltration and 0.0023 cfm/ sq. ft. (0.012 L/s x sq.*m) exfiltration at a pressure differential of 1.57 psf (75 Pa).
9. Exposure Time: Designed to resist weather exposure for 120 days.

2.4 ROOF SHEATHING

A. Oriented-Strand-Board Roof Sheathing: Exposure 1 sheathing.

1. Acceptable manufacturer: Huber Engineered Woods LLC; AdvanTech Sheathing. <http://www.advantechperforms.com/product-lineup/advantech-sheathing.aspx>
3. Span Rating and Nominal Thickness: Not less than 32/16, 1/2 inch (13 mm)
4. Edge Profile: Tongue and groove.
5. Provide fastening guide on top panel surface with pre-spaced fastening symbols for 16-inches (406 mm) and 24-inches (610 mm) on center spacing's.

2.5 SUBFLOORING

A. Oriented-Strand-Board Combination Subfloor-Underlayment: Exposure 1 single-floor panels.

1. Acceptable manufacturer: Huber Engineered Woods LLC; AdvanTech Flooring <http://www.advantechperforms.com/product-lineup/advantech-flooring.aspx>
2. Span Rating and Nominal Thickness: Not less than 24 oc, 23/32 inch (18.3 mm).
3. Edge Detail: Tongue and groove.
4. Surface Finish: Fully sanded face.
5. Performance Standard: DOC PS2
6. Provide fastening guide on top panel surface with pre-spaced fastening symbols for 16-inches (406 mm), 19.2-inches (488 mm) and 24-inches (610 mm) on center spacings.

2.6 FASTENERS

- ### A. General: Provide fasteners of size and type that comply with requirements specified in this article by the authority having jurisdiction, International Building Code, International Residential Code, Wood Frame Construction manual, and National Design Specification.

2.7 MISCELLANEOUS MATERIALS

- ### A. Self-Adhering Tape: Pressure-sensitive, self-adhering, cold-applied, proprietary seam tape consisting of polyolefin film with acrylic adhesive. <http://www.zipsystem.com/zip-system/tape.aspx>

1. Acceptable manufacturer: Huber Engineered Woods; ZIP System Tape
 2. Thickness: 0.012 inch (0.3 mm).
 3. Code Compliance: Comply with requirements of authorities having jurisdiction and ICC Evaluation Service, Inc. "AC148 (2006) - Acceptance Criteria for Flexible Flashing Material."
- A. Underlayment – Nylon vertically-channeled matrix
1. Acceptable manufacturer: Benjamin Obdyke Incorporated 400 Babylon Rd, SuiteA Horsham, PA 19044 <http://www.benjaminobdyke.com>
 2. Home slicker - <http://www.benjaminobdyke.com/resources/137/HSFB1109.pdf>

PART 4 - EXECUTION

4.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Install underlayment material per manufacturer's standard instructions and recommendations.
- D. Securely attach to substrate by fastening as indicated, complying with the following:
 1. NES NER-272 for power-driven fasteners.
 2. Chapter 23 in ICC's "International Building Code."
 3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
- E. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- F. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- G. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- H. Only mechanically attached and drainable EIFS and exterior insulation should be used with ZIP System wall sheathing.

4.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
1. Combination Subfloor-Underlayment:
 - a. Glue and nail to wood framing.
 - b. Glue and screw to cold-formed metal framing.
 - c. Space panels 1/8 inch (3 mm) apart at edges and ends.
 - d. Install fasteners 3/8 inch (9.5 mm) to 1/2 inch (12.7 mm) from panel edges.
 - e. Space fasteners 6 inches (152 mm) on centers on supported edges (4-foot ends), and 12 inches (305 mm) on centers at intermediate support locations.
 - f. For 1-1/8 inch (28.6 mm) panels supported at 48 inch (1220 mm) spacing, space fasteners 6 inches (152 mm) on centers on supported edges and intermediate support locations.
 - g. Penetrate wood framing members at least 1 inch (25.4 mm).
- C. Fastening Methods: Fasten panels as indicated below:
1. Wall and Roof Sheathing:
 - a. Nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch (3 mm) apart at edges and ends.
 - d. Install fasteners 3/8 inch (9.5 mm) to 1/2 inch (12.7 mm) from panel edges.
 - e. Space fasteners in compliance with requirements of authority having jurisdiction.

4.3 SHEATHING JOINT TREATMENT

- A. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply proprietary seam tape to joints between sheathing panels.
 2. Utilize self-adhering tape gun or hard rubber roller provided by manufacturer to ensure tape is completely adhered to substrates.

4.4 FLEXIBLE FLASHING INSTALLATION

- A. Apply flexible flashing where indicated to comply with manufacturers written instructions.
1. After flashing has been applied, roll surfaces with a hard rubber to ensure that flashing is completely adhered to substrates.

END OF SECTION 061600

SECTION 061700 – SHOP FABRICATED STRUCTURAL WOOD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Laminated Veneer Lumber.
- B. Related Sections:
 - 1. Section 061000: Rough Carpentry.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturers product data and installation instructions
- B. Shop Drawings: Provide drawings indicating lumber grade, size, location, and connection details

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements and Approvals: Provide laminated veneer lumber meeting the requirements of the following building code compliance reports.
 - 1. ICC-ES:
 - a. Report Number: ESR-1254.
 - 2. CCMC:
 - a. Report Number: 11518-R

1.4 DELIVERY STORAGE AND HANDLING

- A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
 - 1. Carefully unload lumber by lifting, using forklifts or cranes to avoid damage.
 - 2. Keep lumber stored in wrapped and strapped bundles stacked no more than 10 feet high.
 - 3. Support bundles to prevent excessive bowing. Support and separate bundles with 2 × 4 or larger dimension lumber spaced no more than 10 feet apart. Keep supports in line vertically.
 - 4. Handle individual pieces in a manner to prevent physical damage during measuring, cutting and erection.

- B. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
1. Keep lumber dry.
 2. Store lumber on a hard, dry, level surface.
 3. Do not store lumber in contact with the ground.
 4. Do not allow lumber to have prolonged exposure to weather.

PART 2 - PRODUCTS

2.1 LAMINATED VENEER LUMBER

A. MANUFACTURER:

1. LP – building products

- a. Contact: 414 Union St., Nashville, TN 37219; Telephone: (800) 999-9105, (910) 762-9878; Fax: (910) 763-8178; E-mail: customer.support@lpcorp.com; website: www.lpcorp.com.

B. LP LVL 2650Fb-1.9E:

1. Material: Ultrasonically and visually graded veneers arranged to specific patterns so that naturally occurring defects have no concentrated effect on the member's performance.
2. Adhesive: Waterproof adhesive, bonded under pressure and heat.
3. Thickness: 1 3/4 inches
4. Plies: 4.
5. Depth: 14 inches.
6. f. Water Resistant Coating: No coating required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. SITE VERIFICATION OF CONDITIONS:

1. Verify that site conditions are acceptable for installation of lumber.
2. Do not proceed with installation of lumber until unacceptable conditions are corrected.

3.2 INSTALLATION

A. TEMPORARY BRACING:

1. LVL must be securely braced during construction. Temporary bracing must be anchored to the ground, foundation, a braced wall or other completed stable section of the structure.
2. Exercise caution when removing temporary bracing when applying sheathing. Remove bracing as sheathing is attached.
3. All rim joists, blocking, connections and temporary bracing must be installed before erectors are allowed on the structure.
4. Impose no loads other than the weight of the erectors on the structure before it is permanently sheathed.
5. After sheathing, do not exceed design loads on members with construction materials.
6. Support members laterally at end bearings and cantilevers.
7. All conditions calling for notched or drilled beams must be reviewed and approved by a licensed professional engineer.

B. CONDITIONS AND PRACTICES NOT PERMITTED

1. Do not place holes closer to supports than recommended by manufacturer.
2. Do not over cut holes.
3. Do not make holes not in compliance with allowable hole size and location recommendations of manufacturer.
4. Do not install visibly damaged lumber.

C. PROTECTION

1. Protect installed work from damage due to subsequent construction activity on site.

END OF SECTION 061700

SECTION 061753 – SHOP FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Open web wood roof joist.

1.2 RELATED SECTIONS

- A. Section 061000 Rough Carpentry.
- B. Section 061600 Sheathing.

1.3 SUBMITTALS

- A. Product Data: include joist configurations, bearing and anchor details, bracing and blocking.
- B. Shop Drawings: indicate sizes and spacing of joist and associated components, web and chord member sizes, loading, bracing and blocking and framed openings.

1.4 QUALITY ASSURANCE

- A. Manufacturer
 - 1. Member of Wood truss Council of America.
- B. Lumber Grading Agency: Certified to NIST PS 20.
- C. Joist: Meet requirements of ICC international building code; certified by ICC Evaluation Service.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Handle joist upright by bottom flange.
- B. Prevent excessive flat-wise bending of joist.
- C. For joist stored outside.
 - 1. Place on blocks or spacers located at ends and maximum 10 feet on center.
 - 2. Cover joists with properly vented, waterproof coverings.
 - 3. Do not stack joist bundles more than three high.
 - 4. Leave joist bundle bands in place until ready to use.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. OPEN JOIST by universal Forest Products, INC <http://www.openjoist.com>

2.2 MATERIALS

- A. Lumber: Spruce-Pine-Fur, graded to requirements of Canadian Wood Council lumber grading agencies.

2.3 ACCESSORIES

- A. Lumber for bracing, blocking and framed openings.
- B. Fasteners.

2.4 FABRICATION

- A. Fabricate joist to achieve specified structural requirements
 - 1. Grade: No. 2
 - 2. Chord Size: 3x2

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install joist and accessories in accordance with manufacturer's instructions and approved shop drawings
- B. Set joists level, plumb, right side up, in correct position.
- C. Joists may be trimmed maximum 5-1/2 inches on each end; leave minimum 1-3/4 inches of solid end block intact.
- D. Do not cut, notch, or drill joist top chords, bottom chords or webs.
- E. Provide minimum 1-1/2 inches of bearing at each end of joists.
- F. Fasten joists to top plates, bearing plates, rim boards, and other joists butting end to end or lapping at ends.
- G. Place temporary 2x4 lumber bracing perpendicular to joists at maximum 8 feet on-center, spanning minimum of three joists. Fasten bracing to each joist.

- H. Place triangulated 2x4 lumber bracing or 4-foot wide strip of temporary or permanent sheathing where end walls are not braced.
- I. Remove temporary bracing and sheathing progressively as permanent subflooring is installed.
- J. Install permanent bracing at locations indicated on shop drawings.

END OF SECTION 061753

SECTION 062000 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: None Required

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and grading rules of inspection agencies certified by American Lumber Standards Committee Board of Review.
- B. Softwood Plywood: DOC PS 1.
- C. Hardwood Plywood: HPVA HP-1.
- D. Particleboard: ANSI A208.1, Grade M-2.
- E. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

2.2 EXTERIOR FINISH CARPENTRY

- A. Exterior Lumber Trim: Smooth
 - 1. Maximum Moisture Content: 15 percent.
- B. Lumber Siding: Kiln-dried
- C. Plywood Siding: APA-rated siding, 1/2-inch- (12.7-mm-) thick
- D. Plywood Soffits: 1/2-inch- (12.7-mm-) thick

2.3 INTERIOR STANDING AND RUNNING TRIM

- A. Interior Softwood Lumber Trim: 1 Common white woods
 - 1. Maximum Moisture Content: 15 percent.
- B. Interior Hardwood Lumber Trim: Clear, kiln-dried

- C. Wood Moldings: WMMPA WM 4 made to patterns in WMMPA WM 12 from kiln-dried stock.
 - 1. Softwood Moldings for Transparent Finish
 - 2. Moldings for Painted Finish: P-Grade primed medium-density fiberboard.
 - 3. Base: As indicated on drawings
 - 4. Shoe Mold: WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round shoe.
 - 5. Casing: As indicated on drawings casing.
 - 6. Stop: As indicated on drawings.
 - 7. Chair Rail: WM 297.

2.4 PANELING

- A. Hardwood Veneer Plywood Paneling: Manufacturer's stock panels complying with HPVA HP-1.
 - 1. Face Veneer Species: Birch or Maple
 - 2. Veneer Matching: Selected for similar color and grain.
 - 3. Thickness: As indicated on drawings
 - 4. Face Pattern: Manufacturer's standard pattern, with grooves at edges, center, and third points of panels, and at other locations to provide pattern resembling random width boards.
- B. Hardboard Paneling: Factory finished, thickness as indicated on drawings, complying with AHA 135.5
- C. Maple Plywood milled wall panels:
 - 1. Panel A
 - a. Milled pattern as indicated on drawings
 - b. Finish: Opaque finish, milled and sanded to smooth face surface finish.
 - 1) Contractor – Columbus Idea Foundry, 1158 Corrugated Way. Columbus, OH 43201, Tel; 614-299-IDEA (4332)
 - a) <http://www.columbusideafoundry.com/>

2.5 SHELVING AND CLOTHES RODS

- A. Shelving: 1/2-inch (12.7-mm) finish boards as specified on drawings for interior softwood lumber trim
- B. Clothes Rods: 1-1/2-inch- (38-mm-) diameter
- C. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.

2.6 MISCELLANEOUS MATERIALS

- A. Fasteners for Exterior Finish Carpentry: aluminum.
- B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer.
 - 1. Use waterproof resorcinol glue for exterior applications.
- C. Adhesive for Cellular PVC Trim: Product recommended by trim manufacturer.
- D. Installation Adhesive for Foam Plastic Moldings: Product recommended for indicated use by foam plastic molding manufacturer.
- E. Insect Screening for Soffit Vents: Aluminum

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Condition finishes carpentry in installation areas for 24 hours before installing.
- B. Prime and back prime lumber for painted finish exposed on the exterior.
- C. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Scribe and cut to fit adjoining work. Refinish and seal cuts.
- D. Install standing and running trim with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Stagger joints in adjacent and related trim. Cope at returns and miter at corners.
- E. Nail siding at each stud. Do not allow nails to penetrate more than one thickness of siding, unless otherwise recommended by siding manufacturer. Seal joints at inside and outside corners and at trim locations.
- F. Select and arrange paneling for best match of adjacent units. Install with uniform tight joints.

END OF SECTION 062000

SECTION 067300 – COMPOSITE DECKING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Composite decking.

1.2 RELATED SECTIONS

- A. Section 061100: Wood Framing.

1.3 DESIGN / PERFORMANCE REQUIREMENTS

- A. Structural Performance:

1. Deck: Uniform Load: 100 lbf/sq. ft.
2. Treads of Stairs: Concentrated Load: 750 lbf/sq. ft., and 1/8" max. deflection with a concentrated load of 300 lbf on area of 4 sq. in

- B. Fire-Test-Response Characteristics per ASTM E-84:

1.4 SUBMITTALS

- A. Product Data: Indicate sizes, profiles, surface style, and performance characteristics.
- B. Samples: For each product specified, one sample, minimum size 4 inches long, representing actual product, color, and finish.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling:

1. Never dump composite decking materials when unloading.
2. Store on a flat surface and cover with non-translucent material.
3. When carrying planks, carry on edge for better support.
4. Refer to installation instructions for additional guidelines on each product.

1.6 WARRANTY

- A. Warranty: Limited Residential Warranty against rot, decay, splitting, checking, splintering, or termite damage for a period of 25 years beginning from date of purchase under normal conditions of use and exposure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Documents are based on products by: TimberTech Limited, 894 Prairie Avenue, Wilmington, Ohio 45177.

2.2 APPLICATIONS/SCOPE

- A. Wood/Plastic Composite Lumber:

1. Material Description: Composite plank consisting of high density polyethylene (HDPE) and wood flour, extruded into sizes and shapes indicated with the following physical properties:
 - a. TwinFinish Decking Boards: 1 inch x 5.4-inches wide. In lengths 12, 16 and 20 feet
 - b. Color
 - 1) TwinFinish plank- Color to be Cedar - <http://www.timbertech.com/products/decking-planks/twin-finish/default.aspx>
 - a) Flat Grain Surface
 - b) Edges are Smooth for face fastening
 - c. Specific Gravity: 1.2 g/cu. cm. when tested in accordance with ASTM D-792.
 - d. Flexural Properties when tested in accordance with ASTM D-6109:
 - 1) Solid Profiles
 - a) Modulus of Elasticity (MOE): 542,200 psi.- Ultimate
 - b) Modulus of Rupture (MOR): 3157 psi. – Ultimate
 - 2) Floorizon Plank
 - a) Flexural Stiffness 426,508 lb·in²
 - b) Moment Capacity 3157 in·lb
 - e. Hardness when tested in accordance with ASTM D-143: 225 lb (101.25 kg).
 - f. Water Absorption when tested in accordance with ASTM D-1037, %vol. <1.35%, %mass <1.29%.
 - g. Flame Spread Index when tested in accordance with ASTM E-84: 75

- h. Direct Screw Withdrawal Force when tested in accordance with ASTM D-1761: 787 lbs/in.
- i. Slip resistance when tested in accordance with ASTM F-1679:
 - 1) Vertigrain Dry: 0.63 Wet: 0.55
 - 2) Brushed Dry: 0.77 Wet: 0.56
 - 3) Woodgrain Dry: 0.54 Wet: 0.43
- j. Smoke Development when tested in accordance with ASTM E-84, 200.
- k. Flash Ignition Temperature when tested in accordance with ASTM D-1929, 651 degrees F.
- l. Spontaneous Ignition Temperature when tested in accordance with ASTM D-1929, 788 degrees F.
- m. Coefficient of Linear Thermal Expansion when tested in accordance with ASTM D-696: length 2.0×10^{-5} in/in/°F, width 3.4×10^{-5} in/in/°F.
- n. Fungus Resistance (Brown/White Rot Fungus) when tested in accordance with ASTM D-1413: No decay.

2.3 ACCESSORIES

A. Fasteners:

- 1. Camo Hidden Deck Fastening system – <http://www.camofasteners.com/>
 - a. Fasteners – 1-7/8" protech coated screws
 - 1) <http://www.camofasteners.com/fasteners.html>
 - b. Fastener guide – Marksman
 - 1) <http://www.camofasteners.com/marksman-tools.html>
 - c. 3 inch driver bit
 - 1) <http://www.camofasteners.com/accessories.html>

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL

- A. Install according to manufactures instructions.
- B. Cut, drill, and rout using carbide tipped blades.
- C. Fasten located closer than 1 1/2 inches from ends of plank.

- D. Cut ends square.
- E. Do not use composite wood material for structural applications.

3.2 FASTENING

- A. No pre drilling is required.
- B. Secure fastener guide flat on surface centered on board.
- C. Using fastener guide drill screw on outside edge first before installing fastener on inside edge
- D. Completely fasten board to substructure before beginning next board.

3.3 CLEANING

- A. Power wash with a fan tipped nozzle in the direction of the grain of the planks with a maximum of 1500 psi

END OF SECTION 067300



Division 07

Thermal and Moisture Protection

SECTION 072100 – THERMAL INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product data: Manufacturer's data sheets and specifications.

PART 2 - PRODUCTS

2.1 INSULATION PRODUCTS

A. Surface-Burning Characteristics: ASTM E 84, and as follows:

1. Flame-Spread Index: 25 or less where exposed; otherwise, as indicated in Part 2 "Insulation Products" Article.
2. Smoked-Developed Index: 450 or less.

B. Extruded-Polystyrene (XPS) Board Insulation: ASTM C 578, Type IV with flame-spread index of 75 or less. –
<http://insulation.owenscorning.com/professionals/insulation-products/foamular-250.aspx>

1. Owens Corning Foamular 250
2. 2 inch rigid insulation.

C. Mineral-Fiber-Blanket Insulation: ASTM C 665, Type I, unfaced with fibers manufactured from glass with flame-spread index of 25 or less.

1. Owens Corning: Ecotouch
2. R-4.2 per inch
3. Formaldehyde free
4. Green guard certified

D. Unbonded Loosefill Insulation: ASTM C764 Type 1 category 2, with flame spread index of 25 or less - <http://insulation.owenscorning.com/professionals/insulation-products/propink-l77-loosefill.aspx>

1. Owens corning PROPINK L77 PINK Fiberglass

2.2 ACCESSORIES

A. Spray applied air infiltration barrier

1. Owens Corning: EnergyComplete Air Infiltration Barrier with Flexible Seal Technology
 - a. <http://www.ocenergycomplete.com/system/>

- B. Loos fill insulation barrier fabric:
 - a. Owen Corning: Propink fabric

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install insulation in areas and in thicknesses indicated or required to produce R-values indicated. Cut and fit tightly around obstructions and fill voids with insulation.

- B. Except for loose-fill insulation and insulation that is friction fitted in stud cavities, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

- C. END OF SECTION 072100

SECTION 074600 - SIDING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product data: Manufacturer's data sheets and specifications.
2. Samples for verification: Submit samples with factory applied finish in length no shorter than 12 inches in full width of panel.

PART 2 - PRODUCTS

2.1 WOOD SIDING

A. SIDING TYPE-1 -Western Red Cedar

1. Vertical Pattern: 4-inch and 6-inch tongue and groove board style
2. Sizes: 1 inch x 6 inch and 1 inch x 4 inch
3. Grade: Select
4. Finish: Transparent finish 1

B. SIDING TYPE 2 – Western Red Cedar

1. Vertical Pattern: 8-inch exposure in plain board style
2. Size: 1 inch x 8 inch
3. Grade: Select
4. Finish: Transparent finish 2

2.2 FASCIA BOARD

A. Fiber-Cement Soffit: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84. Factory primed.

1. Products:

a. Hardie Board.

- 1) http://www.jameshardie.com/builder/products_trim_hardietrim.py

2. Pattern: smooth texture
3. Finish: as selected by architect from manufacturers full range

2.3 ACCESSORIES

- A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
 - 1. Provide accessories made from same material as adjacent siding unless otherwise indicated.
 - 2. Louvers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wood siding:
 - 1. Countersink all fasteners at no more than 16 inches o.c.
 - 2. Nail siding at each stud. Do not allow nails to penetrate more than one thickness of siding, unless otherwise recommended by siding manufacturer. Seal joints at inside and outside corners and at trim locations.
 - 3. Select and arrange paneling for best match of adjacent units. Install with uniform tight joints.
- B. Install fiber-cement fascia related accessories per manufactures written instruction.
 - 1. Install fasteners no more than 16inches (600 mm) o.c.

3.2 FIBER CEMENT FINISHING

- A. Field apply finish per manufacturers written instruction.

END OF SECTION 074600

SECTION 075323 – KETONE-ETHYLENE-ESTER (KEE) ROOFING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A
- B. Warranties: N/A

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.79 and emissivity not less than 0.75 when tested according to CRRC-1.
- B. Exterior Fire-Test Exposure: ASTM E 108, Class A.

2.2 ROOFING MATERIALS

- A. KEE Sheet: ASTM D 4637, Type I, nonreinforced 36 mils white.

- 1. Products:

- a. FiberTite 8530 KEE Membrane

- 1) http://www.fibertite.com/downloads/products/8530_FiberTite.pdf

- B. Auxiliary Materials: Recommended by roofing system manufacturer for intended use and as follows:

- 1. Sheet Flashing: 36-mil- thick KEE.
 - 2. Seaming Material: Heat welded membrane with no less than 6 inch overlaps.

2.3 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II.
- B. Fabricate tapered insulation with slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mechanically fasten each layer of insulation to deck.
- B. Install KEE sheet according to roofing system manufacturer's written instructions and as follows:
 - 1. Adhered Sheet Installation: Apply bonding adhesive to substrate and underside of sheet and allow to partially dry. Do not apply bonding adhesive to splice area of sheet.
 - 2. Mechanically Fastened Sheet Installation: Secure one edge of sheet using fastening plates or battens centered within the membrane splice and mechanically fasten sheet to roof deck.
- C. Seams: Clean splices and heat weld, firmly roll side and end laps of overlapping sheets. Seal exposed edges of sheet terminations.
- D. Install sheet flashings and preformed flashing accessories and adhere to substrates.

END OF SECTION 075323

SECTION 076200 – SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A
- B. Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- C. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 SHEET METAL

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, not less than 0.032 inch (0.8 mm) thick; and finished as follows:
 - 1. Concealed Finish: Manufacturer's standard white or light-colored acrylic or polyester backer finish.

2.2 ACCESSORIES

- A. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners.
 - 1. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
- B. Butyl Sealant: ASTM C 1311, solvent-release butyl rubber sealant.

2.3 FABRICATION

- A. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with SMACNA's "Architectural Sheet Metal Manual." Allow for thermal expansion; set true to line and level. Install Work with laps, joints, and seams permanently watertight and weatherproof; conceal fasteners where possible.
- B. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
- C. Fabricate nonmoving seams in sheet metal with flat-lock seams. For aluminum, form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- D. Aluminum Flashing and Trim: Coat back side of aluminum flashing and trim with bituminous coating where it will contact wood, ferrous metal, or cementitious construction.
- E. Separate dissimilar metals with a bituminous coating or polymer-modified, bituminous sheet underlayment.

END OF SECTION 076200

SECTION 077100 – ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A
- B. Warranties: N/A

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required.
- B. Aluminum Finish: Three-coat fluoropolymer system with color coat and clear coat containing not less than 70 percent PVDF resin by weight.
- C. Self-Adhering Sheet Underlayment, High Temperature: Butyl or SBS-modified asphalt; slip-resisting-polyethylene surfaced; with release paper backing; cold applied. Stable after testing at 240 deg F (116 deg C) and passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
- D. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements.
 - 1. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
- E. Butyl Sealant: ASTM C 1311, solvent-release butyl rubber sealant.

