

TEAM NEW YORK
SOLAR ROOF POD

PROJECT MANUAL

**SPITZER SCHOOL OF ARCHITECTURE
GROVE SCHOOL OF ENGINEERING**

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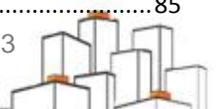
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Summary of Changes

Significant changes to the project manual that have occurred between submissions have been outlined below.

March 22, 2011 Revision

Comment	How comment was addressed	Refer to:
PDF manual should include easily navigable bookmarks as outlined in Appendix D-4		
Summary of unlisted components		
Missing interconnection application form		
Provides some loads, but service/feeder and neutral calculations missing.		
Specifications missing raceway, conductors, boxes and grounding sections		
Provide detailed water budget		
Remove information provided for sample/template purposes only		
Rule 5.2 - More information is needed concerning shimming methods for home, or an additional drawing reference should be made		
IN GENERAL - Be sure that text applies to information shown		
Rule 8.5 E101 Does not contain the completed interconnection application form		
Rule 8.5 This information should be shown to enable coordination between the organizer utility grid interconnection team and your construction team		
Rule 9.2 P-101 is a more appropriate reference. Note information regarding impact on the turf and placement of water tanks		
Interconnection Application Form - Provide a reference to this information and complete this interconnection application form		
4.2.5 Calculations - Provide this information in your drawings as well for review by John Wiles, Harold Willmann and Tom Meyers		
Section 26 24 16 – Panelboards – 2.2 Materials - Double check the AIC. This is much higher than a normal residential panel		
Section 26 24 16 – Panelboards – 2.3 Safety - NEC 240.24(A). 2008 NEC is being used for the competition		



Comment	How comment was addressed	Refer to:
<p>3.1 Parametric Analysis of the Envelope - Provide the following: Foam > 4" thickness: Foam plastic insulation more than 4 inches (102 mm) thick shall have a maximum flame spread index of 75 and a smoke-developed index of 450 where tested at a minimum thickness of 4 inches (102 mm), provided the end use is approved in accordance with Section R316.6 using the thickness and density intended for use.</p> <p>R316.6 Specific approval. Foam plastic not meeting the requirements of Sections R316.3 through R316.5 shall be specifically approved on the basis of one of the following approved tests: NFPA 286 with the</p>		
<p>6.1.2 HVAC overview - Isolated heat exchange loop. The graphics below are not clear. What is the chemical composition of the PCM storage material?</p>	<p>Graphics will be redone along with HVAC schematic</p> <p>The chemical composition of PCM material is Paraffin wax.</p> <p>Liquid saturated Hydrocarbons, molecular formula C_nH_{2n+2}</p>	<p>Section 5.1.2 HVAC Overview, Figure 1 (Pending)</p> <p>Section 5.5.4 PCM Material</p>
<p>6.1.2 HVAC overview – T&P Relief Device! – PAGE 71, Figure 6.1</p>	<p>Schematic is still being adjusted</p>	<p>Section 5.1.2 HVAC Overview, Figure 1 (Pending)</p>
<p>6.5.2 Design Concept of the PCM Tank - More information is required about specific PCM product to be used. Coordinate as required with Tom Meyers for approval</p>	<p>Rubitherm RT-65 is used as the PCM material. The amount of PCM used is 150 gallon. The PCM material is flammable and will be supplied with MSD provided by the vendor.</p> <p>PCM material will be used in volumetric proportion of 75% with graphite.</p>	<p>Section 5.5.4 PCM Material</p>
<p>6.5.2 Design Concept of the PCM Tank - Where is this located in your home? I saw reference to the PCM tank in the schedule, but did not notice any reference in the drawings. Provide location and details</p>	<p>The PCM tank is located in the mechanical room, occupying space of 2' x 2' x 6.5'.</p> <p>Exact placement of PCM tank is still being decided and will be added soon.</p>	<p>Section 5.5.3.1 Tank Sizing and Location, Figure 6.5 (Pending)</p>
<p>7.1 Introduction - Kitchen sink and dishwasher are not considered grey source. They will need to be treated as black water</p>	<p>Wastewater such as black-water will be derived from kitchen sink, toilet, and mechanical room.</p>	<p>Section 6.1, Introduction,; 3rd paragraph</p>



Comment	How comment was addressed	Refer to:
7.1 Introduction – “OK” Referring to water budget comment? Discuss	Water Balance budget was re-budgeted and calculated in more specific detail	Sub-Section 6.1.1 Water Balance, Table 6.1. Water Balance for the RoodPod
7.5 Sprinkler System - It appears that you will be using a two head calculation. You are permitted to use IRC P2904 or NFPA 13D. This needs to coordinate with a labeled sprinkler plan. I need to see the head manufacturer's data for the heads proposed (PSI and GPM for one head at 12x12 coverage.)	NFPA 13D Fire protection, Sprinkler code was used to direct planning in sprinkler design.	6.3 Fire Sprinkler System, Sub-section 6.3.1 Introduction and 6.3.2 Sprinkler Selection, Figure 6.6. Sprinkler System Layout for the RoofPod
7.5 Sprinkler System – “???” Referring to ASHRAE, maybe spell out acronym?	No ASHRAE reference will be used. NFPA13D Fire Protection will be used instead	6.3 Fire Sprinkler System, Sub-section 6.3.1 Introduction
Section 22 12 00 – 3.1 Insulation - Please provide spec sheets and information on waste tanks to include gallon capacity, fitting size for water removal. Must be minimum 4"	According to the water budget, wastewater in total is 560.4 gal, which will be used for grey water storage tank. As for black water, the total is 214.6gal, which will be stored in the septic tank	Sub-section 6.1.1 Water Balance, Table 6.1. Water Balance for the RoodPod
8.2.2.3 External Shades - Review Appendix B-2 for information relating to moveable components that will be used during the competition and the presentation of these components to the relevant juries	It stated “Control system will be shown to public and judges during competition days”	Section 7.2.2 Control System, Sub-Section 7.2.2.3 Blinds



Rules Compliance Checklist

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	O-101.01 to O-104.01, O-201.01, O-601.01, O-602.01
Rule 4-2	Construction Equipment	Specifications for heavy machinery	41 22 00, 41 62 19
Rule 4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	E-101.02
Rule 4-4	Impact on the Turf	Drawing(s) showing the location, contact area, and soil-bearing pressure of every component resting directly on the turf	S-006.01
Rule 4-5	Generators	Specifications for generators	41 65 16
Rule 4-6	Spill Containment	Drawing(s) showing the locations of all equipment, containers, and pipes that will contain liquids at any point during the event	L-111.01 F-102.01 P-101.01
Rule 4-6	Spill Containment	Specifications for all equipment, containers, and pipes that will contain fluids at any point during the event	22 00 00 32 00 00
Rule 4-7	Lot Conditions	Calculations showing that the structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	p. 144-p.170
Rule 4-7	Lot Conditions	Drawing(s) showing shimming methods and materials to be used if 18 in. (45.7 cm) of vertical elevation change exists on the lot	L-901.01 S-007.01
Rule 5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	G-201.01 G-103.01
Rule 5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	N/A
Rule 6-1	Structural Design Approval	List of, or marking on, all drawing and project manual sheets that have been or will be stamped by the qualified, licensed design professional in the stamped structural submission; the stamped submission shall consist entirely of sheets that also appear in the drawings and project manual	S-001.01 to S-005.01 p.144-170
Rule 6-2	Finished Square Footage	Drawing(s) showing all information needed by the rules officials to measure the finished square footage electronically	G-104.01

Rule 6-2	Finished Square Footage	Drawing(s) showing all movable components that may increase the finished square footage if operated during contest week	N/A
Rule 6-3	Entrance and Exit Routes	Drawing(s) showing the accessible public tour route and the ground surface area that will be covered by organizer-provided walkway material	G-103.01 G-106.01
Rule 7-1	Placement	Drawing(s) showing the location of all vegetation and, if applicable, the movement of vegetation designed as part of an integrated mobile system	L-112.01
Rule 7-2	Watering Restrictions	Drawing(s) showing the layout and operation of greywater irrigation systems	L-111.01
Rule 8-1	PV Technology Limitations	Specifications for photovoltaic components	26 31 00
Rule 8-3	Batteries	Drawing(s) showing the location(s) and quantity of all primary and secondary batteries and stand-alone, PV-powered devices	L-113.01 E-109.01
Rule 8-3	Batteries	Specifications for all primary and secondary batteries and stand-alone, PV-powered devices	25 00 00
Rule 8-4	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	N/A
Rule 8-4	Desiccant Systems	Specifications for desiccant system components	N/A
Rule 8-5	Village Grid	Completed interconnection application form.	p.16
Rule 8-5	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-102.01 E-601.01 E-602.01
Rule 8-5	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	26 31 00
Rule 8-5	Village Grid	One-line electrical diagram	E-601.01
Rule 8-5	Village Grid	Calculation of service/feeder net computed load per NEC 220	E-603.01
Rule 8-5	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	E-101.01
Rule 8-5	Village Grid	Elevation(s) showing the meter housing, main utility disconnect, and other service equipment	E-202.01 E-521.01
Rule 9-1	Container Locations	Drawing(s) showing the location of all liquid containers relative to the finished square footage	M-102.01 P-101.01 P-102.01
Rule 9-1	Container Locations	Drawing(s) demonstrating that the primary supply water tank(s) is fully shaded from direct solar radiation between 9 a.m. and 5 p.m. EDT or between 8 a.m. and 4 p.m. solar time on October 1	P-101.01



Rule 9-2	Team-Provided Liquids	Quantity, specifications , and delivery date(s) of all team-provided liquids for irrigation, thermal mass, hydronic system pressure testing, and thermodynamic system operation	p.13
Rule 9-3	Greywater Reuse	Drawing(s) showing the layout and operation of greywater reuse systems	L-111.01
Rule 9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	L-111.01
Rule 9-6	Thermal Mass	Drawing(s) showing the locations of liquid-based thermal mass systems	P-301.01
Rule 9-6	Thermal Mass	Specifications for components of liquid-based thermal mass systems	HVAC Design p.57
Rule 9-7	Greywater Heat Recovery	Drawing(s) showing the layout and operation of greywater heat recovery systems	L-501.01
Rule 9-8	Water Delivery	Drawing(s) showing the complete sequence of water delivery and distribution events	P-101.01 P-103.01 p-501.01
Rule 9-8	Water Delivery	Specifications for the containers to which water will be delivered	33 16 13.23
Rule 9-9	Water Removal	Drawing(s) showing the complete sequence of water consolidation and removal events	P-104.01
Rule 9-9	Water Removal	Specifications for the containers from which water will be removed	33 16 13.14
Rule 11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	G-106.01



Team Provided Liquids

Team will bring 50 gallons of water, to be used for irrigation of plants.

Team will be using DCA25SUI generator. The generator features an integrated 24-hour fuel tank with a fluid containment system. According to generator manufacturer specs, the generators use 1.66 gallons per hr. at full load and .58 gallons per hr. at ¼ load. Construction before connecting to the grid will occur approximately over 5 day period. 5 days are equivalent to 120 hrs. At full load the team will need 200 gallons of fuel. At 1/4 load the team will need only 60 gallons of fuel. The DCA25SUI generator uses ASTM-D975-No.1 & No.2-D fuel (DIESEL).

Team will bring 41 gallons of fuel on the first day of assembly and refill as necessary based on need. The initial 41 gallons will be already contained in the spill proof tank within the generator. The excess fuel is not to be stored on the competition site and should be delivered when it is ready to be placed in the generator



Summary of Unlisted Electrical Components

At this time there are no non-UL listed components in the design of Team New York's House.

All Electrical Components are UL listed. See attached for PV Panel UL certification.



Certificate of Compliance

Certificate Number 260111-E320066 - A
Report Reference E320066, 2010 Oct. 13
Issue Date 2011 January 26

Page 1 of 1



Issued to: YINGLI ENERGY (CHINA) CO LTD

3399 N Chaoyang Rd
Baoding, Hebei 071051
China

*This is to certify that
representative samples of*

Photovoltaic Modules and Panels

USL/CNL - (YLxxxxC-30b series) YL225C-30b, YL230C-30b, YL235C-30b,
YL240C-30b, YL245C-30b, YL250C-30b, YL255C-30b, YL260C-30b; (YLxxxxC-
27b series) YL205C-27b, YL210C-27b, YL215C-27b, YL220C-27b, YL225C-27b,
YL230C-27b; (YLxxxxC-24b series) YL180C-24b, YL185C-24b, YL190C-24b,
YL195C-24b, YL200C-24b, YL205C-24b.

*Have been investigated by Underwriters Laboratories in accordance with
the Standard(s) indicated on this Certificate.*

Standard(s) for Safety: UL 1703 - STANDARD FOR FLAT-PLATE PHOTOVOLTAIC MODULES
AND PANELS - Edition 3 -Revision Date 2008-04-08
ULC/ORD C1703 - STANDARD FOR FLAT-PLATE PHOTOVOLTAIC
MODULES AND PANELS, FIRST EDITION, REVISED OCTOBER 2001

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Interconnection Application Form

Team Team New York Solar Roofpod Lot 403

PV Systems

Module Manufacturer	Short Description of Array	DC Rating of Array (sum of the DC ratings)
Sunpower E19/238	4 strings composed by 10 PV modules each string.	9.520

Total DC power of all arrays is 9.520 kW (in tenths)

INVERTERS

Inverter Manufacturer	Model Number	Voltage	Rating (kVA or KW)	Quantity
Enphase	M210-84-240-S12	240 V AC	0.210 KW	40

Total AC power of all inverters is 8.4 kVA or kW (in whole numbers)

1. E-601 One-Line Electrical schematic .
2. E-603 Calculations of service/feeder net computer load and neutral load (NEC 220)
3. E-101 Plan the service point and the distribution panel or load center.
4. A-204 Elevation view showing the terminal box (with service point) and the meter
5. E-201 Elevation showing other service equipment



3.0 Energy Analysis Results and Discussion

3.1 Energy Analysis

3.1.1 Approach

The main purpose of this energy analysis, which was done by a team of engineers, was to calculate the total power requirement of the house and to optimize the performance via selection of materials and changes in the envelope elements. The objective of the energy analysis was to aid the architects in designing and developing an energy efficient home. The engineering energy design team consists of Electrical, Environmental and Mechanical engineering students. The thermal load analysis of the *Roof Pod* was done by Mechanical Engineers, while the power consumption analysis was conducted by Electrical Engineers. Both thermal and power analyses required a weather file in order to run the necessary simulations, which were performed by the Environmental Engineers.

The first step taken in the energy analysis was to calculate the thermal load of the house. The thermal load of the house is measured by the amount of necessary power consumed while running the heating and cooling equipment to meet indoor comfort levels. The thermal load results aided in selecting the necessary materials for thermal insulation, amount, type and size of windows and equipment needed for heating and cooling of the house. If the thermal load of the house is smaller than the amount of energy required to run it, then heating and cooling equipment will be needed less.

These simulations were all completed using EnergyPlus™ software from the US Department of Energy (Energy, The Office of Energy Efficiency and Renewable Energy (EERE), 2010) EnergyPlus™ is a building energy simulation tool based on transfer functions that consider the details of the envelope, users' level of activity, lighting, and appliances. There are other simulation tools available for these purposes including those we learned in classrooms (i.e. HCB, HVACExplorer, Revit Building Performance Analysis Tool); however, EnergyPlus™ is comprehensive in terms of representation of the actual building and annual weather conditions. As an initial step in the thermal load analysis, the Energy Analysis team conducted a parametric study on the wall insulation and the window area for each surface of the house. The results were provided to students from architecture to help determine whether the design met with the appropriate thermal insulation values (U-values) to maintain low cooling and heating loads. The design results inferred whether the team has an adequate U-value, if not, the window area and insulation were revised accordingly. When the revisions were completed, the simulation model was updated and further simulations were conducted. The coordination between architecture and engineering was essential in order to understand and determine the most energy efficient and concise envelope for our design.



3.2 Parametric Energy Analysis of the Envelope

The parametric energy analysis provided an objective method to determine how the envelope elements of the house impacted the thermal load. The parametric analysis considered the R-values for walls and roofs, and the amount of openings for windows in each surface of the house. The basic building utilized in EnergyPlus™ is shown in Figure 3.1 below. The parametric analysis was conducted considering weather conditions for Washington, DC, using Typical Meteorological Year 3 of the National Renewable Energy Lab (Energy, The Office of Energy Efficiency and Renewable Energy (EERE), 2010).

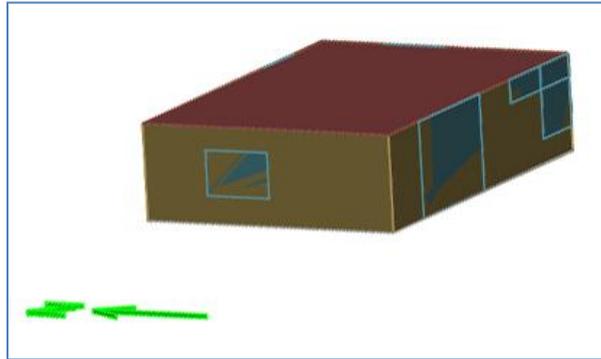


Figure 3.1 - Basic building design utilized for the simulations

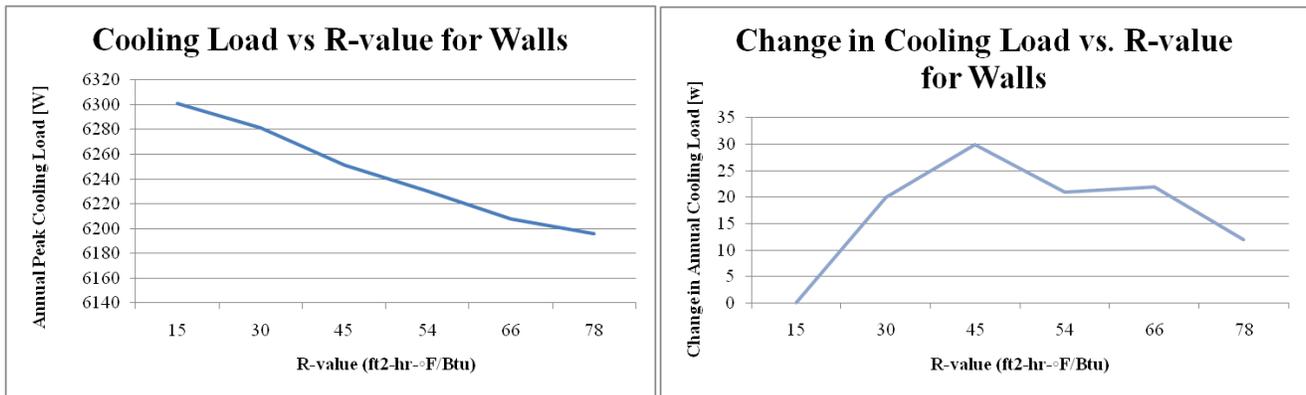


Figure 3.2 - Cooling load (Left) and change in cooling load (Right) as function of R value for the walls

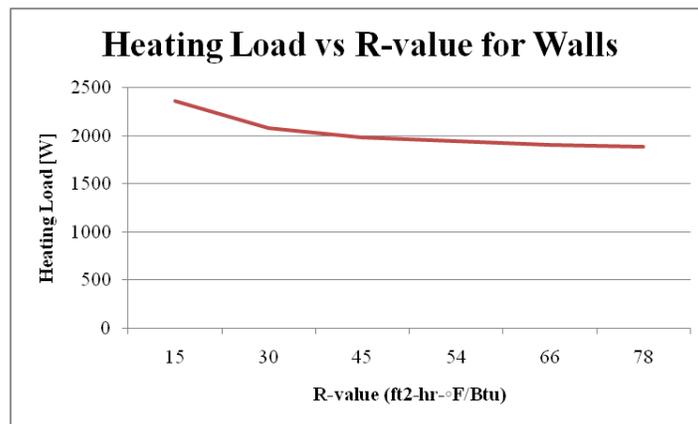


Figure 3.3 - Heating load as function of R value for the walls



In figure 3.2, the graph on the left of shows the cooling load reducing as the R-value increases, while the graph on the right shows that the insulation performance drops after R-45. It is shown that conduction losses are minimal after R-45 insulation; therefore, there is no advantage in increasing the R-value further in the *Roof Pod*. Figure 3.3 shows that the heating load doesn't show a significant change as we increase the R-value.

3.2.1 Roof Insulation Determination

The determination of the roof insulation was a challenging task given the fact that the roof is not directly exposed to the sun due to the placement of the Photovoltaic and solar thermal collectors on the roof. The analysis was, therefore, conducted considering the roof to be exposed directly to the sun; this was used as a safety factor.

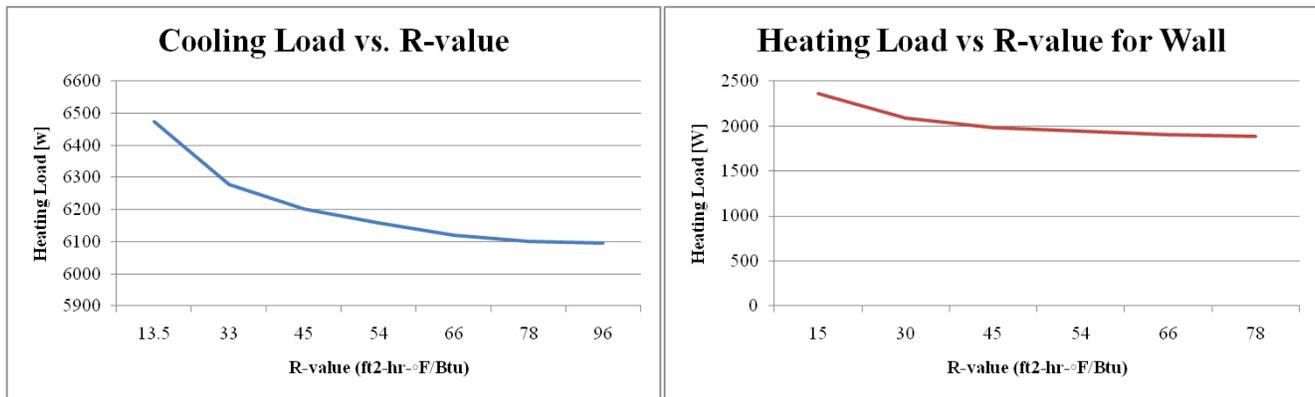


Figure 3.4 - Impact on cooling load (Left) and heating load (Right) as function of R value for the roof

In Figure 3.4, the left graph shows the cooling load reducing as the R-value increases. After R-55, the graph begins to flatten and there are no significant changes in the cooling load. The right graph of figure 3.4 shows that there is no significant drop in the heating load with increasing R-value.

3.2.2 Floor Insulation Determination

The house is meant to be set on the roof tops of buildings. This means that there is no direct contact between the floor of the house and the earth. To take this into account during the simulation, the floor is exposed to the ambient air, which will also be the case for the competition in DC. The assumption that was made was the following: the floor was assumed to be exposed to outdoor air because the *Roof Pod* will be considered a floating zone.



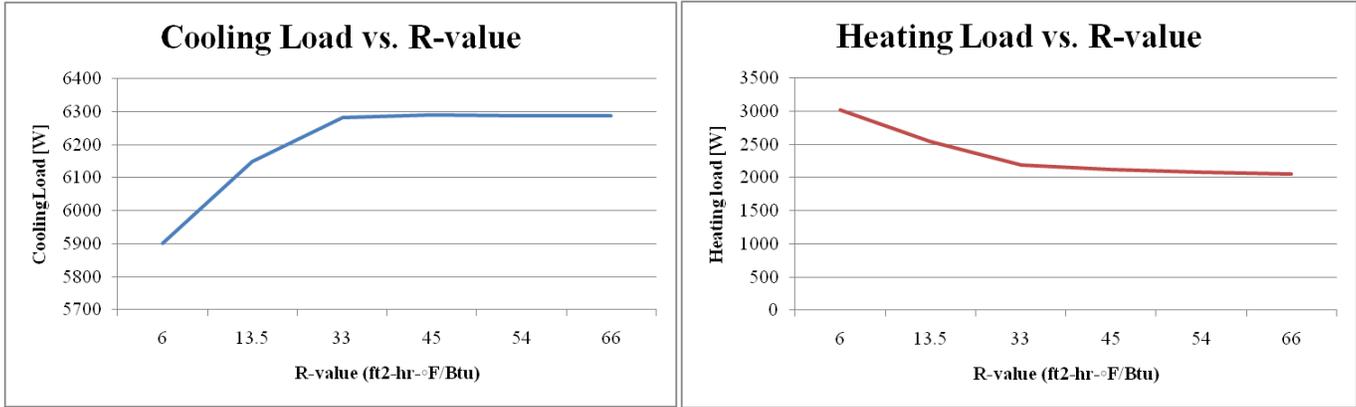


Figure 3.5 - Cooling (Left) and heating loads (Right) as function of R values for the floor

The left graph of Figure 3.5 shows an anomaly in the cooling load results due to the floating zone assumption. This could be due to the fact that the floor is not touching the ground and the EnergyPlus™ code possibly assuming the outdoor air temperature as the ground temperature. Also, the cooling results do not change after R-45. Another reason could be due to increase in thermal mass caused by the increase in the amount of insulation. The cooling load will increase if the thermal mass of the house increase. Heat transfer rate is very low between the floor and air when the house is assumed to be a floating zone. If the floor is touching the ground the cooling load might decrease, since the floor and ground have a high heat transfer rate, which will help release the heat from the thermal mass. Additional caution must be exercised regarding this floor setup assumption. A different thermal load analysis software has to be used for cross validation of EnergyPlus™ results. HCB (Heating and Cooling of Building) software was used to double check the results from Energy Plus™. HCB results and setup options were given in the Appendix of energy analysis.

3.2.3 Summary of Parametric Energy Analysis of the Envelope

The Energy Analysis team recommends the solution on Table 3.1 after conducting parametric analysis on the *Roof Pod* envelope.