2.2 ROOF SPECIALTIES

- A. SPRI Wind Design Standard: Provide roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
 - 1. Design Pressure: As indicated on Drawings.
- B. Copings: Manufactured coping system consisting of formed-metal coping cap, concealed anchorage; corner units, end cap units, and concealed splice plates.
 - 1. Extruded Aluminum: 0.040 inch (1.02 mm) thick.

PART 3 - INSTALLATION

3.1 INSTALLATION

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement.
- B. Coat back side of aluminum roof specialties with bituminous coating where they will contact wood, ferrous metal, or cementitious construction.
- C. Separate dissimilar metals with a bituminous coating or polymer-modified, bituminous sheet underlayment.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

END OF SECTION 077100

SECTION 077200 – ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A
- B. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and finish. Coil-coat finish as follows:
 - 1. Baked-Enamel Finish: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.

2.2 ROOF ACCESSORIES

- A. Fall Protection Anchors: Secure anchors in to framing with 1/2 inch x 3 1/2 inch lag screws.
 - 1. Products:
 - a. SNAPPY anchor, meets ANSI Z359.1 and OSHA requirements for a fall protection device.
 - 1) <http://www.guardianfall.com/faqs-snappy-anchor/>
- B. Equipment Supports: Fabricate from 0.052-inch- thick, metallic-coated steel with welded or sealed mechanical corner joints.
 - 1. Products:
 - a. AP Solutions Modular Solar Racking array mounting system
 - 1) http://www.apalternatives.com/pdf/GROUND_MOUNT
 - 2. Provide manufacturer's standard rigid or semirigid insulation.
 - 3. Finish: Baked enamel posts and galvanized Unistrut channel.

- C. Scuppers: 4 high thru wall scuppers
 - 1. (2) 12 inch x 6 inch aluminum wall scuppers.
 - 2. (2) 96 inch x 6 inch aluminum wall scupper

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation: Unless otherwise indicated, install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual." Coordinate with installation of roof deck, vapor barriers, roof insulation, roofing, and flashing to ensure combined elements are secure, waterproof, and weathertight.

END OF SECTION 077200

SECTION 079200 – JOINT SEALANTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A
- B. Environmental Limitations: Do not proceed with installation of joint sealants when ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).

PART 2 - PRODUCTS

2.1 JOINT SEALANTS

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under service and application conditions.
- B. Sealant for General Exterior Use Where Another Type Is Not Specified. Retain one or more of three subparagraphs below.
 - 1. Single-component, neutral-curing silicone sealant, ASTM C 920, Type S; Grade NS; Class 25; for Use NT.
- C. Sealant for Use in Interior Joints in Ceramic Tile and Other Hard Surfaces in Kitchens and Toilet Rooms and Around Plumbing Fixture:
 - 1. Single-component, mildew-resistant silicone sealant, ASTM C 920, Type S; Grade NS; Class 25; for Use NT; formulated with fungicide.
- D. Sealant for Interior Use at Perimeters of Door and Window Frames:
 - 1. Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
- E. Acoustical Sealant:
 - 1. Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission as demonstrated by testing according to ASTM E 90.

2.2 MISCELLANEOUS MATERIALS

- A. Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for

applications indicated by sealant manufacturer based on field experience and laboratory testing.

- B. Cylindrical Sealant Backings: ASTM C 1330, of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.
- D. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with ASTM C 1193.
- B. Install sealant backings to support sealants during application and to produce cross-sectional shapes and depths of installed sealants that allow optimum sealant movement capability.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal perimeters, control joints, openings, and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions. Comply with ASTM C 919.

END OF SECTION 079200



Division 08

Openings

SECTION 081613 – FIBERGLASS DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Non Fire Rated Fiberglass doors and frames.
- B. Fire Rated Fiberglass doors and frames

1.2 RELATED SECTIONS

- A. Division 6 Carpentry
- B. Division 8 Section Door Hardware
- C. Division 9 Section Painting/Staining

1.3 REFERENCES

- A. ASTM E-90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- B. NFPA 80 - Standard for Fire Doors and Windows; 1999.
- C. NFPA 252 - Standard Methods of Fire Tests for Door Assemblies; 1995.
- D. ANSI/DHI-A1151G-Installation Guide for Doors and Hardware.
- E. Warnock Hersey, Inc. (WHI) Directory of Listed Products.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's data sheets and specifications.
- B. Shop Drawings: Include schedule identifying each unit, with door marks or numbers referencing drawings. Show layout, profiles, product components and anchorages. Include schedule identification for each door unit referencing drawings.
- C. List of proposed materials with recycled content. Indicate post-consumer recycled content and pre-consumer recycled content for each product having recycled content.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's ordering and lead time procedures to ensure timely delivery to avoid construction delays
- B. Deliver doors and frames palletized and wrapped to provide protection while in transit.
- C. Store all materials under cover. Avoid use of non-vented plastic or canvas shelters to prevent forming of humidity chambers that cause rust.
- D. If cardboard wrapping becomes wet, remove cartons immediately.
- E. Provide 1/4 inch (6 mm) spacing between doors to provide air circulation.

1.6 WARRANTY

- A. Project Warranty: Comply with conditions of the contract for project warranty provisions.
- B. Manufacturer's Warranty Provide current warranty for owner records and acceptance's

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: ProVia Door: 2150 State Route 39, Sugarcreek, OH 44681 Tel: 800-669-4711; Tel: 330.852.4711; Email: request info (info@proviadoor.com) Web: www.proviadoor.com

2.2 MATERIALS

- A. Door Construction General: All doors shall be manufactured by ProVia Door. The panels shall be laminated, using a high-performance adhesive to thermally broken, stiles and rails forming a perimeter to reduce transmission and allow for field preparation of hardware. The bottom edge shall be manufactured from a moisture-resistant and decay-resistant composite.

2.3 DOORS

- A. Fiberglass doors:
 - 1. Heritage 460 - <http://www.proviadoor.com/Doors/Entry/Type/Heritage-Fiberglass-Entry-Doors.aspx>
 - 2. High Definition Wood grain Face: Authentic Wood Grain made from nickel vapor deposition technology.

- a. Dovetailed and Glued Stiles and Rails
- b. Door Edges of Mahogany to match finish.
- c. Composite Bottom Rails
- d. Polyurethane Core: Foamed In Place polyurethane with a 2.0 pcf minimum density and a "U" value as low as .17.

B. GLASS

1. GLD - TYPE 1

- a. Tempered, Triple glazed glass with Low-E and Krypton Gas

2.4 FRAMES CONSTRUCTION:

- A. Rot-resistant Wood Frame.

2.5 Door hardware

- A. Schlage Lattitude Door Lever: accent lever - <http://www.proviadoor.com - Entry hardware>
- B. Schlage classic series: Thumb turn 1" deadbolt
- C. Finish: Satin Nickel

2.6 FABRICATION

- A. Coordinate with hardware and frame manufacturers to assure that doors are prepared to receive hinges and hardware. Provide copies of approved frame and hardware schedule as listed on door schedule.

2.7 FINISHING

- A. Factory Paint: Clean and prep surfaces of fiberglass doors. Factory applied two component catalyzed polyurethane, heat cured.
- B. Factory Stain: Also available utilizing exclusive hand staining finish system. Color to be selected from manufacturer's standard colors. Top and bottom of the doors to be sealed. Clear coated with two coats of a two component catalyzed polyurethane containing UV inhibitors and heat cured.
- C. Twelve month finish warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of doors and frames in accordance with manufacturer's installation instructions and technical bulletins.
- B. Verify door frame openings are installed plumb, true, and level.
- C. Select fasteners of adequate type, number, and quality to perform intended functions.

3.2 INSTALLATION

- A. Install fiberglass doors and frames in accordance with manufacturers published guidelines.

3.3 CLEARANCES

- A. Clearance between the door and frame head and jambs for both single swing and pairs of doors shall be 1/8 inch (3.2 mm).
- B. Clearance between the meeting edges of pairs of doors shall be 3/16 inch plus or minus 1/16 inch (5 mm plus or minus 1.6 mm). For fire rated applications, the clearance between the meeting edges of pairs of doors shall be 1/8 inch plus or minus 1/16 inch (3.2 mm plus or minus 1.6 mm).
- C. Bottom clearance shall be 3/4 inch (19 mm).
- D. The clearance between the face of the door and door stop shall be 1/16 inch to 1/8 inch (1.6 mm plus or minus 3.2 mm).
- E. All clearances shall be, unless otherwise specified, subject to a tolerance of plus or minus 1/32 inch (.4 mm).

3.4 ADJUSTING AND CLEANING

- A. Adjust doors for free swing without binding.
- B. Adjust hinge sets, locksets, and other hardware. Lubricate using a suitable lubricant compatible with door and frame coatings.
- C. Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions before owner's acceptance.
- D. Remove from project site and legally dispose of construction debris associated with this work.

3.5 PROTECTION

- A. Protect installed products and finished surfaces from damage during construction.

END OF SECTION 081613

SECTION 083219 – INTERIOR SLIDING DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes sliding wood-framed in-filled doors for interior locations with finish-coated exposed surfaces.
- B. Solid core doors with wood veneer faces
- C. Related Sections:
 - 1. Section 099300 "Staining and Transparent Finishing" for on-site finishing of bare, unfinished sliding wood-framed doors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Material descriptions, dimensions of individual components and profiles, hardware, finishes, and operating instructions.
- B. Samples for Verification: For sliding wood-framed doors and components required, prepared on Samples of size indicated below:
 - 1. Hardware: Full-size units with factory-applied finish.
 - 2. Infill material: Sample no smaller than 12 inches x 12 inches
 - 3. Solid core door finish: Finish applied to actual door face material

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Manufactures stand warranty for infill material

1.4 PROJECT CONDITIONS

- A. Wood framed infill sliding doors are to be constructed by OSU solar decathlon team with infill material as specified.

PART 2 - PRODUCTS

2.1 WOOD FRAME

- A. Wood Frame: Clear fir or pine or another suitable fine-grained lumber; kiln-dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger

joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.

- B. Wood Trim and Glazing Stops: Material and finish to match frame members.
- C. Mullions: Provide mullions matching door units at sizes indicated, complete with anchors for support to structure and installation of sliding wood-framed door units. Allow for erection tolerances and provide for movement of door units due to thermal expansion and building deflections, as indicated.
- D. Construct wood frame to thickness indicated for door hardware connection and support of infill material.

2.2 INFILL MATERIAL

- A. Basis of Design Product: Subject to compliance with requirements, provide the following:
 - 1. 3form (USA), 2300 South 2300 West, Suite B, Salt lake city, Utah 84119, Tel: 801-649-2500, <http://www.3form.com>
 - a. Varia Ecoresin – C3 Color – <http://www.3form.com/specs.php?product=537>
 - 1) Color: White Out
 - 2) Panel thickness: 1/2 inch
 - 3) Width: 48 inches
 - 4) Length 96 inches
 - 5) Edge: Flat

2.3 FLUSH WOOD DOORS, GENERAL

- A. Source limitations: Obtain flush wood doors from single manufacturer.
- B. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
 - 1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.
- C. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
- A. Regional Materials: Flush wood doors shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Certified Wood: Flush wood doors shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest

Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

- C. WDMA I.S.1-A Performance Grade: Heavy Duty unless otherwise indicated

2.4 DOORS FOR OPAQUE FINISH

1. Grade: Premium
2. Faces: Any closed-grain hardwood of mill option.
3. Retain option in "Exposed Vertical(and Top) Edges"
4. Exposed Vertical and Top Edges: Any closed-grain hardwood.
5. Core: structural composite lumber.
6. Construction: Five plies.
7. WDMA I.S.1-A Performance Grade: Heavy Duty unless otherwise indicated

2.5 HARDWARE

- A. Roller Assemblies for pocket doors and multi pass sliding doors: Basis of Design Product: Subject to compliance with requirements, provide the following:

1. Johnson hardware, L.E. Johnson Products, Inc, 2100 Sterling avenue, Elkhart, IN 46515, Tel: 800-837-5664 – <http://www.johnsonhardware.com>
 - a. Pocket Door Hardware:
 - 1) 1500 series pocket door frame for 2inch x 4 inch stud walls – <http://www.johnsonhardware.com/1500.htm>
 - a) Size hardware according to door size indicated.
 - b. Multi-Pass Sliding Door Hardware
 - 1) 100 MD series Commercial grade multi pass sliding door hardware - <http://www.johnsonhardware.com/100md.htm>

- B. Door Pulls: Basis of design: Subject to compliance with requirements provide the following or approved equal.

1. Johnson Hardwar - Flush pull 40 –<http://johnsonhardware.com/parts1.htm>
 - a. Finish: To be selected by architect from manufacturer's full range.

2.6 FABRICATION

- A. Fabricate sliding wood-framed doors in sizes indicated. Use member sizes indicated for frame construction.
- B. Complete fabrication, assembly, finishing, hardware application, and other work before installation to greatest extent possible. Disassemble components only as

necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

- C. Factory cut all infill material when possible. Field cut infill material when necessary sizes indicated according to manufacturer's written instructions.

2.7 WOOD FINISHES

- A. Field applied transparent finish:

- 1. Color: As selected by Architect from manufacturer's full range

- B. Filed applied opaque finish

- 1. Color: As selected by architect from manufacturer's full drange

PART 3 - EXECUTION

3.1 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.
- B. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.
- C. Examine wall and other built-in components to ensure a coordinated sliding door installation.
 - 1. Wood-Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76 mm) of opening.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing, hardware, accessories, and other components.
- B. Install sliding doors level, plumb, square, true to line, without distortion, warp or rack of frames and panels, or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall and other adjacent construction.
- C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by

manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Lubricate hardware and moving parts.
- B. Adjust operating panels and screens to provide a tight fit at contact points and weather stripping for smooth operation, without binding.
- C. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.
- D. Clean frame surfaces immediately after installing sliding doors. Comply with manufacturer's written recommendations for final cleaning and maintenance. Avoid damaging protective coatings and finishes.
- E. Clean infill material immediately after installing sliding doors. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.
- F. Protect sliding door surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact sliding door surfaces, remove contaminants immediately according to manufacturer's written instructions.
- G. Refinish or replace sliding doors with damaged finishes.
- H. Replace damaged components.

END OF SECTION 083219

SECTION 085413 – FIBERGLASS WINDOWS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section included: Fiberglass Reinforced Polymer (FRP) windows of the following type (s):
 - 1. Single Hung tilt windows
 - 2. Casement windows
 - 3. Fixed windows
 - 4. Awning windows

1.2 RELATED SECTIONS

- A. Section 061000 – Rough Carpentry
- B. Section 072700 - Air Barriers: Water-resistant barrier.
- C. Section 079200 - Joint Sealants: Sealants and caulking.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets and specifications.
- B. Shop Drawings: Include window schedule, window elevations, sections and details, and multiple window assembly details. Will submit shop drawings as required, including location floor plans or exterior wall elevations showing all window openings, typical unit elevations, and full size detail sections of every typical composite member. Indicate the type of anchors, hardware, operators and other components not included in manufacturer's standard data. Include glazing details and standards for factory glazed units.
- C. Quality Assurance / Control Submittals:
 - 1. U-Factor and structural rating charts required for AAMA and NFRC labeling requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
 - 1. Deliver materials to site undamaged in manufacturer's original, unopened containers and packaging, with labels clearly identifying manufacturer and product name. Include installation instructions.

B. Storage:

1. Protect the windows and accessories from the elements, construction activities, and other hazards until the project is complete.
 - a. Store materials in accordance with manufacturer's instructions.
 - b. Store materials off ground and under cover.
 - c. Protect materials from weather, direct sunlight, and construction activities.

C. Handling: Protect materials and finish during handling and installation to prevent damage.

1. Handle all windows and accessories in accordance with AAMA CW-10.
2. Protect materials and finish during handling and installation to prevent damage.

1.5 WARRANTY

A. Residential special warranty

1. Full Lifetime guarantee to original owner.
2. Guarantee windows against defect in materials and workmanship

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Serious Materials, 1250 Elko Dr., Sunnyvale, CA 94089, Tel: 408-541-8000, Fax: 408-715-2560, Website: www.seriousmaterials.com

B. Window Series

1. 925 series fiberglass window
<http://www.seriouswindows.com/residential/super-insulating-windows/fiberglass/925-series.html>

2.2 MATERIALS

- A. Frame and Sash: Pultruded Fiberglass Reinforced Polymer, with color coating.
- B. Hardware: Hardware having component parts which are exposed shall be of brass, aluminum, stainless steel or other non-corrosive material(s) compatible with fiberglass and of sufficient strength to perform the functions for which they are used. Cadmium or zinc-plated steel, where used, shall be in accordance with ASTM A 165 or B 633. Nickel chrome-plated steel, where used, shall be in accordance

with ASTM B 456. Operable single-hung windows shall have at least one (1) zinc die-cast sweep-type lock (two (2) on units over 40" wide) and an integral keeper for positive locking. Inoperable windows will have no exposed hardware.

- C. Weather-stripping: Weather-stripping conforming to AAMA 701 or 702. Weather-stripping shall meet the requirements of the specifications as detailed in the appropriate test report. All weather-stripping shall be installed in specially-extruded ports and secured to prevent movement, shrinkage, or loss when removing sash either for cleaning or repair. Adhered weather-stripping shall not be allowed. Sash of single hung windows shall be weather-stripped using woven pile with Mylar center fin, double on sash stiles and single on sash rails. Lift rail shall seal to frame sill with dual vinyl compression bulb.
- D. Balances for sash that operate shall be heavy duty ultralift or similar conforming to AAMA 902 and of appropriate capacity to hold each sash stationary and permit it to operate freely; nylon balance shoes which lock in the tilted position to prevent sash travel. Balances shall be factory applied, easily accessible and shall be field replaceable.
- E. Screens: Full screens supplied separately or delivered applied to windows as requested.

2.3 ASSEMBLY

- A. Fabricate frames and sash with mitered and mechanically joined corners. Mitered seams shall be sealed thoroughly to prevent air or water penetration
- B. Provide metal or composite reinforcement in sash or frame for attaching operating or locking mechanisms
- C. Factory glazed, inside, with snap on PVC or Fiberglass glazing stops. Note: Field glazing is required for large window units (over 40sf (3.72 m²)). Insulating glass units shall be reglazable without dismantling sash framing.
- D. The windows shall be assembled in a secure and professional manner to perform as herein specified and to assure neat and weather tight construction. Construction shall be neatly joined and secured by means of two screws into reinforced Shear blocks.
- E. All sash corners shall be neatly joined and secured by means of two screws anchored into integral screw port at all horizontal member locations. Meeting rails of both sashes shall mechanically interlock in a closed position. All main framing joints shall be sealed with sealants meeting the requirement of AAMA 803 or 809.
- F. All main framing joints shall be sealed with sealants meeting the requirement of AAMA 803 or 809.

2.4 INSECT SCREENS

- A. Provide tight-fitting screen for operating sash with hardware to allow easy removal.

1. Screen Cloth: Charcoal colored fiberglass mesh
2. Frame:
 - a. Rollformed or extruded aluminum.
 - b. Pull tabs or plunger pin

2.5 GLASS TYPES

A. GLW-1

1. Serious Glass 9H – tempered – breather tubes required

B. GLW-2

1. Serious Glass 9L – tempered – breather tubes required

C. GLW-3

1. Serious Glass 7L – annealed – breather tubes required

D. GLW – 4

1. Serious Glass 9L – annealed – breather tubes required

E. GLW-5

1. Serious Glass 9L – tempered – breather tubes required – inner layer frosted

2.6 WINDOW TYPES

A. CASEMENT (925 SERIES)

1. Factory assembled and glazed outward opening fiberglass casement
2. Frame:
 - a. Chambered, foam filled, pultruded fiberglass
 - b. Interior Exposed Surfaces: Factory applied coating
 - c. Overall Frame Depth: 3-1/4 inch (83 mm)
3. Sash:
 - a. Chambered, foam filled, pultruded fiberglass
 - b. Interior Exposed Surfaces: Factory applied coating
 - c. Minimum 2-1/4 inch (57 mm) deep, chambered, pultruded fiberglass profile.
4. Sightlines: edge of frame to tip of glazing tower or glass line 2 7/8" (72mm)
5. Weather stripping:

- a. Double weather stripping
 - b. Continuous, flexible PVC type around sash perimeter
 - c. Foam with fabric skin around frames interior perimeter
 6. Hardware:
 - a. Operator – steel worm-gear operator, zinc die cast base with painted finish
 - b. Crank Handle – integrated folding handle with painted finish
 - c. Locking System – Single handle multi-point with positive action (reaches out and pull tight).
 - d. All exposed fasteners- stainless steel
 7. Simulated-Divided-Lite (SDL) Grids (Optional)
 - a. Interior (room side) grids: Solid
 - b. Exterior Grids: Extruded Aluminum
 8. Performance Class Structural
 - a. Commercial (C) and Heavy Commercial (CW) 45
- B. AWNING (925 SERIES)
1. Factory assembled and glazed outward opening fiberglass awning
 2. Frame:
 - a. Chambered, foam filled, pultruded fiberglass
 - b. Interior Exposed Surfaces: Factory applied coating
 - c. Overall Frame Depth: 3-1/4 inch (83 mm)
 3. Sash:
 - a. Chambered, foam filled, pultruded fiberglass
 - b. Interior Exposed Surfaces: Factory applied coating
 - c. Minimum 2-1/4 inch (57 mm) deep, chambered, pultruded fiberglass profile.
 4. Sightlines: edge of frame to tip of glazing tower or glass line 2 7/8" (72mm)
 5. Weatherstripping:
 - a. Double weatherstripping
 - b. Continuous, flexible PVC type around sash perimeter
 - c. Foam with fabric skin around frames interior perimeter
 6. Hardware:
 - a. Operator – steel worm-gear operator, zinc die cast base with painted finish
 - b. Crank Handle – integrated folding handle with painted finish

- c. Locking System – Single handle multi-point with positive action (reaches out and pulls tight).
 - d. All exposed fasteners- stainless steel
 - 7. Simulated-Divided-Lite (SDL) Grids (Optional)
 - a. Interior (room side) grids: Solid
 - b. Exterior Grids: Extruded Aluminum
 - 8. Performance Class Structural
 - a. Commercial (C) and Heavy Commercial (CW) 40
- C. SINGLE HUNG (925 SERIES)
 - 1. Factory assembled and glazed single-hung windows
 - 2. Frame:
 - a. Multi-chambered, foam filled, pultruded fiberglass
 - b. Interior Exposed Surfaces: Factory applied coating
 - c. Base Frame Depth: 3-1/4 inch (83 mm)
 - d. Overall Frame Depth (interior plane to exterior plane of screen channel): 4 inch (102mm)
 - 3. Sash:
 - a. Chambered, foam filled, pultruded fiberglass
 - b. Interior Exposed Surfaces: Factory applied coating
 - c. Minimum 1 3/8 inch (34.9 mm) deep, chambered, pultruded fiberglass profile.
 - d. Bottom sash tilt-inward, via activation of tilt-latch for easy cleaning.
 - e. Integral fiberglass pultruded lift rail on lower sash.
 - f. Positive, coupling interlock at meeting rail.
 - 4. Sightlines: edge of frame to tip of glazing tower or glass line 3 5/8 inch (91mm)
 - 5. Weatherstripping:
 - a. Single continuous weatherstrip on sill upstand, with finned woolpile.
 - b. One fin woolpile type weatherstrip around sash perimeter's exterior face
 - c. One foam with fabric skin around sash perimeter's edge.
 - 6. Hardware
 - a. Cam style lock, zinc die cast base with painted finish
 - b. Keeper, zinc die cast with painted finish
 - c. Spring loaded tilt latch with beveled throw bolt.
 - d. Lift handles, zinc die cast base with painted finish
 - e. Constant force balances utilizing stainless steel spring coil.

- f. All exposed fasteners- stainless steel
 - 7. Simulated-Divided-Lite (SDL) Grids (Optional)
 - a. Interior (room side) grids: Solid
 - b. Exterior Grids: Extruded Aluminum
 - 8. Performance Class Structural
 - a. Commercial (C) 30
- D. PICTURE WINDOW (925 Series) – Low Profile
- 1. Factory assembled and glazed Fixed (non-operating)
 - 2. Frame:
 - a. Chambered, foam filled, pultruded fiberglass
 - b. Interior Exposed Surfaces: Factory applied coating
 - c. Overall Frame Depth: 3-1/4 inch (83 mm)
 - 3. Sightlines: edge of frame to tip of glazing tower or glass line 1 ½" (39 mm)
 - 4. Simulated-Divided-Lite (SDL) Grids (Optional)
 - a. Interior (room side) grids: Solid
 - b. Exterior Grids: Extruded Aluminum
 - 5. Performance Class Structural
 - a. Commercial (C) and Heavy Commercial (CW) 50
- 2.7 FINISHING
- A. Frame and Sash colors: As selected by architect from manufacturers full range
 - 1. Split – one color inside; different color outside
 - B. Color match screen frame to window frame and sash color

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings in which windows will be installed.
 - 1. Field verify that the existing window openings are within tolerance, plumb, level, clean, and provide a solid anchoring surface and substrate. Also

confirm that the openings and are in accordance with approved shop drawings.

2. Verify that framing complies with method of installation
3. Verify that fasteners in framed walls are fully driven and will not interfere with window installation

3.2 INSTALLATION

- A. Install windows in framed walls in accordance with AAMA 2400, and manufacturer's instruction
- B. Install windows in accordance with manufacturer's instructions.
- C. Install windows to be weather-tight and freely operating.
- D. Maintain alignment with adjacent work.
- E. Secure assembly to framed openings, plumb and square, without distortion.
- F. Integrate window system installation with exterior water-resistant barrier using flashing/sealant tape. Apply and integrate flashing/sealant tape with water-resistant barrier using watershed principles in accordance with window manufacturer's instructions.
- G. Place interior seal around window perimeter to maintain continuity of building thermal and air barrier using insulating-foam sealant.
- H. Seal window to exterior wall cladding with sealant and related backing materials at perimeter of assembly.
- I. Leave windows closed and locked.
- J. Do not remove temporary labels
- K. Install insect screens on operable windows

3.3 CLEANING

- A. Clean window frames and glass in accordance with Division 1 requirements.
- B. Remove temporary labels and retain for Closeout Submittals.
- C. Clean soiled surfaces and glass using a mild detergent and warm water solution with soft, clean cloths.

3.4 PROTECTION

- A. Protect installed windows to ensure that, except for normal weathering, windows will be without damage or deterioration at time of substantial completion.

END OF SECTION 085413

SECTION 088400 – PLASTIC GLAZING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Multi-layered extruded cellular polycarbonate panels.
- B. Installation accessories and materials.

1.2 SUBMITTALS

- A. **Product Data:** Manufacturer's data sheets on each product to be used, including:
- B. Installation methods and guidelines.
- C. Shop Drawings: Show layout of panels, jointing, anchorages, and trim.
- D. Verification Samples:
 - 1. Two samples, minimum size 3 inches (76 mm) by 6 inches (152 mm), of each specified product, color, and thickness.
 - 2. Accessories: Two samples, 6 inches (150 mm) long, of installation accessories.

1.3 QUALITY ASSURANCE

- A. Manufacturer's qualifications: ISO 9002 and 14001 certified

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver panels in enclosed wooden crates.
- B. Store panels in dry, dark, and well-ventilated area until ready for installation. Prevent dirt or debris from entering cellular structure by applying approved sealing tape.
- C. Store panels at slant of 5 to 10 degrees from vertical after removal from crates.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.5 PRODUCT 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.

1.6 WARRANTY

- A. Provide manufacturer's standard 10 year warranty for sheets of minimum thickness of 1/4 inch (6 mm) against loss in light transmission in excess of 6 percent of the original value when tested per ASTM D 1003, and against a change in yellowing index in excess of 10 delta from the original value when tested per ASTM E 313.
- B. Provide manufacturer's standard 10 year warranty for sheets of minimum thickness of 1/4 inch (6 mm) against breakage due to hail, for hail up to 0.79 inch (20 mm) in diameter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Gallina, Inc.; 4335 Capital Circle, Janesville, WI 53546. ASD. Tel: (608) 531-0450. Fax: (608) 531-0451. Email: info@gallinausa.com
<http://www.gallinausa.com/>

2.2 MATERIALS

- A. General Requirements: Provide glazing panels of extruded polycarbonate cellular sheet with UV-stabilized co-extruded outer layer; removable protective film on outer surface.
 - 1. Panel Length: Provide panels of sufficient size to span purlins and rafters without requiring joining, up to 36 feet
 - 2. Thermal Expansion: Maximum of 1/8 inch (3 mm) per 3 feet (914 mm), for clear and ice colors; maximum of 1/4 inch (6 mm) per 4 feet (1219 mm), for bronze; 100 degrees F (56 degrees C) temperature differential.
 - 3. Provide anti-fog coating.
 - 4. Flatness, Warp, and Overall Bow: Comply with ASTM C 1048.
 - 5. Provide factory cut panels in required dimensions, with clean cuts without chips or other deformities; without debris, grease, oil, or other materials lodged inside cells.

2.3 GLAZING PANELS

- A. Glazing Panels: Gallina 3-wall; extruded polycarbonate cellular sheet with UV-stabilized co-extruded outer layer; triple wall configuration; blocking UV transmission.

1. <http://www.gallinausa.com/pdfs/PolycarbonateModularPanelsandSheets.pdf>
- B. Panel Width: 72 inches (1200 mm).
- C. Rib Pitch: 0.630 inches (16 mm) on center.
- D. Color: Opal; 52 percent light transmission.
- E. Panel Thickness: 5/8 inches (16 mm).
- F. Flammability: Horizontal burn rate of 1.375 inch (35 mm) or less, when tested in accordance with ASTM D 635.
- G. Self-Ignition Temperature: 986 degrees F (530 degrees C), when tested in accordance with ASTM D 1929.
- H. Weight: 0.553 pounds per square foot (2.69 kg per square meter).
- I. Minimum Radius for Cold Bent Arches: 9 feet 2 inches (2.8 meters).
- J. U-Factor, Winter Night: 0.4 Btu per hour-square feet-degree F (2.21 Watt per square meter-degree K).

2.4 ACCESSORIES

- A. Edge Trim
 1. Aluminum profile – Fry Reglet J-Channel – 313 (16mm) -
http://www.fryreglet.com/shape/pdf/8540682745_JMolding.pdf
- B. Edge Tape
 1. Perforated Vent Tape, 509, sill / gutter -
<http://www.gallinausa.com/photo.galleries/accessories.html>
 - a. 1 1/2 inches in standard roll length of feet.
 2. Solid Vent tape, 51, head / ridge -
<http://www.gallinausa.com/photo.galleries/accessories.html>
 - a. 1 1/2 inches in standard roll length of 108 feet.
- C. Polygal Silicone
 1. Glazing Sealants: Polycarbonate panels should be glazed using a "dry glazing clamping system"; Verify compatibility of sealant or tape with polycarbonate with manufacturer of sealant or tape and with manufacturer of polycarbonate sheets; do not use amine or benzamid curing silicone sealants.
<http://www.gallinausa.com/photo.galleries/accessories.html>
- D. Screen Opening Hardware

1. Windows
 - a. Acceptable manufacturer: Hardware source
 - 1) Friction type lid support, Reversible action: 286422
www.hardware-source.com
 - a) Horizontal Lid lift up to 90 degrees
 - b) Finish: nickel plated
 - 2) Piano Hinge: 596162 www.hardware-source.com
 - a) Cut to length by manufacturer
 - b) Finish: Stainless steel.
 - c) Material thickness: .60 inch
 - d) Pin Diameter: .120 inch
 - b. Acceptable manufacturer: Rixson Hardware
 - 1) 10-Series Standard Duty Surface Mount Holder/Stop: 10-Series, #10-126, <http://www.qualifiedhardware.com/brands/rixson/10-series-standard-duty-surface-mount-holderstop-108.cfm>
 - a) Finish: 689
2. Sliding screen Hardware
 - a. Acceptable manufacturers: Cannon Ball; HNP, LLC
 - 1) Cannon Ball Square Door Track Systems
 - a) Top: Square Track Soffit mounted - <http://www.cnbhnp.com-door-track-system>
 - b) Bottom: bottom channel

PART 3 - EXECUTION

3.1 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.
- C. Examine crates for damage immediately upon delivery.
- D. Examine panels for damage prior to installation.

3.2 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. Treat open ends of panels upon opening crates to prevent dirt or other material from entering glazing.
- D. Verify panels are correct size.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions. For architectural structures use an aluminum glazing system with EPDM or Neoprene gaskets.
- B. Install with extruded ribs vertical with "Exposure Side" to exterior, as indicated on protective film (the printed side should be faced outside).
- C. Remove chips and dust from internal cells with compressed air. Seal open ends with approved sealing tape.
- D. Apply aluminum edge trim per manufacturers written instructions.
- E. Just prior to installation expose glazing edges by peeling back protective film sufficient for edge bite.
- F. Drill holes minimum 1-1/2 inches (38 mm) from edge, to allow for thermal expansion.
- G. Install in accordance with manufacturer's recommendations for edge bite and expansion allowance.
 - 1. Minimum Edge Engagement: 1/2 inch (13 mm).
 - 2. Rabbet Depth: Edge engagement plus allowance for thermal expansion. Rabbet depth should be not less than 3/4".
- H. Remove protective film immediately upon completion of installation.

3.4 PROTECTION

- A. Protect uninstalled sheet products from direct exposure to the sun's rays. Exposure to the direct rays of sun will bake the protective masking on to the sheet making removal of the masking extremely difficult or impossible. Sheets should be protected indoors until completion of project with open flute edges sealed.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 088400

SECTION 089000 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Provide louvers complying with performance requirements indicated
- B. Submittals:
 - 1. Product data

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, No. 4 finish or No. 6 finish. To be approved by architect.
- D. Fasteners: Use types and sizes to suit unit installation conditions.

2.2 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Louver general requirements:
 - 1. Louver depth, frame blade nominal thickness and louver performance ratings are to be provided as indicated.
 - 2. Louver free area, air performance and wind driven rain performances to be provided as indicated
 - 3. All louvers to have AMCA certified ratings
 - 4. Provide the following louver types as indicated:
 - a. Horizontal Storm-Resistant Louver
 - b. Vertical Storm-Resistant Louver
 - c. Horizontal, Drainable-Blade Louver

2.3 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
- B. Louver Screen Frames: Same kind and form of metal as indicated for louver to which screens are attached.

2.4 ALUMINUM FINISHES

- A. High-Performance Organic Finish:
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range color and gloss.

2.5 STAINLESS-STEEL SHEET FINISHES

- A. Repair sheet finish by grinding and polishing irregularities, weld spatter, scratches, and forming marks to match surrounding finish.

END OF SECTION 089000



Division 09

Finishes

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing and inspecting agency.

2.2 METAL FRAMING AND SUPPORTS

- A. Steel Framing Members, General: ASTM C 754.
 - 1. Steel Sheet Components: ASTM C 645. Thickness specified is minimum uncoated base-metal thickness.
 - 2. Protective Coating: manufacturer's standard corrosion-resistant zinc coating.
- B. Suspended Ceiling and Soffit Framing:
 - 1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch (1.59-mm) diameter, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
 - 2. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, and 0.162-inch (4.12-mm) diameter.
- C. Partition and Soffit Framing:
 - 1. Studs and Runners: In depth indicated and 0.0296 inch (0.752 mm) thick unless otherwise indicated.
 - 2. Flat Strap and Backing: 0.0296 inch (0.752 mm) thick.
 - 3. Rigid Hat-Shaped Furring Channels: In depth indicated and 0.0296 inch (0.752 mm) thick.
 - 4. Resilient Furring Channels: 1/2 inch (12.7 mm) deep, with single- or double-leg configuration.
 - 5. Cold-Rolled Furring Channels: 0.0538 inch (1.37 mm) thick, 3/4 inch (19.1 mm) deep.

6. Z-Furring: In depth required by insulation, 1-1/4-inch (31.8-mm) face flange, 7/8-inch (22.2-mm) wall-attachment flange, and 0.0179 inch (0.454 mm) thick.

2.3 ACCESSORIES

- A. General: Comply with referenced installation standards.
 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.
- B. Acoustical Sealant for Concealed Joints: Nonsag, latex sealant complying with ASTM C 834.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation and with United States Gypsum's "Gypsum Construction Handbook."
 1. Gypsum Plaster Assemblies: Also comply with ASTM C 841.
 2. Portland Cement Plaster Assemblies: Also comply with ASTM C 1063.
 3. Gypsum Veneer Plaster Assemblies: Also comply with ASTM C 844.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Isolate steel framing from building structure, except at floor, to prevent transfer of loading imposed by structural movement.
 1. Where studs are installed directly against exterior walls, install asphalt-felt or foam-gasket isolation strip between studs and wall.
- D. Fire-Resistance-Rated Assemblies: Comply with requirements of listed assemblies.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing and inspecting agency.

2.2 PANEL PRODUCTS

- A. Provide in maximum lengths available to minimize end-to-end butt joints.
- B. Interior Gypsum Board: ASTM C 36/C 36M or ASTM C 1396/C 1396M, in thickness indicated, with manufacturer's standard edges. Regular type unless otherwise indicated, or as required for specific fire-resistance-rated assemblies
- C. Exterior Gypsum Soffit Board: ASTM C 931/C 931M or ASTM C 1396/C 1396M, in thickness indicated, with manufacturer's standard edges. Regular type unless otherwise indicated or Type X where required for fire-resistance-rated assemblies and where indicated.
- D. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M, in thickness indicated. Regular type unless otherwise indicated or Type X where required for fire-resistance-rated assemblies and where indicated.
- E. Glass-Mat, Water-Resistant Gypsum Backing Board: ASTM C 1178/C 1178M, of thickness indicated. Regular type unless otherwise indicated or Type X where required for fire-resistance-rated assemblies and where indicated.
 - 1. Product: G-P Gypsum; Dens-Shield Tile Guard.
- F. Cementitious Backer Units: ANSI A118.9.

2.3 ACCESSORIES

- A. Trim Accessories: ASTM C 1047, formed from galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet. For exterior trim, use accessories formed from hot-dip galvanized-steel sheet, plastic, or rolled zinc.
1. Provide cornerbead at outside corners unless otherwise indicated.
 2. Provide LC-bead (J-bead) at exposed panel edges.
 3. Provide control joints where indicated.
 4. Provide corner support clips.
- B. Aluminum Accessories: Extruded-aluminum accessories indicated with manufacturer's standard corrosion-resistant primer
1. Fry Reglet:
 - a. "Z" reveal molding
 - 1) <http://www.fryreglet.com/shape/pop/129.htm>
 - b. "F" Reveal molding
 - 1) <http://www.fryreglet.com/shape/pop/114.htm>
- C. Joint-Treatment Materials: ASTM C 475/C 475M.
1. Joint Tape: Paper unless otherwise recommended by panel manufacturer.
 2. Joint Compounds: Drying-type, ready-mixed, all-purpose compounds
 3. Skim Coat: For final coat of Level 5 finish, usedrying-type, all-purpose compound
 4. Cementitious Backer Unit Joint-Treatment Materials: Products recommended by cementitious backer unit manufacturer.
- D. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gypsum board to comply with ASTM C 840.
1. Isolate gypsum board assemblies from abutting structural and masonry work. Provide edge trim and acoustical sealant.
 2. Single-Layer Fastening Methods: Fasten gypsum panels to supports with screws.
 3. Multilayer Fastening Methods: Fasten base layers and face layer separately to supports with screws
- B. Install cementitious backer units to comply with ANSI A108.11.
- C. Fire-Resistance-Rated Assemblies: Comply with requirements of listed assemblies.

- D. Finishing Gypsum Board: ASTM C 840.
1. At concealed areas, unless a higher level of finish is required for fire-resistance-rated assemblies, provide Level 1 finish: Embed tape at joints.
 2. At substrates for tile, provide Level 2 finish: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges.
 3. Unless otherwise indicated, provide Level 4 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges.
 4. Where indicated, provide Level 5 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges. Apply skim coat to entire surface.
- E. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.
- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- G. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.

END OF SECTION 092900

SECTION 093000 - TILING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Product Samples: Provide sample of min 12 inch by 12 inch square.

PART 2 - PRODUCTS

2.1 GLASS TILE

A. Wall Tile

1. TILE – 2

- a. Mosaics: glass mosaics

- 1) http://www.homedepot.com/Bath-Tile-Stone/h_d1/N-5yc1vZbqxt/R-202530987/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

- b. Color: Glacier Ice Brick

2. TILE – 3

- a. Mosaics: glass mosaics

- 1) http://www.homedepot.com/Bath-Tile-Stone/h_d1/N-5yc1vZbqxt/R-202530987/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

- b. Color: Glacier Ice Brick

2.2 PORCELAIN TILE

A. FLOOR TILE

1. PT-2

- a. American Olean – infusion

- 1) <http://americanolean.com/series.cfm?series=170&c=48>

- b. Color: to be selected by architect from manufacturers full range

- c. Size: 4 inches x 24 inches

- d. Thickness: 3/8 inches

2.3 INSTALLATION MATERIALS

- A. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, 1/2 inch (12.7 mm) thick.

- B. Fiber-Cement Underlayment: ASTM C 1288, 1/4 inch (12.7 mm) thick.
- C. VOC Limit for Adhesives and Fluid-Applied Waterproofing Membranes: 65 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Waterproofing Membranes for Thin-Set Installations: ANSI A118.10.
- E. Setting and Grouting Materials: Comply with material standards in ANSI's "Specifications for the Installation of Ceramic Tile" that apply to materials and methods indicated. For other tile types comply with manufactures recommendations for mortar and grout types.
 - 1. Thin-Set Mortar Type: Latex-portland cement.
 - 2. Thin-Set Mortar Type for Wood Subfloors: EGP latex-portland cement.
 - 3. Grout Type: Water-cleanable epoxy unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For installations indicated below, follow procedures in ANSI's "Specifications for the Installation of Ceramic Tile" for providing 95 percent mortar coverage. Listed locations below are examples only; revise to suit Project.
 - a. Tile floors in wet areas.
- B. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- C. Lay tile in grid pattern unless otherwise indicated. Align joints where adjoining tiles on floor, base, walls, and trim are the same size.
- D. Install cementitious backer units and treat joints according to ANSI A108.11.
- E. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
- F. Install waterproofing to comply with ANSI A108.13.

- G. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.
- H. Interior Floor Tile Installation Method(s):
 - 1. Over Wood Subfloors: TCA F144 (thin-set mortar bonded on cementitious backer units or fiber cement underlayment.)
- I. Interior Wall Tile Installation Method(s):
 - 1. Over Wood Studs or Furring: Thinset mortar over ½" cement backer board over 20# asphalt felt paper.

END OF SECTION 093000

SECTION 096400 - WOOD FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Factory-finished wood flooring.
- B. Related Sections:
 - 1. Section 061600 Sheathing: for subfloor.

1.3 ACTION SUBMITTALS

- A. Samples for Verification: For each type of wood flooring and accessory, with stain color and finish required, approximately 12 inches (300 mm) long and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

1.4 QUALITY ASSURANCE

- A. Hardwood Flooring: Comply with NOFMA's "Official Flooring Grading Rules" for species, grade, and cut.
 - 1. Certification: Provide flooring that carries NOFMA grade stamp on each bundle or piece.
- B. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wood flooring materials in unopened cartons or bundles.
- B. Protect wood flooring from exposure to moisture. Do not deliver wood flooring until after concrete, masonry, plaster, ceramic tile, and similar wet work is complete and dry.

- C. Store wood flooring materials in a dry, warm, ventilated, weathertight location.

1.6 PROJECT CONDITIONS

- A. Conditioning period begins not less than seven days before wood flooring installation, is continuous through installation, and continues not less than seven days after wood flooring installation.
 - 1. Environmental Conditioning: Maintain an ambient temperature between 65 and 75 deg F (18 and 24 deg C) and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.
 - 2. Wood Flooring Conditioning: Move wood flooring into spaces where it will be installed, no later than the beginning of the conditioning period.
 - a. Do not install flooring until it adjusts to relative humidity of, and is at same temperature as, space where it is to be installed.
 - b. Open sealed packages to allow wood flooring to acclimatize immediately on moving flooring into spaces in which it will be installed.
- B. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.
- C. Install factory-finished wood flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 FACTORY-FINISHED WOOD FLOORING

- A. Solid-Wood Flooring:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide:
 - a. Somerset solid hardwood flooring – <http://www.paneltown.com-Somerset Wood Flooring>
 - 2. Species: Maple
 - 3. Grade: residential
 - 4. Thickness: 3/4 inches
 - 5. Face Width: 3.25 inches
 - 6. Length: Random
 - 7. Edge Style: Smooth
 - 8. Finish: Ultimate Polyurethane Finish
 - a. Color: Maple Natural

2.2 ACCESSORY MATERIALS

- A. Wood Underlayment: As specified in Section 061600 "sheathing."

- B. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.
- C. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood flooring manufacturer.
- D. Fasteners: As recommended by manufacturer, but not less than that recommended in NWFA's "Installation Guidelines: Wood Flooring."
- E. Thresholds and Saddles: To match wood flooring. Tapered on each side.
- F. Metal trim for expansion joint flooring lay-in.
 - 1. Schluter: Schiene – <http://www.schluter.com/2171.aspx>
 - a. Secure metal trim to subfloor by setting in adhesive or screwing / nailing in place.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- B. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in NWFA's "Installation Guidelines: Wood Flooring."
- B. Subfloor: Install according to requirements in Section 061600 "sheathing"
- C. Wood Underlayment: Install according to requirements in Section 061600 "sheathing"

- D. Provide expansion space at walls and other obstructions and terminations of flooring per manufacturer written instructions
- E. Engineered-Wood Flooring: Nail or staple

3.4 PROTECTION

- A. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.
 - 1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 096400

SECTION 099100 - PAINTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product data: manufacturers written product data for each product.
2. Samples for verification: each type of paint in sheen indicated. Stains applied to each type of substrate to level of finish quality no smaller than 12 inches x 12 inches.

PART 2 - PRODUCTS

2.1 PAINT

A. Acceptable manufacturer: Provide the following

1. Olympic premium interior paint
 - a. Zero VOC formula
 - b. http://www.olympic.com/Paint/Find_Products/interior_paints.aspx
2. Olympic premium exterior paint
 - a. http://www.olympic.com/Paint/Find_Products/exterior_paints.aspx
3. Olympic Interior Stains
 - a. http://www.olympic.com/Stain/Find_Products/interior_products.aspx
4. Olympic exterior Stains
 - a. http://www.olympic.com/Stain/Find_Products/exterior_products.aspx

B. MPI Standards: Provide materials that comply with MPI standards indicated and listed in its "MPI Approved Products List."

C. Material Compatibility: Provide materials that are compatible with one another and with substrates.

D. Use interior paints, coatings and transparent finishes that comply with the following limits for VOC content:

1. Flat Paints and Coatings: 50
2. Nonflat Paints, Coatings: 150

3. Primers, Sealers, and Undercoaters: 200
4. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
5. Shellacs, Clear: VOC not more than 730 g/L.
6. Stains: VOC not more than 250 g/L.

E. Colors: As indicated on drawings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, lighting fixtures, and similar items that are not to be painted. Mask items that cannot be removed. Reinstall items in each area after painting is complete.
- C. Clean and prepare surfaces in an area before beginning painting in that area. Schedule painting so cleaning operations will not damage newly painted surfaces.

3.2 APPLICATION

- A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Paint exposed surfaces unless otherwise indicated.
 1. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
 2. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint the back side of access panels.
- C. Apply paints according to manufacturer's written instructions.
 1. Use brushes only for exterior painting and where the use of other applicators is not practical.
 2. Use rollers for finish coat on interior walls and ceilings.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
 1. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

- E. Apply stains and transparent finishes to produce surface films without color irregularity, cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other imperfections. Use multiple coats to produce a smooth surface film of even luster.

3.3 EXTERIOR PAINT / FINISH APPLICATION SCHEDULE

A. Aluminum Substrates:

1. Latex System:

- a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
- b. Intermediate Coat: Latex, exterior, matching topcoat.
- c. Topcoat: Latex, exterior, low sheen (Gloss Level 3-4), MPI #15.

- #### B. Wood substrates, nontraffic surfaces, including , wood trim, architectural woodwork, doors, windows, wood siding, wood fences, wood-based panel products, glued-laminated construction, exposed joists, exposed beams

1. Semitransparent Stain System:

- a. Prime Coat: Stain, exterior, solvent based, semi-transparent, matching topcoat.
- b. Topcoat: Stain, exterior, solvent based, semi-transparent, MPI #13.

- #### C. Wood substrates, traffic surfaces, including wood decks and stairs.

1. Prime Coat: Stain, for exterior wood decks, matching topcoat.

D. Exterior Gypsum Board Substrates:

1. Latex System:

- a. Prime Coat: Latex, exterior, matching topcoat.
- b. Intermediate Coat: Latex, exterior, matching topcoat.
- c. Topcoat: Latex, exterior, low sheen (Gloss Level 3-4), MPI #15.

3.4 INTERIOR PAINT APPLICATION SCHEDULE

A. Dressed Lumber: Including architectural woodwork, doors.

1. Semigloss Latex: Two coats over primer: MPI INT 6.3T.

B. Gypsum Board:

- 1. Eggshell Latex: Two coats over primer/sealer: MPI INT 9.2A.
- 2. Low-Sheen Latex: One coat over alkyd primer/sealer: MPI INT 9.1B.

END OF SECTION 099100

Division 10

Specialties

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, No. 4 finish (satin), 0.0312-inch minimum nominal thickness unless otherwise indicated.
- B. Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T6 or 6463-T6.
- C. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- D. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.
- E. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- F. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- G. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.2 TOILET AND BATH ACCESSORIES

- A. Manufacturers:
 - 1. Kohler
- B. Towel Bar:
 - 1. Basis-of-Design Product: Kohler
 - 2. Description: 3/4-inch round tube with circular end brackets.
 - 3. Mounting: Flanges with concealed fasteners.
 - 4. Length: 24 inches Material and Finish: Vibrant brushed nickel.
- C. Towel Hook:
 - 1. Basis-of-Design Product: Kohler

2. Description: Pin projecting approximately 2-1/2 inches (63 mm) from wall with.
3. Pin Material and Finish: Stainless steel finished in vibrant brushed nickel.

D. Towel Rack

1. Basis-of-Design Product: Kohler
2. Description: Surface-mounted, guest-towel unit with approximately 1/4-inch- (6-mm-) diameter wire rings welded to upright wire bracket.
3. Capacity: Three sets of bath towels.
4. Nominal Height: 17 inches
5. Material and Finish: Stainless steel finished in vibrant brushed nickel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items. Remove temporary labels and protective coatings.

END OF SECTION 102800

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. Portable Fire Extinguishers NFPA 10, listed and labeled for the type, rating, and classification of extinguisher.
 - 1. Multipurpose Dry-Chemical Type:
 - 2. UL-rated 1-A:10-B:C, 2.5-lb nominal capacity, in chrome-plated brass container.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fire extinguishers in where indicated.