Table 3.1 - Summary of Optimized R Values for the Roof pod

Surface	R-value (ft ² -hr-°F/Btu)	Material Used
Walls	34	SPRAY FOAM:STYROFOAM™
Roof	45	SPRAY FOAM:STYROFOAM™
Floor	35	SPRAY FOAM:STYROFOAM™



3.3 Parametric Energy Analysis on Window Area vs. Thermal Load

The amount of windows placed on each façade plays a key role in the cooling load of the house since they bring daylight into the house. Therefore, there should be a balance when considering the window area size. From an energy analysis perspective, the tendency is to reduce the amount of south side window area as much as possible to reduce thermal loads (for Northern latitudes), and to expose them in winter for passive heating. Here, the approach was to study all walls for reduction of thermal loads and to maximize day lighting.

The basic window type used for the analysis was a double pane window with a SHGC (Solar Heat Gain Coefficient) or SHGF (Solar Heat Gain Factor) of 0.7 and a U value of 0.53 Btu/hr-ft²-°F. Results of these simulations are given in Figures 3.6 through 3.9 for both cooling and heating loads. The summary of the results is shown in Table 3.2 below. During each analysis, the window area on one side of the house was changed but the window area on all the other three sides were kept constant.

Table 3.2 - Summary of Optimized Window Area for the Roof pod

Surface	Percentage of Wall Area
South	49
North	4
East	18
West	11

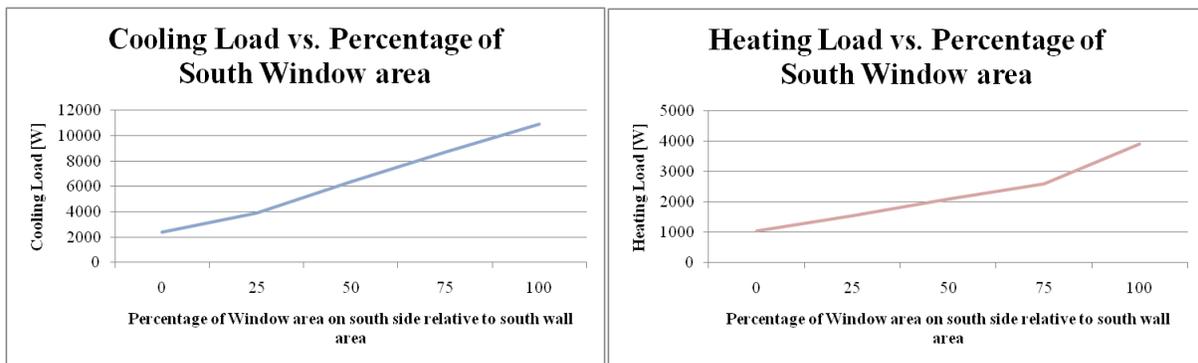


Figure 3.6 - Impact of thermal load as function of Southside wall to window area, cooling (Left), heating (Right)

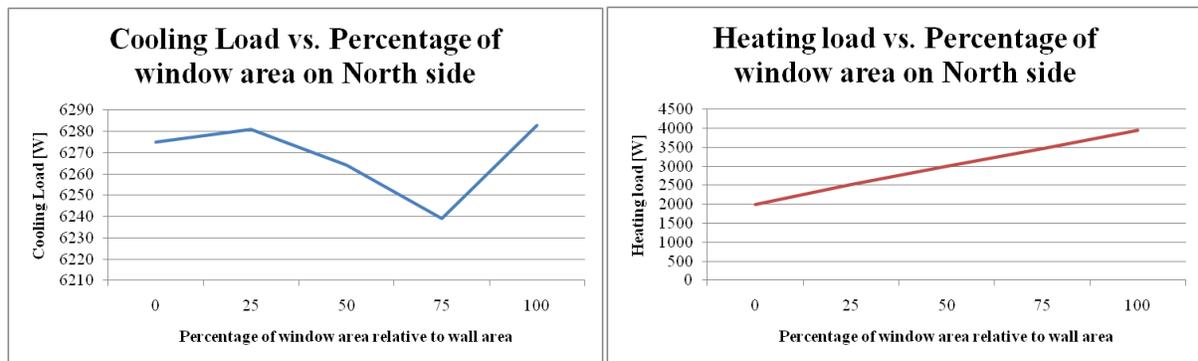


Figure 3.7 - Impact of thermal load as function of North side wall to window area, cooling (Left), heating (Right)



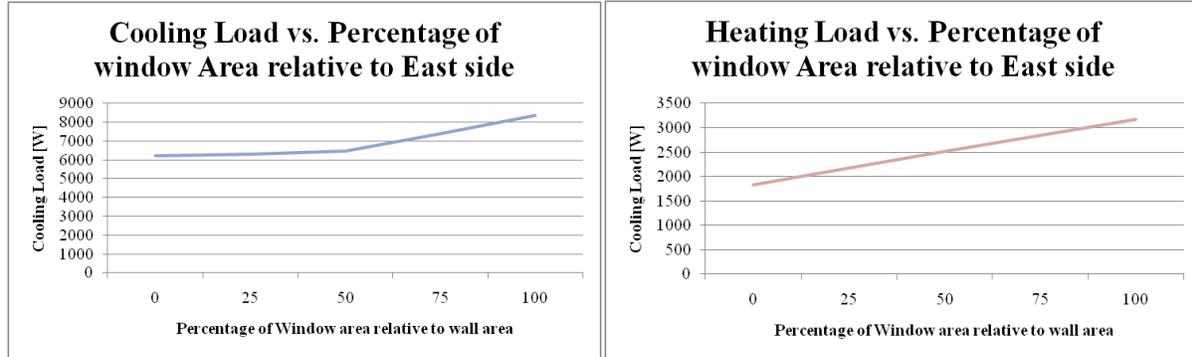


Figure 3.8 - Impact of thermal load as function of East side wall to window area, cooling (Left), heating (Right)

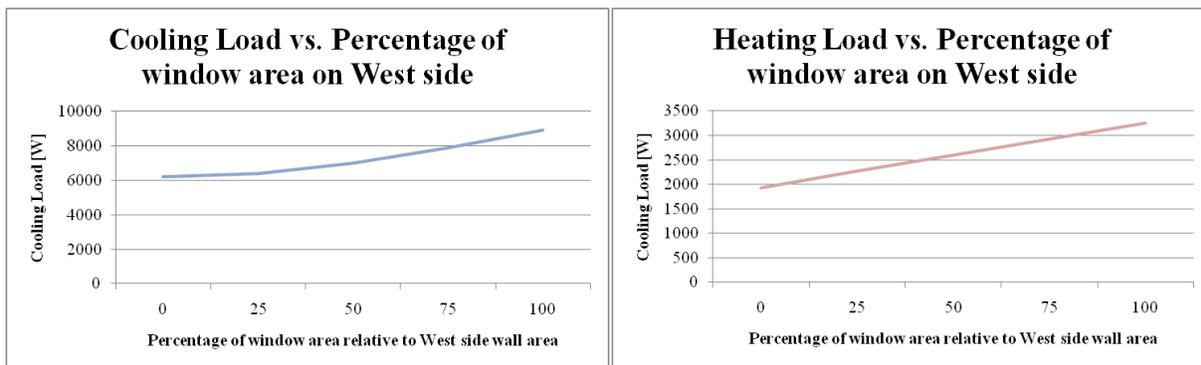


Figure 3.9 - Impact of thermal load as function of West side wall to window area, cooling (Left), heating (Right)

As expected, the figures show that the largest impact on the thermal load occurs in the south side of the building. In figure 3.6, the left graph shows an increase in the cooling load as the window area on the south side is increased. The cooling load ranges between 2000 W and 12000 W. In the left graph of figure 3.7, it can be seen that there is no significant increase in the cooling load as the window area increases on the north side. The range is between 6230 W to 6280 W. Thus, if more windows are preferred for the home, the Energy Analysis recommends they be implemented on the north side of the *Roof Pod*.

3.3.1 Parametric Energy Analysis on Shading and Blinds

Implementing shades and blinds will reduce the amount of sunlight that goes into the house. This will help in reducing the thermal load of the house. Before determining the amount of shades or blinds required, a daylight analysis should be conducted to insure the house received enough daylight. Shading and Blind Analysis results were passed to the Control and Monitoring team to develop a strategy to control the shades and maintain daylight. Day lighting is discussed in the following subsections. Table 3.3 below provides a summary of the shading analysis, showing reductions with the use of shadings and blinds in the south side walls.

Table 3.3 - Summary of results with and without shading and blinds

Optimization	Cooling Load [W]
No Shading or Blinds	6222
Only Shades	5747
Shades and Blinds	4979



3.3.2 Parametric Energy Analysis on Implementation of Overhang on the south side

In order to increase the amount of windows on the south side, an overhang should be implemented. This is because an overhang on the south side would reduce the cooling load of the house. The overhang was also implemented to increase the amount of photovoltaic panels on the roof. The dimensions of the overhang are 0.6 m in depth by 9.7 m in length.

Table 3.4 - Summary of results with and without overhang

Optimization	Cooling Load [W]
No Overhang on the south side	4650
Overhang on the south side	3532

As an extra development, the Architectural team decided to add more windows on the south elevation. This will provide the resident with a better view of his or her surroundings. The addition of more windows along with the overhang did not affect the analysis greatly so it was deemed as a good design in terms of energy analysis.



3.4 Conservative and Optimized Energy Analysis

The *Solar Roof Pod* has a very interesting and complex window arrangement. It is a challenge to quantify the performance of this house with a single simulation result. The Energy Analysis team decided to conduct two types of analysis to understand the performance of the *Roof Pod*. These two types of analyses are conservative and optimized energy analysis. The conservative energy analysis results will show the worst case scenario for the performance of the house and the optimized analysis results will show the optimum performance of the house by using different window configurations.

The conservative energy analysis was done for Washington DC and New York City. Optimized energy analysis was only done for Washington DC. NREL Typical Meteorological Year-3 (TMY3) weather files were used for conservative and optimized energy analysis results.

3.4.1 Weather Files

- For Central Park, New York

New York-Central Park 725033 (TMY3)

http://apps1.eere.energy.gov/buildings/energyplus/cfm/weather_data3.cfm/region=4_north_and_central_america_wmo_region_4/country=1_usa/cname=USA#NY

- For Washington DC

Baltimore-Washington Intl AP 724060 (TMY3)

http://apps1.eere.energy.gov/buildings/energyplus/cfm/weather_data3.cfm/region=4_north_and_central_america_wmo_region_4/country=1_usa/cname=USA#MD

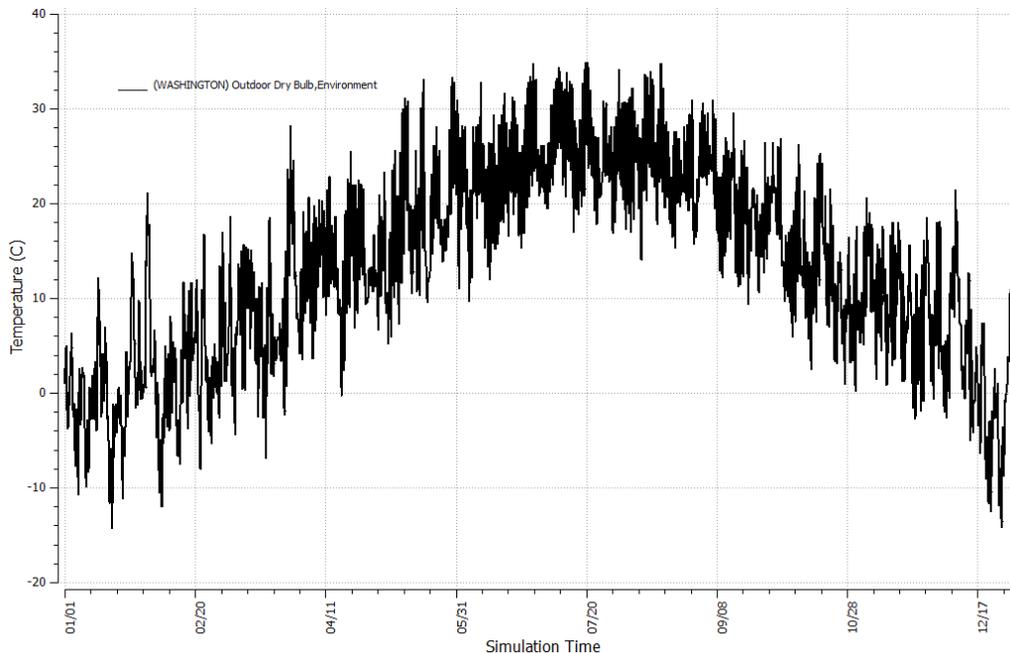


Fig 3.10 - Annual Outdoor Dry Temperature for Washington DC, Data from TMY3 weather files



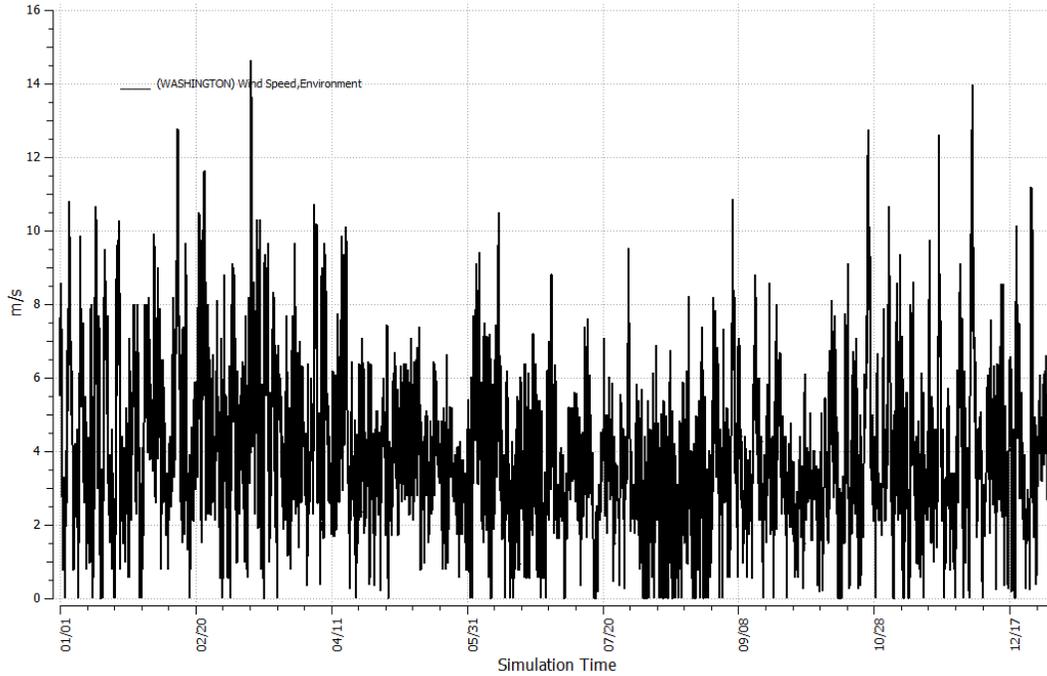


Fig 3.11 - Annual Wind Speed for Washington DC, Data from TMY3 weather files

3.4.2 Conservative Energy Analysis Results

In the conservative energy analysis, a constant U-value data from ASHRAE Handbook – Fundamentals Table 4 was used.

Table 3.5 - Maximum Thermal Load Results for Washington DC and New York

Maximum Thermal Load Results	Cooling Load (W)	Heating Load (W)
Washington		
<i>Annual Load</i>		
SHGF = 0.8	6700	5500
SHGF = 0.5	5700	5500
SHGF = 0.3	5000	5700
<i>Months of September and October</i>		
SHGF = 0.8	6400	2400
SHGF = 0.5	4600	1900
New York		
<i>Annual Load</i>		
SHGF = 0.8	7400	5800
SHGF = 0.5	5900	5900
SHGF = 0.3	5200	5900



As previously stated, the conservative energy analysis is used to show the low limit or worst performance design of the *Roof Pod*. Based on table 3.5, this occurs under an SHGF of 0.8. Therefore, the *Roof pod* should have a cooling load of 6700W.

Table 3.6 - Envelope output details from conservative energy analysis results

Component	Construction	U-Factor with Film [W/m ² -K]	Gross Area [m ²]	Azimuth Angle [°]	Tilt Angle [°]	Cardinal Direction
SOUTH WALL	WALL	0.159	23.09	180	90	S
NORTH WALL	WALL	0.159	23.09	0	90	N
EAST WALL	WALL	0.159	15.55	90	90	E
WEST WALL	WALL	0.159	15.55	270	90	W
FLOOR	FLOOR	0.157	62.34	270	180	
ROOF	ROOF	0.158	62.34	180	0	

Table 3.7 - Window output details from conservative energy analysis results

Component	Construction	Area of Openings [m ²]	U-Factor [W/m ² -K]	SHGC	Visible Transmittance
SOUTH DOOR	DOUBLE PANE WINDOW	7.78	5.837	0.301	0.901
SOUTH WINDOW 1	DOUBLE PANE WINDOW	0.94	5.837	0.301	0.901
SOUTH WINDOW 2	DOUBLE PANE WINDOW	0.88	5.837	0.301	0.901
SOUTH WINDOW 3	DOUBLE PANE WINDOW	1.84	5.837	0.301	0.901
SOUTH WINDOW 4	DOUBLE PANE WINDOW	0.94	5.837	0.301	0.901
NORTH DOOR	DOUBLE PANE WINDOW	7.78	5.837	0.301	0.901
NORTH WINDOW 1	DOUBLE PANE WINDOW	1.94	5.837	0.301	0.901
EAST WINDOW 1	DOUBLE PANE WINDOW	1.96	5.837	0.301	0.901
EAST WINDOW 1	DOUBLE PANE WINDOW	0.94	5.837	0.301	0.901
WEST WINDOW 1	DOUBLE PANE WINDOW	1.94	5.837	0.301	0.901
WEST WINDOW 1	DOUBLE PANE WINDOW	0.94	5.837	0.301	0.901
Total or Average		27.88	5.84	0.301	0.901
North Total or Average		1.94	5.84	0.301	0.901
Non-North Total or Average		25.94	5.84	0.301	0.901



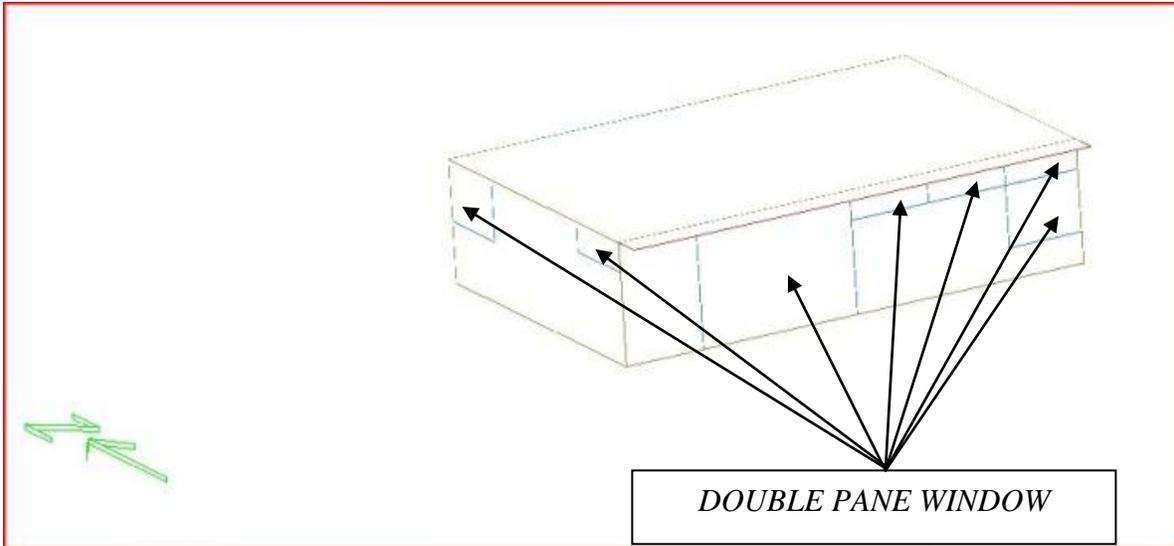


Fig 3.12- South and West façade window configuration for conservative energy analysis

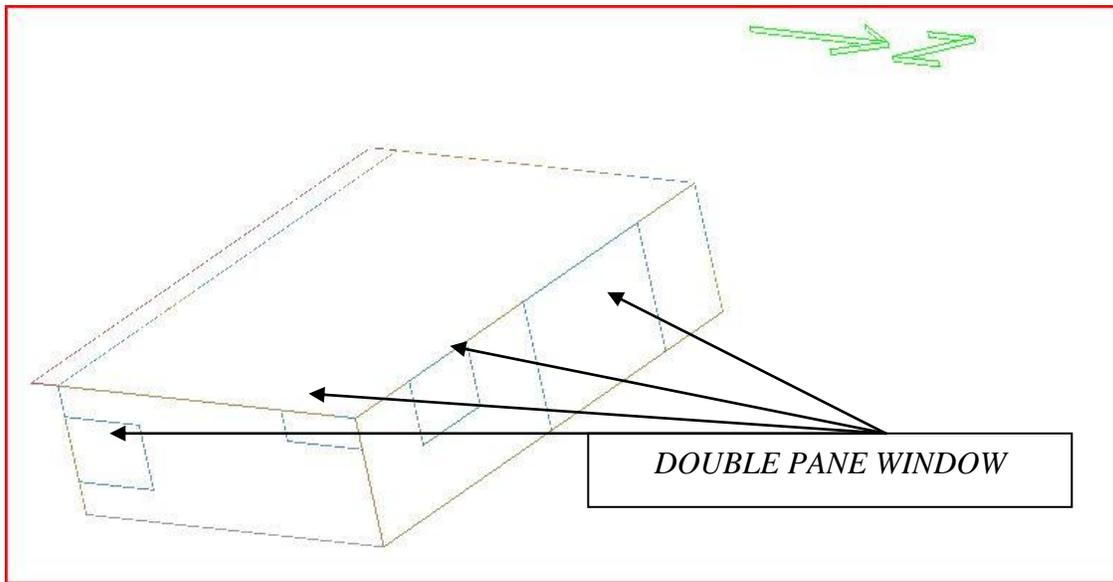


Fig 3.13 - North and East façade window configuration for conservative energy analysis

Table 3.8 shows the profile of the cooling and heating loads as the SHGF of the windows change. These graphs stress the importance of selection of good windows to get good performance output.