END OF SECTION 104416



Division 11

Equipment

SECTION 113100 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Allowances: See Division 01 "Price and Payment Procedures" Section for appliance allowances.
- B. Submittals: Product Data.
- C. 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.
- D. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
- E. Energy Ratings: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

PART 2 - PRODUCTS

2.1 RESIDENTIAL APPLIANCES

- A. Electric Cooktop: 30-inch built-in induction cooktop with four burner elements, with touch control, 300 Series
 - 1. Bosch: NIT3065UC
 - 2. <http://www.bosch-home.com/us/product-comparison.html?ps=NIT3065UC>
- B. Convection Oven: 30-inch Single Wall oven 500 Series, 4.7-cu. ft. capacity, 2000 W baking power, 2000 W convection power, 3600 W broiling power.
 - 1. Bosch : HBL5450UC
 - 2. <http://www.bosch-home.com/us/product-comparison.html?ps=HBL5450UC>
- C. Microwave Oven: 30-inch OTR Microwave Oven 500 Series, 1.7-cu. ft. capacity, 1000 W cooking power

1. Bosch: HMV5051U
 2. <http://www.bosch-home.com/us/product-comparison.html?ps=HMV5051U>
- D. Refrigerator/Freezer: Freestanding, cycle-defrost, three door French door refrigerator, bottom freezer, 800 Series Standard Depth.
1. Fresh Food Compartment Volume: 17 cu. ft.
 2. Freezer Compartment Volume: 9 cu. ft.
 3. Bosch: B26FT70SNS
 4. <http://www.bosch-home.com/us/product-comparison.html?ps=B26FT70SNS>
- E. Dishwasher: Built-in, under counter, automatic dishwasher, sized to replace 18-inch base cabinet, 5 wash cycles with hot-air and heat-off drying cycles, [stainless steel Eurotub and door liner.
1. Bosch: SRX53C15UC
 2. <http://www.bosch-home.com/us/product-comparison.html?ps=SRX53C15UC>
- F. Clothes Washer: Stacked, front-loading, automatic clothes washer with 3.3-cu. ft. capacity stainless-steel tub and 15 wash cycles including regular, delicate, and permanent press; 1150 RPM reversible motor, 500 Series
1. Bosch: WFVC5400UC
 2. <http://www.bosch-home.com/us/product-comparison.html?ps=WFVC5400UC>
- G. Electric Clothes Dryer: Stackable, front-loading clothes dryer, 6.7-cu. ft. capacity with stainless-steel interior, 500 Series Vented Dryer with Steam.
1. Bosch: WED7500VW:
 2. <http://www.bosch-home.com/us/product-comparison.html?ps=WTVC5330US>

PART 3 - EXECUTION

3.1 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 113100



Division 12

Furnishings

SECTION 123200 – MANUFACTURED CASEWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Manufactured factory finished wood casework.

1.02 RELATED REQUIREMENTS:

- A. Division 061000 – “Rough Carpentry” for blocking

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting attachment details.
- C. Samples: For each exposed product and for each color and texture specified.

1.04 WARRANTY

- A. Provide manufacturers standard warranty on product lines.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Acceptable manufacturer, provide the following:
 - 1. IKEA West Chester, 9500 IKEA Way West Chester, OH 45069, Tel: 513-779-7100 – [IKEA.com](http://www.ikea.com)
 - 2. Kitchen Cabinet Series:
 - a. Akurum: quantity and configuration as shown on drawings
 - 1) BC-1 – Base Cabinet Domsjo Single bowl sink
 - a) <http://www.ikea.com/us/en/catalog/products/S39869626>
 - b) Product number: 398.269.67
 - c) Width: 29 7/8 inches
 - d) Depth: 24 3/4 inches
 - e) Height: 30 3/8 inches

- f) Frame color: White
 - g) Door Front: Abstrakt high gloss white
- 2) BC-2 – Base Cabinet four drawers
- a) <http://www.ikea.com/us/en/catalog/products/S49869659>
 - b) Product number: 798.268.52
 - c) Width: 14 7/8 inches
 - d) Depth: 24 1/8 inches
 - e) Height: 30 3/8 inches
 - f) Frame Color: White
 - g) Door: Abstrakt high gloss white
- 3) BC-3 – Base Cabinet with shelves
- a) <http://www.ikea.com/us/en/catalog/products/S29863489>
 - b) Product number: 398.270.47
 - c) Width: 11 7/8 inches
 - d) Depth: 24 1/8 inches
 - e) Height: 30 3/8 inches
 - f) Frame Color: White
 - g) Door: Abstrakt high gloss white
- 4) BC-4 – Oven Base Cabinet
- a) <http://www.ikea.com/us/en/catalog/products/S49869621>
 - b) Product number: 298.635.21
 - c) Width: 30 inches
 - d) Depth: 24 3/4 inches
 - e) Height: 30 3/8 inches
 - f) Frame Color: White
3. Closet series:
- a. Pax: quantity and configuration as shown on drawings
- 1) WB-1 – Wardrobe with sliding doors
- a) <http://www.ikea.com/us/en/catalog/products/S09873700>
 - b) Product number: 098.737.00
 - c) Width: 78 3/4 inches
 - d) Depth: 26 inches
 - e) Height: 93 1/8 inches
 - f) Frame Color: white
 - g) Door: White glass
- 2) WB-2 – Wardrobe with sliding doors
- a) <http://www.ikea.com/us/en/catalog/products/S69873698>
 - b) Product number: 698.736.98
 - c) Width: 59 inches
 - d) Depth: 26 inches
 - e) Height: 93 1/8 inches
 - f) Frame Color: white
 - g) Door: White glass
- 3) SH-1 – Shelf
- a) <http://www.ikea.com/us/en/catalog/products/70121522>

- b) Product number: 701.215.22
 - c) Width: 28 inches
 - d) Frame width: 29 1/2 inches
 - e) Depth: 22 5/8 inches
 - f) Frame depth: 22 7/8 inches
 - g) Thickness: 3/4 inches
 - h) Frame Color: White
- 4) SH-2 – Shelf
- a) <http://www.ikea.com/us/en/catalog/products/20014874>
 - b) Product number: 200.148.74
 - c) Width: 37 7/8 inches
 - d) Frame width: 39 1/4 inches
 - e) Depth: 22 5/8 inches
 - f) Frame depth: 22 7/8 inches
 - g) Thickness: 3/4 inches
 - h) Frame Color: White
4. Closet accessories series:
- a. Komplement – quantity and configuration as shown on drawings
- 1) CR-1 – Clothes rail
- a) <http://www.ikea.com/us/en/catalog/products/10141165>
 - b) Product number: 101.411.65
 - c) Width: 28 inches
 - d) Frame Width: 29 1/2 inches
- 2) CR-2 – Clothes rail
- a) <http://www.ikea.com/us/en/catalog/products/60141163>
 - b) Product number: 601.411.63
 - c) Width: 37 7/8 inches
 - d) Frame Width: 39 3/8 inches
- 3) CR-3 – Clothes rail add on
- a) <http://www.ikea.com/us/en/catalog/products/80141162>
 - b) Product number: 801.411.62
 - c) Min width: 21 1/4 inches
 - d) Max width: 30 3/8 inches
- 4) DW-1 – Drawer
- a) <http://www.ikea.com/us/en/catalog/products/80121456>
 - b) Product number: 801.214.56
 - c) Width: 26 3/4 inches
 - d) Frame width: 29 1/2 inches
 - e) Depth: 22 1/2 inches
 - f) Frame depth: 22 7/8 inches
 - g) Height: 6 1/4 inches
 - h) Frame Color: White
- 5) DW-2 – Drawer
- a) <http://www.ikea.com/us/en/catalog/products/00121460>
 - b) Product number: 001.214.60

- c) Width: 36 5/8 inches
 - d) Frame width: 39 3/8 inches
 - e) Depth: 22 1/2 inches
 - f) Frame depth: 22 7/8 inches
 - g) Height: 6 1/4 inches
 - h) Frame Color: White
- 6) PH -1 - Pants Hanger
- a) <http://www.ikea.com/us/en/catalog/products/80120918>
 - b) Product number: 801.209.18
 - c) Width: 28 3/8 inches
 - d) Frame width: 29 1/2 inches
 - e) Depth: 21 1/4 inches
 - f) Frame depth: 22 7/8 inches
 - g) Height: 1 1/8 inches
- 7) SR-1 – Shoe rack
- a) <http://www.ikea.com/us/en/catalog/products/60141158>
 - b) Product number: 601.411.58
 - c) Width: 22 7/8 inches
 - d) Frame width: 29 1/2 inches
 - e) Built in Depth: 13 5/8 inches
5. Bathroom Series:
- a. Godmorgon series: quantity and configuration as shown on drawings
 - 1) MC - 1 – Mirror Cabinet with two doors
 - a) <http://www.ikea.com/us/en/catalog/products/90147644>
 - b) Product number: 901.476.44
 - c) Width: 23 5/8 inches
 - d) Depth: 5 1/2 inches
 - e) Height: 37 3/4 inches
 - f) Color: White
 - 2) SC - 1 – Sink Cabinet with two drawers
 - a) <http://www.ikea.com/us/en/catalog/products/30180995>
 - b) Product number: 801.955.36
 - c) Width: 23 5/8 inches
 - d) Depth: 18 1/2 inches
 - e) Height: 22 7/8 inches
 - f) Color: High gloss white
 - b. Bathroom Storage Door: Rubrik series
 - 1) BDR - 1 – Frosted glass door
 - a) <http://www.ikea.com/us/en/catalog/products/60145019>
 - b) Product number: 601.450.19
 - c) Width: 14 3/4 inches
 - d) Height: 79 1/4 inches
 - e) Thickness: 3/4 inches
 - f) Frame: Aluminum
 - g) Door Panel: Tempered / safety glass

h) Hinges: Integral Series, Product number: 501.323.76

6. Baseboard Series

a. Perfekt

- 1) <http://www.ikea.com/us/en/catalog/products/70038504>
- 2) 700.3385.04
- 3) Color: White

7. Hardware Series

a. Strecket

- 1) <http://www.ikea.com/us/en/catalog/products/60116700>
- 2) Product Number: 601.167.00

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of casework.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install cabinets with no variations in flushness of adjoining surfaces; use concealed shims. Where cabinets abut other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match cabinet face. I
- B. Install cabinets without distortion so doors and drawers fit the openings, are aligned, and are uniformly spaced. Complete installation of hardware and accessories as indicated.
- C. Install cabinets level and plumb to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m).
- D. Fasten cabinets to adjacent units and to backing.
- E. Fasten wall cabinets through back, near top and bottom, and at ends not more per manufactures but not less than 16 inches (400 mm) o.c. with manufacturer suggested fasteners
- F. Units to receive appliances:
 1. Install necessary supports and additional blocking per appliance manufactures written instructions.

3.03 ADJUSTING AND CLEANING

- A. Adjust cabinets and hardware so doors and drawers are centered in openings and operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
- B. Clean casework on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 123200

SECTION 123530 – RESIDENTIAL CASEWORK

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals:
 - 1. Product data: manufacturers written information for each type of hardware
 - 2. Samples for verification: all exposed finishes.
- B. Verify dimensions by field measurements; measure for countertops after base cabinets are installed.

PART 2 - PRODUCTS

2.1 CASEWORK

- A. Comply with KCMA A161.1.
- B. Open Shelving
 - 1. Products:
 - a. Open shelves are manufactured by the OSU Solar Decathlon Team.
 - 2. Exposed Wood: Maple or Birch clear solid wood or hardwood plywood with Grade A faces per HPVA HP-1, selected for compatible color and grain.
 - 3. Semi-exposed Materials: Solid wood or hardwood plywood with Grade C faces per HPVA HP-1, clear finish, Plastic laminate, NEMA LD 3, Grade VGS or Medium-density particleboard, with melamine surface. Any are acceptable
 - 4. Thickness: adhered layered exposed wood to thickness indicated in drawings
 - 5. Mounting brackets: concealed type, heavy duty.
 - a. Approved Manufacturers: Rockler
 - b. http://www.rockler.com/product_Blind_Shelf_Supports
- C. Countertop Configuration:
 - 1. See drawings for profile, dimension, and construction.

2.2 HARDWARE

- A. Murphy bed:

1. Provide the following: Acceptable manufacturer or approved equal.
 - a. Create a bed
 - 1) Side Mount horizontal hardware: full size bed.
 - 2) <http://www.wallbed.com/>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cabinets and shelves with no variations in flushness of adjoining surfaces by using concealed shims. Where casework abuts other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match casework face.
- B. Install cabinets and shelves without distortion so doors and drawers fit openings properly and are aligned.
- C. Install level and plumb to a tolerance of 1/8 inch in 8 feet.
- D. Fasten each cabinet to adjacent unit and to structural members of wall construction. Fasten wall cabinets through back, near top and bottom, at ends and not less than 24 inches o.c.
 1. Use No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips.
 2. Use toggle bolts through metal backing behind gypsum board.
- E. Fasten countertops by adhering with silicone adhesive on the underside of countertop. Align adjacent surfaces.
 1. Seal counters with manufacturer recommended sealer for porous surfaces.

END OF SECTION 123530

SECTION 123661 - SIMULATED STONE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-surface-material countertops and backsplashes.

B. Related Sections:

1. Section 123640 "Stone Countertops."
2. Section 224100 "Residential Plumbing Fixtures" for undermount nonintegral sinks and fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials

B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

C. Samples for Verification: For the following products:

1. Countertop material, 6 inches (150 mm) square.

1.3 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.4 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS

A. Configuration: Provide countertops with the following front and backsplash style:

1. Front edge: Beveled edge with apron
2. Backsplash: Beveled
3. Endsplash: Matching backsplash.

- B. Countertops: 1 1/4-inch- (31.8-mm-) thick composite solid surface material with exposed edges
- C. Fabrication: Fabricate tops in one piece with beveled and sanded edges and integral backsplashes unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

2.2 COUNTERTOP MATERIALS

- A. Solid Surface Material: Composite solid sheets from 100% post-consumer recycled paper and petroleum free resin.
 - 1. Approved Manufacturers: PaperStone, Solid Surface Panels
 - a. Thickness: 1 ¼-inch
 - b. Color: Gunmetal
 - c. <http://www.paperstoneproducts.com/products-panels-gunmetal.php>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m).
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 1. Install backsplashes and endsplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 2. Seal edges of cutouts in particleboard subtops by saturating with varnish.

END OF SECTION 123661



Division 13

Special Construction

SECTION 130000 – SPECIAL CONSTRUCTION: PHASE CHANGE MATERIAL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Manufacturers Specifications.
- B. Drawings in the M series apply to the work included in this section.

1.2 DESCRIPTION OF WORK

- A. HVAC and sheet metal contractor shall furnish a plenum for pre assembled of the shelf HDPE encased phase change material.
- B. Due to space constraints the exact size and location of the plenum and ducting is subject to field installation and determination.
- C. Sheet M-501 shows a proposed detail.

PART 2 - PRODUCTS

2.1 PHASE CHANGE MATERIAL

- A. General: Provide factory assembled PCM units as indicated. Each panel shall be encased in standard size HDPE from the manufacturer.
- B. Product: RGEES PCM29P: http://www.rgees.com/product_PCM29P.php
- C. Manufacturer has provided details regarding encapsulation. Sheets are to be 860x200x20 mm. PCM material must be encased in this material to avoid damage to any Stainless Steel and Aluminum sheet metal work.
- D. Product is non-flammable and non-combustible. MSDS states that is classified as a non-dangerous good.
- E. MSDS

MATERIAL SAFETY DATA SHEET PCM29P Phase Change Material**PRODUCT IDENTIFICATION:**

Name: UN No.: CAS Registry No.: Dangerous Goods Class: Hazchem Code: EPG: IMDG:
Packaging Group Revision: July 2008

PHYSICAL DESCRIPTION AND PROPERTIES:

Appearance:	White-cream crystalline solid. Clear to milky white above melting point
Composition:	Calcium chloride hexahydrate (min.90%) Magnesium chloride hexahydrate (min. 18%) Proprietary salts (max. 5%)
Melting Point:	25 °C
Boiling point:	>1400C (anhydrous)
Vapour pressure:	<20mmHg at 40 °C and associated with water content only
Flammability Limits	
LEL:	Not applicable
UEL:	Not applicable
Autoignition temperature:	Not applicable
Solubility:	Soluble in water and some alcohols
pH:	6-10

HEALTH HAZARD INFORMATION

1. Acute Health Effects

Ingestion: Single dose oral toxicity is low. Ingestion may cause gastrointestinal irritation. (Acute oral LD50 for rats is > 1500mg/kg)

Eye: May cause mild to moderate irritation and some corneal injury in the most severe and untreated cases.

Skin: Short single exposure is unlikely to cause skin irritation. Prolonged or repeated skin exposure may cause mild or moderate skin irritation. (Acute dermal LD50 for rabbits is > 2500mg/kg)

Inhalation: Vapours do not pose an acute health risk due to non volatility of salts. Dust may cause irritation to upper respiratory tract.

2. Chronic Health Effects

The components are not listed by IARC, NTP or PHSA as carcinogens for hazard communication purposes. Results of in vitro mutagenicity tests have been negative for calcium chloride.

3. First Aid

Swallowing: If swallowed, induce vomiting by giving two glasses of water and placing fingers towards back of throat. Do not attempt to induce vomiting if the victim is unconscious. Call a physician.

Eye: Irrigate with water immediately and continuously for at least 15 minutes. Consult a physician.

Skin: Wash effected area with water either locally or under shower. If irritation persists consult a physician.

Inhalation: In the event of dust inhalation remove patient to well ventilated fresh air area. Rinse mouth and gargle with water. Consult physician if irritation persists.

Advice to physician for any of the above health issues is to treat symptomatically.

PRECAUTIONS FOR USAGE

1. Exposure standards

Exposure limits have not been established on TLV basis for continuously working with the product.

2. Engineering Controls.

Ensure adequate ventilation and standard dust control provisions

3. Personal Protection

No special PPG equipment is required for the handling of PC29. However, good manufacturing practice will include: safety glasses and gloves and a dust mask if solid product is being broken down mechanically.

4. Flammability

The product is not flammable and no special precautions are required in this respect.

SAFE HANDLING INFORMATION

1. Storage and Transportation

Transport and store the product under dry and cool conditions - ideally below 35 °C. Container should be sealed to air tightness. The containers should be suitably flexible to retain containment integrity with a variation in volume of the product of ~10% between its solid and liquid phases above and below 25 °C.

2. Spills and Disposal

Recovery of spilt solids or liquid should be placed in suitable, labeled containers for re-use. Wash down affected area with excess water. Where it is not possible to reuse the recovered product then disposal should observe all local, state and federal regulations governing the disposal of calcium and magnesium chloride waste.

3. Fire and Explosion Hazard.

The product is not flammable and has no auto-ignition temperature. If it is heated sufficiently due to proximity to a fire, it can decompose to give off noxious chlorine containing gases. Where possible the product should be removed from the proximity to a fire.

4. Packaging and Labeling

There are no labeling requirements specified by regulatory authorities for PC29. Safety phrase recommendations include: Keep out of reach of children Avoid contact with skin and eyes. If swallowed seek medical advice.

No further information

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' design.
- B. Examine areas and conditions under units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- C. Review MSDS

3.2 INSTALLATION OF SPLIT SYSTEM HEAT PUMP UNITS

- A. General: Install units in accordance with manufacturer's installation instruction. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.
- B. See M-501 for mounting details.
- C. Approve duct work connecting the solar thermal hot air system.

END OF SECTION 238419



Division 21

Fire Protection Systems

SECTION 211000 – WATER BASED FIRE SUPPRESSION SYSTEM

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and system operating description.
- B. 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.
- C. General: UL listed and labeled as complying with NFPA 70, Article 760.

1.2 SPRINKLER AND FIRE SUPPRESSION

- A. General:
 - 1. If explicit distinction is not listed below all installations shall comply with the specification 221119, Plumbing specialties.
- B. Pipes and Fittings
 - 1. Pipe shall meet or exceed the requirements of ASTM F442 in standard dimension ratio (SDR) 13.5.
 - 2. Fittings shall meet or exceed the requirements of ASTM F437 (schedule 80 threaded), ASTM F438 (schedule 40 socket) and ASTM F439 (schedule 80 socket).
 - 3. Both pipe and fittings shall be Listed by Underwriters Laboratories (UL) for use in wet automatic fire sprinkler systems and shall bear the logo of the Listing Agency. See UL Fire Protection Equipment Directory, categories VIWT and HFYH.
 - 4. Ancillary products coming into contact with pipe and fittings must be chemically compatible as determined by CPVC pipe and fittings manufacturer or compound manufacturer, and thus Listed on pipe, fittings or compound manufacturer's chemical compatibility program.
- C. Basic Use
 - 1. One and two family dwellings and manufactured homes as defined by NFPA 13D.
- D. Material
 - 1. The piping systems (pipe and fittings) shall be constructed from materials extruded/molded by manufacturers using the same compound manufacturer
- E. System Design
 - 1. System design shall be in accordance with standard industry practice for fire sprinkler systems and the manufacturer's instructions. The design shall take into consideration such factors as pressure and flow requirements, friction

- loss, operating temperatures, support spacing, joining methods, and thermal expansion and contraction.
2. The fire sprinkler piping system shall be hydraulically calculated using a Hazen-Williams C Factor of 150, and designed in accordance with the Standard for Installation of Sprinkler Systems NFPA 13.
 3. The maximum design temperature/pressure rating shall not exceed 175 psi at 150°F.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Installation

1. Installation practices such as pipe support spacing, bracing, allowance for thermal expansion/contraction, solvent cementing and handling and storage shall be in accordance with the manufacturer's instructions and the UL Listing which includes installation limitations.

B. Testing

1. After the system is installed and any solvent cement is cured per the manufacturer's installation instructions, the systems shall be hydrostatically tested per the requirements of the applicable NFPA Standard (NFPA 13, 13R or 13D).

END OF SECTION 211000



Division 22

Plumbing

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Mechanical Sleeve Seals: Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. PVC Pipe: ASTM D 1785, Schedule 40.

2.2 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2.3 MOTORS

- A. Motor Characteristics:
 - 1. Motors 1/2 HP and Larger: Three phase.
 - 2. Motors smaller than 1/2 HP: Single phase.
 - 3. Frequency Rating: 60 Hz.
 - 4. Voltage Rating: NEMA standard voltage for circuit voltage to which motor is connected.
 - 5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
 - 6. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
 - 7. 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.
 - 8. Enclosure: Unless otherwise indicated, open drip-proof.

9. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

2.4 HANGERS AND SUPPORTS

- A. Hanger and Pipe Attachments: Factory fabricated with galvanized coatings; nonmetallic coated for hangers in direct contact with copper tubing.
- B. Powder-Actuated Fasteners: Threaded-steel stud, with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, with pull-out and shear capacities appropriate for supported loads and building materials where used.

2.5 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 deg F.

PART 3 - EXECUTION

3.1 MOTOR INSTALLATION

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

3.2 GENERAL PIPING INSTALLATIONS

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Install sleeves for pipes passing through concrete walls, gypsum board partitions, and concrete floor and roof slabs.
- D. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.
- E. Install unions at final connection to each piece of equipment.

- F. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.
- G. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

3.3 GENERAL EQUIPMENT INSTALLATIONS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.4 BASES, SUPPORTS, AND ANCHORAGES

- A. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods on 18-inch centers around the full perimeter of the base to connect concrete base to concrete floor.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete"
- B. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors. Place grout, completely filling equipment bases.

3.5 HANGERS AND SUPPORTS

- A. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.
- B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.

- C. Install powder-actuated fasteners and mechanical-expansion anchors in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.
- D. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30
 - 2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 to allow off-center closure for hanger installation before pipe erection.
 - 3. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 4. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
- F. 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 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

END OF SECTION 220500

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 GENERAL-DUTY VALVES

- A. Valve Sizes: Same as upstream piping unless otherwise indicated.
- B. Valves in Insulated Piping: With 2-inch stem extensions.
- C. End Connections: Threads shall comply with ANSI B1.20.1. Flanges shall comply with ANSI B16.1 for cast-iron valves and with ANSI B16.24 for bronze valves. Solder-joint connections shall comply with ANSI B16.18.
- D. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, and 400-psig minimum CWP rating.
- E. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with regular-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
- F. Bronze, Swing Check Valves: Class 125, bronze body with bronze disc and seat.
- G. Bronze Gate Valves: Class 125, bronze body with rising or non-rising stem and bronze solid wedge
- H. Bronze Globe Valves: Class 125, bronze body with bronze disc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use gate and ball valves for shutoff duty; globe and ball for throttling duty.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves for each fixture and item of equipment.

- D. Install three-valve bypass around each pressure-reducing valve using throttling-type valves.
- E. Install valves in horizontal piping with stem at or above center of pipe.
- F. Install valves in a position to allow full stem movement.
- G. Install check valves for proper direction of flow in horizontal position with hinge pin level.

END OF SECTION 220523

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Quality Assurance: Labeled with maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to ASTM E 84.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- B. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- C. Mineral-Fiber Blanket Insulation: Comply with ASTM C 553, Type II and ASTM C 1290, Type I.
- D. Mineral-Fiber Board Insulation: Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation factory-applied FSK jacket.
- E. Mineral-Fiber, Preformed Pipe Insulation: Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ.
- F. Mineral-Fiber, Pipe and Tank Insulation: Complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB; and having factory-applied FSK jacket. Nominal density is 2.5 lb/cu. ft or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.
- G. Polyolefin Insulation: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
- H. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- I. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- J. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

- K. Factory-Applied Jackets: When factory-applied jackets are indicated, comply with the following:
 - 1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
- L. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

PART 3 - EXECUTION

3.1 PIPE INSULATION INSTALLATION

- A. Comply with requirements of the Midwest Insulation Contractors Association's "National Commercial & Industrial Insulation Standards" for insulation installation on pipes and equipment.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Flexible Elastomeric Insulation Installation:
 - 1. Seal longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Mineral-Fiber Insulation Installation:
 - 1. Insulation Installation on Straight Pipes and Tubes: Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 2. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 - 3. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- E. Polyolefin Insulation Installation:
 - 1. Seal split-tube longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of polyolefin pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- F. Interior Piping System Applications: Insulate the following piping systems:

1. Domestic hot water.
2. Recirculated domestic hot water.
3. Roof drain bodies and horizontal rainwater leaders of storm water piping.
4. Exposed water supplies and sanitary drains of fixtures for people with disabilities.

G. Do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Sanitary drainage and vent piping.
3. Drainage piping located in crawlspaces unless otherwise indicated.
4. Chrome-plated pipes and fittings, except for plumbing fixtures for people with disabilities.
5. Piping specialties, including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.2 EQUIPMENT INSULATION SCHEDULE

A. Domestic hot-water storage tank insulation shall be included with the tank

3.3 INDOOR PIPING INSULATION SCHEDULE

A. Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawlspaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

B. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.

- b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
- 1. All Pipe Sizes: Insulation shall be[one of] the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 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

2.1 PIPE AND FITTINGS

- A. Galvanized-Steel Piping: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe, with ASME B16.4, Class 125, galvanized, standard pattern gray-iron, threaded fittings.
- B. CPVC Piping: ASTM F 441/F 441M, Schedule 40 pipe with ASTM F 438, CPVC Schedule 40 socket-type fittings.
- C. PEX Tube and Fittings: ASTM F 877, SDR 9 PEX tubing and ASTM F 1807, metal insert-type fittings with copper or stainless-steel crimp rings.
 - 1. Manifold: ASTM F 877 plastic or corrosion-resistant-metal assembly, with a plastic or corrosion-resistant-metal valve for each outlet.
- D. PVC Pipe: ASTM D 1785, Schedule 40.
 - 1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.
- E. Special-Duty Valves:
 - 1. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
 - 2. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
 - 3. PVC Union Ball Valves: MSS SP-122, with full-port ball, socket and threaded detachable end connectors, and pressure rating not less than 125 psig at 73 deg F.
 - 4. PVC Non-Union Ball Valves: MSS SP-122, with full- or reduced-port ball, socket or threaded ends, and pressure rating not less than 125 psig at 73 deg F.
 - 5. PVC Butterfly Valves: With lever handle and pressure rating not less than 125 psig at 73 deg F.
 - 6. PVC Check Valves: Swing or ball-check design and pressure rating not less than 125 psig at 73 deg F.

- F. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping installation requirements.
- B. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- D. Install domestic water piping without pitch for horizontal piping and plumb for vertical piping.
- E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- F. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
 - 1. Soldered Joints: Comply with procedures in ASTM B 828 unless otherwise indicated.
- G. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.
- H. Support vertical piping at each floor.
- I. 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.

3.2 INSPECTING 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.

3.3 PIPING SCHEDULE

- A. Underground, Service Entrance Piping: Not Applicable.
- B. Aboveground Distribution Piping:
 - 1. PEX Tubing : 500 ft ½" Diameter
Viega ½" PEX Tubing:
<http://www.pexsupply.com/Viega-32225-1-2-Blue-ViegaPEX-500-ft-coil-12415000-p>
 - 2. PEX Tubing: 200 Ft. 1" Diameter
Viega 1" PEX Tubing:
<http://www.pexsupply.com/Viega-32061-1-White-ViegaPEX-100-ft-coil-12431000-p>

3.4 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Install gate valves close to main on each branch and riser serving two or more plumbing fixtures or equipment connections and where indicated.
- C. Install gate or 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. PVC ball, butterfly, and check valves may be used in matching piping materials.
- E. Install drain valve at base of each riser, at low points of horizontal runs, and where required to drain water distribution piping system.
- F. Install swing check valve on discharge side of each pump and elsewhere as indicated.
- G. Install ball valves in each hot-water circulating loop and discharge side of each pump.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 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.
- C. All domestic water piping shall be ASTM F877 compliant Crosslinked Polyethylene (PEX) Plastic. This includes both hot and cold water distribution systems.
- D. Piping connecting the storage tanks to the domestic system shall be PVC Pipe: ASTM D 1785, Schedule 40.

PART 2 - PRODUCTS

2.1 POTABLE DOMESTIC WATER STORAGE TANK

- A. Provide two Potable Water Storage Tanks to hold a minimum of 300 gallons of potable water each, with a height no greater than 12" for storing below the house
- B. Material to be XR3 FDA/NSF-61 approved material for storing consumable fluids
- C. Have a 4" PVC flange fill fitting and 1" drain fitting for connecting to domestic water piping

2.2 INSTALLATION

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping installation requirements.
- B. Tank shall not be sitting directly on the ground. Raised stand or mounting points for suspension should be provided for the tank below the house.

2.3 INSPECTING AND CLEANING

- A. Inspect and test piping systems as follows:
 - 1. Fill domestic water piping. Test for leaks and defects in new supply tanks and connections to piping that have been altered, extended, or repaired.

- B. Clean and disinfect potable domestic water tank 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.

2.4 PIPING SPECIALTIES SCHEDULE

- A. Manifold: 18 Port ½" Compression Fittings.
 - 1. Viega MANABLOC: <http://www.pexsupply.com/Viega-MXBD18-3-1-2-18-Port-Compression-MANABLOC-8-hot-10-cold-5383000-p>
- B. Ecodrain A1000 Shower Drain Heat Exchanger
 - 1. <http://www.ecodrain.ca/>
- C. MIFAB M-500 Pressure Drop Activated Trap Seal Primer
 - 1. <http://www.mifab.com/pdf/m-500.pdf>

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data. Include certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PUMPS

- A. In-Line, Single Stage, Self-Priming Centrifugal Pumps: Factory-assembled and - tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps. Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal; rated for 108-psig maximum working pressure, maximum suction lift of 25 ft, minimum continuous water temperature of 32 deg F and maximum continuous water temperature of 95 deg F.

1. Products:

- a. Grundfos MQ3-45-115:
[http://www.us.grundfos.com/Web/Download.nsf/Pages/6A0893C7B967963088256EDF00546536/\\$File/L-MQ-PG-001.pdf](http://www.us.grundfos.com/Web/Download.nsf/Pages/6A0893C7B967963088256EDF00546536/$File/L-MQ-PG-001.pdf)

- 2. Casing: Plastic or other corrosion-resistant material
- 3. Impeller: 304 Stainless Steel
- 4. Sound Pressure Level: equal or less than 70 dB

2.2 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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 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. Suspend in-line pumps independent from piping. Use continuous-thread hanger rods and vibration isolation hangers. Fabricate brackets or supports as required for pumps.
- F. Install vertical in-line pumps on concrete bases.
- G. Connect piping with valves that are at least the same size as piping connecting to pumps.
- H. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- I. Install shutoff valve and strainer on suction side of pumps.
- J. Install nonslam check valve and throttling valve on discharge side of pumps.
- K. Install thermostats in hot-water return piping.
- L. Install pressure gages on suction and discharge of each pump. Install at integral pressure gage tapings where provided.

END OF SECTION 221123

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 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

2.1 PIPES AND FITTINGS

- A. PVC Plastic, DWV Pipe and Fittings: ASTM D 2665, Schedule 40, plain ends with PVC socket-type, DWV pipe fittings.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping installation requirements.
- B. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.
 - 1. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- C. 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 1/4 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 drain pipe. 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.
- D. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's

written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- E. 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.
- F. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- G. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- I. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
- J. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure unless otherwise indicated.
- K. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.

3.2 PIPE SCHEDULE

- A. Aboveground Applications: PVC plastic, DWV pipe and fittings with solvent-cemented joints
- B. Belowground Applications: PVC plastic, DWV pipe and drainage-pattern fittings with cemented joints

END OF SECTION 221316

SECTION 221353 - FACILITY SEPTIC TANKS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 SEPTIC TANKS

- A. No septic tanks being used.

2.2 WASTE TANKS

Note: See 327100 2.1 A 1 For Bioremediation tanks. Do not double count on estimate.

- A. 1 x 325 Gallon Rigid Tanks, 1 x 4" PVC fitting, 1 x 1" PVC fitting

2.3 DISTRIBUTION PIPES AND FITTINGS

- A. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, nonperforated, for solvent-cement or elastomeric gasket joints.
 - 1. Solvent Cement: ASTM D 2564.
 - 2. Gaskets: ASTM F 477, elastomeric seal.
- B. ABS Sewer Pipe and Fittings: ASTM D 2751, SDR 35, for solvent-cement or elastomeric gasket joints.
 - 1. Solvent Cement: ASTM D 2235.
 - 2. Gaskets: ASTM F 477, elastomeric seal.
- C. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 , Class 2, for rubber gasket joints, with ASTM C 443 , rubber gaskets.
- D. Vitrified-Clay Sewer Pipe and Fittings: ASTM C 700, Standard Strength, unglazed, with gasket joints, and ASTM C 425, rubber sealing elements.

END OF SECTION 221353

SECTION 223300 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.
- C. Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings."
- D. Warranties: 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

2.1 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.

2.2 ELECTRIC WATER HEATERS

- A. Products:

Note: These products serve to provide both heating and cooling water as well. Do not duplicate in estimate. Alternatives are not acceptable.

- 1. Daikin, Hot Water Tank Residence Heater, EKHWS080BA3VJU:
<http://www.daikinac.com/DOC/PCAWUSE09-09B%20-%20Daikin%20Altherma%20Brochure%20-%20Daikin.pdf>

2. Daikin, Altherma Condenser/Inverter, ERLQ018BAVJU:
<http://www.daikinac.com/DOC/ERLO%20Split%20Install%20Manual%20-%204PW55905-1.pdf>
3. Daikin, Altherma Hydrobox, EKHBX030BA3VJU:
<http://www.daikinac.com/DOC/EKHB%20Installation%20Manual%20-%204PW54216-1.pdf>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install temperature and pressure relief valves and extend to closest floor drain.
- B. Install vacuum relief valves in cold-water-inlet piping.
- C. Install shutoff valves and unions at hot- and cold-water piping connections.
- D. Make piping connections with dielectric fittings where dissimilar piping materials are joined.
- E. Electrically ground units according to authorities having jurisdiction.

END OF SECTION 223300

SECTION 223301 - SOLAR THERMAL WATER HEATING SYSTEM

PART 1 - GENERAL

- 1.1 Install domestic water heating system complete, ready for operation including flat plate collector, heat exchange loop with pump, storage tank and all accessories shall be provided as shown on the drawings and as specified.
- 1.2 Refer to equipment bases and supports, plumbing specialties and other sections for work related to this section.

PART 2 - PRODUCTS

2.1 Solar Collection Units

- A. Flat Plate Collector (FPC) type solar collection panels shall be water based units factory assembled. The complete unit shall be tested and certified hail and wind exposure based on the area of installation.
- B. Collector tubing shall be 3/4" Type L soft copper tubing running through the FPC.
- C. Units shall be rated for the capacity indicated on the drawings for glycol heat transfer fluid.
- D. See end of specification for Glycol MSDS
- E. Units shall be manufactured by Sunmazz
 1. Sunmaxx Titan Power Plus SU-2
http://www.siliconsolar.com/admin/kt_download.php?document_id=34156

2.2 Storage Tank

- A. Tank shall be 80 gallon capacity, featuring two heating elements; one stainless steel heat exchanger for domestic hot water and solar thermal inlets and outlets for heat pump and solar thermal heating applications. The tank is the same as specified in 223300. It is not to be duplicated.
- B. Unit shall be as manufactured by Daikin.
 1. Daikin :
<http://www.daikinac.com/residential/altherma-domestic-hot-water.asp?sec=products&page=53>

2.3 Circulation Pump

- A. Circulation pump shall be 115V 1/25 HP stainless steel. It is included as part of package with the control panel.

- B. Unit shall be as manufactured by Daiken.
 - 1. Daikin Solar Kit EKSOLHWBAVJU:
<http://www.daikinac.com/residential/altherma-solar-kit.asp?sec=products&page=53>

2.4 Control Panel

- A. Unit shall control the operation of the circulation pump and monitor the flat plate collector array array, loop supply and return temperatures. Digital temperature difference logic and intelligent control algorithms shall be fully customizable to specifications. The system shall be single point power connection, 12V, 1PH, 60Hz. It is included in the solar kit package. System temperature shall be limited to 180 degrees Fahrenheit.
- B. Unit shall be as manufactured by Daiken.
 - 1. Daikin Solar Kit EKSOLHWBAVJU:
<http://www.daikinac.com/residential/altherma-solar-kit.asp?sec=products&page=53>EXECUTION

2.5 Installation

- A. Flat plate collector units shall be installed on a structural steel with prime coat or aluminum frame to achieve the direction and solar angle necessary to optimize performance and achieve the design capacity.
- B. Provide insulation or heaters where insulation and jacket are not included as a part of factor packaged equipment. All insulation shall meet the energy code requirements.

2.6 MSDS

- A. <http://www.jtbaker.com/msds/englishhtml/p6928.htm>

Product Identification

Synonyms: 1,2-propanediol; 1,2-dihydroxypropane; methyl glycol; methylethylene glycol
 CAS No.: 57-55-6
 Molecular Weight: 76.09
 Chemical Formula: CH₃CHOHCH₂OH
 Product Codes:
 J.T. Baker: 9402, 9403, U510
 Mallinckrodt: 1925, 6263

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
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Note to Physician:

In case of ingestion, monitor for acidosis and central nervous system changes. Exposed persons with previous kidney dysfunction may require special treatment.

5. Fire Fighting Measures**Fire:**

Flash point: 99C (210F) CC

Autoignition temperature: 371C (700F)

Flammable limits in air % by volume:

lel: 2.6; uel: 12.5

Material can support combustion.

Explosion:

Containers may explode in heat or fire.

Fire Extinguishing Media:

Dry chemical, foam, water or carbon dioxide.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Move exposed containers from fire area, if it can be done without risk. Use water to keep fire-exposed containers cool.

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer!

7. Handling and Storage

Protect container from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture, and incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection**Airborne Exposure Limits:**

AIHA Workplace Environmental Exposure Level (WEEL): TWA = 10mg/m³.

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a half-face respirator with an organic vapor cartridge and particulate filter (NIOSH type P95 or R95 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency

or respirator supplier, whichever is lowest. A full-face piece respirator with an organic vapor cartridge and particulate filter (NIOSH P100 or R100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. Please note that N series filters are not recommended for this material. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. **WARNING:** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Clear oily liquid.

Odor:

Odorless.

Solubility:

Miscible in water.

Specific Gravity:

1.0361 @ 20C/4C

pH:

No information found.

% Volatiles by volume @ 21C (70F):

No information found.

Boiling Point:

188.2C (370F)

Melting Point:

-59C (-74F)

Vapor Density (Air=1):

2.6

Vapor Pressure (mm Hg):

0.129 @ 25C (77F)

Evaporation Rate (BuAc=1):

0.01

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Carbon dioxide and carbon monoxide may form when heated to decomposition. Aldehydes or lactic, pyruvic or acetic acids may also be formed.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong oxidizing agents.

Conditions to Avoid:

Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Oral rat LD50: 20g/kg. Skin rabbit LD50: 20.8g/kg.
 Irritation: Eye rabbit/Draize, 500 mg/24H mild.
 Investigated as a mutagen and reproductive effector.

-----\Cancer Lists\-----

Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Propylene Glycol (57-55-6)	No	No	None

12. Ecological Information

Environmental Fate:

When released into the soil, this material is expected to readily biodegrade. When released into the soil, this material is expected to leach into groundwater. When released into water, this material is expected to readily biodegrade. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life between 1 and 10 days.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----

Ingredient	TSCA	EC	Japan	Australia
Propylene Glycol (57-55-6)	Yes	Yes	Yes	Yes

-----\Chemical Inventory Status - Part 2\-----

Ingredient	--Canada--			
	Korea	DSL	NDSL	Phil.
Propylene Glycol (57-55-6)	Yes	Yes	No	Yes

-----\Federal, State & International Regulations - Part 1\-----

Ingredient	-SARA 302-		-----SARA 313-----	
	RQ	TPQ	List	Chemical Catg.
Propylene Glycol (57-55-6)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----

Ingredient	-RCRA-	-TSCA-	
	CERCLA	261.33	8(d)
Propylene Glycol (57-55-6)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
 SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
 Reactivity: No (Pure / Liquid)

Australian Hazchem Code: None allocated.

Poison Schedule: None allocated.

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 0 Flammability: 1 Reactivity: 0

Label Hazard Warning:

CAUTION! MAY CAUSE IRRITATION TO SKIN AND EYES.

Label Precautions:

Avoid contact with eyes, skin and clothing.

Wash thoroughly after handling.

Label First Aid:

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. Call a physician if irritation develops or persists.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

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Prepared by: Environmental Health & Safety
 Phone Number: (314) 654-1600 (U.S.A.)

END OF SECTION 223301

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: N/A
- B. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 WATER CLOSET

- A. Vitreous-China Water Closet: Elongated, siphon-jet type, floor-mounted.
 - 1. Basis-of-Design Product: Saile Dual Flush Toilet K-3654 or comparable product by the following:
 - a. Kohler
<http://www.us.kohler.com/onlinecatalog/detail.jsp?item=13118302§ion=2&category=13&subcategory=117>
 - 2. Design Consumption: 1.6 gal./flush (solid waste) or 0.8 gal./flush (liquid only waste).
- B. Toilet Seat: Elongated solid plastic closed front with cover with bumpers and hardware, Residential class.
 - 1. Basis-of-Design Product: Saile toilet seat and cover K-4748 or comparable product by the following:
 - a. Kohler
<http://www.us.kohler.com/onlinecatalog/detail.jsp?item=291502§ion=2&category=14>

2.2 LAVATORY

Cast Iron: Self-rimming/undercounter, 7/16" inch thick.

- 1. Basis-of-Design Product: Iron/Tones Lavatory K-2826 or comparable product by one of the following:

- a. Kohler
<http://www.us.kohler.com/onlinecatalog/detail.jsp?item=10452202§ion=2&category=16&retail=false>
 - b. Finish: As selected by architect from manufacturer's full range
- B. Faucet: Solid brass Maximum 1.5-gpm flow rate.
1. Basis-of-Design Product: Stillness Wall Mount Faucet K-T944-4 or comparable product by following:
 - a. Kohler
<http://www.us.kohler.com/onlinecatalog/detail.jsp?item=6124202§ion=2&category=8&subcategory=49&retail=false>
 2. Type: Widespread with inlets on 4-inch centers.
 3. Finish: Polished chrome. Refer to price book for additional colours and finishes.
 4. Handle(s): Dual lever wall mounted.
 5. Spout: Wall mounted
 6. Drain(s): 2 1/8 inch chrome pop up drain K - 7114.
 - a. <http://search.us.kohler.com/?q=K-7114&x=12&y=0>
- 2.3 SHOWER / BATH
- A. Undermount Bath:
1. Basis of Design product: K-895, cast Iron with safeguard finish. Or comparable by the following
 - a. Kohler
 - b. <http://www.us.kohler.com/onlinecatalog/detail.jsp?item=13964302§ion=2&category=10&retail=false>
- B. Thermostatic Faucet Trim:
1. Basis of design product: Stillness K-T10940, Polished chrome, or comparable by the following
 - a. Kohler
<http://search.us.kohler.com/?q=K-T10940>
 2. Include ball, gate, or globe valves on supplies if check stops are not included with faucet.
 3. Body Material: Solid brass.
 4. Shower Arm, Flow-Control Fitting: 2-1/2 gpm.
- C. Bath Spout:
1. Basis of design product: Souris K-6946, Polished Chrome or comparable by the following

- a. Kohler
- b. <http://www.us.kohler.com/onlinecatalog/detail.jsp?item=352302§ion=2&category=8&subcategory=51&retail=false>

D. Showerhead:

1. Basis of design product: Purist 1.75 GPM K-997-CP. Or comparable by the following
 - a. Kohler
 - 1) <http://www.us.kohler.com/savewater/products/residential/showerheads/detail.htm?productNumber=997&business=KPNA&resultPageKey=-999118245-0>

E. Drain:

1. Basis of design product: Clearflo slotted overflow bath drain K-7272
 - a. Kohler
 - b. <http://search.us.kohler.com/?q=K-7272>

2.4 KITCHEN

A. Sink: 18-gauge stainless steel

1. Basis-of-Design Product: Undertone undercounter single compartment sink K-3325:
 - a. Kohler
<http://www.us.kohler.com/onlinecatalog/detail.jsp?item=5868102§ion=1&category=5&subcategory=36&retail=false>

B. Faucet: metal construction

1. Basis-of-Design Product: Stillness 1.5 GPM K-942-4:
 - a. Kohler
 - 1) <http://www.us.kohler.com/savewater/products/residential/faucets/detail.htm?productNumber=942-4&business=KPNA&resultPageKey=-616407827-0>
2. Finish: Polished chrome.
3. Handle(s): Two quarter-turn washerless ceramic disc valves, 8" centers
4. Maximum Flow Rate: 2.2 gpm.

C. Trap: Chrome-plated with slip-joint inlet and wall flange.

PART 3 - EXECUTION

3.1 INSTALLATIONS

- A. Install fitting insulation kits on fixtures for people with disabilities.
- B. Install fixtures with flanges and gasket seals.
- C. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- D. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- E. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- F. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- G. Fasten wall-mounted fittings to reinforcement built into walls.
- H. Fasten counter-mounting plumbing fixtures to casework.
- I. Secure supplies to supports or substrate within pipe space behind fixture.
- J. Set shower receptors and mop basins in leveling bed of cement grout.
- K. Install individual supply inlets, supply stops, supply risers, and tubular brass traps with cleanouts at fixture.
- L. Install water-supply stop valves in accessible locations.
- M. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes unless otherwise indicated.
- N. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.
- O. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.
- P. Install piping connections between plumbing fixtures and piping systems and plumbing equipment. Install insulation on supplies and drains of fixtures for people with disabilities.
- Q. All domestic water piping shall be PEX.
- R. Ground equipment.

END OF SECTION 224000



Division 23

Heating, Ventilating, and Air-Conditioning (HVAC)

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Certified TAB reports.
- B. TAB Firm Qualifications: AABC and NEBB certified.
- C. TAB Report Forms: Standard TAB contractor's forms approved by Architect.
- D. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine the approved submittals for HVAC systems and equipment.
- C. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- D. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- E. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- F. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of dampers and valves for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at indicated values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to indicated values.
- G. Report deficiencies discovered before and during performance of test and balance procedures.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and ASHRAE 111 and NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare schematic diagrams of systems' "as-built" duct layouts.
- B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- C. Verify that motor starters are equipped with properly sized thermal protection.
- D. Check for airflow blockages.
- E. Check condensate drains for proper connections and functioning.
- F. Check for proper sealing of air-handling unit components.
- G. Check for proper sealing of air duct system.

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data; number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 - 4. Set system controls so automatic valves are wide open to heat exchangers.
 - 5. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.5 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Quality Assurance: Labeled with maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to ASTM E 84.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- B. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- C. Mineral-Fiber Blanket Insulation: Comply with ASTM C 553, Type II and ASTM C 1290, Type I.
- D. Mineral-Fiber Board Insulation: Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ.
- E. Mineral-Fiber, Preformed Pipe Insulation: Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ.
- F. Mineral-Fiber, Pipe and Tank Insulation: Complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB; and having factory-applied ASJ. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.
- G. Polyolefin Insulation: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
- H. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- I. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- J. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

- K. Factory-Applied Jackets: When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
- L. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

PART 3 - EXECUTION

3.1 INSULATION INSTALLATION

- A. Comply with requirements of the Midwest Insulation Contractors Association's "National Commercial & Industrial Insulation Standards" for insulation installation on pipes and equipment.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Flexible Elastomeric Insulation Installation:
 - 1. Seal longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Mineral-Fiber Insulation Installation:
 - 1. Insulation Installation on Straight Pipes and Tubes: Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 2. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - 3. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
 - 4. Blanket and Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 5. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier.
- E. Polyolefin Insulation Installation:
 - 1. Seal split-tube longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of polyolefin pipe insulation. Secure insulation materials and seal seams with

adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

F. Plenums and Ducts Requiring Insulation:

1. Concealed and exposed supply and outdoor air.
2. Concealed and exposed return air located in nonconditioned space.
3. Concealed and exposed exhaust between isolation damper and penetration of building exterior.

G. Plenums and Ducts Not Insulated:

1. Metal ducts with duct liner.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

H. Piping Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawlspaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.2 DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed duct insulation shall be **one of** the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Polyolefin: 1 inch thick.

B. Exposed duct insulation shall be **one of** the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Polyolefin: 1 inch thick.

3.3 HVAC PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Piping: Insulation shall be **one of** the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
3. Polyolefin: 1 inch thick.

- C. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Polyolefin: 1 inch thick.

- D. Dual-Service Heating and Cooling: Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals

B. System Description:

1.) Ventilation Coupled Forced Air System:

Passive Haus standards recommend that .3-.4 AVC every hour. The super insulated building envelope results in extremely low heating and cooling loads. A series of passive and semi-passive measures described in the operations sequence below will be employed to meet the heating, cooling, and dehumidification loads. If these measures are not sufficient the control system will use either a hydronic heating coil or a hydronic cooling coil to supplement the systems.