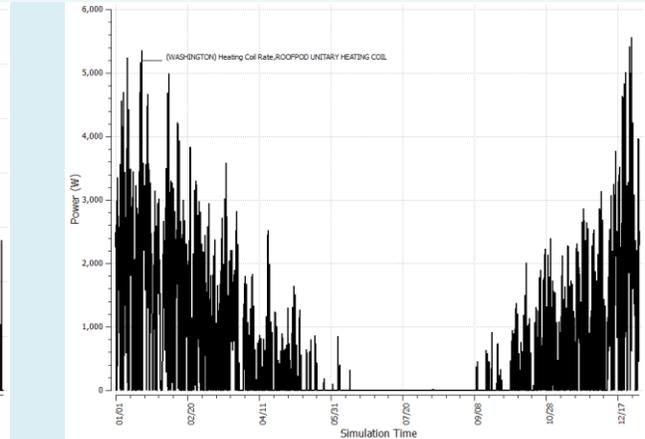
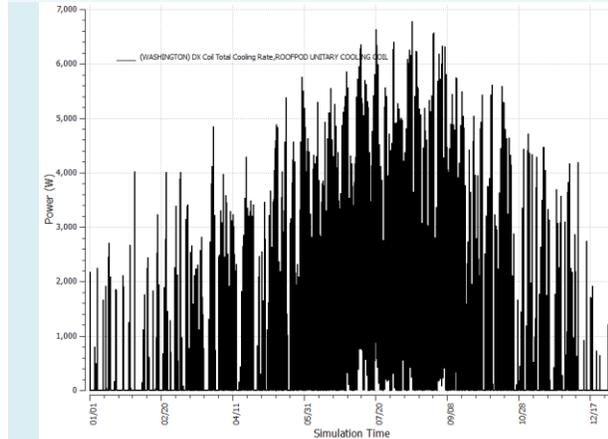
Table 3.8 - Summary of Conservative Energy Analysis Results for Washington DC

Annual Thermal Load

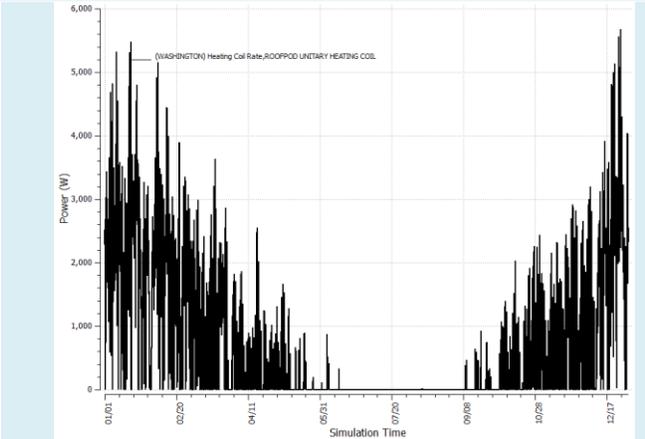
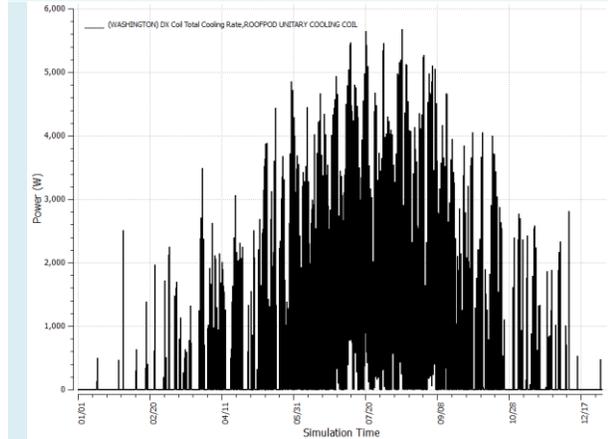
Cooling Load

Heating load

SHGF 0.8



SHGF 0.5



SHGF 0.3

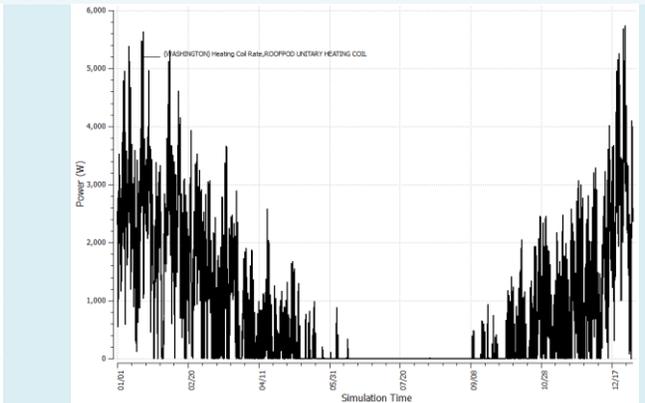
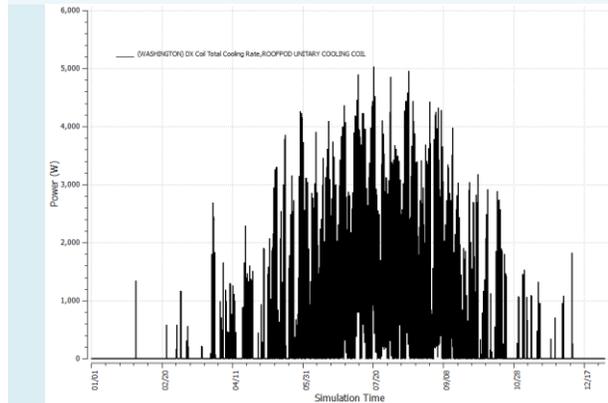


Table 3.9 - Conservative Energy Analysis Results for Washington DC for the months of September and October
For the months of September and October

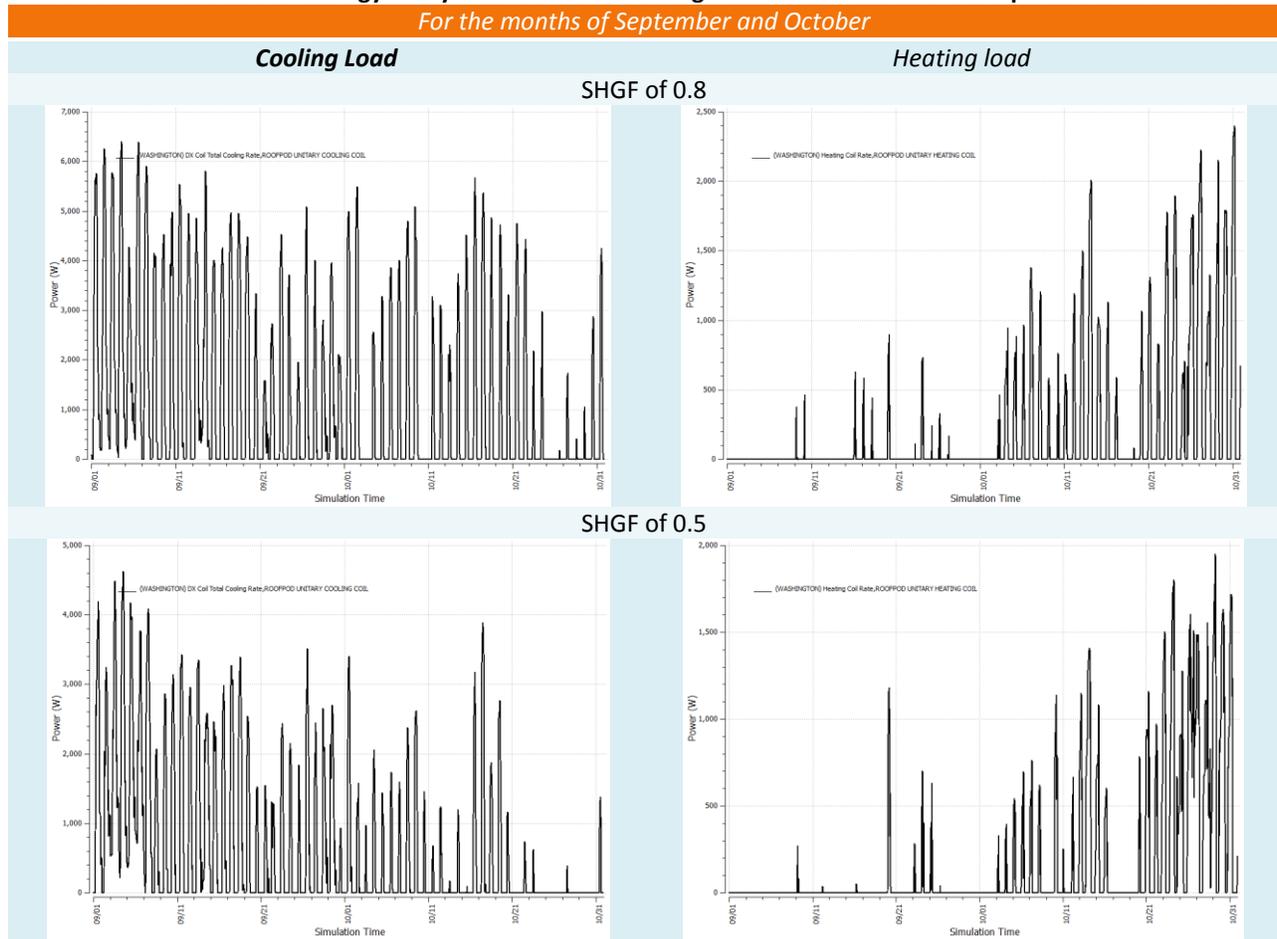
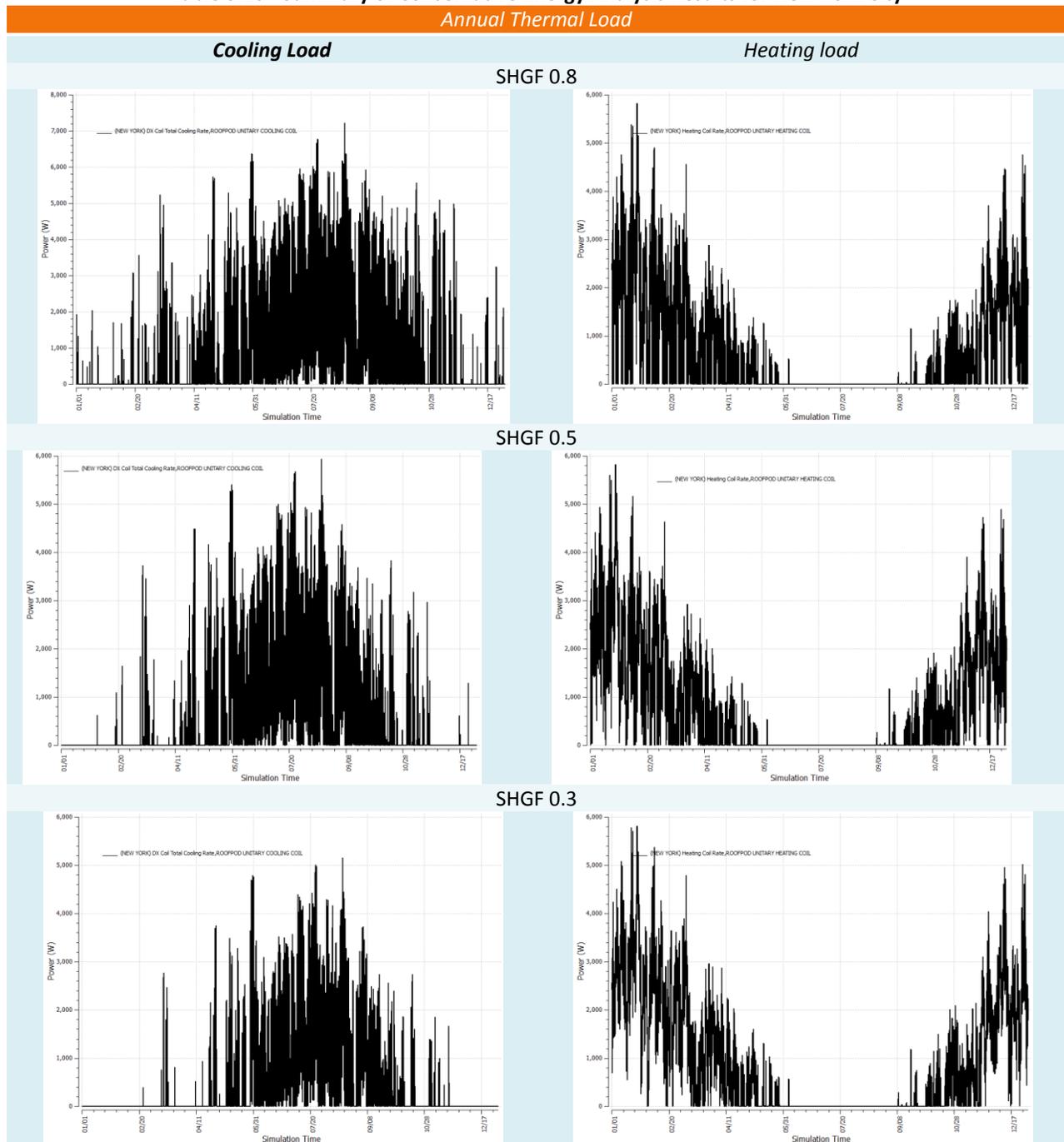


Table 3.10 - Summary of Conservative Energy Analysis Results for New York City

Annual Thermal Load



3.4.3 Optimized Energy Analysis

Unlike the conservative energy analysis, the optimized energy analysis used window properties that were updated because most of the windows in the *Roof Pod* have a low SHGF and Different U-values. Some windows or doors with low U-value, or low SHGF were removed and replaced with walls. This was done since these windows have a U-values that are almost similar to the wall U-value. This means the conduction losses are similar to a wall and relatively less than other windows. These windows also have SHGF value of 0.10. This means the radiational heat gain is also less, so we can treat these windows as walls.



Table 3.11 - Window output details from Optimized Energy Analysis Results

Component	Construction	Area of Openings [m ²]	U-Factor [W/m ² -K]	SHGC	Visible Transmittance
SOUTH DOOR	<i>MICROSHADEWINDOW</i>	7.78	1.099	0.303	0.471
SOUTH WINDOW 1	<i>RETROFLEXWINDOW</i>	0.94	1.199	0.084	0.033
SOUTH WINDOW 2	<i>RETROFLEXWINDOW</i>	0.88	1.199	0.084	0.033
SOUTH WINDOW 3	<i>DEKOREXWINDOW</i>	1.84	1.199	0.801	0.742
SOUTH WINDOW 4	<i>RETROFLEXWINDOW</i>	0.94	1.199	0.084	0.033
NORTH WINDOW 1	<i>WINDOW TYPE1</i>	1.94	1.099	0.801	0.901
EAST WINDOW 1	<i>DEKOREXWINDOW</i>	1.96	1.199	0.801	0.742
WEST WINDOW 1	<i>DEKOREXWINDOW</i>	1.94	1.199	0.801	0.742
WEST WINDOW 2	<i>RETROFLEXWINDOW</i>	0.94	1.199	0.084	0.033
Total or Average		19.17	1.15	0.46	0.512
North Total or Average		1.94	1.1	0.801	0.901
Non-North Total or Average		17.22	1.15	0.422	0.468

Cooling and heating load numbers will be even better when shading controls are implemented. However, shading controls for DEKOREXWINDOWS in Table 3.11 are not performed in the optimized energy analysis. Current simulations use Simple Glazing object in EnergyPlus™ but shading controls can be implemented only when a detailed glazing analysis is performed. The detailed glazing analysis will be the future developments in the energy analysis of the *Solar Roof Pod*.

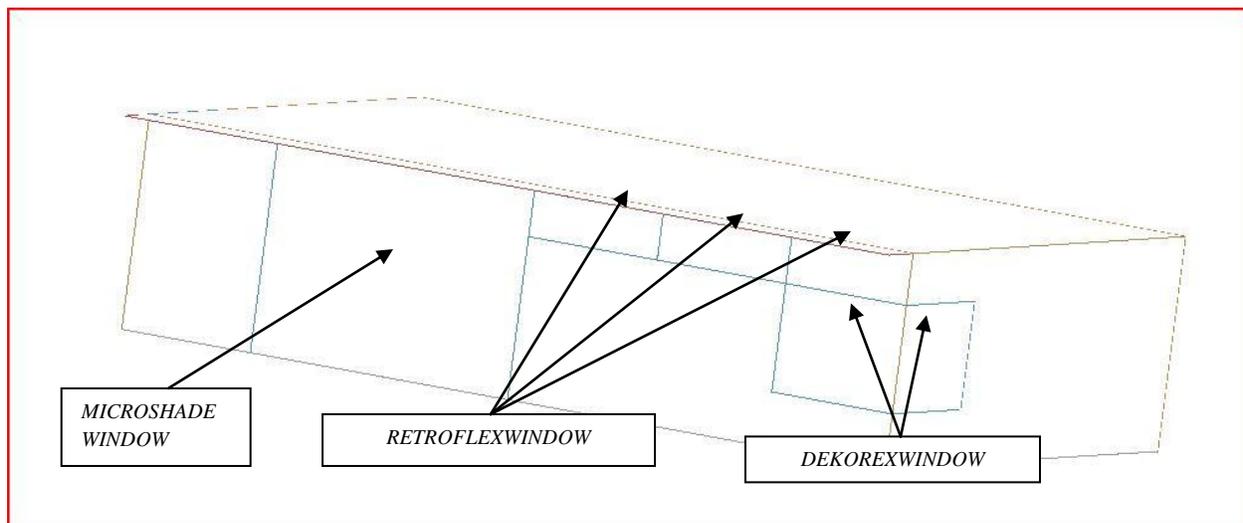


Fig 3.14- South and East façade used for Optimized Energy Analysis



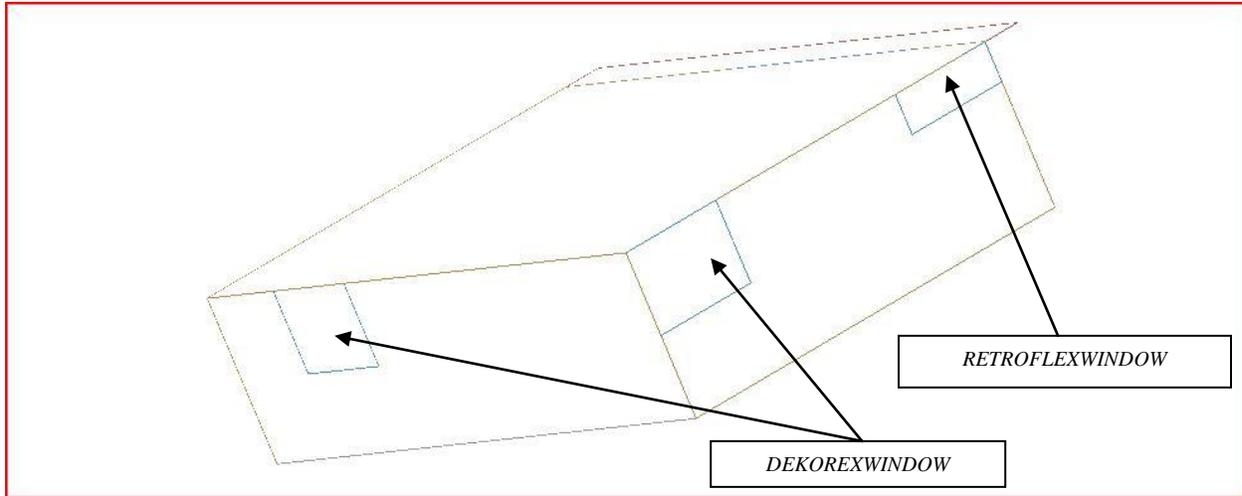


Fig 3.15 - North and West façade used for Optimized Energy Analysis

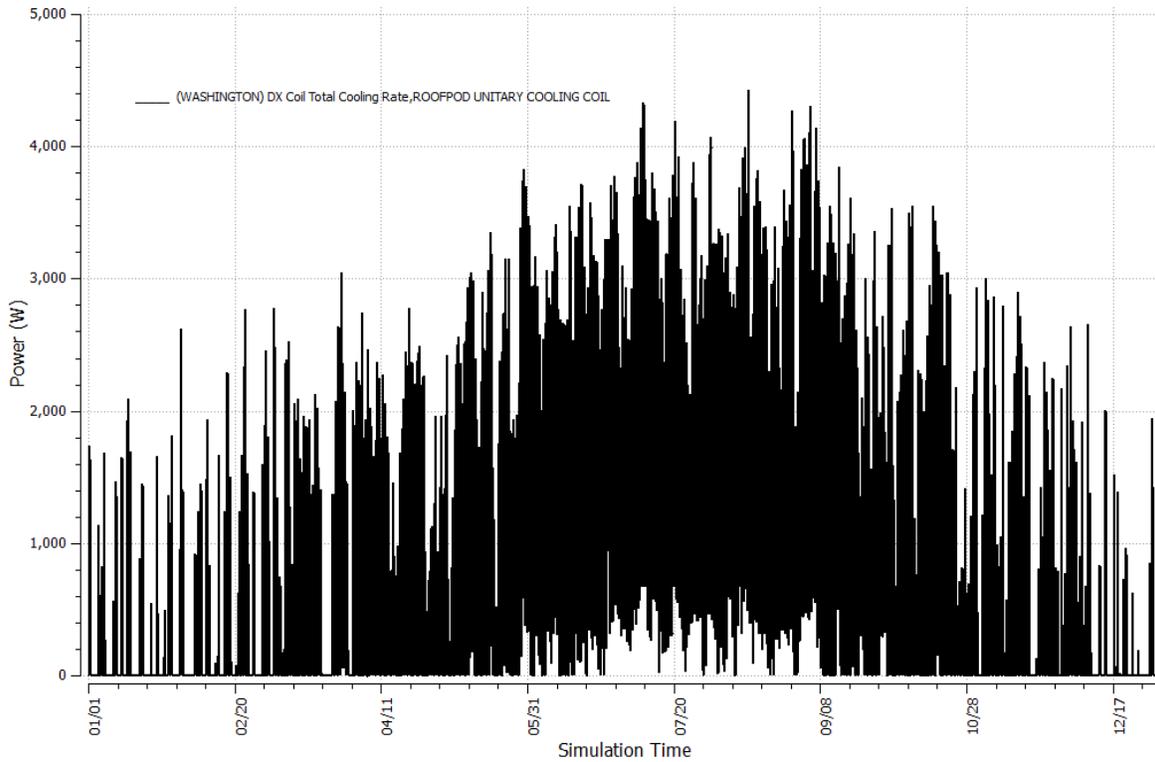


Fig 3.16 - Cooling Load Result from Optimized Energy Analysis, Location: Washington DC



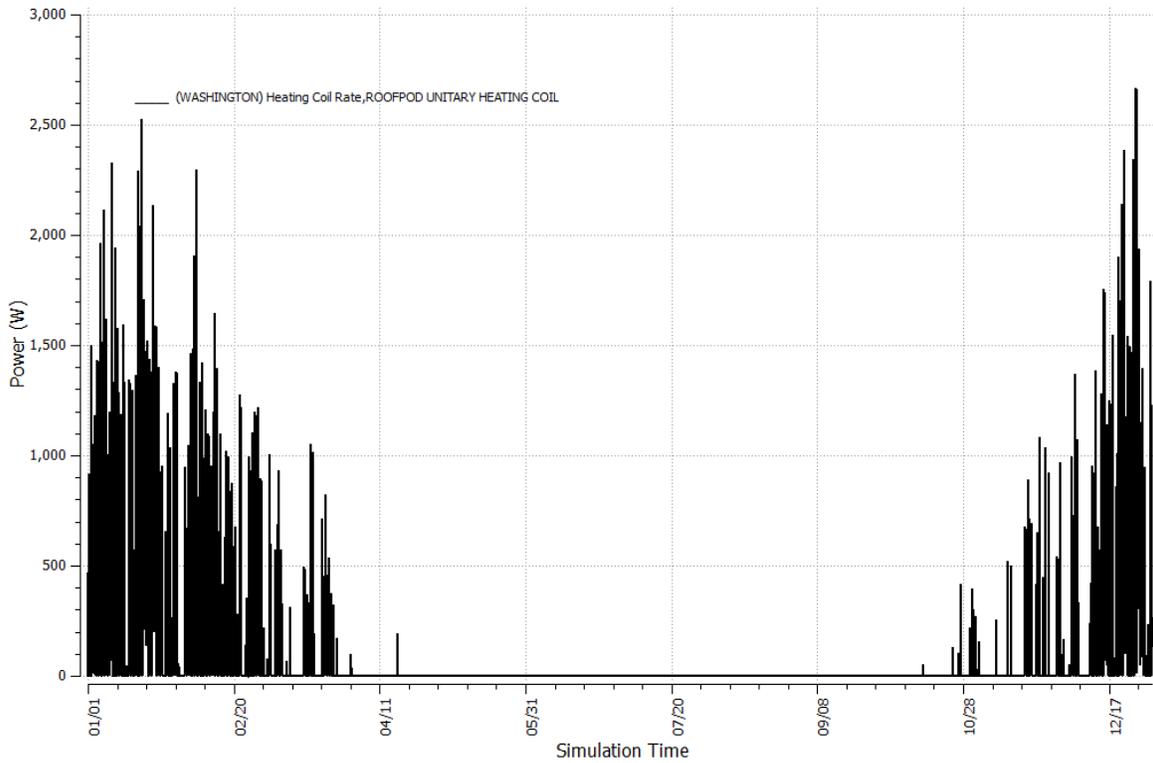


Fig 3.17- Heating Load Result from Optimized Energy Analysis, Location: Washington DC

Table 3.12 - Cooling and Heating Load Results from Optimized Energy Analysis

Optimized Analysis Results for Washington DC

<i>Maximum Cooling Load (W)</i>	<i>Maximum Heating Load (W)</i>
4500	2750



3.5 HAVC Power Consumption

Details of the HVAC equipment selection will be discussed further in section 5.0 HVAC Design. However, to proceed with sizing, the power consumption needed will be based on the thermal load analysis discussed above. HVAC power consumption was done for a 7000W house. The reason for this choice is due the fact that the *Roof Pod* will go through continuous upgrades and improvement until the competition date. It is hard to pin point or predict the exact thermal load of the house due to this continuous development and upgrades on the *Roof Pod* elements. It would be safe to size the HVAC power consumption for a low performance house and use the HVAC control system to run the HVAC under part load conditions.

The power consumption for HVAC was based on basic assumptions from professionals who worked on an adsorption cooling system. Such assumptions would be that the pump for the solar thermal collector will run for ten hours because during a regular day, sunlight will most likely be available for ten hours. The pumps for the cooling equipment were assumed to run for six hours. This means the pumps will run for fifteen minutes every hour to maintain indoor comfort levels. Similar assumptions were made for heating power consumption.

The adsorption system requires less electrical power than regular vapor compression system. This is because the only components that require energy are the pumps and fans used for fluid circulations. Again the operation hours for these equipment are assumed based on experience of professionals who worked on similar system.

3.5.1 Cooling Power Requirement

Table 3.13 – Cooling Power Requirement

Component	Power [W]	Operating hours	Total Power
Adsorption chiller	7	6	24
Pump Cooling tower	559	6	3354
Pump heat source	559	6	3354
Pump Solar collector	279	10	2790
fan in the cooling tower	124	6	744
		Wh/day	10266
		kWh/day	10.26

3.5.2 Heating Power Requirement

Table 3.14 – Heating Power Requirement

Component	Power [W]	Operating hours	Total Power
Pump heat source	559	12	6708
Pump Solar collector	279	10	2790
Radiant heating Pump	186	12	2232
		Wh/day	11732
		kWh/day	11.8



3.6 Daylight Analysis

3.6.1 Approach

The daylight simulation was performed using the same TMY3 weather file used to run the energy analysis of *The Roof Pod*. This was done to keep the elements in the simulations consistent across tasks. The simulation ran during the September 22nd equinox at 12:00 p.m.

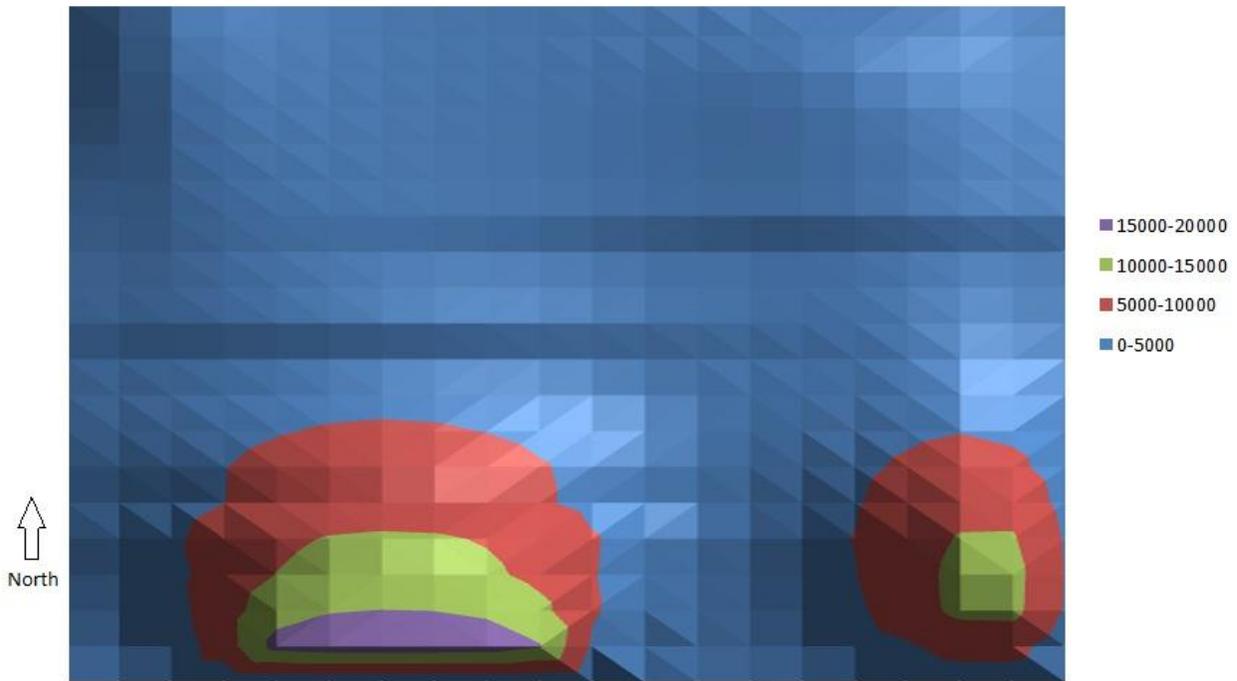


Figure 3.17 – Amount of Lux inside the house on September 22nd at 12:00 p.m.