2.) Solar Thermal Pre-Heat:

The Solar Thermal Pre-Heat system will serve three functions; dehumidification, direct heating, and heat storage. In the summer the hot air from the solar thermal collectors will be used to regenerate a desiccant wheel dehumidification system. In the winter the hot air generated by the collector will be feed directly to the air handler and also used in conjunction with a phase change material system to preheat outside air. The collector will consist of an air intake, a glass enclosed absorber portion which is insulated on the back side, a booster fan, a differential temperature controller, and an exhaust plenum.

3.) Daikin Altherma

The Daikin Altherma system (an air to water heat pump) will provide heating and cooling water. The system employs a heat exchanger, specified in company literature as a "Hydrobox", to transfer energy from an R-410 refrigerant loop to a hydronic loop. The system is also capable of heating a domestic water supply using another heat exchanger.

4.) Novel Aire 300mm x 100mm Desiccant Wheel Cassette:

The Novel Aire 300mm x 100mm Desiccant Wheel Cassette Dehumidifier is capable of providing controlled dehumidification of the conditioned space in the summer months. It will be coupled with a solar thermal hot air system to regenerate the desiccant wheel. It includes two blowers to supplement the forced air system and solar thermal hot air collector.

5.) ERV:

The energy recovery ventilator (ERV) will serve three primary functions. It will provide a means to recover heat and moisture from exhausted air, a means of mechanical ventilation, and be coupled with an air handler to heating and cooling coils. It will also interface directly with the solar thermal pre heat system. The ventilation requirements of the house will be met through the use of an energy recovery ventilator. The return for the ventilator will be strategically placed in the

house to achieve even air circulation. Because of the tight construction of the house, CO₂ load based ventilation is necessary to ensure good indoor air quality.

C. Operation Sequence

1. Cooling Mode:

The Daikin Altherma system will generate cooling water to be sent to the hydronic coil. The control system will regulate the fan speed of the air handling unit before the coil such that the necessary volume of air is conditioned to meet the cooling load.

2. Dehumidification Mode:

During the summer months the ERV will provide a portion of the dehumidification necessary to maintain the comfort zone. In addition some dehumidification will be provided by the hydronic cooling coil; however, this will not be controlled with a humidistat. A Novel-Aire Desiccant Cassette will instead be controlled to provide any additional dehumidification necessary to maintain comfort zone requirements.

3. Heating Mode 1:

The first source of heat will come from the solar thermal hot air system. In this system air is drawn in to an air collector located on the south facing vertical wall of the house. A differential temperature controller will then trigger a fan and damper system. If the indoor and outdoor air temperatures are such that the house requires heating the damper system will direct the air to the air handler and consequently to the home's supply ducts. While traveling to the air handler this hot air will pass through the phase change material plenum. This cavity is in series with the energy recovery ventilator and insulated from ambient air temperatures, allowing the hot air to charge the PCM. During night time operation the ventilation air from the ERV will be directed through the PCM where it will gain heat and provide additional night time heating.

4. Heating Mode 2:

If space heating conditions have not been met, the hydronic heating coil, in series with the energy recovery ventilator, will be activated. This coil is fed from two possible heat sources. The least energy option being the use of hot water collected in the houses hot water thermal storage tank. This water has been heated already by a flat plate collector on the roof of the house in a closed loop configuration. The use of water from this tank is dictated by both expected demand and the temperature of the tank. Alternately, if conditions are not favorable the hydronic coil will signal the Hydrobox and call for heating hot water to be generated by the heat pump. Finally, in extreme temperatures where the COP and output of the heat pump is compromised an electrical resistance heater included with the hot water thermal storage tank will operate.

5. Economizer:
In steady state mode, the desired indoor conditions are similar enough to the outdoor environment that neither heating or cooling is needed. In this case the ERV will run to ensure the necessary .3-.4 air changes per hour. Alternately the control system may prompt occupants that outdoor conditions are favorable and suggest utilizing natural ventilation and shutting down all mechanical ventilation and conditioning systems. In this scenario the control system would continue to monitor both outdoor and indoor conditions and again prompt the user to cease natural ventilation and turn the mechanical systems back on.

PART 2 - CONTROLS SCHEDULE

2.1 Products:

- A. ACI Relative Humidity/Temperature Sensor A/RH5-AN-D-ACT:
<http://energycontrol.com/ACI-arh5-an-d-act.aspx>
- B. ACI Temperature Sensor A/AN-D-4"-GD: <http://energycontrol.com/ACI-aan-d-4-gd.aspx>
- C. ACI Carbon Dioxide Sensor A/CO2-010-D: <http://energycontrol.com/ACI-aco2-010-d.aspx>
- D. DuroZone Spring Return Damper NSPRD024-4:
http://www.durodyne.com/pdf/RoundIn_SR.pdf
- E. Honeywell Enthalpy Sensor C7400A1004: <http://dticorp.com/catalog/honeywell-c7400a1004-enthalpy-sensor-p-3456.html>
- F. Georgia Controls VPV Converter P/N 236-803:
<http://www.georgiacontrols.com/vpvconverter.htm>
- G. Fantech Backdraft Damper RSK5: <http://casaelectric.com/fantech-rsk5.html>
- H. Aprilaire 10k Thermocouple

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install control wiring concealed, except in mechanical rooms, and according to requirements specified in Division 26 Sections.

END OF SECTION 230900

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 -GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Shop Drawings detailing duct layout and including locations and types of duct accessories, duct sizes, transitions, radius and vaned elbows, special supports details, and inlets and outlet types and locations.
- B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Comply with NFPA 96 for ducts connected to commercial kitchen hoods.
- D. Comply with UL 181 for ducts and closures.

PART 2 -PRODUCTS

2.1 DUCTS

- E. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip galvanized coating.
- F. Carbon-Steel Sheets: ASTM A 1008/A 1008M; with oiled, matte finish for exposed ducts.
- G. Stainless Steel: ASTM A 480/A 480M, Type 304, with a No. 2D finish for concealed ducts and No. 4 finish for exposed ducts.
- H. Joint and Seam Tape, and Sealant: Comply with UL 181A.
- I. Rectangular Metal Duct Fabrication: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- J. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 - 1. Thickness: 1 inch .
 - i. Airstream surface coated with an antimicrobial erosion-resistant coating.
 - ii. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - iii. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment.

2. ACCESSORIES

- a. Volume Dampers and Control Dampers: Single-blade and multiple opposed-blade dampers, standard leakage rating, and suitable for horizontal or vertical applications; factory fabricated and complete with required hardware and accessories.
- b. Flexible Connectors: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- c. Flexible Ducts: Spiral-wound steel spring with flameproof vinyl sheathing complying with UL 181, Class 1.

PART 3 -EXECUTION

3.1 INSTALLATION

- K. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- L. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1.1.1.1.L.1 Outdoor, Supply-Air Ducts: Seal Class A.
 - 1.1.1.1.L.2 Outdoor, Exhaust Ducts: Seal Class C.
 - 1.1.1.1.L.3 Outdoor, Return-Air Ducts: Seal Class C.
 - 1.1.1.1.L.4 Unconditioned Space, Supply-Air Ducts in Pressure Classes **2-Inch wg** and Lower: Seal Class B.
 - 1.1.1.1.L.5 Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than **2-Inch wg**: Seal Class A.
 - 1.1.1.1.L.6 Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 1.1.1.1.L.7 Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 1.1.1.1.L.8 Conditioned Space, Supply-Air Ducts in Pressure Classes **2-Inch wg** and Lower: Seal Class C.
 - 1.1.1.1.L.9 Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than **2-Inch wg** Seal Class B.
 - 1.1.1.1.L.10 Conditioned Space, Exhaust Ducts: Seal Class B.
 - 1.1.1.1.L.11 Conditioned Space, Return-Air Ducts: Seal Class C.
- M. Conceal ducts from view in finished and occupied spaces.
- N. Avoid passing through electrical equipment spaces and enclosures.
- O. Support ducts to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Hangers and Supports."
- P. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in

NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

- Q. Install volume and control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.
- R. Clean new duct systems before testing, adjusting, and balancing.

1.1.1.2 TESTING, ADJUSTING, AND BALANCING

- A. Balance airflow within distribution systems, including submains, branches, and terminals to indicated quantities.

END OF SECTION 233100

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 -GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Products shall be licensed to use the AMCA-Certified Ratings Seal.
- C. Power ventilators shall comply with UL 705.
- 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.

PART 2 –PRODUCTS

2.1 AIR HANDLER

- E. Product:
 - 1. Magic Aire DVA04BARA1AAAM
<http://www.magicaire.com/upload/Direct%20Drive/DVA%201.0%205-14-08.pdf>
- F. Capacities and Characteristics
 - 1. 3-Speed 515, 405, 280 cfm.
 - 2. Vertical orientation.
 - 3. 1 ton.
 - 4. 2 pipe CHW / HW coil

2.2 ENERGY RECOVERY VENTILATORS

- G. Product:
 - 1. Fantech SE704N
<http://fantech.net/docs-resi/412122-se704n-spec.pdf>
- H. Accessories:
 - 1. Two EBМ motors with permanently sealed ball bearings.
 - 2. Enthalpy core heat exchanger.
 - 3. Electrostatic panel filters.
- I. Capacities and Characteristics:
 - 1. Airflow: 35-80 CFM
 - 2. Static Pressure: < 1" inches wg.
 - 3. Volts: 115.
 - 4. Phase: Single.

5. Hertz: 60.

2.3 CEILING FAN

J. Product

1. Panasonic FV-05VK3 Ceiling Fan
http://panasonic.com/business/building-products/ventilationsystems/pdf/WhisperGreen3_En.pdf

K. Housing: Compact, 25 gage galvanized steel

L. Accessories:

1. White polymeric grille
2. Motor assembly shall be removable and permanently lubricated
3. Internal back draft damper
4. Polymeric duct fitting with tapered sleeve for duct connection

M. Capacities and Characteristics:

1. Airflow: 50 cfm
2. Static Pressure: < .500" inches wg.
3. Volts: 120
4. Phase: Single
5. Speed: 60 Hz

2.4 IN-LINE DUCT FAN

N. Product

1. Ebm-Papst DC Diagonal Compact Fan
<http://img.ebmpapst.com/products/datasheets/DC-diagonal-fan-DV5214N-ENG.pdf>

O. Capacities and Characteristics

1. Airflow: 70-130 cfm
2. Nominal Voltage: 24V DC
3. Power Input: 20.4 W
4. Speed: 83 Hz

PART 3 -EXECUTION

3.1 INSTALLATION

- P. In-Line Centrifugal Fans: Suspend units from structure using metal straps.
- Q. Ceiling-Mounted Units: Suspend units from structure using steel wire or metal straps.
- R. Ground power ventilators.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and color charts for factory finishes.

PART 2 - PRODUCTS

2.1 OUTLETS AND INLETS

- A. Ceiling Air Supply Registers:

- 1. Hart and Cooley Model 682 14" x 4" Register or equivalent.
- 2. Material: Steel
- 3. Flow Rating: 100cfm

- B. Sidewall Return Air Registers:

- 1. Hart and Cooley Model 650 14" x 4" Register or equivalent.
- 2. Material: Steel
- 3. Flow Rating: 166cfm

- C. ERV Ceiling Return Air Register:

- 1. Hart and Cooley Model 681 8" x 4" Register or equivalent.
- 2. Material: Steel
- 3. Flow Rating: 70cfm

- D. HVAC External Fresh Air Intakes:

- 1. Imperial Manufacturing PA-4W Intake Cap or equivalent.
- 2. Material: Polymer
- 3. Flow Rating: 100cfm

- E. HVAC External Exhaust Caps:

- 1. Broan Model 885AL Wall Cap or equivalent.
- 2. Material: Aluminum
- 3. Flow Rating: 100cfm

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install diffusers level and plumb.
- B. Ceiling-Mounted Outlets & Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel unless otherwise indicated. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 235616 – PACKAGED SOLAR HEATING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Shop Drawings and installation manuals.

PART 2 - PRODUCTS

2.1 SOLAR HOT AIR COLLECTORS

- A. Your Solar Home 1500GS Solar Hot Air Panels:
 - 1. Weight: net 164 pounds
 - 2. Dimension: 87" x 86.3" x 3.8"
 - 3. Heavy duty extruded aluminum frame
 - 4. High temperature R4 polyisocyanurate insulation in the back and sides
 - 5. Tempered Low Iron Solar Glass
 - 6. External EMB Fan
 - 7. Stainless steel screws and hardware
 - 8. Aluminum mounting brackets

Installation Manual:

<http://www.yoursolarhome.com/SolarSheat%20Installation%20Manual1.9.pdf>

Specification:

<http://www.yoursolarhome.com/SolarSheat1500GS.pdf>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install level and plumb.
- B. Ceiling-Mounted Outlets & Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel unless otherwise indicated. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 235616

SECTION 237113 – THERMAL HEAT STORAGE: PHASE CHANGE MATERIAL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Manufacturers Specifications.
- B. Drawings in the M series apply to the work included in this section.

1.2 DESCRIPTION OF WORK

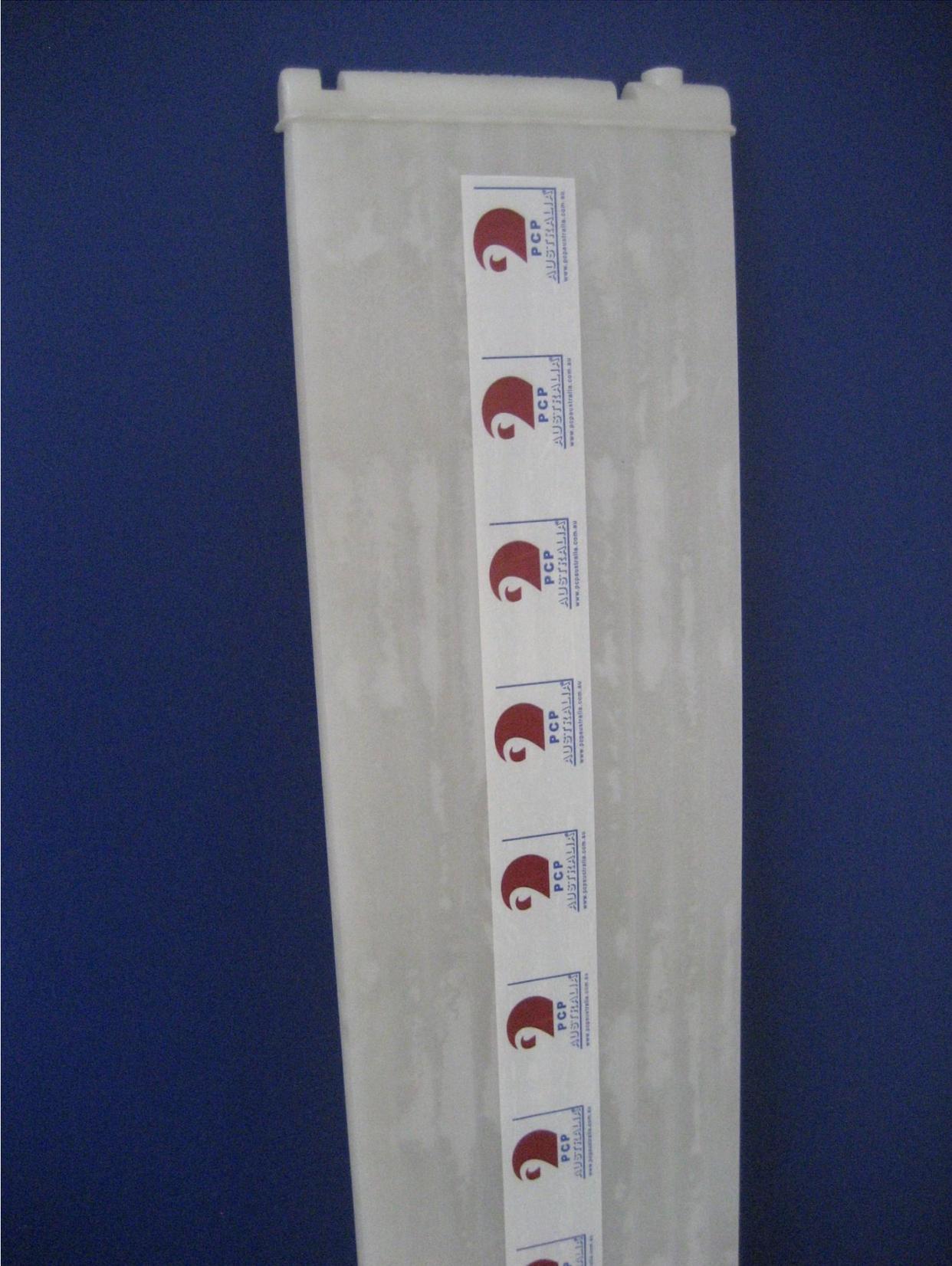
- A. HVAC and sheet metal contractor shall furnish a plenum for pre assembled of the shelf HDPE encased phase change material.
- B. Due to space constraints the exact size and location of the plenum and ducting is subject to field installation and determination.
- C. Sheet M-501 shows a proposed detail.

PART 2 - PRODUCTS

2.1 PHASE CHANGE MATERIAL

- A. General: Provide factory assembled PCM units as indicated. Each panel shall be encased in standard size HDPE from the manufacturer.
- B. Product: PCP Australia PC29. No other alternatives acceptable.

http://www.pcpaustralia.com.au/pc_29.html
- C. Manufacturer has provided details regarding encapsulation. Sheets are to be 860x200x20 mm. PCM material must be encased in this material to avoid damage to any Stainless Steel and Aluminum sheet metal work.
- D. Product is non-flammable and non-combustible. MSDS states that is classified as a non-dangerous good.
- E. Figure below shows a photograph of the panel.



F. MSDS

PHASE CHANGE PRODUCTS PTY LTD
ABN 31 116 015 751

c/- Norvest Corporate P/L Grd Floor, 16 Ord Street West Perth, WA 6005
Telephone: +618 9324 8555 Facsimile: +618 9324 8560 Email:
pcp@norvest.com.au

MATERIAL SAFETY DATA SHEET: PC29 Phase Change Material

PRODUCT IDENTIFICATION:

Name: UN No.: CAS Registry No.: Dangerous Goods Class: Hazchem Code: EPG:
IMDG: Packaging Group
Revision: July 2008

PHYSICAL DESCRIPTION AND PROPERTIES:

Appearance: White-cream crystalline solid. Clear to milky white above melting point.

Composition: Calcium chloride hexahydrate (min.90%) Magnesium chloride
hexahydrate (min. 18%) Proprietary salts (max. 5%)
Melting Point: 25 °C Boiling point: >1400C (anhydrous) Vapour
pressure: <20mmHg at 40 °C and associated with water content
only Flammability Limits LEL: Not applicable
UEL: Not applicable Autoignition temperature: Not applicable
Solubility: Soluble in water and some alcohols pH: 6-10

HEALTH HAZARD INFORMATION

1. Acute Health Effects

Ingestion: Single dose oral toxicity is low. Ingestion may cause gastrointestinal irritation. (Acute oral LD50 for rats is > 1500mg/kg)

Eye: May cause mild to moderate irritation and some corneal injury in the most severe and untreated cases.

Skin: Short single exposure is unlikely to cause skin irritation. Prolonged or repeated skin exposure may cause mild or moderate skin irritation. (Acute dermal LD50 for rabbits is > 2500mg/kg)

Inhalation: Vapours do not pose an acute health risk due to non volatility of salts. Dust may cause irritation to upper respiratory tract.

2. Chronic Health Effects

The components are not listed by IARC, NTP or PHSA as carcinogens for hazard communication purposes. Results of in vitro mutagenicity tests have been negative for calcium chloride.

3. First Aid

Swallowing: If swallowed, induce vomiting by giving two glasses of water and placing fingers towards back of throat. Do not attempt to induce vomiting if the victim is unconscious. Call a physician.

Eye: Irrigate with water immediately and continuously for at least 15 minutes. Consult a physician.

Skin: Wash effected area with water either locally or under shower. If irritation persists consult a physician.

Inhalation: In the event of dust inhalation remove patient to well ventilated fresh air area. Rinse mouth and gargle with water. Consult physician if irritation persists.

Advice to physician for any of the above health issues is to treat symptomatically.

PRECAUTIONS FOR USAGE

1. Exposure standards
Exposure limits have not been established on TLV basis for continuously working with the product.
2. Engineering Controls.
Ensure adequate ventilation and standard dust control provisions
3. Personal Protection
No special PPG equipment is required for the handling of PC29. However, good manufacturing practice will include: safety glasses and gloves and a dust mask if solid product is being broken down mechanically.
4. Flammability
The product is not flammable and no special precautions are required in this respect.



SAFE HANDLING INFORMATION

1. Storage and Transportation
Transport and store the product under dry and cool conditions - ideally below 35 °C. Container should be sealed to air tightness. The containers should be suitably flexible to retain containment integrity with a variation in volume of the product of ~10% between its solid and liquid phases above and below 25 °C.
2. Spills and Disposal
Recovery of spilt solids or liquid should be placed in suitable, labeled containers for re-use. Wash down affected area with excess water. Where it is not possible to reuse the recovered product then disposal should observe all local, state and federal regulations governing the disposal of calcium and magnesium chloride waste.
3. Fire and Explosion Hazard.
The product is not flammable and has no auto-ignition temperature. If it is heated sufficiently due to proximity to a fire, it can decompose to give off noxious chlorine containing gases. Where possible the product should be removed from the proximity to a fire.
4. Packaging and Labeling
There are no labeling requirements specified by regulatory authorities for PC29. Safety phrase recommendations include: Keep out of reach of children Avoid contact with skin and eyes if swallowed seek medical advice

No further information.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' design.
- B. Examine areas and conditions under units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- C. Review MSDS

3.2 INSTALLATION OF SPLIT SYSTEM HEAT PUMP UNITS

- A. General: Install units in accordance with manufacturer's installation instruction. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.
- B. See M-501 for mounting details.
- C. Approve duct work connecting the solar thermal hot air system.

END OF SECTION 237113

SECTION 238143 – AIR-SOURCE UNITARY HEAT PUMPS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Manufacturers Specifications.
- B. Drawings in the M series apply to the work included in this section.

1.2 DESCRIPTION OF WORK

- A. Extent of heat pump units required by this section is indicated on drawings and schedules, and by the requirements of this section.
- B. Refer to Division 26 sections for wiring and electrical work. All electrical work performed must comply with the specifications in Division 26 and related drawings.

PART 2 - PRODUCTS

2.1 HEAT PUMP UNITS

- A. General: Provide factory assembled and tested units as indicated, consisting of insulated casing, filter and rack, fan, motor and drive, fan and limit controls, and control transformer. Provide full cased evaporator coil and electric heat package.
- B. Refrigeration Circuit: provide refrigerant thermal expansion valve for refrigerant control. Provide access valves in suction and liquid lines.
- C. Product: Daikin Altherma Single Fan Condenser ERLQ018BAVJU. No other alternatives acceptable.

<http://www.daikinac.com/DOC/SDS%20ERLQ018BAVJU%2003-11.pdf>

- D. Product: Daikin Altherma Hydrobox EKHBX030BA3VJU. No other alternatives acceptable. Must be used with Daikin Single Fan Condenser ERLQ018BAVJU.

<http://www.daikinac.com/DOC/SDS%20EKHBX030BA3VJU%2003-11.pdf>

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' design.

- B. Examine areas and conditions under which heat pump units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF SPLIT SYSTEM HEAT PUMP UNITS

- A. General: Install units in accordance with manufacturer's installation instruction. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.
- B. See A-212 for mounting details. The unit will be installed as though it is ground-mounted. Provide 4" PVC sleeve with full radius elbows for refrigerant piping.
- C. Connect pre-charged refrigerant tubing to unit's quick-connect fittings. Run tubing so as not to interfere with access to unit. Install all furnished accessories.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- F. Drain Piping: Connect unit drain to nearest indirect waste connection.
- G. Start-up AC units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

END OF SECTION 238143

SECTION 238419 – INDOOR DEHUMIDIFICATION UNITS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Manufacturers Specifications.
- B. Drawings in the M series apply to the work included in this section.

1.2 DESCRIPTION OF WORK

- A. Extent of dehumidification units required by this section is indicated on drawings and schedules, and by the requirements of this section.
- B. Refer to Division 26 sections for wiring and electrical work. All electrical work performed must comply with the specifications in Division 26 and related drawings.

PART 2 - PRODUCTS

2.1 DESICCANT WHEEL DEHUMIDIFIER

- A. General: Provide factory assembled and tested units as indicated, consisting of insulated casing, motor and drive, fan and limit controls, and control transformer. Provide full cased desiccant wheel cartridge.
- B. Product: Novel Aire 300x100 Cartridge. No other alternatives acceptable.

<http://www.novelaire.com/images/pdfs/dw-brochure.pdf>

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' design.
- B. Examine areas and conditions under units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF SPLIT SYSTEM HEAT PUMP UNITS

- A. General: Install units in accordance with manufacturer's installation instruction. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.
- B. See A-212 for mounting details.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- D. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- E. Approve duct work connecting the solar thermal hot air system connecting to the desiccant wheel unit.

END OF SECTION 238419



Division 25

Integrated Automation

SECTION 251100 – HOME AUTOMATION AND CONTROL SYSTEMS (HACS)

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the Systems Integration scope of work for the project. This section also coordinates the responsibilities of the Mechanical and Electrical trade contractors pertaining to control products or systems, furnished by each trade, that will be integrated by this Division
- B. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.
- C. It is the owner's goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).

1.2 SYSTEM DESCRIPTION

- A. The Home Automation and Control System (HACS) shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to LonMark/LonTalk (IDC) and/or BACnet (IBC) controllers and other open and legacy protocol systems/devices provided under Division 23 or Division 26.
- B. The Home Automation and Control System (HACS) as provided in this Division shall be based on the Niagara Framework (or "Niagara"), a Java-based framework developed by Tridium. Niagara provides an open automation infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be easily managed in real time over the Internet using a standard Web browser. Systems not developed on the Niagara Framework platform are unacceptable.

1.3 SPECIFICATION NOMENCLATURE

- A. Acronyms used in this specification are as follows:

HACS Home Automation and Control System
TCS Temperature Control System
NAC Network Area Controller
IDC Interoperable Digital Controller

IBC Interoperable BACnet Controller
GUI Graphical User Interface
WBI Web Browser Interface
POT Portable Operator's Terminal
PMI Power Measurement Interface
DDC Direct Digital Controls
LAN Local Area Network
WAN Wide Area Network
OOT Object Oriented Technology
PICS Product Interoperability Compliance Statement

1.4 DIVISION OF WORK

- A. The Division 23 and 26 (if applicable) contractors shall be responsible for all controllers (IDC and IBC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.
- B. The Division 23 contractor shall be responsible for the Network Area Controller(s) (NAC), software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, LonWorks network management and connection of the NAC to the local or wide area network.

1.5 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 23, Mechanical:
 - 1. Providing control devices and systems including but not limited to:
 - a. Interoperable Digital Controllers and programming
 - b. Interoperable BACnet Controllers and programming
 - c. Control panels, devices and wiring
 - d. Local controller and control device networks
- B. Division 26, Electrical:
 - 1. Providing motor starters and disconnect switches (unless otherwise noted).
 - 2. Power wiring and conduit (unless otherwise noted).
 - 3. Provision, installation and wiring of smoke detectors (unless otherwise noted).
 - 4. Other equipment and wiring as specified in Division 26.

1.6 AGENCY AND CODE APPROVALS

- A. All products of the HACS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
 - 1. UL-916; Energy Management Systems
 - 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "signal Equipment"
 - 3. CE
 - 4. FCC, Part 15, Subpart J, Class A Computing Devices

1.7 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.
- B. It is the owners express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, HACS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner. The owner shall determine which organizations to be named in the SI organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier, by Tridium Inc.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.9 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The Home Automation Control System (HACS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices and other devices as specified herein.

- B. The installed system shall provide secure password access to all features, functions and data contained in the overall HACS.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, LonWorks technology, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file and a resource file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance shall support the ability to support data read and write functionality and those features as specified. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified.
- C. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
 - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 DEVICES AND SOFTWARE

- A. Controller (Also see 2.6 Network Area Controller)
 - 1. Vykon Java Application Control Engine - 200 (JACE-200):
http://www.vykon.com/galleries/datasheet_pdf/JACE-2-2008-12.pdf

- B. Input/Output Device
 - 1. Vykon IO-16: http://www.blxcentral.com/data/library/IO-16_InstallGuide.pdf
 - 2. Vykon IO-34: http://www.blxcentral.com/data/library/IO-34_InstallGuide.pdf
- C. Software
 - 1. AX SoftJACE:
http://www.tridium.com/galleries/datasheet_pdf/SoftJACE_1108.pdf
- D. Current Sensor
 - 1. F. W. Bell PC-50 AC Current Sensor: <http://www.fwbell.com/>

2.4 NETWORKS

- A. The Local Area Network (LAN) shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.
- B. Local area network minimum physical and media access requirements:
 - 1. Ethernet; IEEE standard 802.3
 - 2. Cable; 100 Base-T, UTP-8 wire, category 5
 - 3. Minimum throughput; 100 Mbps.

2.5 NETWORK ACCESS

- A. Remote Access.
 - 1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a server providing access to an Internet Service Provider (ISP).

2.6 NETWORK AREA CONTROLLER (NAC)

- A. The Division 25 contractor shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided under Divisions 23 and 26. It is the responsibility of the Division 25 contractor to coordinate with the Division 23 and 26 contractors to determine the quantity and type of devices.
- B. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing

5. Time synchronization
 6. Integration of LonWorks controller data, BACnet controller data, and any device connected through an optional software driver installed in the NAC
 7. Network Management functions for all LonWorks based devices.
- C. The Network Area Controller (Jace 2 version) must provide the following hardware features as a minimum:
1. One Ethernet Port – 10/100 Mbps
 2. One RS-232 port
 3. One LonWorks Interface Port – 78KB FTT-10A
 4. One RS-485 port (electrically isolated)
 5. Optional auto-dial/answer 56K modem
 6. Battery Backup
 7. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 8. The NAC must be capable of operation over a temperature range of 32 to 122°F
 9. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F
 10. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.
- D. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- E. Event Alarm Notification and actions
1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
 4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 5. Provide timed (schedule) routing of alarms by class, object, group, or node.
 6. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- F. Control equipment and network failures shall be treated as alarms and annunciated.
- G. Alarms shall be annunciated in any of the following manners as defined by the user:
1. Screen message text

2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - a. Day of week
 - b. Time of day
 - c. Recipient
 3. Pagers via paging services that initiate a page on receipt of email message
 4. Graphic with flashing alarm object(s)
 5. Printed message, routed directly to a dedicated alarm printer
- H. The following shall be recorded by the NAC for each alarm (at a minimum):
1. Time and date
 2. Location (building, floor, zone, office number, etc.)
 3. Equipment (air handler #, accessway, etc.)
 4. Acknowledge time, date, and user who issued acknowledgement.
 5. Number of occurrences since last acknowledgement.
- I. Alarm actions may be initiated by user defined programmable objects created for that purpose.
- J. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- L. Provide a "query" feature to allow review of specific alarms by user defined parameters.
- M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- N. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- ## 2.7 DATA COLLECTION AND STORAGE
- A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
- B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
1. Designating the log as interval or deviation.
 2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

- C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.
- D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- E. All log data shall be available to the user in the following data formats:
 - 1. HTML
 - 2. XML
 - 3. Plain Text
 - 4. Comma or tab separated values
- F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
- G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - 1. Archive on time of day
 - 2. Archive on user-defined number of data stores in the log (buffer size)
 - 3. Archive when log has reached it's user-defined capacity of data stores
 - 4. Provide ability to clear logs once archived

2.8 AUDIT LOG

- A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
 - 1. Time and date
 - 2. User ID
 - 3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.9 DATABASE BACKUP AND STORAGE

- A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
- B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
- C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.10 GRAPHICAL USER INTERFACE SOFTWARE

- A. Operating System:
 - 1. The GUI shall run on Microsoft Windows XP Professional.
- B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
- C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
 - 1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
 - 2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 - 3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
 - 4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.
 - 5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - 6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
- D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
 - a. Create, delete or modify control strategies.
 - b. Add/delete objects to the system.
 - c. Tune control loops through the adjustment of control loop parameters.
 - d. Enable or disable control strategies.
 - e. Generate hard copy records or control strategies on a printer.
 - f. Select points to be alarmable and define the alarm state.
 - g. Select points to be trended over a period of time and initiate the recording of values automatically.
- E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen.

Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

- F. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- H. Alarm Console
 - 1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 - 2. When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.11 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the HACS, shall not be acceptable.
- C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using

- Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - c. View logs and charts
 - d. View and acknowledge alarms
 - e. Setup and execute SQL queries on log and archive information
 7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
 8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.12 SYSTEM PROGRAMMING

- A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display.

Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.13 LonWorks NETWORK MANAGEMENT

- A. The Graphical User Interface software (GUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.
- B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
- C. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
- D. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

- E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

2.14 OBJECT LIBRARIES

- A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
- D. All control objects shall conform to the control objects specified in the BACnet specification.
- E. The library shall include applications or objects for the following functions, at a minimum:
 - 1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
 - 2. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 - 3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
 - 4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
 - 5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
 - 6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric,

oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

- F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
 3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
 4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
 6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
 7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
 8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application

- requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
 10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
 11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.
- G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:
1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.
 2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.
 3. For BACnet devices, provide the following objects at a minimum:
 - a. Analog In
 - b. Analog Out
 - c. Analog Value
 - d. Binary
 - e. Binary In

- f. Binary Out
 - g. Binary Value
 - h. Multi-State In
 - i. Multi-State Out
 - j. Multi-State Value
 - k. Schedule Export
 - l. Calendar Export
 - m. Trend Export
 - n. Device
4. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
5. For BACnet devices, provide the following support at a minimum
- a. Segmentation
 - b. Segmented Request
 - c. Segmented Response
 - d. Application Services
 - e. Read Property
 - f. Read Property Multiple
 - g. Write Property
 - h. Write Property Multiple
 - i. Confirmed Event Notification
 - j. Unconfirmed Event Notification
 - k. Acknowledge Alarm
 - l. Get Alarm Summary
 - m. Who-has
 - n. I-have
 - o. Who-is
 - p. I-am
 - q. Subscribe COV
 - r. Confirmed COV notification
 - s. Unconfirmed COV notification
 - t. Media Types
 - u. Ethernet
 - v. BACnet IP Annex J
 - w. MSTP
 - x. BACnet Broadcast Management Device (BBMD) function
 - y. Routing

2.15 MODBUS SYSTEM INTEGRATION

- A. The Network Area Controller shall support the integration of device data from Modbus RTU, Ascii, or TCP control system devices. The connection to the Modbus system shall be via an RS-232, RS485, or Ethernet IP as required by the device.
- B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the FPMS. Objects provided shall include at a minimum:
- 1. Read/Write Modbus AI Registers
 - 2. Read/Write Modbus AO Registers
 - 3. Read/Write Modbus BI Registers
 - 4. Read/Write Modbus BO Registers

- C. All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the Network Area Controller.
- D. The HACS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning.

2.16 OPC SYSTEM INTEGRATION

- A. The Network Area Controller shall act as an OPC client and shall support the integration of device data from OPC servers. The connection to the OPC server shall be Ethernet IP as required by the device. The OPC client shall support third party OPC servers compatible with the Data Access 1.0 and 2.0 specification.
- B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the OPC system data into the BAS. Objects provided shall include at a minimum:
 - 1. Read/Write OPC AI Object
 - 2. Read/Write OPC AO Object
 - 3. Read/Write OPC BI Object
 - 4. Read/Write OPC BO Object
 - 5. Read/Write OPC Date/Time Input Object
 - 6. Read/Write OPC Date/Time Output Object
 - 7. Read/Write OPC String Input Object
 - 8. Read/Write OPC String Output Object
- C. All scheduling, alarming, logging and global supervisory control functions, of the OPC system devices, shall be performed by the Network Area Controller.
- D. The HACS supplier shall provide a OPC client communications driver. The equipment system vendor that provided the equipment utilizing OPC shall provide documentation of the system's OPC server interface and shall provide factory support at no charge during system commissioning.

2.17 GRAPHICAL USER INTERFACE COMPUTER HARDWARE (DESKTOP)

- A. The browser workstation shall be an Intel Pentium based computer (minimum processing speed of 2.4 Ghz with 1.0 GB RAM and a 100-gigabyte minimum hard drive). It shall include a DVD-ROM/CD-RW Combination Drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17"flat panel color monitor, 1280 x 1024 optimal preset resolution, 25 ms response time, shall also be included.
- B. Connection to the HACS network shall be via an Ethernet network interface card, 10 Mbps.
- C. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 12 PPM print speed minimum.

2.18 GRAPHICAL USER INTERFACE COMPUTER HARDWARE (LAPTOP COMPUTER)

- A. The laptop computer shall consist of an Intel Pentium based laptop computer (minimum processing speed of 2 Ghz with 1 GB RAM and a 80-gigabyte minimum hard drive). It shall include a DVD-ROM/CD-RW Combination Drive. Connection to the HACS network shall be via an Ethernet network interface card, 10/100 Mbps.
- B. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 12 PPM print speed minimum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
- B. Drawings of HACS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the architect shall be furnished and installed without additional cost.

3.2 WIRING

- A. All electrical control wiring and power wiring to the NAC, computers and network components shall be the responsibility of the HACS contractor.
- B. The electrical contractor (Div. 16) shall furnish all power wiring to NAC, computer and any networking equipment (routers, hubs, switches, etc.).
- C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All HACS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where HACS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

- A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.
- B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the Division 25 contractor at no expense to the Owner.

3.4 WARRANTY ACCESS

- A. The Owner shall grant to the Division 25 contractor, reasonable access to the HACS during the warranty period. The owner shall allow the contractor to access the HACS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 SOFTWARE LICENSE

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). The owner, or his appointed agent, shall determine which organizations to be named in the "orgid" of all Niagara Framework software licenses.
- B. The owner, or his appointed agent, shall be free to direct the modification of the "orgid" in any Niagara Framework software license, regardless of supplier.
- C. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within Niagara Framework (Niagara) based controllers and/or servers and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the owner.

3.6 ACCEPTANCE TESTING

- A. Upon completion of the installation, the Division 25 contractor shall load all system software and start-up the system. The Division 23 contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications. The Division 23 and 25 contractors are to coordinate the checkout of the system such that each Division has a representative present during system checkout.
- B. The Division 23 contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation. The Division 25 contractor shall have a representative present during system checkout by the Division 23 contractor.
- C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- D. System Acceptance: Satisfactory completion is when the Division 23, 25 and 26 contractors have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the

satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

PART 4 - SEQUENCES OF OPERATION

4.1 SUMMARY

- A. The Division 25 contractor shall refer to this Item under Division 23 to determine what level of control the Network Area Controller, must provide, which is the responsibility of this Division. It is the responsibility of the Division 25 contractor to coordinate control functions, such as scheduling and supervisory-level global control with the Division 23 contractor.

PART 5 - POINT LISTS

5.1 SUMMARY

- A. The Division 25 contractor shall refer to this item under Division 23 to determine what data in the local controllers must be integrated into the Network Area Controller, which is the responsibility of this Division. It is the responsibility of the Division 25 contractor to coordinate control functions, such as scheduling and supervisory-level global control with the Division 23 contractor

END OF SECTION 251100



Division 26

Electrical

SECTION 260923 – LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product data for each control device.
- B. System Description: The lighting control system consists of sensors, interface equipment, other apparatus, accessories, and software connected to lighting loads and the building automation system and programmed to control lighting equipment according to sequences of operation indicated and specified. Lighting will be turned on or off using occupancy sensors and momentary switches. LED and fluorescent lighting will also be dimmed by the building automation system using input from the ambient light sensors.

PART 2 - CONTROLS SCHEDULE

2.1 Products:

- A. WattStopper DT-300 Dual Technology Ceiling Occupancy Sensor:
<http://www.goodmart.com/products/the-watt-stopper-corp-dt-300-white-24vdc-dual-technology-ceiling-sensor.htm>
- B. ECT MK7-B-CCF-0/10 Ambient Light Sensor:
<http://energycontrol.com/MK7-B-CCF-0-10.aspx>
- C. WattStopper DCC2-W Low Voltage Momentary Switch:
<http://energycontrol.com/dcc2-w.aspx>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install control wiring concealed except in mechanical rooms. Install devices according to manufacturer's specifications.
- B. Install occupancy sensors a minimum distance of 6' from air supply vents where possible. Occupancy sensors should be installed with DIP switches 2,3,5,7 and 8 set to the ON position, and DIP switchers 1, 4 and 6 set to the OFF position. Install the momentary switches as indicated in both the occupancy sensor installation instructions and the momentary switch installation instructions so that the momentary switch allows for manual control of the lights controlled by the occupancy sensor.

END OF SECTION 260923

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 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

2.1 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.2 SPARE-FUSE CABINET

- A. Cabinet: Gray, baked-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 spare fuses specified with 15 percent spare capacity minimum.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Service Entrance: Class RK1, fast acting.
- B. Feeders: Class RK1, fast acting.
- C. Motor Branch Circuits: Class RK5, time delay.
- D. Other Branch Circuits: Class J, fast acting.
- E. Control Circuits: Class CC, fast acting.

3.2 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 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 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.

PART 2 - PRODUCTS

2.1 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Fusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type GD, that accommodate specified fuses, and with lockable handle interlocked with cover in closed position.
- B. Nonfusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type GD, with lockable handle interlocked with cover in closed position.
- C. Receptacle Nonfusible Switches 240 and 600-V ac, 30 and 60 A: UL 98 and NEMA KS 1, Type GD, with lockable handle interlocked with cover in closed position.
 - 1. Interlocking Linkage: Prevents inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- D. Shunt Trip Switches: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

2.2 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: Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with field-adjustable instantaneous trip settings.
 - 3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.

4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
5. GFEP Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
6. AFCI Circuit Breakers: Single- and two-pole configuration with 5-mA trip sensitivity.

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.

2.3 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.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Sections "Common work Results for Electrical."
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field 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 262816

SECTION 263100 - SOLAR PHOTOVOLTAIC COLLECTORS

PART 1 - GENERAL

- 1.1 Drawings and General Provisions of the Contract, including General Conditions, General and Trade Specific Scopes of Work and Division 1 Specification Sections apply to this Section.
- 1.2 Materials, design and installation shall comply with Underwriters Laboratories, Inc. requirements and National Electrical Code Article 690.
- 1.3 All electrical work under this Contract shall comply with Specifications Section 26000.
- 1.4 Scope of Work
 - A. Furnish and install all material, equipment and service for a complete, fully operational photovoltaic system; ratings as specified herein.
 - B. The system shall consist of roof mounted photovoltaic solar panels, inverters, and associated disconnects.
 - C. All circuit breakers and fuses, disconnects and wiring connections required for system operation and compliance shall be included.
 - D. The photovoltaic system shall be designed and installed by a factor certified installer of proposed system.
 - E. This contractor shall consult with the photovoltaic system representative and installer for the final system design.
 - F. Coordinate flashing equipment or mounting system to roof with roofing contractor including all roof penetrations and associated weatherproofing and sealing.
 - G. Connect to electrical system provided under Division 26 as indicated on the drawings.

PART 2 - PRODUCTS

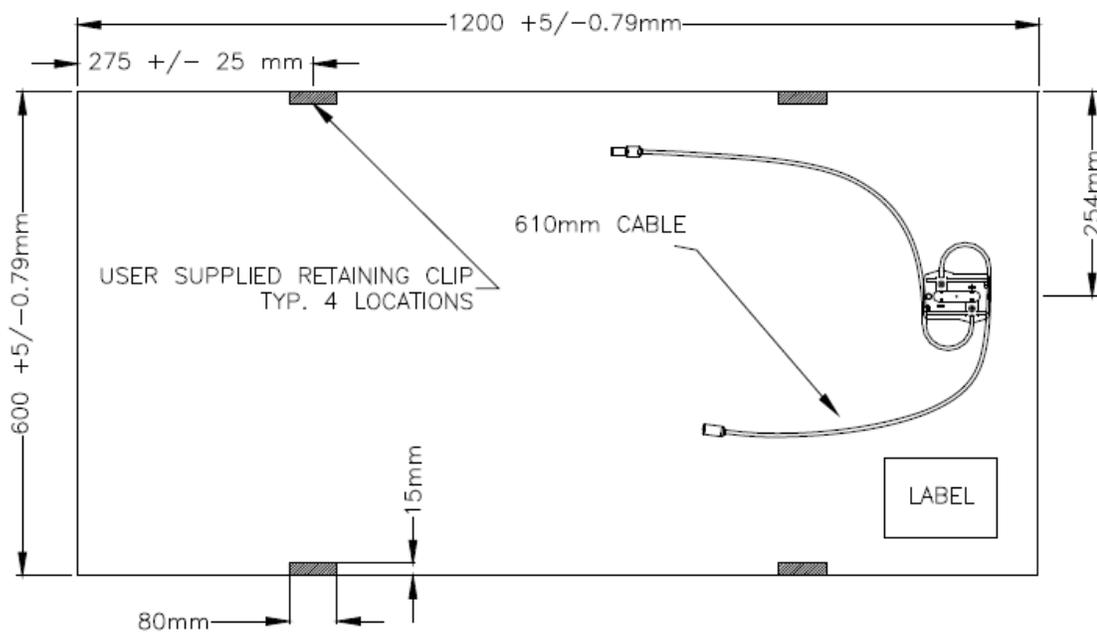
- 2.1 Equipment shall be equal in quality and performance to equipment as specified herein for establishing equipment criteria. All material and/or equipment necessary for proper operation of the system not specified or described herein shall be deemed part of these specifications.
- 2.2 Photovoltaic Modules (Panels)
- A. The Solar Photovoltaic (SPV) modules shall be provided in an array, which fits within the area of the roof as indicated on the Architectural drawings.
 - B. Provide an SPV array consisting of the quantity of modules to achieve a total array output of 8370 DC Watts.
 - C. Module efficiency shall not be less than 10 percent. Cell efficiency shall not be less than 18.8 percent. Output power tolerance shall be +10% / -0% to assure the maximum rated output.
 - D. Provide complete racking system at 48 O.C. as manufactured by DPW Solar Corporation or approved equal for support and mounting of the SPV array on the roof. Scope includes all routing of conduits, fasteners and supports, connections and all work associated with the roof structure for support and mounting of the racking system onto the roof. Coordinate this work closely with the roofing Contractor. All roof penetrations shall be by the roofing contractor.
 - E. First Solar FS-277:
http://www.firstsolar.com/Downloads/pdf/Datasheet_s2_EU.pdf
- 2.3 Grid Tie Solar Inverters shall meet IEEE 519, UL 1741 and NEC 690 as well as any other requirement of AEP to ensure that the output AC is properly synchronized with the utility grid's AC sine wave.
- A. Provide quantity of continuous output power inverters to accommodate the total array output rating as specified and meet manufacturer's sizing guidelines.
 - B. Inverters shall be as manufactured by PV Powered, SMA America and Sunny Boy. The inverter manufacturer's peak efficiency rating shall not be less than 97.1 percent.
 - C. DC input range shall not exceed 600V. DC operating voltage range shall be 250V-600V with a nominal AC voltage of 240V - 60Hz.
 - D. Inverters shall communicate with BAS and send electrical information via communications lines. Refer to division 26 specifications for wiring requirements. Provide communications lines to local controls/monitoring panel.

- E. SMA Sunny Boy 7000US Grid Tie Inverter: http://www.sma-america.com/en_US/products/grid-tied-inverters/sunny-boy/sunny-boy-5000-us-6000-us-7000-us-8000-us.html
 - F. SMA Sunny Webbox and Sunny Sensor Box shall be installed with the SMA Sunny Boy inverter, and connected as referenced in section 251100
 - 1. Sunny Webbox
 - 2. Sunny Sensor Box
- 2.4 Provide disconnect switches, fused and non-fused, where indicated on the drawings and in the specifications, and where required by the N.E.C.
- A. Disconnect switches shall be listed by Underwriter's Laboratories and shall be manufactured per specification section 26 28 16. All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

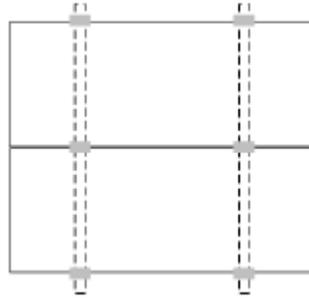
PART 3 - EXECUTION

- 3.1 The Solar Photovoltaic System Contractor shall submit for approval with shop drawings, schematic and point to point wiring diagrams showing all solar panels and array layouts, inverters, ground fault protection, all Dc and AC disconnect switches, overcurrent protection, combiner boxes as required including all respective branch circuitry, wiring and grounding. SHOP DRAWINGS WILL BE REJECTED UNLESS THE SUBMITTAL INCLUDES ALL THIS REQUIRED INFORMATION. At completion of the project, the wiring diagrams shall be revised "as-built" and included as part of the maintenance manuals.
- A. Shop drawing shall include diagram indicating connection of the PV System AC unit to the Division 26 Electric Distribution System; coordinate this with the Electrical Contractor.
 - B. Submit catalog cut sheets of all Solar Photovoltaic System equipment for approval by the Engineer.
 - C. Submit drawings indicating communication wiring between the inverters and the controls/monitoring panel provided by Division 23.
- 3.2 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:
- A. 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.
 - B. The roof mounted photovoltaic arrays shall be provided with Dc ground-fault protection.
 - C. Circuit sizing, overcurrent protection and disconnecting means shall be sized for the specific application and equipment provided for this system.

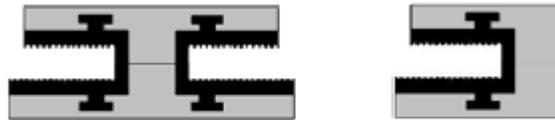
- D. The connection to a module or panels on the roof mounted array shall be arranged to facilitate the removal of a module without interrupting the grounding system or disrupting connection of the remaining modules or panel to the inverter(s).
- 3.3 Upon completion and before acceptance, system performance 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.
- 3.4 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.
- 3.5 Provide twenty (20) year warranty from date of Owner acceptance for the solar photovoltaic panels mounted on the roof. Inverter(s) shall be warranted for a period of five (5) years.
- 3.6 Mounting Structure
- A. Mounting Rails – Used with all clip types - Steel, 18 Gauge (0.045 in. min.), type A653, galvanized (G90). Nominal dimensions – 1.5 in. high, 2.25 in. wide and 156.9 in. long. Ends are swaged to allow interface between adjacent rails.
- B. Rails must be manufactured by OMCO First Solar approved.
- C. Clips must be located according to First Solar's Specifications indicated in the figure below:



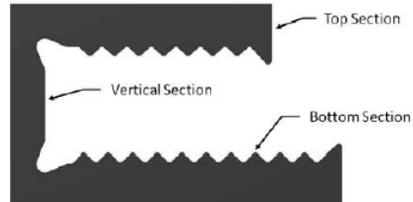
D. Rails will be oriented according to First Solar’s specifications as shown in the figure below:



E. Use First Solar approved two-part clip design



Top Section: 3mm [0.12 in] minimum
 (includes “teeth” or “ridges”)
 Bottom Section: 3mm [0.12 in] minimum
 (includes “teeth” or “ridges”)
 Vertical Section: 2mm [0.08in] minimum



F. Use locking clamshells on all module electrical connections.

G. All mounting designs and systems must be approved by First Solar.

END OF SECTION 263100

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.
- C. System Certificate: UL Master Label.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Main and Bonding Conductors: Copper.
- C. Ground Rods: Zinc-coated; 5/8 inch in diameter by 96 inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Where indicated, run conductors in nonmetallic raceway.
- C. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors within normal view of exterior locations at grade within 200 feet of building.