This first analysis of *The Roof Pod* showed that the house is receiving intense direct daylight during the daytime hours, which creates direct glare and discomfort for the inhabitants of *The Roof Pod*. For a more detailed look at the amount of daylight inside the house, the team selected 4 significant points inside *The Solar Roof Pod*. These points include:

- Living room (1)
- North hallway (2)
- South hallway (3)
- Bedroom (4)

The approximate locations are shown in figure 3.18.



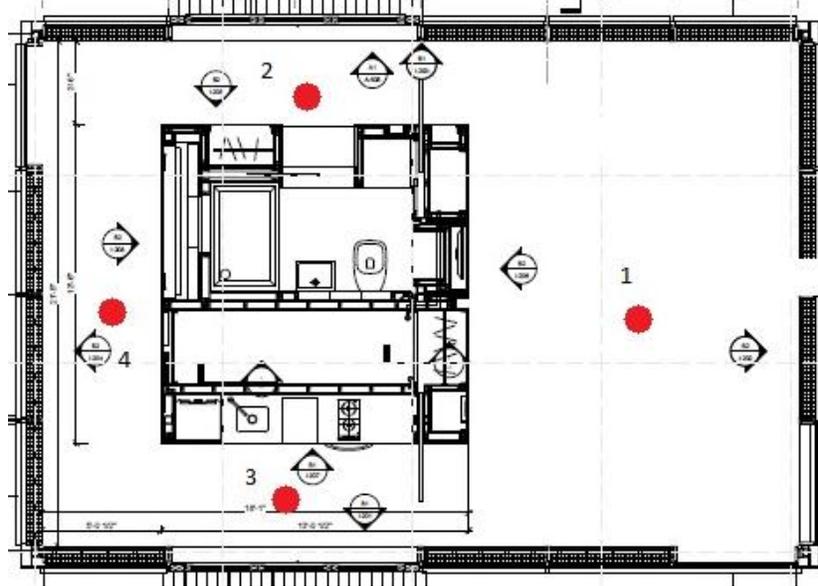


Figure 3.18 – Approximate locations of points of interest inside the Roof Pod.

The first point of interest is in the middle of the living room. It is assumed that the occupants of *The Solar Roof Pod* will spend plenty of leisure time in the living room. For this reason, the living room should be well illuminated, both with natural light whenever possible, and artificial light when needed.

Figure 3.19 shows the distribution of daylight in the living room over a period of time from 5:00 a.m. to 7:00 p.m.

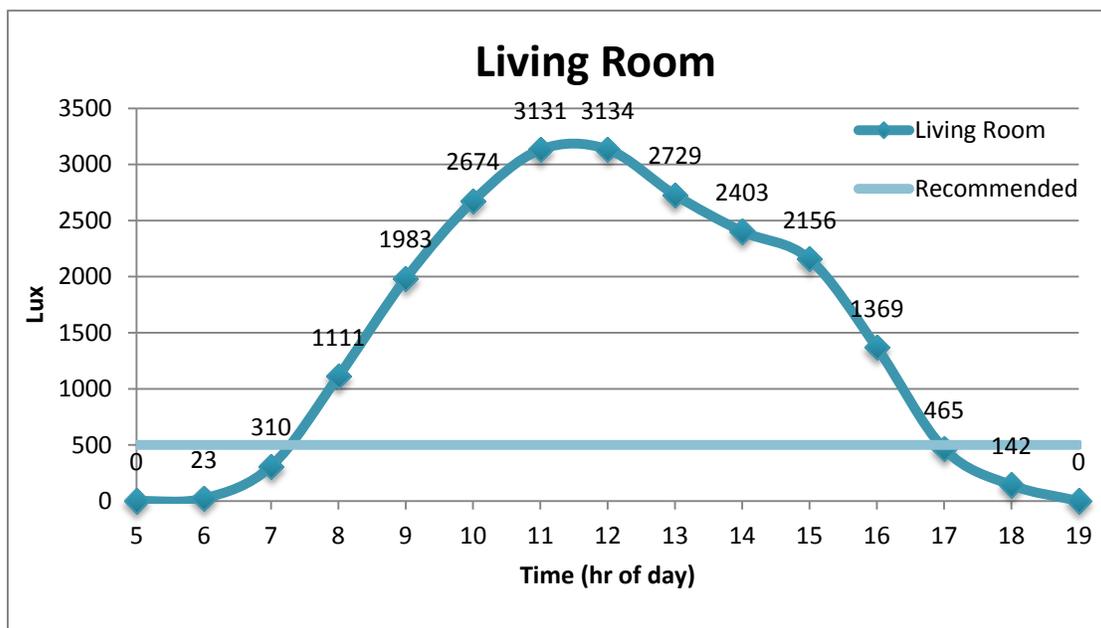


Figure 3.19 – Amount of lux in the living room.

It can be observed that lux levels in the living room reach a peak of around 3100 lux at around noon. This signifies that the living room is receiving more than enough daylight. In fact, the amount of lux is higher than the recommended task lux levels for a living room, which is at around 500 lux.



The analysis now focuses on the south hallway of the *Solar Roof Pod*. Since the hallway is located on the south side of the house, and faces large windows and glass doors, it is expected that this location will have significant amounts of daylight.

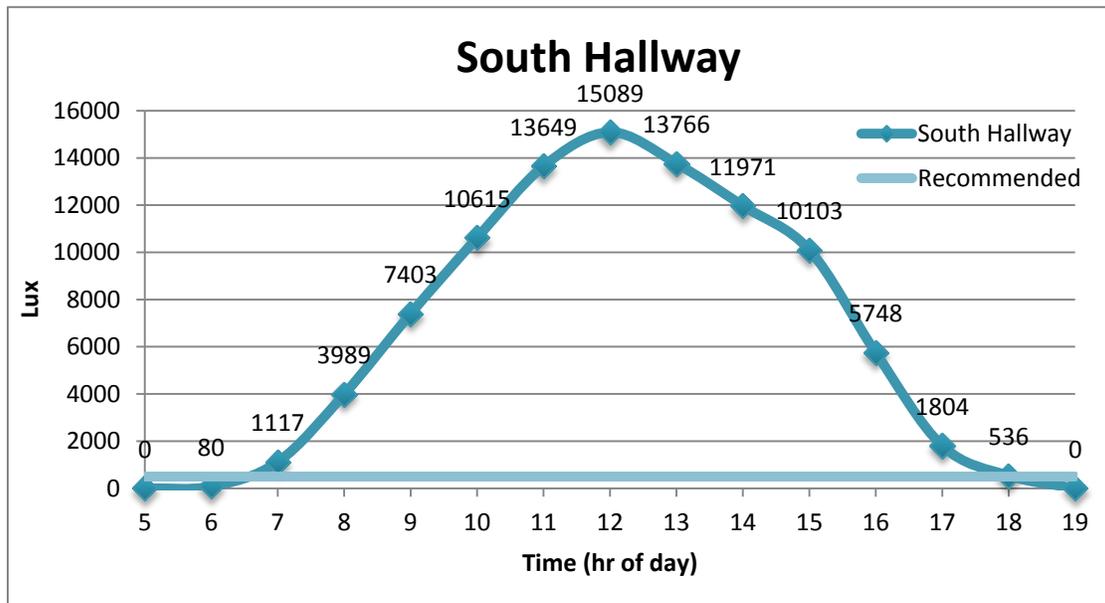


Figure 3.20 – Amount of lux in the south hallway.

Figure 3.20 depicts the varying amounts of lux the south hallway receives as the day progresses. As expected, the lux levels at this location inside the house are very high. The peak lux occurs at noon also, and it reaches levels exceeding 15,000 lux. Lux levels at above 10,000 are considered as full daylight. This full daylight requires to be mitigated, since this elevated lux levels creates glare and thus discomfort for the inhabitants of the *Roof Pod* as well as increasing thermal load.

Similar to the south hallway, the team analyzed the lux levels in the northern hallways. Figure 3.21 shows the amount of lux in the northern hallway.

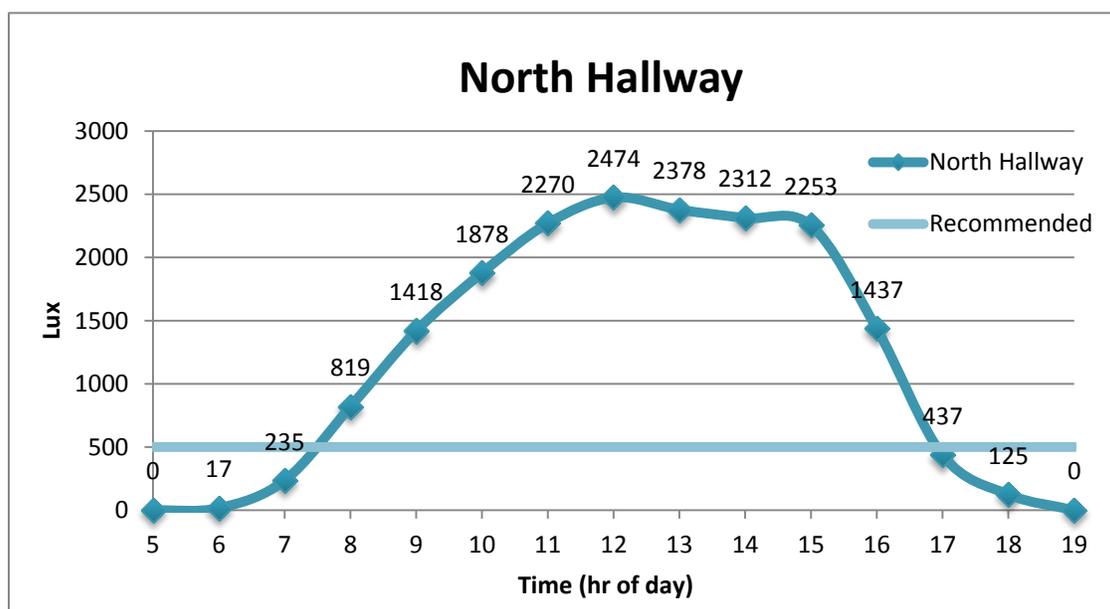


Figure 3.21 – Amount of lux in the north hallway.



The northern hallway has very little exposure to daylight due to its orientation and lack of fenestration. As figure 3.21 depicts, the peak lux hovers at around 2400 and it also occurs at noon. Once again, 2400 lux are high levels of illuminance that are considered high for a residence. The same also occurs for the bedroom, shown in figure 3.22.

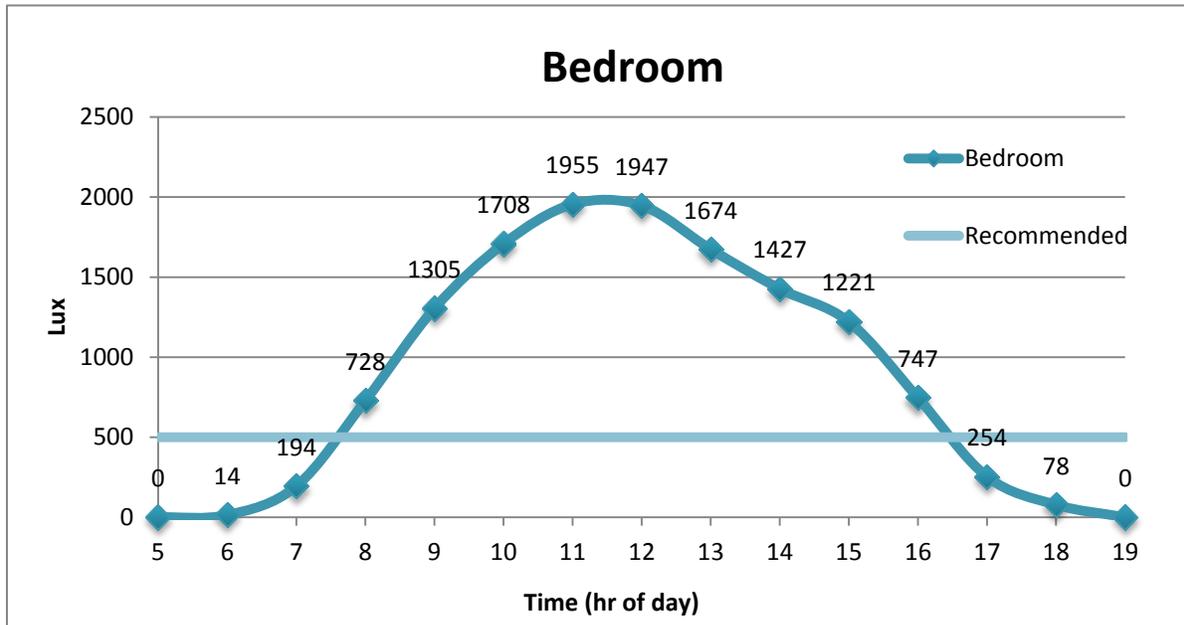


Figure 3.22 – Amount of lux in the bedroom.

Lux levels inside the bedroom are around 1900, which is less when compared to the other locations presented in the house, but still elevated. The peak lux occurs between 11:00 a.m. and noon, and reaches a peak of around 1960 lux.

The locations investigated inside the *Roof Pod* all show a common element: natural light levels inside the house are high. As mentioned in the beginning of this analysis, all the simulations were done without blinds or shades added to the simulated model. The analysis concludes that the house needs some type of shading or blinds elements.

3.6.1 Conclusions

To address this issue, the team selected specialized windows which have internal blinds at different angles. These internal blinds redirect or reflect light at certain times of the day; depending on the angle the sunrays hit the window elements. These types of windows are not only innovative, but also aid mitigating the excessive daylight reaching inside the *Solar Roof Pod*. In addition, with their reflective characteristics, the windows aid to minimize the solar heat gains of the *Roof Pod*.



3.7 Extreme Weather Analysis

The energy analysis of the house was made using a Typical Meteorological Year-3 (TMY3) weather file, which is a weather file that represents average weather conditions over a period of one year over a location, in this case, Baltimore-Washington Intl.

The energy analysis simulates the house under typical conditions; however, it does not tell us anything about how the house will perform under extreme weather conditions. This past decade has proven to be one with record-setting, severe weather events, making imperative an extreme weather analysis, since it will tell us how the house will perform under intense conditions which are to be expected in the future due to our changing climate.

The extreme weather analysis will look into three different weather events which could significantly affect the overall performance of *The Solar Roof Pod*, these events are:

- Heat waves
- Cold spells
- Overcast days

Each weather event will be characterized by a period of 7-15 days of extreme weather, depending on the scenario being observed. Due to its uncharacteristical weather, the year 2005 was chosen by our team as a good example. The year 2005 experienced a series of cold spells during winter, severe heat waves and consecutive days of overcast skies. The team sorted through the 2005 Baltimore-Washington Intl. and selected a series of weather events based on certain criteria according to the desired weather event. Similarly to the TMY3 weather file, this new 2005 weather file has an hourly resolution with both radiation and meteorological data.

3.7.1 Heat Waves

According to NOAA, 2005 was the warmest year on record¹, where consecutive heat waves scorched the northeastern portion of the U.S., including Washington D.C. and New York City. To observe the performance of *The Solar Roof Pod* under these extremes conditions, the team decided to filter the weather file based on a set threshold high temperature during the day. It was decided to put this threshold at 32.2°C, or 90°F, which is considered high for both Washington D.C. and N.Y.C.

After sorting through the data, the team determined that the days with significantly high temperatures above 32.2°C occurred during a period of 9 days running from July 19th, 2005 to July 27th, 2005. During this period of 9 days, the station in Baltimore registered 6-out-of-9 days with temperatures over our threshold of 32.2°C, which classifies it as a heat wave.

With this information, the team decided to run a simulation in Energy Plus™ within the specific timeframe from July 19th to the 27th, with hourly intervals for every day. The simulation will provide us for the cooling load needed for this extreme weather event. The results were plotted along with the original energy analysis with the original TMY3 weather file during the same time period. This will allow us to observe the difference between the two results.



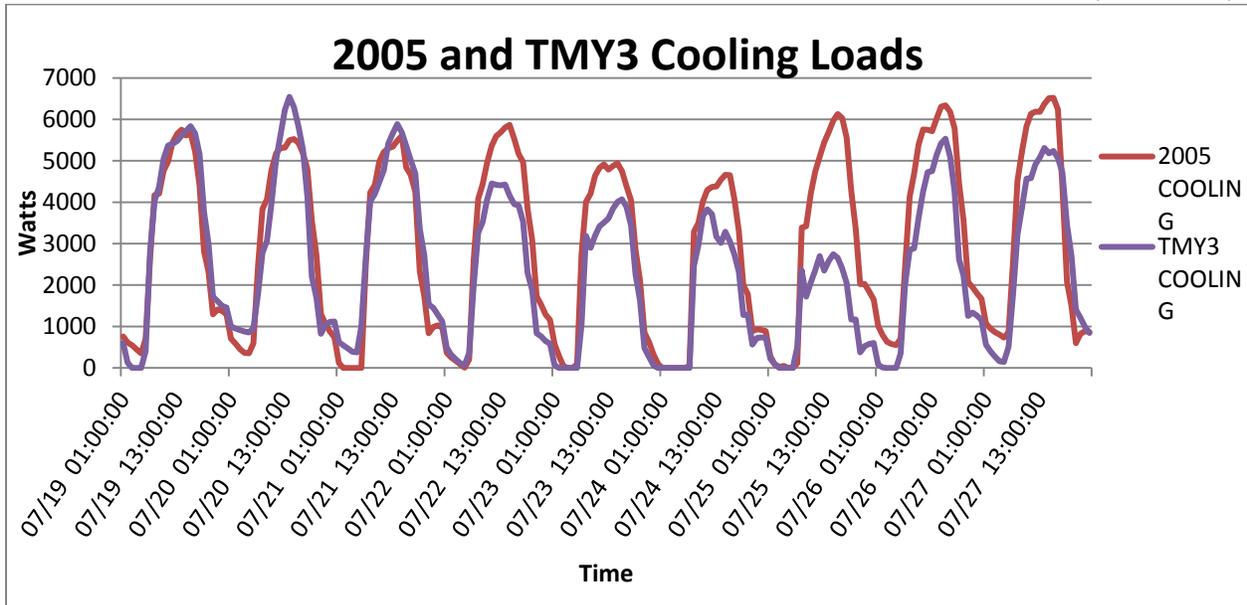


Figure 3.23 – Cooling loads for 2005 and TMY3 weather files

Figure 3.18 shows the relative difference between cooling loads of *The Solar Roof Pod* during 07/19 to 07/27 for both the 2005 weather file and the TMY3 weather file. It can be observed that there is a notable difference between the cooling loads for the set timeframe. This leads the team to believe that extreme weather will have a significant effect on the house performance.

To address this issue, the energy analysis team interfaced with the EMS team to discuss the *Roof Pod's* performance during such events. In the case of heat waves, the team reached

3.7.2 Cold Spells

Although 2005 was known for being the hottest year on record, it also had its shares of extreme cold weather events, or cold spells. The team wanted to analyze the performance of *The Solar Roof Pod* under extreme winter conditions. To do this, the team again decided to set a threshold value for low temperature to filter out days from the 2005 Baltimore-Washington Intl. weather file. In this case, the threshold value was set at -1°C , or 30.2°F .

After applying this filter value, the team obtained a series of days with temperatures lower than the predetermined value. The team also found a period of consecutive days where temperatures persistently lingered at below 30.2°F , with temperatures as low as -13°C , or 8.6°F . This timeframe of extreme cold weather occurred during January 17th through the 29th. A period of such low temperatures persistent during consecutive days could have an effect on the house performance, especially the solar thermal collectors, which could be under great loads to absorb enough heat to maintain a comfortable temperature inside the house. To analyze the heating load of the house, the team simulated the house once again in Energy Plus™ under the specific cold spell timeframe to observe the effect, if any, the cold spell on the house heating system. The results will also be plotted along with the TMY3 heating load data.



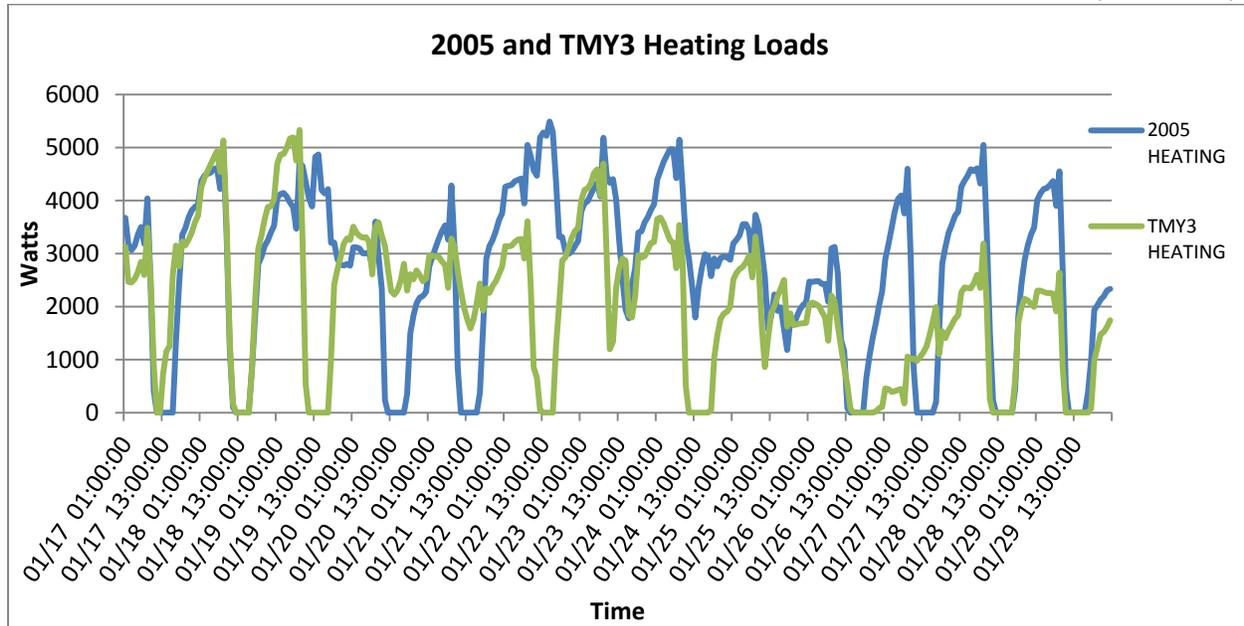


Figure 3.24 – Heating loads for 2005 and TMY3 weather files

Figure 3.19 shows the relative difference between the heating loads during the cold spell period for both TMY3 and 2005 weather files. As in the case of the heat wave scenario, we also observe a notable difference between both cooling loads in some days. This indicates that extreme weather will have a significant impact on *The Roof Pod* performance.

3.7.3 Overcast Days

The Solar Roof Pod relies solely on electricity generated by the photovoltaic solar array. If the PV arrays do not produce enough electricity, the house will not be able to perform. One case where the electricity generation could be compromised is during a period where solar radiation does not reach the solar array directly. This scenario is presented during days where the skies are overcast.

To observe the effect that a succession of overcast days might have on the house’s ability to produce electricity, the team decided to look at the 2005 Baltimore weather file and find days where clouds were present, covering most of the sky. The 2005 Baltimore weather file includes a column with the total sky cover, which is measured in tenths, where 0.0 represents clear skies and 1.0 indicates completely covered skies. The team decided to set the threshold value of total sky cover to .8 (8, as shown in the weather data). In this case, a value of 8 would indicate that the majority of the sky is covered in clouds, which hampers direct radiation from reaching the photovoltaic arrays.

After filtering the results, the team found a period of persistent cloud cover over a period of 10 days. This period of constant overcast skies occurred during October 5th to October 15th, almost coinciding with the competition days for the 2011 Solar Decathlon. With this information at hand, the team decided to simulate the power production of the solar panels under consecutive overcast days. This simulation was done using the code “PV Sim” developed by fellow students who worked on the electrical aspects of *The Solar Roof Pod*. PV Sim outputs the amount of electricity produced by the panels based on the levels of radiation during the day. The power production of the panels during the overcast days was plotted together with the production using the TMY3 weather file.



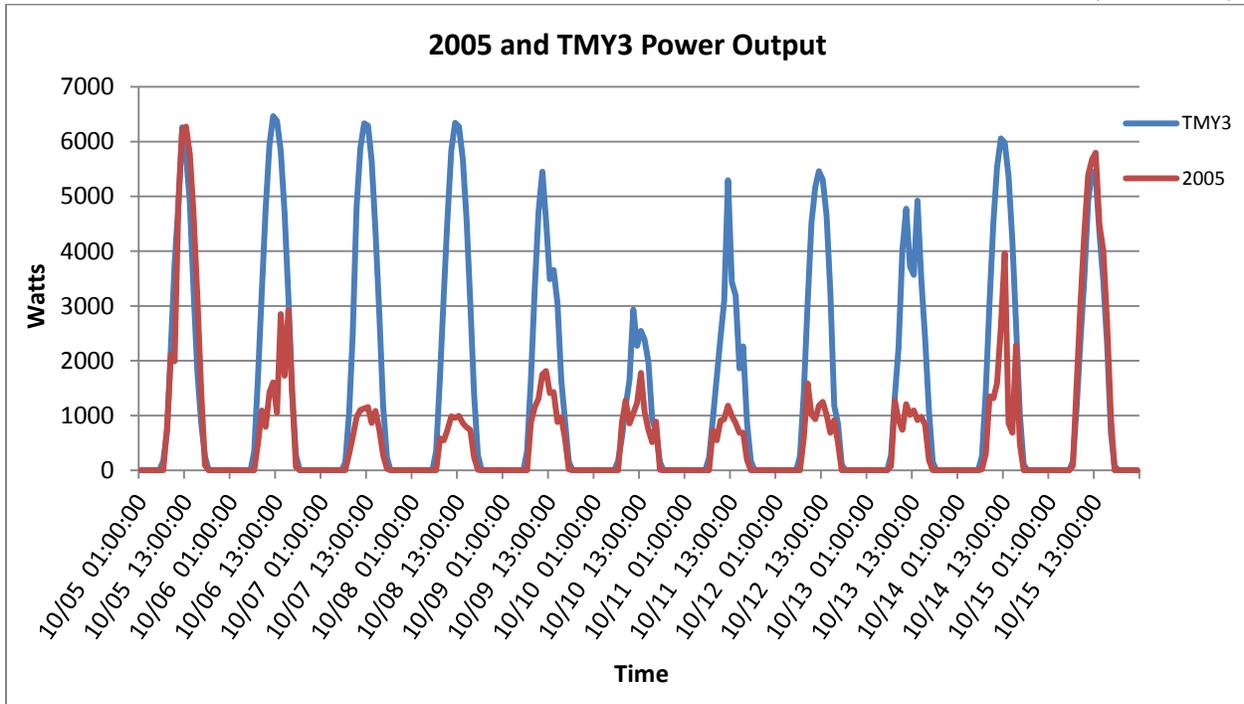


Figure 3.25 – Power output for 2005 and TMY3 weather files

As can be seen in figure 3.20, consecutive days of overcast skies will have a substantial impact on the total power output from the solar array. This will have a serious impact on how the house performs during the competition, or after, throughout the year. This significant power loss could have an impact on the net energy budget of the house.

To address this issue, the extreme weather analysis will lead to a strategy for the operation of the house, during and after the event, to ensure that the house stays net zero. This analysis will also make recommendations in case the scenarios presented in this analysis come true; such recommendations include load shedding strategies, management of appliances and light fixtures, etc.

3.7.4 Conclusions

To address the issue of the performance of the *Roof Pod*, the energy analysis team interfaced with the EMS team to discuss possible approaches and strategies on how to program the house’s controls to address such scenarios. Overall, it was agreed that the house’s response to such extreme events will be all automated. This will be done to minimize human error, and maximize comfort for the resident.

In the case of a heat wave, the teams decided that the best approach would be to close all windows, since heat waves are accompanied by elevated levels of humidity. In addition, this would reduce the solar heat gain, putting a lesser load on the cooling system. Also, the team decided that, if necessary, the cooling system will revert to the backup energy source in the case of such an extreme event where the solar thermal collectors are not replenishing the PCM tank fast enough.

For a cold spell, the team reached the conclusion of opening blinds and shades to maximize solar heat gain, needed in this case. Also, in the event of an extreme cold snap, the house will revert to a backup system, or grid connection, to maintain a comfortable environment inside the residence.

An overcast scenario presents different alternatives. If the overcast day is accompanied by a mild day with low humidity, there will be no need for either cooling or heating. The only elements in the house requiring power will be the pumps and appliances, which should be supplied adequately. In the case the energy demand is not met, the house will be connected to the grid,



and will consume electricity to maintain the comfort level of the user. However, this will require that future performances of the house to be adjusted to ensure an overall net-zero energy consumption.

The previous approaches have not yet been finalized and are in the process of being discussed in depth with the EMS team. The outcome of this analysis is to provide with a quantifiable house performance under extreme circumstances, and to ultimately lead to the best performance strategies to ensure the *Solar Roof Pod* is performing at its best.



3.8 Photovoltaic Energy Analysis

3.8.1 Introduction

The photovoltaic (PV) system sizing was done taking into account the electrical loads for appliances, light fixtures and HVAC system. This produced an overall load for each month, and the PV was sized to meet those loads. The team chose the Sunpower 238 panels at 19.1% efficiency as the best option to meet our electrical needs. Based on the house’s architectural design, we would be able to fit 40 solar panels on the roof in a 4 degrees angle.

3.8.2 House load

In order to reduce the electrical load in the house we have selected Energy Star appliances. Energy Star appliances will not only help us to reduce energy consumption during the competition, it will also help us to protect the environment. From the home owners’ perspective, these appliances will help to reduce high energy bills and give them the initiative for green modeling.

Figure 4.1 - Annual Electrical Power Distribution of the Roof Pod

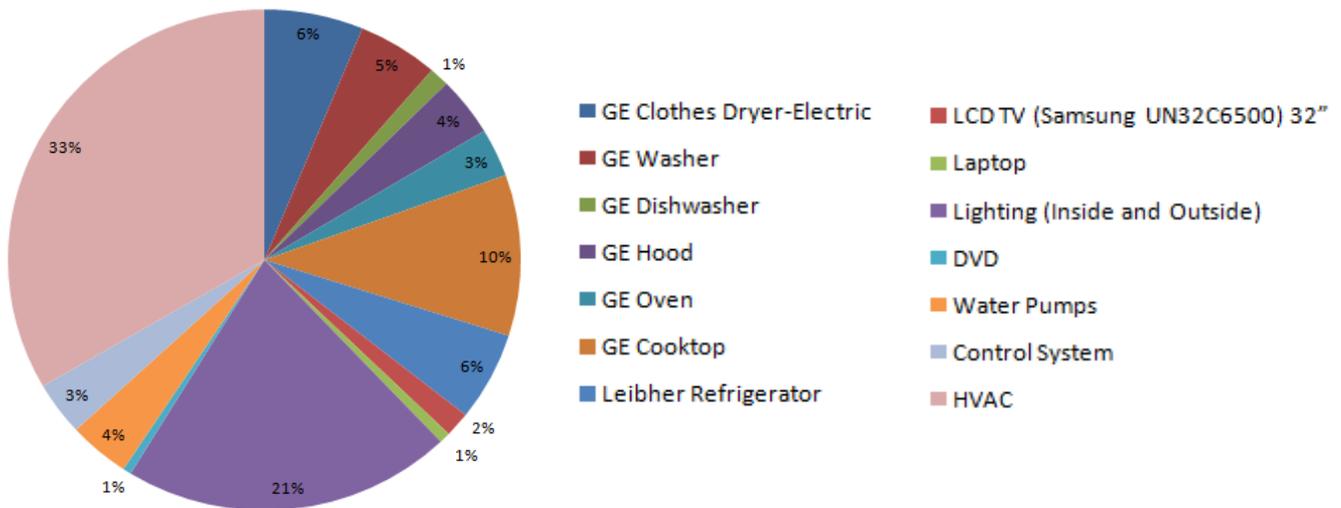


Table 4.1 - Appliances to be used by the Roof Pod

Appliance	Average Monthly KWH	Yearly Average Load (KW)
GE Clothes Dryer-Electric	36	432
GE Washer	29.4	352.8
GE Dishwasher	7.2	86.4
GE Hood	22	264
GE Oven	18	216
GE Cooktop	60	720
Leibher Refrigerator	33.12	397.44
LCD TV (Samsung UN32C6500) 32"	9.2	110.4
Laptop	4	48
Lighting (Interior and Exterior)	120.24	1442.88
DVD	3	36
Water Pumps	22.35	268.2
Control System	20	240
HVAC		2313.630087
Sum	384.51	6927.750087



3.8.3 Lighting System

Lighting is a very crucial element of the design of the Solar Roof pod. It is a key component of the overall human comfort within the environment. Our design contains a variation of CFL, Halogen, and LED lights which will be energy efficient. In addition to the low levels of energy, the system’s energy usage can be dramatically decreased with the automated control system. Together with the control system, our lighting design will strive to provide ample lighting for the pod while illuminating areas only when activity arises. The system will also allow for manual control of the lights when desired by the user. Lighting fixtures will blend with the environment to provide an unnoticeable sense of where the light originates. The table below is the summary of the lighting fixtures to be used by the *Roof Pod*.

Table 4.2 - Summary of Light fixtures to be used by the Roof Pod

Light Source	Type	Wattage (W)	Qty	Total Power (Wh)	Usage (Hours/Day)	KWh/Day	KWh/Month	Comments
Interior Lighting								
EnduraLED MR16	LED	7	5	35	6	0.21	6.3	Living Room
EnduraLED MR16	LED	7	8	56	6	0.336	10.08	Hallway (North & South)
EnduraLED MR16	LED	7	5	35	6	0.21	6.3	Bedroom
T8 Standard	Fluorescent	17	2	34	6	0.204	6.12	Mechanical Room
Linear T6	Fluorescent	45	1	45	6	0.27	8.1	Bathroom
Boxie Ceiling	LED	10	2	20	6	0.12	3.6	Bathroom Entrance
LED Strip	LED	54	1	54	6	0.324	9.72	Cabinet
Mono Point	LED	6	2	12	6	0.072	2.16	Dining Room
Exterior Lighting								
FloodLED	LED	14	4	56	6	0.336	10.08	Trellis
Dekor LED Recessed	LED	30	-	30	6	0.18	5.4	Walkway
Total		197	30	377	6	2.262	67.86	



3.8.4 Power Production

An electrical engineering group of students worked on an Excel simulation called “PV Sim”. PV Sim is based on a weather data file that uses the Sandia Model method to perform the analysis for the inclined surface radiation, weather data from NREL TMY3 (National Solar Radiation Data Base). This method selects a typical month based on daily indices consisting of the maximum, minimum, and means dry bulb and dew point temperatures, maximum and mean velocity, and the total solar radiation. For example, all January 1sts are examined, and the one judged to occur the most on average is selected. This is repeated with the other months of the year. The method was compared with PV Watts with excellent results. Information from the vendor was used for the nominal efficiency of the panel, the nominal operating cell temperature (NOCT), the temperature coefficient for open circuit, and the heat transfer coefficient. Using these values from the vendors and plugging it into the following equation, we were able to estimate the power output from the PV panels. All calculations were done using 40 Sunpower 238 solar panels at 4°.

- Monthly Power formula(from Duffie and Beckman, 200X)

$$P = A * IT * \rho_{PV} * \rho_{DC/AC} * \left[\left(1 + \left(\frac{\mu_{mp}}{\rho_{PV}} \right) (T_a - T_{ref}) \right) + \left(\frac{\mu_{mp} * IT * \tau\alpha}{\rho_{PV} * U_L} \right) (1 - \rho_{PV}) \right]$$

Where

A = Area from the Photovoltaic panel

T_a = Ambient temperature

IT = Solar Radiation

T_{ref} = Reference temperature

ρ_{PV} = Photovoltaic panel efficiency

$\tau\alpha$ = Transmission absorption

$\rho_{DC/AC}$ = DC/AC efficiency

U_L = Lost heat coefficient

μ_{mp} = Temperature coefficient

- Solar radiation formula

$$IT = I_b * R_b + I_d \left(\frac{1 + \cos \beta}{2} \right) + I_{\rho g} \left(\frac{1 - \cos \beta}{2} \right)$$

Where

I_b = Direct solar radiation

I_d = Diffuse solar radiation

R_b = Beam radiation

β = Tilt angle

$I_{\rho g}$ = Ground reflectivity

Through this simulation we calculated and estimated how much power the photovoltaic panels were producing, hourly, daily, monthly and yearly. By obtaining these results we were able to compare the total output power with the total electrical load, to come to a conclusion on whether we will have a net zero system. In Figure 3.8.2 is an estimate on how much power the system could produce each month through the year in New York.



Table 3.8.3 - Net Monthly PV Power output for the proposed array for the Roof Pod

Month	Power KWh
January	441.1215187
February	625.8741693
March	1046.434029
April	1291.249273
May	1530.163301
June	1797.60022
July	1848.183077
August	1595.581193
September	1216.044296
October	875.8861159
November	550.1625898
December	394.7900778

Total power/year 13213.08986

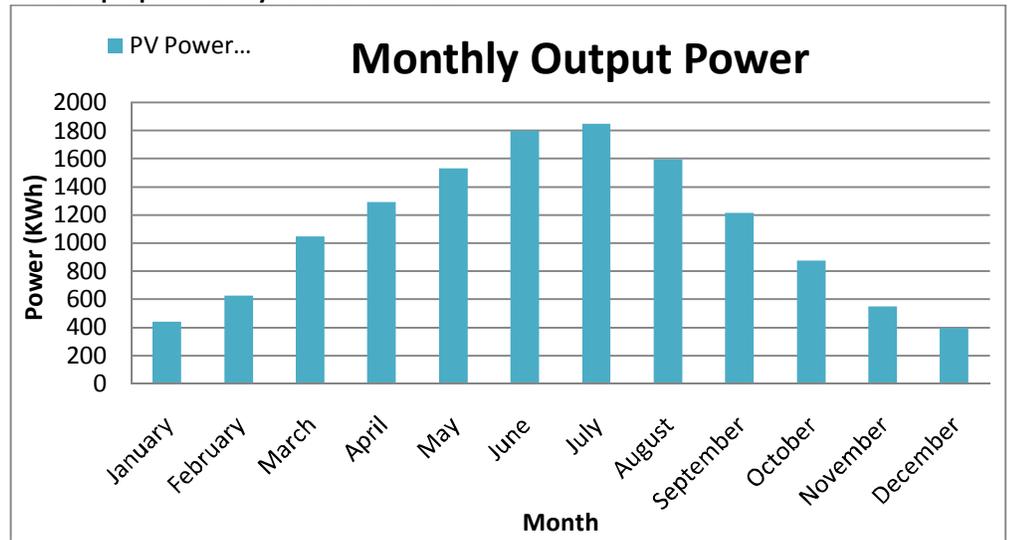


Figure 3.8.2 - Monthly PV Power Output for Roof Pod Array

Through PV Sim, we could estimate which months we will produce more than what we consume. Overall, throughout the entire year our power production is higher than the power consumed, generating more power back to the grid.

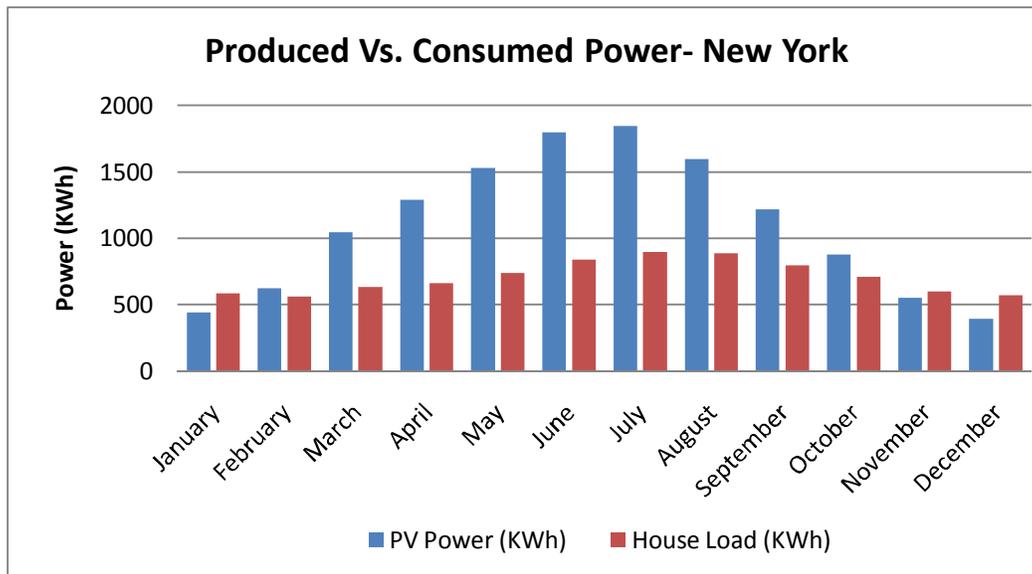


Figure 3.8.3 - Monthly PV Power Output vs. House load for Roof Pod Array in New York

We also took into consideration how much power the system will produce in Washington DC, giving a result of 1.1% higher power production in Washington DC.



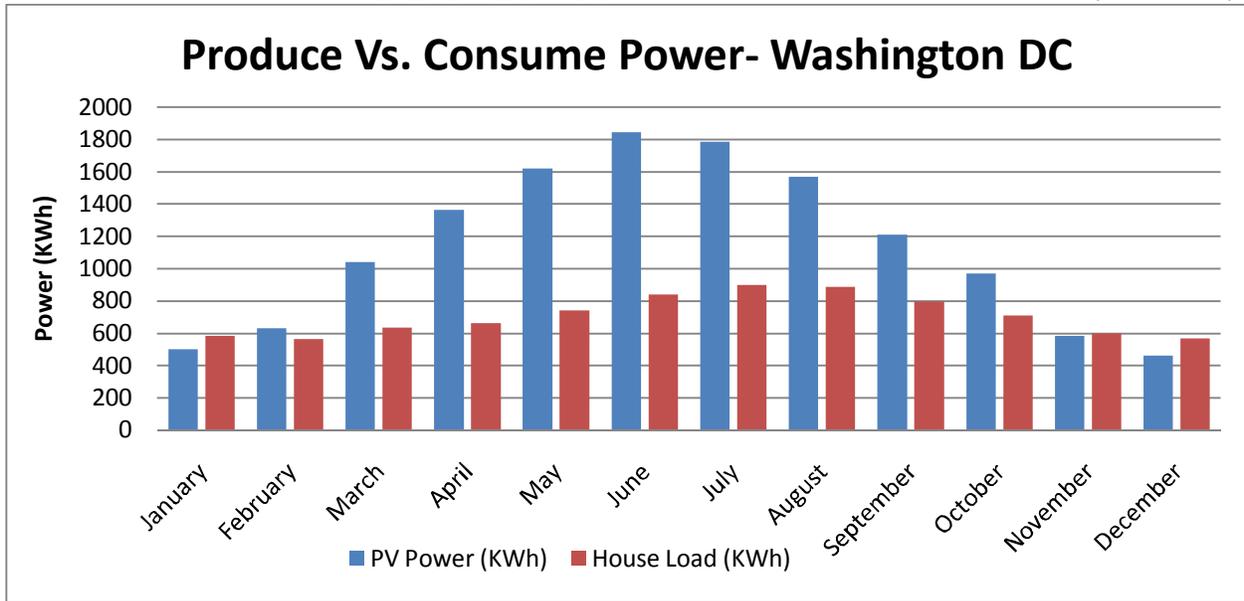


Figure 3.8.4 - Monthly PV Power Output vs. House load for Roof Pod Array in Washington DC

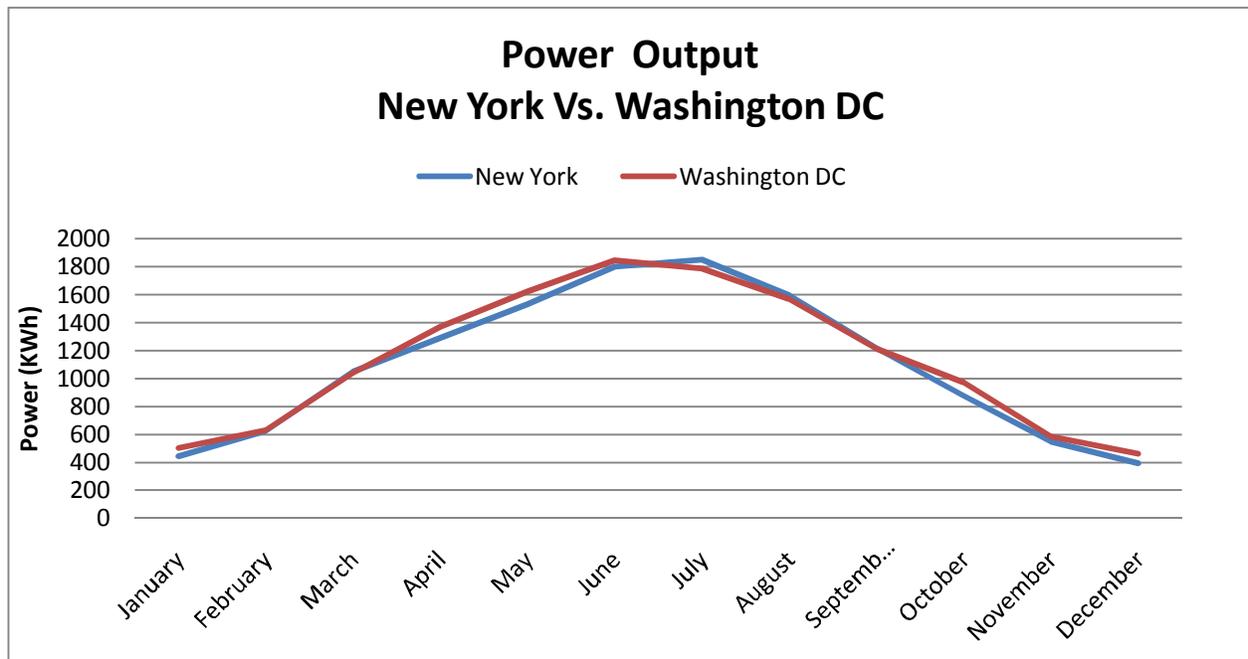


Figure 4.5 - Comparison of Monthly PV Power Output for Roof Pod Array for NY and DC

To assure that our simulation was giving us correct values for the total power produced by the solar panels we compared PV Sim with PV WATTS. PV WATTS is an online simulation program from NREL (National Renewal Energy Laboratory) that uses hourly typical meteorological year (TMY) weather data and a PV performance model to estimate annual energy production and cost savings for a crystalline silicon PV system for locations in the United States and its territories.

In the following graphs (**Figures 3.8.6 and 3.8.7**) we compared the results from PV Sim and PV WATTS, which were very close. One of the reasons that the results are a little dissimilar is PV WATTS uses the TMY2, which contains the data files for the TMY



data sets derived from the 1961-1990 National Solar Radiation Data Base (NSRDB). PV Sim used the TMY3, which contains the data files for the TMY data sets derived from the 1961-1990 and 1991-2005 NSRDB archives. Since PV Sim is based on more recent and accurate data, it gives us a better approximation of the power that the photovoltaic panel will produce through the year. Another reason of why the results are dissimilar is that in PV Sim the size (Area) of the photovoltaic panels can be adjusted depending on the vendor, while PV WATTS has a standard size for the simulation.

Table 3.8.4 – PV Sim vs PVWATTS at 0-degrees inclination

Month	PV Sim KWh	PV WATTS (KWh)
January	461.3445309	525
February	591.2983737	709
March	998.2122259	1021
April	1337.859414	1223
May	1607.867788	1384
June	1839.126284	1454
July	1779.247044	1438
August	1548.2778	1246
September	1178.670866	994
October	918.3682063	845
November	541.7146668	524
December	427.1126063	405

Total power/yr 13229.09981 11768

Table 3.8.5 - PV Sim vs PVWATTS at 4-degrees inclination

Month	PV Sim KWh	PV WATTS (KWh)
January	500.349926	585
February	630.5830031	767
March	1039.358491	1064
April	1365.897737	1249
May	1621.390673	1398
June	1843.913424	1462
July	1785.555591	1449
August	1567.905902	1266
September	1210.721226	1028
October	969.6241947	909
November	583.643551	579
December	463.4495459	459

Total power/yr 13309.12622 12216

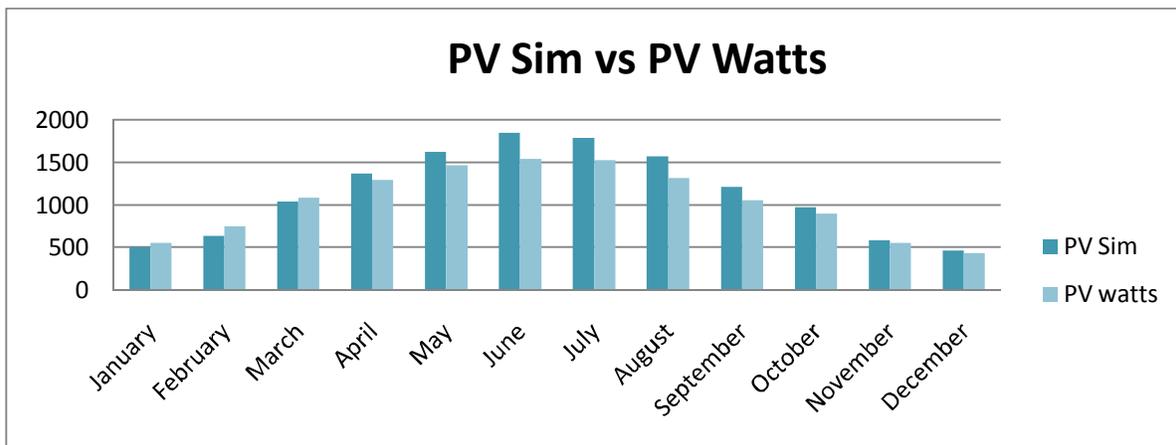


Figure 3.8.6 - Comparison of Team's Simulation Tool with PV Watts at 0° Incline Angle

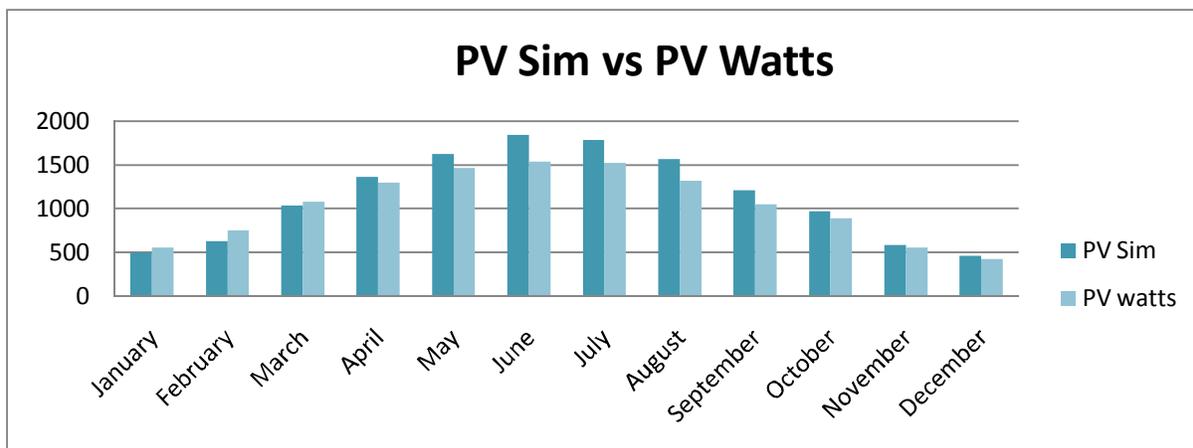


Figure 3.8.7 - Comparison of Team's Simulation Tool with PV Watts at 10° Incline Angle



3.8.5 Competition Load Modeling

PV Sim was also used to estimate the total output power from the photovoltaic panels during the days of the competition, projected for Sep XX and Oct YZ. This analysis helped us to predict how the components of the house would behave and how the user should react in order for the house to be net-zero.

Table 3.8.6 - Net Daily PV Power output for the proposed array for the Roof Pod during the completion days

Days	Total Power (KWh/day)	House Load (KWh/day)
Day 6	53.73036404	25.7775238
Day 7	44.46615602	26.9723493
Day 8	13.49507094	23.0457536
Day 9	22.64800237	26.0839643
Day 10	49.67316998	27.0839785
Day 11	34.56311558	27.8376493
Day 12	19.22202014	26.0370985
Day 13	34.46715334	25.8374434
Day 14	27.04934674	24.9837983
Day 15	18.0657728	26.0839643
Day 16	22.96420528	26.9723493
Day 17	14.38987412	25.9839645
Day 18	38.23693905	23.0457536
Sum	392.9711904	335.7455907



4.0 Grid Interconnection

4.1 Introduction

Through the process of research in the design of the system, our team came up with different ideas and strategies to reduce the energy consumption of the house by having appliances that are energy efficient and by having a low power HVAC system, which uses a thermally-driven system ; therefore, obtaining the maximum possible energy from the PV panels.

The engineering team and the architecture team have worked together in order to merge the aesthetic design of the Solar Roof Pod to be also energy efficient, by creating a smart façade that will optimize the use of passive and active solar energy, regulating the indoor temperature. This fusion between engineers and architects will help the Solar Roof Pod to be more energy efficient and more independent from the photovoltaic panels, especially during cloudy days.

4.2 Design

4.2.1 Goals and Challenges

The Solar Roof Pod design goal is to harvest the maximum power from the photovoltaic panels so it can satisfy the load demanded from the user. One of the challenges in the electrical design for the Solar Roof Pod is that it is a design developed for urban environment where the house is expected to be placed on top of a roof in New York City, where it will be surrounded by buildings that will produce shade throughout most of the day.

4.2.2 Risk Factor

Our system output is based on weather data from NREL TMY3 and the energy supply is more than enough to supply the electrical consumption of the house and to send extra energy to the grid. However due to the dramatic changes in weather patterns, the solar radiation could be lower than our expectations, making the energy demand higher than the energy supply. In this case we would not have a net-zero system.

4.3 Photovoltaic Panel Selection

After calculating the load of the house, we advanced in the process of selecting photovoltaic panels that could satisfy the requirements of the team. From the engineering point of view it is desired to have a photovoltaic panel that could have high efficiency and that could have great performance under high temperatures and low irradiation conditions. And from the architectural point of view we need a photovoltaic panel that could fit densely on our roof. In addition both engineers and architects agree that the photovoltaic panel will have to be affordable and environment friendly.

As a final result we selected the photovoltaic panels from Sunpower 238 for its high efficiency, perfect dimension, price and dedication to the environment, since Yingli is a member of PV CYCLE (*PV CYCLE*).



4.4 Inverters

As explained before, one of the major challenges in the design of the Solar Roof Pod is that it will be surrounded by buildings that will produce shade throughout most of the day. In traditional solar energy systems, modules are wired in a single electrical series, and the lowest performing module determines the performance of the entire series. So in order to solve this challenge we selected the Enphase micro-inverter, where the performance of one module does not affect the performance of the others; maximizing energy production at all times.

Another reason that we have selected Enphase micro-inverters is because it will help us simplify the installation. It will also give us more space in the mechanical room and it will be safer by eliminating the use of high voltage wiring.

4.4.1 Calculations

Maximum Output from the Microinverters = 210W
 $210W / 240V = 0.875 \text{ Amp}$
NEC 690.64(B)

Branch A, B, C

Circuit current calculation

maximum output power
 $210W / 240V = 0.875 \text{ Amp}$
 $0.875 \text{ A} \times 10 = 8.75$
overcurrent protection calculation
 $8.75 \times 1.20 = 10.5$

Conclusion

2 poles 15 Amp Circuit Breaker



4.5 Module Compatibility

The system should be design to determine the specifications of a PV module so it will not exceed the microinverter model's nameplate ratings under all expected environmental conditions for a given application. There are two considerations for Voc; according to the National Weather Service Forecast Office the lowest temperature ever recorded in New York City was -15°F (-26°C) on February 9, 1934. And the highest temperature ever recorded was 106°F (41°C). First, we consider Voc at the highest expected cell temperatures to verify that the Voc will meet the inverter's minimum start up voltage.

Voltage Correction Factor for Ambient Temperature -26°C to -30° is 1.21 X Voc as per NEC code: 690.7

SunPower (E19/328) Voc = 48.5V

Voc X 1.21 = Corrected Voltage

48.5V X 1.21= 46.464 V

Maximum Inverter Input Voltage = 58.685V

*** Voc at the highest expected temperature:**

$(Voc) + (Voc) * (Highest\ Expected\ Cell\ Temp.\ -\ STC) * (Temp.\ Coefficient / 100) > 38V$

$48.5 + [(48.5)*(41-25) * (-0.29/100)] > 38V$

46.2496 > 38V

*** Voc at the lowest expected temperature:**

$(Voc) + (Voc) * (Lowest\ Expected\ Cell\ Temp.\ -\ STC) * (Temp.\ Coefficient / 100) \leq 56V$

$48.5 + [(48.5)*(-26-25) * (-0.29/100)] \leq 56V$

55.6732 ≤ 62V

The same as the Voc we also have to consider Vmp. First, we should consider Vmp at the highest expected cell temperature to ensure that the inverter will be able to perform Maximum Power Point Tracking.

*** Vmp at the the highest expected temperature:**

$(Vmp) + (Vmp) * (Highest\ Expected\ Cell\ Temp.\ -\ STC) * (Temp.\ Coefficient / 100) \geq 22V$

$40.5 + [(40.5)*(41-25) * (-0.29/100)] \geq 31V$

38.6208V ≥ 31V



*** V_{mp} at the lowest expected temperature:**

$$(V_{mp}) + (V_{mp}) * (\text{Lowest Expected Cell Temp.} - \text{STC}) * (\text{Temp. Coefficient} / 100) \leq 40V$$

$$40.5 + [(40.5) * (-26 - 25) * (-0.29 / 100)] \leq 50V$$

$$46.49 \leq 50V$$

The I_{sc} calculation must be made for I_{sc} at high temperature to certify that the maximum fuse rating of the module is less than or equal to the inverter's rated maximum short circuit current.

$$I_{sc} + (I_{sc}) * (\text{Highest Expected Cell Temp.} - \text{STC}) * (I_{sc} \text{ Temp. Coefficient} \% / 100) \leq 12A$$

$$6.25 + [(6.25) * (41 - 25) * (0.05 / 100)] \leq 12A$$

$$6.3 < 12A$$

This can also be calculated by $I_{max} = I_{sc} * (1 + [(\beta / 100) * \Delta T]) * 1.25$

$$= 6.25 * (1 + [(0.05 / 100) * 50]) * 1.25$$

$$= 8.00781$$

$$8.00781 < 12A$$



4.6 Feeder and Service Calculations

Lighting load for specified occupancies [NEC 210.12]

Area=700 sqft

700 sqft * 3VA per sqft = 2100VA

Minimum number of branch circuit required [NEC 210.11(A)]

$2100VA / 120V = 17.5A$ 1 20A circuit or 2 15A circuit

Branch circuit required for Dwelling Units [NEC 210.11(C)]

(1) Small-Appliances: 2 20A circuit

Rated at 1500VA each [NEC 220.52(A)]

(2) Laundry 1 20A circuit

Rated at 1500VA each [NEC 220.52(B)]

(3) Bathroom 1 20A circuit

Total = at least 5 branch circuits

Other Loads [NEC 220.14]

(A) Specific Appliances or Loads

Appliance	Rating (Volts * Amps)	Load (VA)
Refrigerator	115V * 15A	1725VA
Hood	120V * 3.7A	444VA
Dishwasher	120V * 9A	1080VA
Washer	120V * 12A	1440VA

(B) Electric Dryers and Household Electric Cooking Appliances

Oven	120V * 15A	1800VA
Cook top	240 * 7.7A	1848VA
Range	1800VA+1848VA	3648VA
	3648VA*0.75	2736VA



[NEC Table 220.55]

Dryer	240V * 12.5A	3000VA
	3000VA * 1	3000VA

[NEC Table 220.54]

(C) Motor Loads

Chiller Water Pump (NRF36)	115V * 2.347A	270VA
Solar Collector Pump (NRF36)	115V * 2.347A	270VA
Cooling Tower Pump (NRF36)	115V * 2.347A	270VA
Driving Heat Pump (NRF33)	115V * 1.087A	125VA
Radian Heat Pump (NRF22)	115V * 0.8A	92VA
DWH Pump (NRF 22)	115V * 0.8A	92VA
Absorption Chiller	230V * 0.03A	7VA

Total: 17299VA

General Loads [NEC 220.82(B)] 100% of the first 10 kVA plus 40% of the remainder

General Lighting	2100VA
Small Appliances	2(1500VA)
Laundry	1500VA
Bathroom	1500VA
<u>Other Loads [from NEC 220.14]</u>	<u>17299VA</u>

Total 25,399VA

Total General Load $10,000VA + 0.40 (25,399VA - 10,000VA) = 16,159.6VA$

Total Feeder Amperage Load $16,159.6VA / 240V = 67.332A$



5.0 HVAC Design

5.1 Summary

5.1.1 Introduction

The Solar Roof Pod is in itself an innovative building, and as such, it required and an innovative Heating, Ventilating and Air Conditioning (HVAC). This system contributes to the aim of an energy efficient and smart solar home. The system is designed to consume a low amount of electrical energy while efficiently providing a comfortable environment for the resident.

The HVAC system will run mainly by using thermal energy. This thermal energy is collected by utilizing solar thermal collectors. The selected solar thermal collectors for this solar home are heat pipe evacuated tube collectors, since they are able to collect larger amounts of thermal energy in the temperate New York City weather compared to flat plate collectors. These types of collectors also perform desirably in Washington DC. These solar collectors send heated fluid to a custom designed 175 gal. Phase Change Material (PCM) tank in a closed water loop. This tank is used to store the hot water until it is required by the HVAC equipment. Any cool water that resides at the bottom of the tank will then be pumped back up to the collectors to gather more energy, completing this closed loop. The sizing of the solar thermal collector array as well as the equipment sizing and PCM tank design will be developed in this section.

5.1.2 HVAC Overview

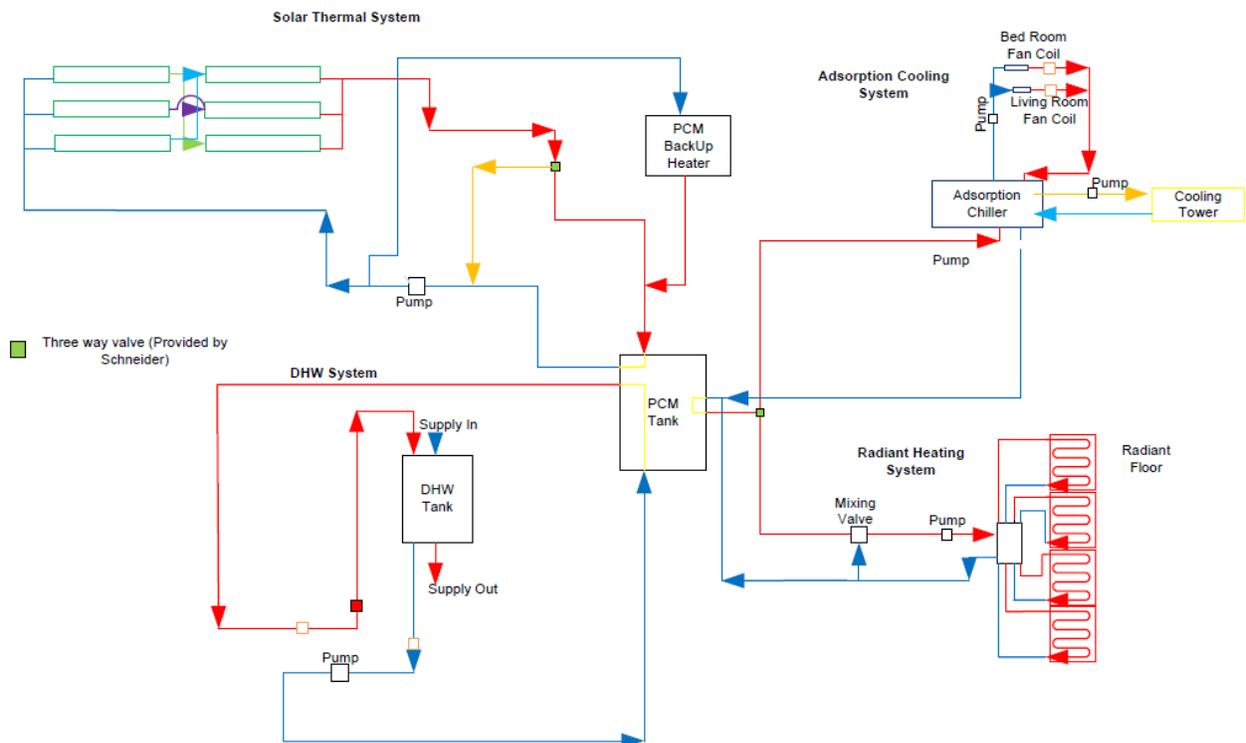


Figure 5.1 General Schematic of HVAC System



Domestic Hot Water

When domestic hot water is demanded, hot water is sent from the PCM tank to a 40 gal water heater, where it is then kept until further domestic use. The PCM tank also sends water to either the adsorption cooling system or the radiant floor heating system when either cooling or heating is demanded.

Cooling System

The adsorption cooling system requires hot water to perform its function. The hot water required, supplied at a range between 82 °C (180°F), will be obtained from the PCM storage tank. The cooling of the home is then achieved using the SorTech ACS 08 Adsorption Chiller which can cool a nominal load of 8 kW, and has a nominal COP of 0.6. The heat removed by the chiller will be rejected into the environment using the RSD 005 cooling tower by Refrigeration Supplies Distributor. The chilled water produced by this system will then run through two fan coil units by Multiaqua, of model MHCCW. The fan coils, in turn, will blow cooled air into the home.

Heating System

For heating of the home, hot water from the PCM tank will be pumped and circulated through the tubes of a hydronic radiant floor heating system provided by Warmboard. The heat from the water will transfer through the tubes and will be conducted through the radiant floor. The aluminum surface of the radiant floor will then transfer heat to the floor surface and emit heat into the environment.



5.2 Adsorption Cooling

5.2.1 Overview of the Adsorption Cooling System

As mentioned in Section 5.1.2 HVAC Overview, the adsorption cooling system will be supplied with hot water ranging from 82°C (180°F) from the PCM tank. The SorTech ACS 08 Adsorption Chiller will then be used to provide chilled water that will run through two fan coil units. Although the chiller has a nominal cooling capacity of 8 kW (about 2.3 RT) and 0.6, the full capacity is not needed. The flow rates can be controlled to decrease the inlet cooling water temperature to achieve the required loads. Based on the chiller manufacturer's COP curves, this variation will not drastically decrease the COP to achieve the optimal part-load operation. The COP will then be around the range of 0.45 to 0.55.

The low COP of the chiller leads to a slightly larger cooling tower. Thus, it is used in combination with the RSD 005 cooling tower by Refrigeration Supplies Distributor (with a nominal cooling capacity of 5 tons) which will reject heat from the chiller. This chilled water will then be supplied to two fan coil units, of models MHCCW06-00 and MHCCW04-00 by Multiaqua.

5.2.2 Adsorption Chiller Operation

The adsorption process depends on the interaction between a solid adsorbent and a liquid refrigerant (adsorbate). Typically the chamber with the adsorbent is connected to both a condenser and evaporator. During desorption, the valve connecting the adsorber to the condenser is open while the valve to the evaporator is closed. The hot refrigerant causes the adsorbent to desorb, or drying the adsorbent. This causes the water vapor molecules from the adsorbent to evaporate and condense in the condenser at low temperatures.

Desorption continues until the adsorbent becomes fully desorbed, which may otherwise be described as becoming dry. Once this occurs, the adsorber closes its valve to the condenser and opens its valve to the evaporator, allowing adsorption to take place. The condensate which was created in the condenser then travels down to the evaporator. The dried adsorbent creates low humidity conditions allowing for low temperature evaporation. The liquid in the evaporator becomes vapor, which travels up to the adsorber and collects on the surface of the adsorbent, and therefore may be described as rehydrating the adsorbent. This process produces cold temperatures for the refrigerant to become chilled.

Although this cooling process may be done with one adsorber, most adsorption chillers follow the 4-chamber principle. This means the adsorption chiller contains a condenser, evaporator, and two adsorbers, allowing for both adsorption and desorption to occur simultaneously without a need to wait for the adsorbent to regenerate in the adsorption process.

5.2.3 Adsorption Chiller Comparison

The initial cost for the adsorption chiller or the absorption chiller is relatively high compared to conventional systems. However, the use of these chillers will bring long term savings, so the initial costs would be considered an investment. These chillers are thermally driven and therefore they consume less electricity than typical vapor compressors. Also, the refrigerants used in a vapor compressor may cause ozone depletion while others may have high greenhouse gas emissions. The refrigerant for the adsorption or absorption chiller is water which has no global warming potential. The chiller also does not contain a large amount of pumps and rotating parts, making it noise free. Therefore, the benefits of using an adsorption system are both economical and environmental, in reducing ozone depletion and noise pollution.

Though the absorption chiller may have been more easily attainable due to the fact that it has been out in the market for some time compared to the adsorption chiller, the latter option has been selected. Although absorption chillers generally have higher COP values, that are approximately 0.7, however the adsorption chiller is still more favorable due to their lower cooling



capacities and lower regeneration temperatures. The most commercially available absorption chillers are designed for a capacity of 17.5 kW or more (i.e. Yazaki absorption chillers). The absorption chiller cooling capacity may be adjusted using the same methods for the adsorption chiller, however a decrease in the hot water temperature would cause a tremendous drop in the COP compared to adsorption chillers. A distinctive advantage of the adsorption process is the relatively lower temperature to regenerate the silica gel, which is about 160°F versus 180°F for the absorption process.

5.2.4 Cooling Tower

The cooling tower is typically used with either the absorption or the adsorption chillers to reject heat from the condenser. The disadvantage of using the adsorption chiller is that the size of the cooling tower is larger than the cooling tower for the absorption chiller.

Sizing for the cooling tower requires the heat load, range, and GPM. The heat load may be calculated by

$$HeatLoad \cong Q_c \left(1 + \frac{1}{COP_{ads}} \right) [Btu/min]$$

Where

Q_c = Cooling Load of the Home, Btu/hr

COP_{ads} = COP of the Adsorption Chiller

Since the maximum load for a home of this size would be 2 Tons and the most efficient system would reduce the load of a home to 1 Ton, the average of these two values was used as Q_c in this calculation. Therefore, the cooling load would be approximately 1.5 Tons, or 18000 Btu/hr.

The Range is given by

$$R = T_i - T_o \text{ [}^\circ\text{F]}$$

Where

T_i = Inlet Temperature = 32°C = 89.6°F

T_o = Outlet Temperature = 27°C = 80.6°F

The GPM can then be determined using relations between the heat load and the range

$$HeatLoad = GPM \times R \times 8.5$$

Where 8.5 represents pounds per gallon of water.

The inlet and outlet temperatures were taken from the required inlet and outlet temperatures for cooled water given by the adsorption chiller. Using the efficiency curves given by SorTech in their chiller design manual, the COP of the chiller is approximately 0.5. The required values may now be calculated.



$$\text{HeatLoad} \cong (1.5 \text{ Tons}) \left(1 + \frac{1}{0.5}\right) = 4.5 \text{ Tons} = 54000 \text{ Btu/hr} = 900 \text{ Btu/min}$$

$$R = 32^{\circ}\text{C} - 27^{\circ}\text{C} = 89.6^{\circ}\text{F} - 80.6^{\circ}\text{F} = 9^{\circ}\text{F}$$

$$\text{GPM} = \frac{\text{HeatLoad}}{R \times 8.5} = \frac{900 \text{ Btu/min}}{9^{\circ}\text{F} \times 8.5} = 12 \text{ Gal/min}$$

A cooling tower may now be selected for a heat load of 54000 Btu/hr, a range of 9°F and a GPM of 12 Gal/min. The calculations led us to consider the RSD-005 by RSD Fiberglass Cooling Tower is as an option for the cooling tower.



5.3 Air Distribution System

5.3.1 Initial Calculations for Central Air Distribution

In order to size the air distribution system, the air conditioning schematic and process along the psychrometric chart is needed. This is shown in the following two figures.

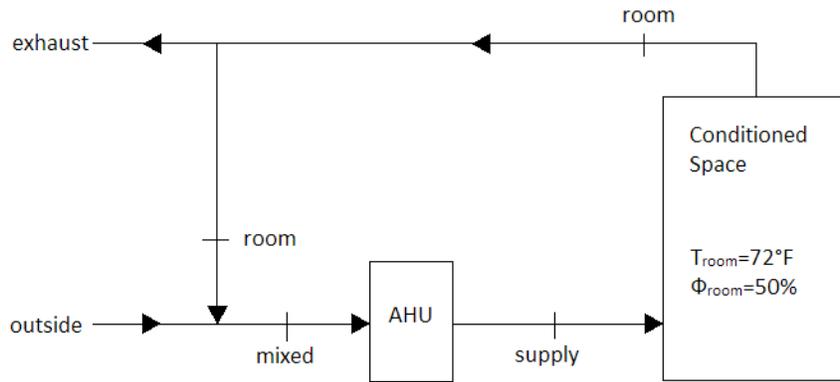


Figure 5.2 - Air Distribution Schematic

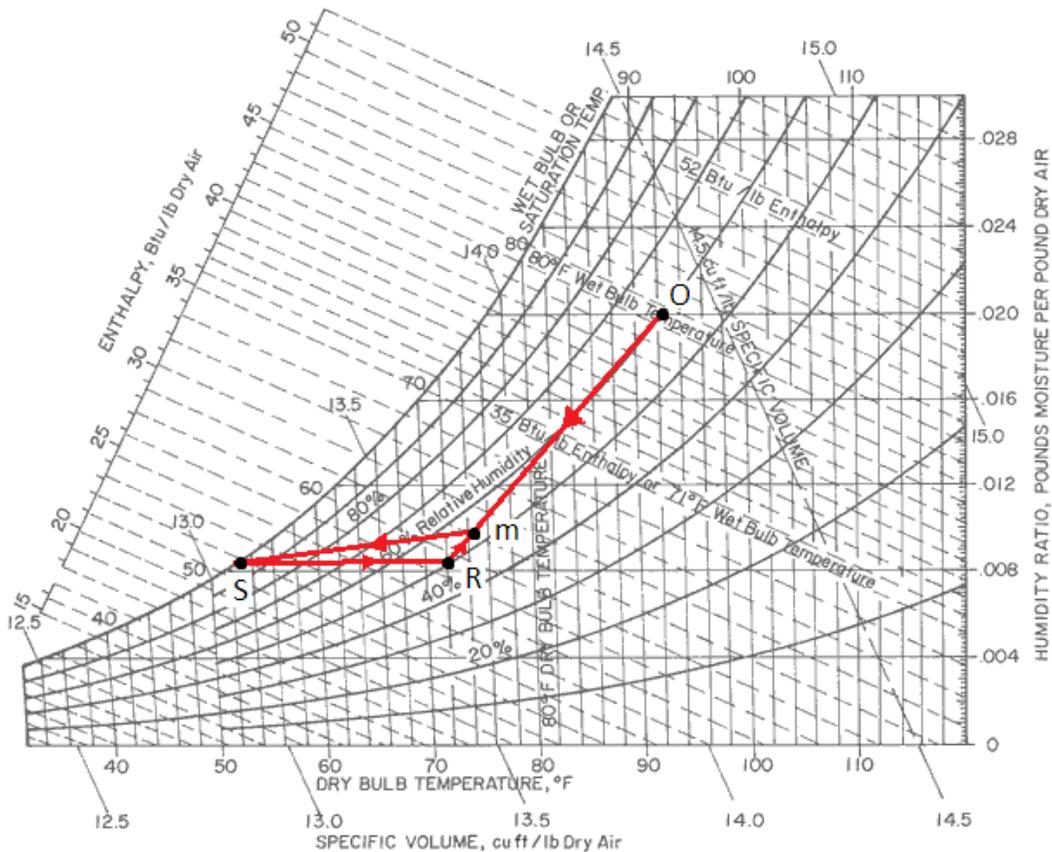


Figure 5.3 - Psychrometric Process



Typical outside condition for New York City, NY is

$$T_o = 92^\circ\text{F}$$

$$\phi_o = 60\%$$

$$v_o = 14.35 \text{ ft}^3/\text{lb}$$

Selecting a room condition allowing us to obtain 100 points for scoring gives

$$T_R = 72^\circ\text{F}$$

$$\phi_R = 50\%$$

$$h_R = 26.4 \text{ Btu/lb}$$

$$v_R = 13.6 \text{ ft}^3/\text{lb}$$

Assuming unchanging humidity ratio from the supply to the room, Supply conditions are

$$T_S = 53^\circ\text{F}$$

$$\phi_S = 100\%$$

$$h_S = 22 \text{ Btu/lb}$$

$$v_S = 13.1 \text{ ft}^3/\text{lb}$$

The volume of the home is 6440 ft^3 while the total cooling load, Q_{load} , is 21,000 Btu/hr (HCB).

Therefore, the supply mass flow rate and the supply volume flow rate is given by

$$\dot{m}_S = \frac{Q_{load}}{h_R - h_S} = \frac{21000}{26.4 - 22} = 4545 \text{ lb/hr}$$

$$\dot{V}_S = \dot{m}_S v_S = \left(\frac{4545 \text{ lb/hr}}{60 \text{ min}} \right) (13.1) \cong 1000 \text{ CFM}$$

1 ACH is assumed for the home. Therefore the required outside air required is

$$\dot{V}_O = ACH \cdot Volume = \left(\frac{1/\text{hr}}{60 \text{ min}} \right) 6440 \cong 107 \text{ CFM}$$

The mixed condition can be determined by finding the mass flow rates and mixed temperature

$$\dot{m}_{in1} = \dot{m}_O = \frac{\dot{V}_O}{v_O} = \frac{107 \text{ CFM}/60 \text{ s}}{14.35} = 0.125 \text{ lb/s}$$

$$\dot{m}_{out} = \dot{m}_m = \dot{m}_S = 4773 \text{ lb/hr} = 1.253 \text{ lb/s}$$

$$\dot{m}_{in2} = \dot{m}_{out} - \dot{m}_{in1} = 1.253 - 0.125 = 1.13 \text{ lb/s}$$



$$T_{out} = T_m = \frac{\dot{m}_{in1}T_O + \dot{m}_{in2}T_R}{\dot{m}_{out}} = \frac{(0.125)(92) + (1.13)(72)}{1.253} = 74^\circ\text{F}$$

Therefore mixed conditions are

$$T_m = 74^\circ\text{F}$$

$$\phi_m = 55\%$$

$$h_m = 28.2 \text{ Btu/lb}$$

The Coil Cooling Load is then solved by

$$Q_c = \dot{m}_s(h_m - h_s) = 4545(28.2 - 22) \cong 2700 \text{ Btu/hr} \approx 2.2 \text{ Ton}$$

Therefore Cooling coil size needs 1000 CFM and 2.2 Ton, which can be satisfied using an absorption chiller.

The total leakage area of the Roof Pod is calculated using

$$A_{leak} = \sum A_{comp}A_{ul}$$

Where

$$A_{leak} = \text{net leakage area, cm}^2$$

$$A_{comp} = \text{area or perimeter of exposed component, m}^2 \text{ or m}$$

$$A_{ul} = \text{Leakage area per area or perimeter from ASHRAE, cm}^2/\text{m}^2 \text{ or cm}^2/\text{m}$$

The exposed components used to calculate the leakage area are the walls, roof, windows, window frames and door frames. Providing the exposed area or perimeter for each component based on the dimensions of the house, and the values of A_{ul} provided by ASHRAE gives the leakage area for each. Taking the sum of all the leakage areas give the net leakage area which is approximately 211 cm².

Uncontrolled infiltration is determined by

$$\dot{V}_{leak} = 0.060A_{leak} = 0.060(211 \text{ cm}^2) = 13 \text{ L/s} = 27 \text{ CFM}$$

Therefore, controlled fresh air is equal to

$$107 \text{ CFM} - 27 \text{ CFM} = 80 \text{ CFM}$$

5.3.2 Fan Coil Selection

The required supply air volume rate for the system is 1000 CFM. Two fan coil units will be used to provide this volume rate. The living room fan coil unit will supply 600 CFM and the bedroom fan coil unit will supply 400 CFM. The manufacture of selected fan coils is Multiaqua. The reason for selecting smaller fan coil units is the space constrains in the house available for mechanical equipment. This selection is an accommodation for architectural design. The selected fan coil units have no electric heater. Fresh air inlet duct will be connected to the fan coil with higher CFM.



5.4 Radiant Floor Heating

5.4.1 Overview of Radiant Floor Heating

Instead of using typical heating systems, a more efficient method of heating the home has been considered. The main heating method option for the Solar Roof Pod is hydronic radiant floor heating provided by Warmboard. This method is ideal because it is compatible with our HVAC system which is thermally driven by the hot water provided in the PCM tank. The water from the tank is pumped and circulated through aluminum PEX tubing. These tubes are laid in grooves throughout Warmboard's plywood panels which have an aluminum layer bonded to the surface. The tubing transfers heat to the aluminum surface and subfloor. Since the aluminum surface is face up, heat is directly transferred to the flooring that is placed on top of the Warmboard.

5.4.2 Low Mass Radiant Floor Heating Benefits

Low mass radiant floor heating systems (such as Warmboard) are much lighter than high mass flooring systems, which include floors made from gypsum or cement. The high mass floorings take a considerable amount of time for the floor to maintain heat since the heat transfer rate is very slow. Typically, the high mass systems must be left on for almost 24 hours in order for the home to feel the effects of the radiant floor. On the other hand, the low mass systems are more responsive and take less time to heat up the home. This response time is even less for Warmboard since the product is designed with thin aluminum layers which increase conductivity and improve heat transfer. This is ideal for our high temperature system as it will reduce the use of multiple hot water loops.

5.4.3 Radiant Floor Layer Evaluation

In order to maintain human comfort, the maximum floor surface temperature for rooms with prolonged foot contact is 85°F. This limit is applied to all areas of the home, excluding the bathroom, which will have a maximum floor surface temperature of 92°F. The higher maximum temperature allowable in the bathroom is higher since there will not be prolonged foot contact in this room. Simple conduction heat transfer calculations must be performed in order to assure that these temperature limits are not passed.

The following table provides the layers which are important to this calculation.

Table 5.1 - Radiant Floor Layers

Area	Material	Thickness	R-value/in	R-value
Around Core	Cork w/ MDF Backing	1/2"	2.35	1.175
	APA Plywood	3/4"	1.2	0.6
	Warmboard	1-1/8"		
	Plywood Sheathing	1/2"		
	Total R above Warmboard:				1.125
Bathroom	"IceStone" Slab	1-1/4"	2	2.5
	Thin-Set Mortar	1/8"	0.4	0.05
	Warmboard	1-1/8"		
	Plywood Sheathing	1/4"		
Total R above Warmboard:				2.6

To evaluate if the temperatures satisfy the maximum surface temperature conditions, the following rough calculations were performed.



Heat flux is calculated using

$$q'' = \frac{Q_h}{A}$$

Where

q'' = heat flux, Btu/hr-ft²

Q_h = peak heating load \approx 1 Ton = 12000 Btu/hr

A = conditioned area \approx 680 ft²

Therefore,

$$q'' = \frac{12000}{680} = 17.6 \text{ Btu/hr} \cdot \text{ft}^2$$

Using the following equations, R values above were calculated and floor surface temperature can be calculated:

$$R = \Delta x (R_{p \text{ per inch}})$$

$$q'' = \frac{\Delta T}{\sum R} = \frac{T_1 - T_2}{\sum R}$$

Giving

$$T_2 = T_1 - q'' \sum R$$

Where

T_1 = tube surface temperature, °F

T_2 = floor surface temperature, °F

R = thermal resistivity (or R-values), h-ft²-°F/Btu

$R_{p \text{ per inch}}$ = R-value per inch, h-ft²-°F/Btu-in

Δx = thickness of layer, in.

Using an analysis for internal turbulent convection flow through the radiant floor tubes with Gnielinski correlation, the tube surface temperature is shown to differ from the water temperature by \approx 0.002°F. Thus, it is safe to assume that T_1 is equal to the hot water temperature.

Since the tubing is done as single zone heating, the average hot water temperature through the tubes is used. The hot water temperature provided by the PCM will range from 82°C. The average of this range was used to assume the entering tube temperature of 82°C which is approximate to 180°F. Since a ΔT between the entering and exiting tube temperature is selected to be 20°F, T_1 can be assumed to be 160°F.



For the area around the core:

$$T_2 = 180^\circ\text{F} - (17.6 \text{ Btu/h/ft}^2)(1.125 \text{ h} \cdot \text{ft}^2 \cdot ^\circ\text{F/Btu}) = 160^\circ\text{F}$$

Although this exceeds the max temperature of 85°F, the water may be circulated and mixed in a mixing valve to lower the hot water temperature to a lower average temperature.

For the bathroom:

$$T_2 = 180^\circ\text{F} - (17.6 \text{ Btu/h/ft}^2)(2.6 \text{ h} \cdot \text{ft}^2 \cdot ^\circ\text{F/Btu}) = 134^\circ\text{F}$$

Although the temperature also exceeds the maximum surface temperature, the same idea of circulating water through mixing valve applies for the bathroom floor.



5.5 Design of Thermal Storage System – PCM Tank

5.5.1 PCM Tank Overview

Space limitations are becoming the biggest obstacle in the design and construction of any home, especially in New York, where maximizing space is an important factor in new home layouts. Generally, the square footage for a home is decreased dramatically as new buildings are constructed, which presents restrictions for spaces needed for mechanical equipment. This is why a Phase Change Material (PCM) tank was chosen for this HVAC system. An advantage of using a PCM material for the tank instead of water is that the volume of this tank can be reduced by up to 50% without loss of thermal storage capacity [Ref: Table 5.2]. An additional advantage of using a PCM tank over a conventional tank is these tanks operate at a constant temperature, and their operating temperature can be chosen easily according to the PCM material implemented.

5.5.2 PCM Tank Operation

The system will be charged initially, to allow the PCM material to reach its solidus line state temperature. The control of the HVAC system will control the flowing fluids in the tank to meet energy requirements once the material reaches its melting temperature. The ideal operation of the tank is to maintain the material at its melting temperature, where energy is stored in the form of latent heat. During parts of the day when solar energy is scarce (i.e., early mornings, late evenings, and nights), and energy is needed, fluids in the heat exchangers would start their cycles to collect energy from the tank.

The following diagram shows the basic operational scheme of the tank in the HVAC system of the house:

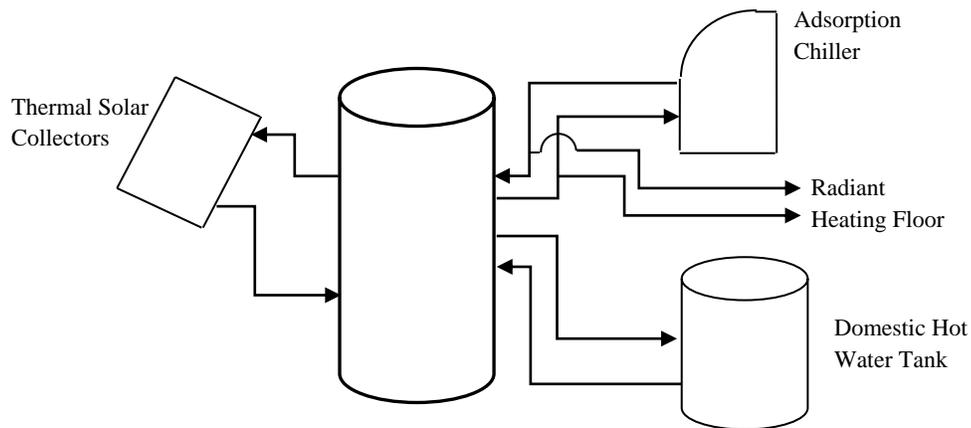


Figure 5.4 - Schematic of how the PCM tank supplies energy to the AC and also the DHW Tank

5.5.3 PCM Tank Design

5.5.3.1 Tank Design & Location

It is a usual practice to use PCM tanks to operate with a single heat exchanger having interaction between two working fluids. For this application, the PCM tank is uniquely designed in order to accommodate three heat exchangers for two separate applications HVAC and DHW, and three working fluids interacting inside the PCM tank. Furthermore, the arrangement of the heat exchangers inside the tank was designed to avoid a temperature gradient ensuring the maximum efficiency of the tank.

The tank size was selected according to the thermal energy requirement of the solar house. Simulations were run to acquire the total energy consumption of the house during a period of 24 hours; the tank was designed to provide this amount of energy.



resulting in the house running on energy solely obtained from the tank during this period (assuming no energy collection due to lack of solar energy). Table 3.9 shows the results of the simulations. The average thermal loads requirement was 244,000 kJ for a period of 24 hours, which is the starting point in sizing the tank. However, this energy requirement was unattainable due to space limitations within the house, and it was chosen instead to fulfill a 10 hour period. In practical terms, this period of time enables the system to run using the energy stored in the tank without energy being collected at all. It is expected that before this period of time has passed the flow of energy into the tank would have resumed and energy is again being brought into the tank; this addresses situations where the collection of energy is low, or negligible during long periods when the at the same time energy is being used to drive other systems. In order to size the tank the sensible heat is neglected and only latent heat is considered to be stored in the tank. The following table shows different sizes according to different materials along with the size required if a water tank was to be used.

Table 5.2 - Design parameters compared using different materials

	Units	Water	Paraffin RT-65	Paraffin RT-82
Energy Storage	kJ	82,190	82,190	82,190
Required (8 hrs.)				
Mass	kg	960.58	540.72	467.00
Volume	m ³	0.775	0.614	0.531
US Gallons	Gal	204.73	162.20	140.27
Mass Reduced	%	N/A	43.7	51.38
Volume Reduced	%	N/A	20.77	31.48

Looking at the results it is easy to observe how dramatic the reduction in the mass needed to store energy is achieved. Rubitherm's RT-82(Rubitherm.com), will be used as the PCM material in this application . The Tank will be atmospheric, and the PCM material will be filled when it is on its granulated state. The PCM material will present a thermal expansion of 14% once it turns into liquid. Hence, in order to accommodate additional volume increase the height of the tank is increased by 1ft. The PCM tank will have base diameter of 2ft and height of 7ft.

6.5.3.2 Tank Sizing

The tank sizing calculation mainly includes tank height , shell thickness, bottom and top plate thickness consideration. The tank sizing calculations are done in such a way that it will give the required quantity of RT_82 (Solid) to have the energy back up of 8 hours based on total energy requirement of 244 MJ/day.

Diameter of Tank Base = 2 ft

Total amount of energy required (MJ/day) = 244 MJ/day

No. of hours of energy back-up = 8.08 hrs

$$\text{Amount of energy storage required} = 244 \left(\frac{8.08}{24} \right) = 82.19 \text{ MJ}$$



$$\text{Quantity of RT - 82 (Solid)} = 82190 \text{ kJ} \cdot \frac{1 \text{ kg}}{176 \text{ kJ}} = 467 \text{ kg}$$

$$\text{Quantity of RT - 82 (Liquid)} = \frac{467 \text{ kg}}{0.88 \text{ kg/liters}} = 530 \text{ liters}$$

Due to 14% volume expansion,

$$\text{Quantity of RT - 82 (Liquid) with 14% expansion} = 604 \text{ liters} = 21 \text{ ft}^3$$

Therefore, total working volume = $V = 21 \text{ ft}^3$

$$\text{Tank height requirement is } V = \pi r^2 h \rightarrow h = \frac{V}{\pi r^2}$$

Thus,

$$h = \frac{21 \text{ ft}^3}{3.24 \text{ ft}^2} \sim 7 \text{ ft}$$

The specific location of the tank in the house can be found in construction drawings **M_603 in the roof pod**.

5.5.3.3 Vessel Design

Shell Thickness Top and Bottom Plate:

Max. longitudinal compressive stress,

The tank thickness is taken as $3/16'' = 0.1875''$ and max allowable stress shall be less than yield stress at then thermal design temperature of 100 °C for the material to be used, in this case Galvanized Steel. The operating temperature of the tank is 82 deg C, but the design stress is considered for and design is optimized for the 100 deg C temperature.

$$\sigma_{max} = -\frac{w}{\pi D_0 t} - \frac{4M}{\pi D_0^2 t} - \frac{P_x D_0}{4t}$$

Where

w = Total Weight (PCM Material, Shell, Heat Exchanger, ect.)	1,500 lbs
M = Bending Moment (No offset loading in the Tank)	0
P _x = External load on the shell	0
D ₀ = Outside diameter of shell = OD (2 ft) + t (0.375in)	24.375in
t = Shell Thickness	0.1875 in

$$\sigma_{max} = -\frac{1500}{\pi(24.375)(0.1875)} - 0 - 0 = -106 \text{ psi}$$



$$\sigma_{max} = -0.75 \frac{N}{mm^2}$$

The maximum induced compressive stress shall not exceed **thecalculated critical stress for buckling** or **design stress for galvanized steel** which ever is lower.

Calculated critical stress for Buckling:

$$\sigma_{cr} = 0.5C\pi^2E \left(\frac{R_0}{L}\right)^2 = 0.5 \times 1 \times \pi^2 \times 27 \times 10^6 \left(\frac{12.1875}{84}\right)^2 = 2755265 \text{ psi} = 18996 \frac{N}{mm^2}$$

Where,

C = End Connection Coefficient	1.0
E = Youngsmodulous	27 x 10 ⁶ psi
R ₀ = Outer radius of shell	12.1875"
L = Length of shell	84"

Max allowable stress based on Factor of Safety:-

Considering

Factor of Safety	2.35
Design Stress at 100 deg C	125 $\frac{N}{mm^2}$

The allowable stress of the shell

$$\sigma_{allowable} = \frac{125}{2.35} = 53 \frac{N}{mm^2}$$

For the tank shell thickness design, $\sigma_{allowable}$ has been considered as it is lower than calculated critical stress for Buckling.

For tank shell thickness $t = 3/16"$ satisfies required condition of $\sigma_{max} < \sigma_{allowable}$. Hence it is appropriate to consider tank shell thickness of 3/16".

Top plate thickness:

$$t = d \left(\frac{CP}{SE}\right)^{1/2}$$

Where

d = Effective diameter of plate 24" + corrosion allowance = 24" + 0.375" = 24.375"

C = 0.33

P = design pressure = 14 psi

S = Allowable stress at 100 °C =



$$S = \frac{125}{2.35} = 53 \frac{N}{mm^2} = 7687 \text{ psi}$$

E = Weld joint efficiency = 1.0

$$t = 24.375 \left(\frac{0.33 \times 14}{7687 \times 1} \right)^{1/2} = 0.6''$$

Bottom plate thickness:

$$t = d \left(\frac{CP}{SE} \right)^{1/2}$$

Where

d = effective diameter of plate = 24'' + corrosion allowance = 24'' + 0.375'' = 24.375''

C = 0.33

P = design pressure = $3 \frac{w}{\pi r^2} = \frac{1500}{\pi(12)^2} = 10 \text{ psi} + atm = 10 + 14 \text{ psi} = 24 \text{ psi}$

S = Allowable stress at 100 °C = $\frac{125}{2.35} = 53 \frac{N}{mm^2} = 7687 \text{ psi}$

E = Weld joint efficiency = 1.0

$$t = 24.375 \left(\frac{0.33 \times 24}{7687 \times 1} \right)^{1/2} = 0.8 \text{ in}$$

Bottom cover fillet weld sizing calculations:

L = Leg length of weld

The leg length is taken equal to min. plate thickness required to be weld. The bottom plate thickness is 0.6'' , hence

L = 0.7''

t = Length of Throat – = $0.707 \times \text{leg length} = 0.707 \times 0.7'' = 0.5''$

Normal bending Stress σ_n ,

$$\sigma_n = \frac{-P}{(\pi D)t} = \frac{1500}{\pi 24 \times 0.5} = -41 \frac{\text{lbs}}{\text{in}^2}$$

Tangential bending Stress σ_t ,

$$\sigma_t = \frac{\sigma_n}{\sqrt{2}} = \frac{41}{\sqrt{2}} = 30 \frac{\text{lbs}}{\text{in}^2}$$

Tangential shear Stress τ_t ,

$$\tau_t = \frac{\sigma_n}{\sqrt{2}} = \frac{41}{\sqrt{2}} = 30 \frac{\text{lbs}}{\text{in}^2}$$



Resultan Tensile Stress

$$\text{Resultant tensile stress} = \beta \sqrt{\sigma_t^2 + 3(\tau_t^2 + \tau_{parallel}^2)}$$

As $\tau_{parallel} = 0 \frac{lbs}{in^2}$

$$\text{Resultant tensile stress} = 0.7 \sqrt{(30)^2 + 3(30)^2} = 42 \frac{lbs}{in^2} = 0.35 \frac{N}{mm^2}$$

$$\text{Max. permissible stress} = \frac{\text{Design stress for galvanised steel}}{F.O.S}$$

$$\sigma_s = \frac{125 \frac{N}{mm^2}}{2.35} = 53 \frac{N}{mm^2}$$

From above calculations shows that Max.permissible stress \ll Resultant tensile stress of weld joint. Therefore, it is safe to use following weld dimensions for the given load.

Leg length of weld = 0.7 "

Throat of the weld = 0.5"

This previous section was done following procedures found in

5.5.3.2 Heat Exchanger Design

The heat exchangers inside the tanks play a critical role in the overall process taking place. Due to the space constrains, these heat exchangers need to be efficient, and they must maximize the space allocated to them. After exploring several options, the team selected to use helical coiled tubes for the heat exchangers. Helical heat exchangers provide enhanced heat transfer, and maximize the amount of heat exchanger area in a small space. Several methods for the design of the heat exchangers are available; however, the most widely used is the Log Mean Temperature Difference (LMTD) [Latif, J. (2002). *Heat Transfer essentials*]. LTMD was used in the heat exchanger design process. In order to simplify the calculations done the following assumptions were made:

- Temperature inside the tank remains constant at the melting temperature of the PCM material chosen.
- PCM material properties are independent of the change in temperature.
- Phase change takes place at a single temperature.
- Heat transferred by convection from the PCM material to the heat exchanger’s tube is negligible.
- Uniform material properties.
- Uniform temperature distribution inside the tank.
- Heat loss to the ambient is negligible.

Making the assumptions mentioned above, allows the design of the heat exchangers as follows:

First, we start with the basic equation relating the heat exchanger to the amount of energy need it from it:

$$q = U_o A_o \Delta T_{lm} \tag{1}$$

Where

q = Rate of heat transfer between the working fluids



U_o = Overall heat transfer coefficient

A_o = Heat Exchanger surface area

ΔT_{lm} = LMTD

Since this is a design process, the outcome of it is expected to be some kind of physical specifications; hence in (1), the surface area of the heat exchanger is what is looked for.

$$A_o = \frac{q}{U_o \Delta T_{lm}} \quad (2)$$

From here the steps to design and size the area needed in order to obtain an efficient heat transfer in the heat exchanger is as follows:

Find the overall heat transfer coefficient (U_o)

For axial heat transfer in internal flow within a pipe, U_o is defined as follows:

$$\frac{1}{U_o} = \frac{D_o}{D_i h_i} + \frac{D_o}{2k_{co}} \ln\left(\frac{D_i}{D_o}\right) + \frac{1}{h_o} \quad (3)$$

Where

h_i = Heat transfer coefficient inside the coil

h_o = Heat transfer coefficient outside the coil

k_{co} = Thermal conductivity of coil's material

D_i = Inner diameter of the pipe

D_o = Outside diameter of the pipe

In order to find the inside heat transfer coefficient the flow needs to be characterized in order to use the appropriate heat transfer correlations. Once the flow is characterized, the heat transfer coefficient is found using the Nusselt number from the following equation:

$$Nu = \frac{h_i D_i}{k_f} \quad (4)$$

Where

Nu = Nusselt number

h_i = Heat inside coefficient

k_f = Thermal coefficient of the fluid



To find the Nusselt number attention is turned to one of the most important parameters in analyzing flow: the Reynolds number which is found as follows

$$Re = \frac{\vec{u}D_e}{\nu} \quad (5)$$

Where

Re = Reynolds number

\vec{u} = Fluid velocity

D_e = Characteristic length (Nominal Diameter).

ν = Kinematic viscosity

For forced internal flow in helical coils the Reynolds transition number is calculated as follows,

$$Re_t = 2100 \left(1 + 12 \sqrt{\frac{d}{2R}} \right) \quad (6)$$

Applicable for

$$10 < \frac{2R}{d} < \infty$$

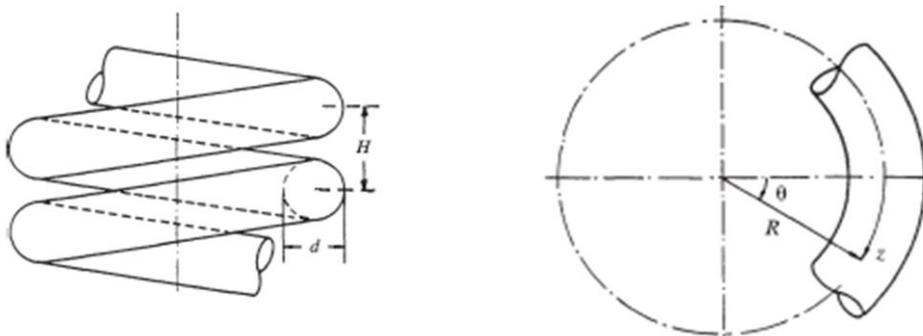
Where

d = Diameter of coil's pipe

R = Radius of the coil

The following diagram explains the values mentioned above:

Figure __ Physical considerations for helical coil heat transfer calculations.



Any flow with a $Re < Re_t$ is laminar; for $Re > Re_t$ the flow is turbulent and correlations equations must be used accordingly. For the PCM Tank design the proposed radius for the coiled heat exchangers are as follows:



Solar: Radius of the Coil R = 12 in.
 Diameter of the Pipe: d = 1.0 in

$$\frac{12}{1.0} = 12 \quad \text{Applies}$$

Adsorption Chiller & Domestic Hot Water

Radius of the Coil R = 18 in
 Diameter of the Pipe: d = 0.5

$$\frac{18}{0.75} = 24 \quad \text{Applies}$$

The fluid velocity is found using the following equation, considering a control volume in the entrance of the pipe:

$$\vec{u} = \frac{\dot{m}}{\rho \pi r^2} \quad (7)$$

Where

\dot{m} = Mass flow rate

r = Pipe Radius

Assuming the Reynolds number shows flow is turbulent flow (most flows are turbulent in real applications), the a correlation equation is needed to find the Nusselt number in order to similarly find the heat transfer coefficient. Innumerable correlation equations are found in literature to analyze the Nusselt of different cases according to type of flow, and the characteristic geometry of the surfaces in contact with the fluid. For the design of these heat exchangers, a helical coil was used due to the enhance heat transfer found in this type of heat exchangers. In addition, they provide a large heat exchanger areas in small space which fits this application very well. For this report we proposed to use the following correlation equations:

Gnielinsky Correlation Equation [Jiji, 2002]

Even though this equation is for straight pipes, it can be applied to helical coils where the radius of curvature is small. This is equation is very reliable and it will provide rough figures of the heat transfer calculations.

$$N_u = \frac{\left(\frac{f}{8}\right) * (R_e - 1000) * P_r}{1 + 12.7 * \left(\frac{f}{8}\right)^2 * [P_r^{0.66} - 1]} \quad (8)$$

Where

P_r = Prandlt number

f = Friction factor



This equation is valid within a certain range of Prandtl numbers and Reynolds numbers, for each case the assumptions were checked in order to establish whether the equation applied or not.

Mori & Nakayama [Manglik, 2003]

This correlation equation was specifically proposed for turbulent helical flow in circular pipes.

$$Nu = \frac{Pr^{0.4}}{41.0} Re^{\frac{5}{6}} \left(\frac{d}{2R}\right)^{\frac{1}{12}} \left[1 + 0.061 \left\{ Re \left(\frac{d}{2R}\right)^{2.5} \right\}^{\frac{1}{6}} \right] \text{ for } Pr > 1 \quad (9)$$

Eq.9 has been successfully used to analyze turbulent flow within a certain range of Prandtl numbers. This equation will provide better approximations to the helical flow found in the heat exchanger design. However, figures using Eq. [9] will provide ideal results for the heat exchangers where the heat transfer process is very efficient as is the case in helical coils. As a result, the design team took the results obtained from Eq. 8 and Eq. 9 and used the average to design the heat exchangers.

Doing the calculations for the other two flows showed they were turbulent. In order to find the Nusselt number the friction factor for each flow was needed to be found. The following equation was used:

$$f = [0.79 * (\ln(Re) - 1.64)]^{-2} \quad (10)$$

With the friction number known, the Nusselt number is found using Eq. 8, and Eq. 9. This leads to finding the inner and overall heat transfer coefficients. Using Eq. 2 the area required for the heat exchanger is found.

The design requirements for the heat exchanger provide most of the physical requirements, additionally some of the heat transfer constants needed as the Prandtl number, dynamic viscosity and so on are evaluated at the mean temperature of the fluid, the following table lists the different properties:

Table 5.3 - Fluid properties of water at different temperatures for various heat exchangers

Heat Exchanger	Units	Domestic Hot Water	Adsorption Chiller	Solar Collector
Inlet Temperature	°F	122	149	203
Outlet Temperature	°F	149	185	180
Mass Flow Rate	kg/s	0.189	0.4332	0.456*
Mean Temperature	°F	135.5	167	191.5
Density	kg/m ³	985.7	974.7	965.1
Prandtl Number		3.27	2.39	1.97
Specific Heat	J/kg°C	4184	4191	4204
Kinematic viscosity	m ² /s	0.511*10 ⁻⁶	0.3881*10 ⁻⁶	0.3264*10 ⁻⁶
Thermal Conduct.	W/m°C	0.6458	0.6653	0.6727

*This mass flow rate is divided into four due to the fact that the flow feeds four heat exchangers in the proposed design, to improve heat distribution in the tank.

With these properties known, the first step of the design process is to characterize the type of flow found in the heat exchangers. The tubing to be used is standard copper tubes, and different diameters were tried to choose the one that better accommodates to



the design. In the first trial the inner and outer diameters for a 1" nominal diameter tube are: 0.995 inches and 1.025 inches respectively (www.copper.org). Using the tube diameter and the fluid properties listed in the table above the Reynolds number is found using the following:

The fluid velocity is considered fully developed and is calculated as follows (for the Solar Collector Heat Exchanger):

$$\bar{u} = \frac{\dot{m}}{\rho \pi r^2} = \frac{(0.114 \text{ kg/s})}{965.1 \text{ kg/m}^3 \left(\pi \frac{0.01905}{2} \text{ m} \right)^2} = 0.51 \text{ m/s}$$

With this velocity the Reynolds number is:

$$Re = \frac{0.51 \text{ m/s} * 0.01905 \text{ m}}{0.3264 * 10^{-6} \text{ m}^2/\text{s}} = 29678$$

Which means that the flow for these coils is turbulent. Once the Reynolds number is known, the Nusselt number is found using correlation equations for internal turbulent flow in as in Gnielinski Equation, stated as follows:

$$f = [0.79(\ln(29678) - 1.64)]^{-2} = 0.0218$$

Inserting this result in the equation for the Nusselt number:

$$Nu = \frac{\left[\frac{0.0218}{8} (429678 - 1000)(1.97) \right]}{1 + 12.7 \left(\frac{0.0218}{8} \right)^{\frac{1}{2}} (1.97^{\frac{2}{3}} - 1)} = 100.94$$

And thus the inside heat transfer coefficient:

$$h_i = \frac{Nu * k_f}{D_i} = \frac{100.94 * 0.6727}{0.01905} = 645.115 \text{ W/m}^2\text{C}$$

In equation (3), the outside heat transfer coefficient is considered to approach infinity. Heat transfer by convection is very low since the tank is pressurized and elements are considered to be in contact allowing only heat transfer by conduction. Thus, plugging in the numbers results in the following:

$$\frac{1}{U_o} = \frac{0.01905}{0.01893 * (645.115)} + \frac{0.01905}{2 * (397.1)} \ln \left(\frac{0.01893}{0.01905} \right)$$

$$U_o = 3557.14 \text{ W/m}^2\text{C}$$

$$q = (0.114) * (4204) * (95 - 85.5) = 4551.85 \text{ W}$$

Inserting these results in equation (2), along with the mean log of the different temperatures results in a surface area required for the heat exchanger:

$$A_o = 0.21 \text{ m}^2$$

This requirement can be met using a coil spiral heat exchanger using the copper tube alluded to before. The total length of the tube using a coil diameter of 0.5 ft is 11.66 ft. A similar procedure was followed to find the area required for the heat exchanger in the other two applications. Due to the space constraints a spiral heat exchanger was chosen to implement the design. Spiral heat exchangers minimize the amount of space occupied by the heat exchanger while maximizing the amount of surface.



The results for the heat exchangers are tabulated in the next table:

Table 5.4 - Values obtained after heat transfer analysis of the various heat exchangers

		Solar Collectors		Adsorption Chiller		Domestic Hot Water	
		m = 0.456 kg/s (Div. by 4)		m = 0.4332 kg/s		m = 0.189 kg/s	
Correlation Equation Used	Symbol	Gnielinsky	Mori & Nakayama	Gnielinsky	Mori & Nakayama	Gnielinsky	Mori & Nakayama
Reynolds Number	Re	26846.91	26846.91	58059.26	58059.26	42486.14	42486.14
Transition Reynolds Number	Re _t	8079.88	8079.88	8768.63	8768.63	6049.77	6049.77
Heat Transfer Coefficient (inner)	h _i	3956.22	5391.47	5601.15	7444.95	10927.78	12811.51
Overall Heat Transfer Coeff.	U	3557.14	4833.01	4848.62	6399.92	8473.93	9878.69
Nusselt Number	Nu _D	100.94	137.56	212.07	281.88	190.06	222.82
Heat Transfer Rate	q	4551.85	4551.85	36310.82	36310.82	15815.52	15815.52
Number of Turns	n	3.71	2.73	12.27	9.30	0.83	0.71
	n _{avg}	3.22		10.785		0.77	
	Chosen	3.5		10.5		1	
Heat Exchanger Area	A _o	1.67		11.34		0.56	
Heat Exchanger Length	L	8.58		43.81		3.89	
Heat Exchanger Height	H	1.15		3.70		N/A	



As seen in the table above, the area required for the solar collector heat exchangers is extremely small, this is due to the high flow rate required in the liquid coming from the solar collectors. In this unique design where the temperature distribution is critical for the performance of the unit, it has been decided to use four heat exchangers in parallel. The heat exchangers bringing energy into the system (solar collector), will be placed in the center of the tank and its coil diameter is to be small. This will distribute the heat better among the entire tank. The other two coils corresponding to the other heat exchangers have a greater radius so they are concentric to the solar heat exchanger so heat is transferred more efficiently between the heat exchangers. As stated before the additional space in the top part of the tank is was allocated for the thermal expansion expected from the PCM material. The following is a rendering of the arrangement of the heat exchangers inside the tank as the design is proposed:

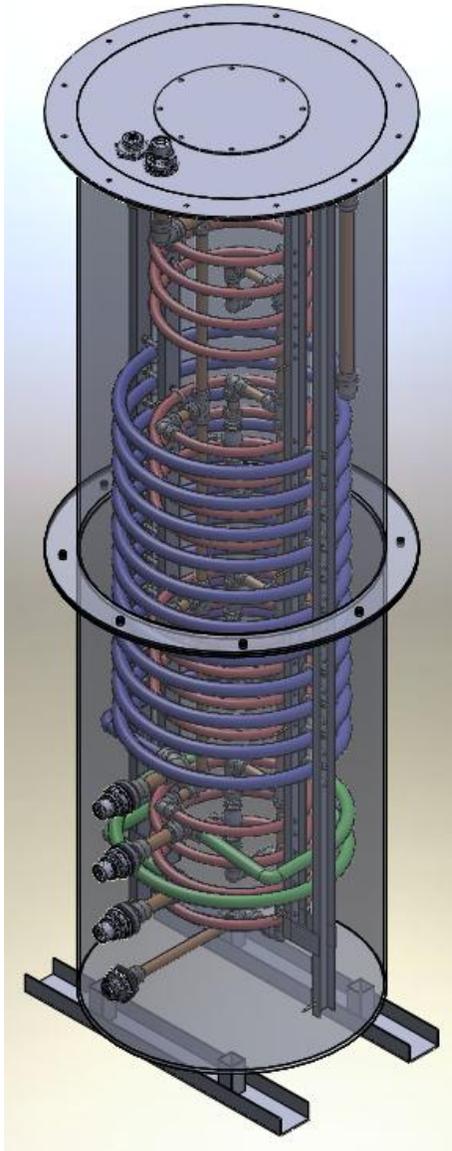


Figure 5.5 - Cylindrical Tank with heat exchangers. Red Heat Exchanger, corresponds to the incoming energy. Violet is the AC Heat Exchanger, and green Heat Exchanger is for DHW.

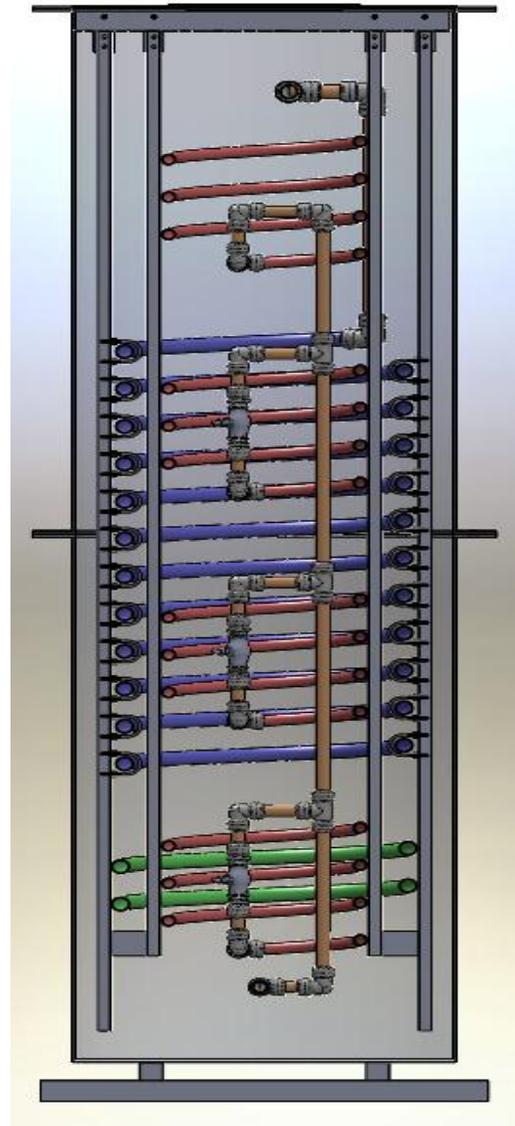
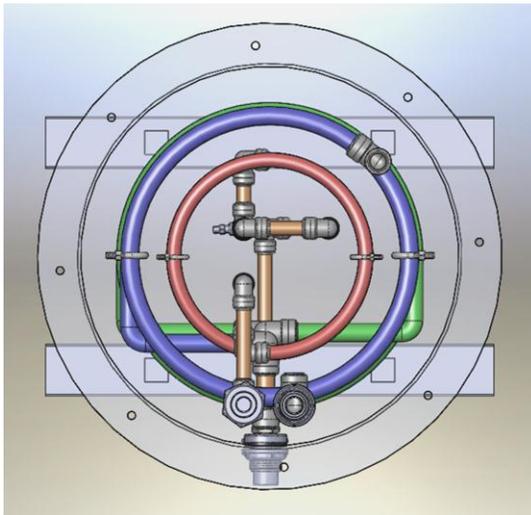
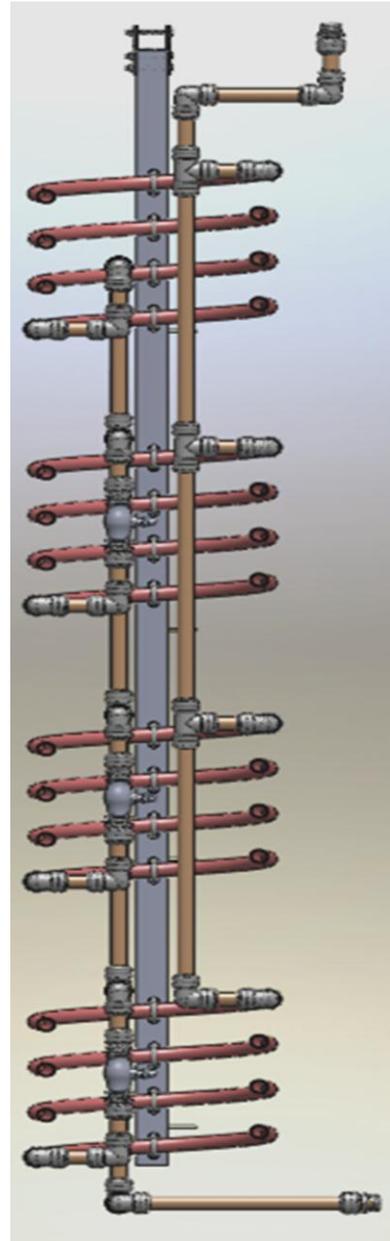


Figure 5.6 - Close-up of heat exchanger arrangement. System of heat exchangers in the middle add energy to the TES. Thermocouple are inserted in the supporting system to document performance.



Figure 5.7 – Heat Exchangers bring in energy into the system. The incoming flow rate gets divided into four by controlling output using globe valves. Thermocouples are placed in the supporting beam at different positions to document and monitor the performance of the tank.

Figure 5.7 - Top view of Tank. One tube feeds hot water to four different places in the along the cylinder to achieve even heat distribution.



5.5.4 PCM Material

Several factors were taken into consideration to choose the PCM material to be used as the main energy storage medium. The main selection criteria are as follows:

- Temperature required to drive the Adsorption Chiller (~68 °C)
- Highest Latent Heat
- Low Density
- Non-Corrosive
- Avoid Toxic Materials
- Cost



It was chosen to use Rubitherm’s (www.Rubitherm.com) paraffin RT-82, since it meets the temperature requirement, provides a lower density than water, is not toxic or corrosive, and has a high latent heat. The toxicity of the material was evaluated to comply with the cross contamination code P290.5.2 referring to the contamination of potable water in the case of the domestic hot water heat exchanger.

Toxicity of PCM Material

According IRC (P2902.5.2), for the heat exchangers running toxic fluids must have double wall in order to prevent mixing of toxic fluid with the water. For this application the referred clause would not be applicable as heat exchanger is running water as a heat transfer medium. RT-82 is used as a heat storage medium , it is not a heat transfer medium.

Rubitherm RT-82 has non-corrosive property therefore copper tube of DHW heat exchanger is unlikely to be damaged due to corrosion. Another possibility of damage is due to the direct pressure exerted on the copper tubes due to the weight of the paraffin, the wall thickness (0.068 inches) of DHW is strong enough to sustain this pressure. The heat exchanger tubes will also have a supporting spaces in-between coil turns which will prevent bending of copper tubes.

Germany has codes for paraffin material heat exchanger (WGS code). We have looked into US codes that will be equivalent to German codes; unfortunately there is no such code standards for the paraffin in the American standards. In addition, we have also located an equivalent material MSD provided by a laboratory in Texas for the paraffin wax, (ScienceLab laboratory), see attachment. We found that this material is nearly identical to RT-82. This document quotes that ‘No Toxicological data available for this material ‘ . In addition, Paraffin Oil, a similar Material to the one used here as a thermal storage material (Paraffin Wax), was given a Gosselin Rating of 1 (Sciences, Enerteq, 1991) in a ASHRAE report. Thus, in summary we have determined that our proposed PCM (RT-82) is a thermal storage material with chemical properties identical to wax and represents minimal to zero risks to contaminate potable water.

Table 5.5 – Paraffin Specifications from Rubitherm

Characteristic	Property
Melting Area	170 - 185 ° F (Typically being 180°F)
Congeeing Area	185 - 1170 ° F (Typically being: 181°F)
Heat Storage Capacity	176 kJ/kg
Density Solid (At 59°F)	0.88 kg/L
Density Liquid (At 176°F)	0.77 kg/L
Volume Expansion (In phase change range)	14%
Heat Conductivity	0.22W/m °K
Corrosive Properties:	Chemically inert to most materials
Water Hazard	Water hazard class (WGK) 1
Flash Point	518°C



5.5.5 Tank Insulation

Insulation thickness for the PCM tank is calculated in order to maintain minimum external surface temperature of insulation. The material selected for the insulation is fiberglass wool having low thermal conductivity. The amount of heat transfer is same from inside the tank through tank wall & insulation material to the atmospheric air of the mechanical room. The heat transfer due to conduction through the tank wall & insulation is equated to convection heat transfer between outer insulation surface & the room air.

The calculation are reiterated for various values of outer insulation surface temperature until heat transfer losses due to conduction & convection appears similar. The below calculation shows that the selection of 2" insulation & outer insulation temperature of 28 deg C equalizes the conduction and convection heat transfer.

$$\frac{T_{\infty 1} - T_{r3}}{\frac{1}{2\pi r_1 h_1 L} + \frac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi k_s L} + \frac{\ln\left(\frac{r_3}{r_2}\right)}{2\pi k_i L}} = \frac{T_{r3} - T_{\infty 3}}{\frac{1}{2\pi r_3 h_3 L}}$$

$h_1 = \text{heat transfer coefficient of paraffin wax} = W/m^2 \text{ } ^\circ C$

$h_3 = \text{heat transfer coefficient of paraffin air}$
 $= 6 W/m^2 \text{ } ^\circ C$

$r_2 = \text{outside tank radius} = 12.1875" = 0.31 m$

$r_3 = \text{insulation radius} = 0.31m + 0.05m$
 $= 0.36 m \text{ (Assuming insulation radius of 2")}$

$k_i = \text{thermal conductivity of insulation} = 0.04 W/m \text{ } ^\circ C$

$k_s = \text{thermal conductivity of carbon steel}$
 $= 53 W/m \text{ } ^\circ C$

$T_{\infty 3} = \text{room air temperature} = 23 \text{ } ^\circ C$

$T_{r3} = \text{Required outer surface teperature of insulation}$
 $= 29.5 \text{ } ^\circ C$

$L = \text{length of tank} = 2.134 m$

$r_1 = \text{inside tank radius} = 12" = 0.305 m$

$T_{\infty 1} = \text{Inside tank temperature} = 82 \text{ } ^\circ C$

$$\frac{82 - 29.5}{\frac{1}{2\pi(0.305)h_1 L} + \frac{\ln\left(\frac{0.31}{0.305}\right)}{2\pi(53)L} + \frac{\ln\left(\frac{0.36}{0.31}\right)}{2\pi(0.024)L}} = \frac{29.5 - 23}{\frac{1}{2\pi(0.36)(6)L}}$$

$$\frac{(82 - 29.5)^\circ C}{\frac{1}{(0.305)h_1} + \frac{\ln\left(\frac{0.31}{0.305}\right)}{(53)} + \frac{\ln\left(\frac{0.36}{0.31}\right)}{(0.04)}} = \frac{(29.5 - 23)^\circ C}{(0.36)(6)}$$

$$\frac{52.5}{\frac{1}{(0.305)2000} + 0.00031 + 3.73} = \frac{6.5}{(0.36)(6)}$$

Cancelling $2\pi L$ term from both sides;

$$\frac{52.5}{3.73} W/m \text{ } ^\circ C \cong 14.04 W/m \text{ } ^\circ C$$

$$14.07 W/m \text{ } ^\circ C \cong 14.04 W/m \text{ } ^\circ C$$

The glasswool insulation of 2" gives equal heat transfer values fo conduction & convection through PCM tank to the room air. Hence, glass wool of 2" insulation thickness having thermal conductivity of

0.04 W/m °C is recommended for this application.



5.6 Solar Thermal Collectors

5.6.1 Selection of Solar Thermal Collectors

The thermally driven HVAC system depends on the solar thermal collectors to run. These collectors provide heat which is used in the system. Heat pipe evacuated tube collectors were selected over the flat plate collectors. The heat pipes are a better alternative to providing heat compared to flat plates in a New York City climate. Flat plate collectors usually need to be in direct contact with sunlight and optimum functionality is only achieved in very sunny and hot days. However, New York City has a variety of weather types, and therefore this hot and sunny climate cannot be achieved in the winter. This means that heat pipes can maintain high functionality on cold, cloudy or windy weather.

5.6.2 Solar Thermal Collector Sizing

The following calculations were done to size for flat plate and evacuated tube solar thermal collectors in the month of October. The tank loss is assumed to be around 5% of the heat stored in the tank. The tank temperature is maintained between 100°C to 80°C. The design concept is to have a 20 m² collector area coupled with the PCM tank. Current calculations were done with an assumption of water as the storage liquid. However, as previously mentioned in Section 5.5, if PCM is used as the storage, the tank will be half the capacity of water because the heat storage capacity of PCM is half the heat storage capacity of water.

A Typical System Using Water Tank Storage

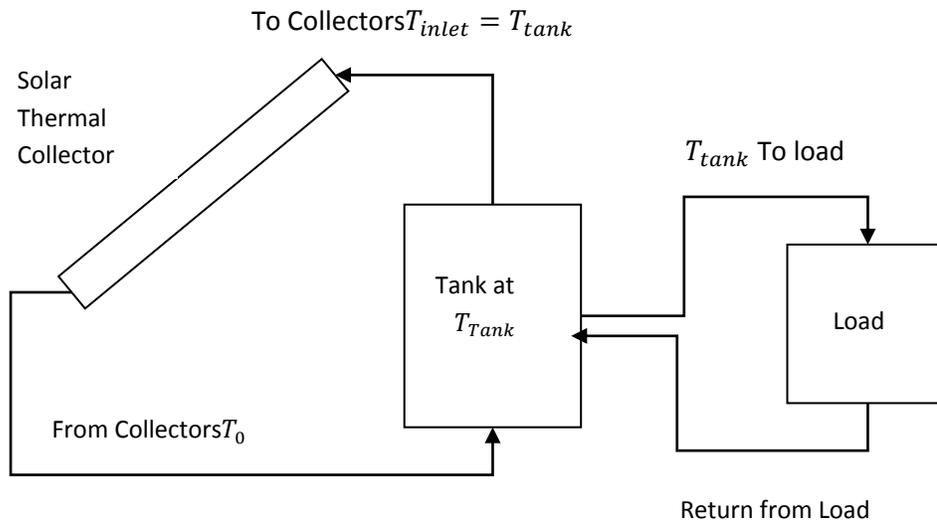


Figure 5.9 –Typical Solar Hot Water System

The following equations were used in this analysis:

(Duffie & Beckman, 2006)

$$Q_s = (mC_p)\Delta T_{Tank}$$



Where

Q_s = Heat capacity of tank

m = Mass of water in tank kg

C_p = Specific heat of water J/kg°C

Energy balance for the storage tank

$$(mC_p) \frac{dT_{\text{tank}}}{dt} = Q_{\text{collector}} - Q_{\text{building}} - (U_{\text{tank}}A_{\text{tank}})(T_{\text{tank}} - T_{\text{ambient}}) \quad (\text{Duffie \& Beckman, 2006})$$

$$T_{\text{tank-Temp}}(\Delta t + t)T_{\text{tank-Temp}}(t) + \frac{\Delta t}{mC_p} [Q_{\text{collector}} - Q_{\text{building}} - (U_{\text{tank}}A_{\text{tank}})(T_{\text{tank-Temp}}(t) - T_{\text{ambient}})]$$

(Duffie & Beckman, 2006)

$$Q_{\text{collector}} = \text{Area}F_r[S - U_L(T_{\text{tank-Temp}}(t) - T_{\text{ambient}})]$$

$$S = I_{bT}(\tau\alpha)_n K_{\tau\alpha,b} + I_