- D. Cable Connections: Exothermic-welded connections for conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturers' written installation instructions.
- F. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.
- G. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.2 FIELD QUALITY CONTROL

- A. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- B. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 264113

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data for each luminaire, including lamps.
- B. Fixtures, Emergency Lighting Units, 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 IEEE C2, "National Electrical Safety Code."
- D. Coordinate ceiling-mounted luminaires with ceiling construction, mechanical work, and security and fire-prevention features mounted in ceiling space and on ceiling.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- 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.

2.2 LAMPS

- A. Linear Fluorescent Lamps: T5 High Efficiency format, rated 35W maximum, nominal length 22 inches (563 mm) to 58 inches (1463 mm), CRI 85 (minimum), color temperature of 6400 K, and average rated life of at least 10,000 hours unless otherwise indicated.
- B. Compact Fluorescent Lamps: Rated 26W maximum, non-integrated ballast, color temperature of 4100 K, CRI 80 (minimum), and average life of at least 10,000 hours.

- C. White LED: Efficacy at least 50 lumens/watt, color temperature of 3500 K, average life of at least 10,000 hours.

2.3 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

- A. Fixture: 6" Vertical Triple Open Compact Fluorescent Downlight Fixture
1. Basis-of-Design Product:
http://www.prescolite.com/products/specs/specs_files/arch_cfl_007.pdf
 2. Voltage: 120V
 3. Recessed downlight
 4. 18-gauge steel platform
 5. Compatible with all 25W, 32W, and 42W triple tube lamps
 6. UL Listed
- B. Fixture: 6" Recessed LED Downlights
1. Basis-of-Design Product: Lithonia Reality 6" LED downlights LXLED T24
http://www.acuitybrandslighting.com/library/LL/documents/SpecSheets/REALITY_6_LED.pdf
 2. Aperture 4-3/8"
 3. Overlap trim: 7-1/2"
 4. Height: 6-3/8"
 5. Lumen output 600 Lumens
 6. Color Temperature 3000 K
 7. Voltage: 120 V
 8. Efficiency 50 Lumens per Watt.
- C. Fixture: Linear T5 Fluorescent Low-profile Fixture
1. Please provide Bartco QT5 linear T5 fixture
http://www.bartcolighting.com/images/files/products_8202009112545am_qt5.pdf
 2. Overall length: 22-1/2" – 46-1/16"
 3. Height: 1-7/16"
 4. Width: 3-1/4"
- D. Fixture: Linear T5 Fluorescent Fixture
1. Basis-of-Design Product: Bartco BFL270-S
http://www.bartcolighting.com/images/files/products_33201110829pm_bartco_bfl270_s.pdf
 2. Compatible with 14W, 21W, 28W, and 35W High Efficiency T5 lamps
 3. Voltage: 120V
 4. Dimming is available
 5. Overall height: 1-1/4"
 6. Overall width: 2-1/16"
- E. Fixture: LED Puck Light
1. Basis-of-Design Product: Euro Lightings Puck Light 100
<http://eurolightings.com/led-puck-light-black-1-watt.html>
 2. 1W LED
 3. Voltage: 12V DC
 4. Surface mount
 5. Diameter: 2-5/8"
 6. Height: 1-1/16"

- F. Fixture: LED Pendant Light
1. Basis-of-Design Product:
http://www.lightinguniverse.com/led-mini-pendants/et2-lighting-e20263-10-hagen-mini-led-small-pendant-chrome_g525511.html?linkloc=catalogProductItemsName
 2. Voltage: 12V
 3. Overall height: 124"
 4. Minimum overall height: 16"
 5. Diameter: 7"
 6. UL Listed
- G. Fixture: Outdoor LED Sconce
1. Basis-of-Design Product:
http://www.lightinguniverse.com/led-wall-sconces/progress-lighting-p5909-20-greenridge-medium-led-exterior-sconce-antique-bronze_g414865.html?linkloc=catalogProductItemsName
 2. Voltage: 120V
 3. Lamp: 5W LED
 4. Install in wet locations
 5. Width: 7.5"
 6. Projection: 8.5"
 7. Height: 11"
 8. UL Listed

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set units level, plumb, and square with ceiling and walls, and secure.
- B. Support for Recessed and Semi-recessed Grid-Type Fluorescent Fixtures:
1. Install ceiling support system wires at a minimum of four wires for each fixture, located not more than 6 inches from fixture corners.
 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
- C. Adjust directional lighting fixtures to provide required light intensities.
- D. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's written instructions.

END OF SECTION 265000



Division 28

Electronic Safety and Security

SECTION 283100 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. System Description: Noncoded, 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

2.1 FACP

- A. General: Modular, power-limited design with electronic modules, UL 864 listed.
- B. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.
- C. Secondary Power: 24-V dc supply system with sealed lead calcium batteries and automatic battery charger and an automatic transfer switch.

2.2 ALARM-INITIATING DEVICES

- A. Manual Pull Stations: UL 38 listed, double-action mechanism, red in color with molded, raised-letter operating instructions in contrasting color.
- B. Smoke Detectors: UL 268, 24-V dc, self-restoring, photoelectric type, plug-in arrangement.

- C. Heat Detectors: UL 521 listed, combination 135 deg F fixed-temperature and rate-of-rise unit.

2.3 NOTIFICATION APPLIANCES

- A. Bells: Electric-vibrating type, with 94 dBA at 10 feet
- B. Low-Level Chimes: Vibrating type with 75 dBA.
- C. High-Level Chimes: Vibrating type with 81 dBA.
- D. Horns: Electric-vibrating-polarized type, 90 dBA at 10 feet .

2.4 WIRE AND CABLE

- A. General: UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 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.
- C. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

END OF SECTION 283100



Division 32

Exterior Improvements

SECTION 327100 – BIOREMEDIATION SYSTEM FOR GREYWATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes engineering, fabricating, furnishing, and installing:
- B. Sub-Surface Flow Wetlands: The waste water treatment will consist of a grey water system. Waste water from the house will be collected to a separate holding tank and then transferred using a booster pump into the bio-remediation (BRS) system for treatment. The BRS will be composed of three sub-surface flow wetland mesocosms that are connected in series with PVC piping and have a total volume of 41 ft³. Grey water will be loaded into the system from the holding tank and flow through the whole system. Microbial communities in the gravel beds will provide much of the waste treatment by utilizing the nutrients and organic matter in the grey water. Wetland plants in each mesocosm will provide additional nutrient and water uptake. The effluent from the living machine will be pumped daily into a 320-gallon holding tank. In accordance with the rules for the Solar Decathlon, the grey water will not be used for anything other than irrigation of landscaping plants.
- C. Related Sections:
 - 1. Section 32 90 00 (02900) – Planting.
 - 2. Division 22 (15) – Plumbing sections.

1.2 SUMMARY

- A. This Section includes engineering, fabricating, furnishing, and installing:
 - 1. Shop Drawings: Not less than 10 days before the Pre-construction meeting, prepare and submit Shop Drawings for the Constructed Wetlands.
 - a. Identify primary contact for Constructed Wetlands installation.
 - b. Indicate system type (surface flow or sub-surface flow), installation process and schedule. Indicate approach to water introduction to system.
 - c. Detail Drawings. Indicate components of system, including: structure cells, liners, flow control structures, soil, aggregate, pipe, vegetation, pumps and related equipment. Identify manufacturer of each component. Indicate connections to related plumbing and landscaping work.
 - d. Plant List. Indicate type, establishment period, size, quantity of each type. Indicate water tolerance limits for each type as applicable during establishment period and after establishment period. Include picture of each type of plant.
- B. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section.
- C. Operations & Maintenance Plan.

PART 2 - PRODUCTS

2.1 BIOREMEDIATION SYSTEM COMPONENTS

A. Structures Cells:

1. 102-gallon open top tank (polyethylene) 60"Lx24"Wx18"H:
A total of three 102-gallon tanks will be used in the BRS. All of them will be the wetland mesocosm cells that provide the grey water treatment.

<http://www.plastic-mart.com/class.php?item=1414>

B. Liners:

1. DuPont 100' x 4' Commercial Weed Control Fabric:
This will be placed on top of the pea gravel layer, to prevent sand and soil from migrating down into the gravel layers. This will help maintain an adequate flow rate through the gravel.

http://www.lowes.com/pd_194946-23132-10015_4294857236_4294937087_?productId=3019284&Ns=p_product_prd_lis_ord_nbr|0||p_product_quantity_sold|1&pl=1¤tURL=%2Fpl_4294857236_4294937087_%3FNs%3Dp_product_prd_lis_ord_nbr%7C0%7C%7Cp_product_quantity_sold%7C1

C. Piping:

1. Woodstock W2026 2-Inch by 10-Foot Clear Hose
http://www.amazon.com/Woodstock-W2026-2-Inch-10-Foot-Clear/dp/B0000DD1V0/ref=pd_bxgy_hi_img_a
2. Woodstock W1315 2-Inch Wire Hose Clamp
http://www.amazon.com/Woodstock-W2026-2-Inch-10-Foot-Clear/dp/B0000DD1V0/ref=pd_bxgy_hi_img_a
3. Shields White Sanitation VAC Heavy Duty Hose (1")
http://www.jamestowndistributors.com/userportal/show_product.do?pid=4133&familyName=Shields+White+Sanitation+VAC+Heavy+Duty+Hose
4. Shields White Sanitation VAC Heavy Duty Hose (1 1/2")
http://www.jamestowndistributors.com/userportal/show_product.do?pid=4133&familyName=Shields+White+Sanitation+VAC+Heavy+Duty+Hose
5. Fittings PVC, Reducing Adaptor WATERW, 1 1/2" Spg x 1" Spg
6. Charlotte Pipe 1-1/2" x 2" PVC Coupling
http://www.lowes.com/pd_23316-1814-PVC+00102++0600_0_?productId=3132735&Ntt=1+1%2F2%22+x+2%22+pvc+coupling&pl=1¤tURL=%2Fpl_0_s%3FNtt%3D1%2B1%252F2%2522%2Bx%2B2%2522%2Bpvc%2Bcoupling
7. 2" Uniseals
<http://www.aquaticeco.com/subcategories/829/Uniseals>
8. Charlotte Pipe 2" x 10' PVC Schedule 40 Pipe

http://www.lowes.com/pd_23832-1814-PVC+07200++0600_0_?productId=3133041&Ntt=pvc+pipe+schedule+40&pl=1¤tURL=%2Fpl_0_s%3FNtt%3Dpvc%2Bpipe%2Bschedule%2B40

9. Charlotte Pipe 2" PVC 45° Elbow

http://www.lowes.com/pd_23832-1814-PVC+07200++0600_0_?productId=3133041&Ntt=pvc+pipe+schedule+40&pl=1¤tURL=%2Fpl_0_s%3FNtt%3Dpvc%2Bpipe%2Bschedule%2B40

10. 2" Tee Slip x Slip x Slip PVC Pipe Fittings Schedule 40

http://www.pvcfittingsdirect.com/e/Tees_Slip_x_Slip_x_Slip/product/401-020/2_Tee_Slip_x_Slip_x_Slip_PVC_Pipe_Fittings_Schedule_40.htm

11. 2" White PVC Schedule 40 Slip Cap

http://www.kvmtools.com/product_info.php?products_id=73632&language=en

12. Oatey 16 Oz. PVC Cement Dark Green Label

http://www.lowes.com/pd_68647-138-31132D_0_?productId=3134965&Ntt=pvc+primer&pl=1¤tURL=%2Fpl_0_s%3FNtt%3Dpvc%2Bprimer

13. Oatey 16 Oz. Purple Primer NSF

<http://www.lowes.com/ProductDisplay?partNumber=51004-138-30757D&langId=-1&storeId=10151&productId=3160397&catalogId=10051&cmRelshp=rel&rel=nofollow&cId=PDIO1>

14. ProPlumber 2" Sewage Pump Check Valve

http://www.lowes.com/pd_184210-15649-PPSPC-200_0_?productId=1052571&Ntt=check+valve&pl=1¤tURL=%2Fpl_0_s%3FNtt%3Dcheck%2Bvalve

- D. Soil and Mulch: The soil shall provide enough organic matter to fuel plant growth and microbial activity, particularly during startup. Dense soils, such as clays and shales, are not permitted. The mulch layer will be composed of approximately one inch of recycled rubber mulch.

http://www.lowes.com/pd_210540-85597-210540_4294857241_4294937087_?productId=3103517&Ns=p_product_quantity_sold|0&pl=1¤tURL=%2Fpl_Bagged%2BSoil_4294857241_4294937087_%3FNs%3Dp_product_quantity_sold|0%26page%3D3

http://www.lowes.com/pd_326447-25888-LRM8BN_0_?productId=3199901&Ntt=mulch&pl=1¤tURL=%2Fpl_0_s%3FNtt%3Dmulch%26page%3D2

- E. Sand and Gravel: The sand and gravel used to fill the BRS shall include three sizes of gravel with the largest size at the bottom of the tanks to facilitate water flow through the system. A layer of limestone gravel will be used to

provide adsorption of phosphorus in the grey water. Paver sand will be used on top of the gravel layers.

http://www.lowes.com/pd_71359-82589-WGM30003_4294858246_4294937087?productId=3138061&Ns=p_product_prd_lis_ord_nbr|0||p_product_quantity_sold|1&pl=1¤tURL=%2Fpl_Sa nd_4294858246_4294937087_%3FNs%3Dp_product_prd_lis_ord_nbr|0||p_p roduct_quantity_sold|1

http://ohiomulchcolumbus.com/natural_stone_pavers.html?gclid=CK711obw1acCFYvsKgodU1sd-A

http://www.lowes.com/pl_Bagged+Rock_4294857240_4294937087?storeId=10151&UserSearch=bagged+rock&newSearch=true&Ns=p_product_quantit y_sold|0&N=0&catalogId=10051&langId=-1

F. PVC pipe: ASTM D2241 SDR 26 or D1785 sch 40.

G. Pumping stations:

1. Pump: Self-Priming Flexible Impeller with Stainless Steel Wearplate.
2. Port(s): Inlet - 1-1/2" (38mm) Hose Barb and 1-1/2" N.P.T. (Male) Outlet - 1" (19mm) Hose Barb;
3. Motor: Permanent Magnet Type, Fully Enclosed, with Stainless Steel Shaft Includes Run-Dry Protection Device that shuts-off pump. Powder coated housing with sealed end-bells and bearings. Complies with USCG Regulation 183.410 and ISO 8846 MARINE for Ignition Protection.
4. Voltage: 12 EMC
5. Amp Draw: 16 A
6. Fuse Rating: 20 A

<http://www.starmarinedepot.com/Jabsco+Macerator+Pump+12VDC.html>

H. Plants: Non-invasive, native Ohio species appropriate to wetland type and as indicated on approved Shop Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions under which system will be installed, with Designer/Installer present, for compliance with requirements.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wetlands system in accordance with approved Shop Drawings, as indicated, and in accordance with applicable regulations.
- B. Planting:

1. Plants assigned to each cell shall be planted in random distribution by type.
2. The water level in the BRS shall be within four to six inches of the surface at the time of planting and be maintained at that level at all times for the duration of the initial growing season.
3. Provide temporary anchoring as necessary.
4. Establishment: Maintain water level as appropriate to plant types and wetland type (sub-surface flow).

END OF SECTION 327100

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Plants.
 - 2. Planting soils.
 - 3. Landscape edgings.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
 - 1. Unit prices apply to authorized work covered by quantity allowances.
 - 2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in landscape installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
- C. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.
- D. Handle planting stock by root ball.
- E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
- F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.
 - 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 3. Do not remove container-grown stock from containers before time of planting.
 - 4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
 - 1. Notify Owner and architect no fewer than 5 days in advance of proposed interruption of each service or utility.
 - 2. Do not proceed with interruption of services or utilities without Owner's written permission.

- C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting:
- D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 - 1. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

- E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- F. Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

2.2 PLANT TYPES

- A. Horsetail
- B. Sage
- C. Maiden Grass

2.3 PLANTING SOILS

- A. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from bogs, or marshes.
 - 1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.4 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Shredded hardwood
 - 2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum
 - 3. Color: Natural.

2.5 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

2.6 LANDSCAPE EDGINGS

- A. Plastic Edging: Standard black polyethylene or vinyl edging, extruded in standard lengths.
 - 1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - a. Oly-Ola Edgings, Inc.
 - b. Valley View Industries.
 - 3. Edging Size: 0.07 inch (1.8 mm) wide by 5 inches (125 mm) deep
 - 4. Top Profile: Straight, with top 2 inches (50 mm) being 1/4 inch (6.4 mm) thick.
 - 5. Top Profile: Round top, [1/2 inch (13 mm)] [1 inch (25 mm)] in diameter.
 - 6. Accessories: Manufacturer's standard alignment clips or plugs.

2.7 MISCELLANEOUS PRODUCTS

- A. Root Barrier: Black, molded, modular panels manufactured with 50 percent recycled polyethylene plastic with ultraviolet inhibitors, 85 mils (2.2 mm) thick, with vertical root deflecting ribs protruding 3/4 inch (19 mm) out from panel, and each panel 24 inches (610 mm)
- B. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 ROOT-BARRIER INSTALLATION

- A. Install root barrier where trees are planted within 60 inches (1500 mm) 48 inches (1200 mm) of paving or other hardscape elements, such as walls, curbs, and walkways unless otherwise shown on Drawings.
- B. Align root barrier vertically and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.
- C. Install root barrier continuously for a distance of 60 inches 1500 mm in each direction from the tree trunk, for a total distance of 10 feet (3 m) per tree. If trees are spaced closer, use a single continuous piece of root barrier.
 1. Position top of root barrier \per manufacturer's recommendations.
 2. Overlap root barrier a minimum of 12 inches (300 mm) at joints.
 3. Do not distort or bend root barrier during construction activities.
 4. Do not install root barrier surrounding the root ball of tree.

3.4 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.5 PLANTING AREA MULCHING

- A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches (150 mm) and secure seams with galvanized pins.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Organic Mulch in Planting Areas: Apply 3-inch (75-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.6 EDGING INSTALLATION

- A. Plastic Edging: Install plastic edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 36 inches (900 mm) apart, driven through upper base grooves or V-lip of edging.

3.7 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

3.8 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After installation and before Substantial Completion remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.9 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300



Division 33

Utilities

SECTION 334713 - POND AND RESERVOIR LINERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes geomembrane liners for ponds and reservoirs.

1.3 DEFINITIONS

- A. Plastics Terminology: See ASTM D 1600 for definitions of abbreviated terms for plastics not otherwise defined in this Section.
- B. EPDM: Ethylene-propylene-diene terpolymer.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide geomembrane liners that prevent the passage of water.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:

1. Sheets for geomembrane liners.
2. Seaming adhesives, solvents, and extrusions.
3. Penetration assemblies.
4. Accessories for floating covers.

1.6 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain geomembrane liner, accessories, and required seaming materials, solvents, and adhesives from single source.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit placement and seaming of geomembrane linersto be performed according to manufacturers' written instructions and warranty requirements.

PART 2 - PRODUCTS

2.1 EPDM SHEET MATERIALS

- A. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible sheets.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Firestone Building Products.
 - b. http://www.firestonebpe.com/lining/syst_comp/epdm_geomembrane/en/index.shtml
 - 2. Nominal Thickness: thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
 - 3. Breaking Strength: Not less than minimum average per ASTM D 882, ASTM D 7004, or ASTM D 751, Procedure A.
 - 4. Tear Resistance: Not less than minimum average per ASTM D 1004.
 - 5. Puncture Strength: Not less than average per ASTM D 4833.

2.2 MISCELLANEOUS MATERIALS

- A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.
- B. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.
- C. Sand: ASTM C 33; fine aggregate, natural or manufactured sand.

2.3 FABRICATION

- A. Fabricate geomembrane linerpanels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.
- B. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.
- C. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

3.3 INSTALLATION

- A. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.
- B. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

3.4 DISINFECTION

- A. Disinfect the complete installation according to procedures in AWWA C652.

3.5 PROTECTION

- A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.
- B. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane and seams and reinspect repaired work.

END OF SECTION 334713



Generated by REScheck-Web Software
Compliance Certificate

Project Title: enCORE House

Energy Code: **2009 IECC**
 Location: **Columbus, Ohio**
 Construction Type: **Single Family**
 Building Orientation: **Bldg. faces 0 deg. from North**
 Glazing Area Percentage: **18%**
 Heating Degree Days: **5708**
 Climate Zone: **5**

Construction Site:
 590 Woody Hayes Dr
 Columbus, Ohio 43210

Owner/Agent:
 The Ohio State University

Designer/Contractor:

Compliance: Passes using UA trade-off

Compliance: **41.6% Better Than Code** Maximum UA: **209** Your UA: **122**

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	980	50.0	20.0		17
North Wall: Wood Frame, 24in. o.c. Orientation: Unspecified	326	32.0	10.0		9
South Wall: Wood Frame, 24in. o.c. Orientation: Unspecified	311	32.0	10.0		9
West Wall: Wood Frame, 24in. o.c. Orientation: Unspecified	353	32.0	10.0		10
East Wall: Wood Frame, 24in. o.c. Orientation: Unspecified	353	32.0	10.0		3
Window: Other SHGC: 0.17 Orientation: Unspecified	8			0.110	1
Window: Other SHGC: 0.33 Orientation: Unspecified	24			0.110	3
Window: Other SHGC: 0.33 Orientation: Unspecified	24			0.110	3
Window: Other SHGC: 0.33 Orientation: Unspecified	24			0.110	3
Window: Other SHGC: 0.33 Orientation: Unspecified	24			0.110	3
Window: Other SHGC: 0.17 Orientation: Unspecified	14			0.110	2
Window: Other SHGC: 0.17 Orientation: Unspecified	14			0.110	2
Window: Other SHGC: 0.17 Orientation: Unspecified	6			0.110	1
Window: Other SHGC: 0.17 Orientation: Unspecified	18			0.110	2

Window: Other SHGC: 0.17 Orientation: Unspecified	14			0.110	2
Window: Other SHGC: 0.24 Orientation: Unspecified	8			0.190	2
Window: Other SHGC: 0.24 Orientation: Unspecified	8			0.190	2
Window: Other SHGC: 0.24 Orientation: Unspecified	8			0.190	2
Window: Other SHGC: 0.24 Orientation: Unspecified	12			0.190	2
Door: Glass SHGC: 0.17 Orientation: Unspecified	21			0.200	4
Door: Glass SHGC: 0.17 Orientation: Unspecified	21			0.200	4
Floor: Steel Frame, 16in. o.c., 2x12, Over Outside Air	980	50.0	10.0		36

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-50.0 cavity + R-20.0 continuous insulation

Comments: _____

Above-Grade Walls:

- North Wall: Wood Frame, 24in. o.c., R-32.0 cavity + R-10.0 continuous insulation

Continuous insulation specified for this above-grade wall has consistent R-value rating across full area of the wall.

Comments: _____

- South Wall: Wood Frame, 24in. o.c., R-32.0 cavity + R-10.0 continuous insulation

Continuous insulation specified for this above-grade wall has consistent R-value rating across full area of the wall.

Comments: _____

- West Wall: Wood Frame, 24in. o.c., R-32.0 cavity + R-10.0 continuous insulation

Continuous insulation specified for this above-grade wall has consistent R-value rating across full area of the wall.

Comments: _____

- East Wall: Wood Frame, 24in. o.c., R-32.0 cavity + R-10.0 continuous insulation

Continuous insulation specified for this above-grade wall has consistent R-value rating across full area of the wall.

Comments: _____

Windows:

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panes ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panes ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panes ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panes ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panes ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panes ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.110

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.190

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.190

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.190

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

- Window: Other, U-factor: 0.190

For windows without labeled U-factors, describe features:

#Panels ____ Frame Type _____ Thermal Break? ____ Yes ____ No

Comments: _____

Doors:

- Door: Glass, U-factor: 0.200

Comments: _____

- Door: Glass, U-factor: 0.200

Comments: _____

Floors:

- Floor: Steel Frame, 16in. o.c., 2x12, Over Outside Air, R-50.0 cavity + R-10.0 continuous 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, glazing U-factors, and heating and cooling equipment efficiency 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 78.4 cfm (8 cfm per 100 ft² of conditioned floor area).
 - (2) Postconstruction total leakage test (including air handler enclosure): Less than or equal to 117.6 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 58.8 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 39.2 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
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Ceiling / Roof	70.00
Wall	42.00
Floor / Foundation	60.00
Ductwork (unconditioned spaces):	_____

Glass & Door Rating	U-Factor	SHGC
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Window	0.11	0.33
Door	0.20	0.17

Heating & Cooling Equipment	Efficiency
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Heating System: _____	_____
Cooling System: _____	_____
Water Heater: _____	_____

Name: _____ Date: _____

Comments: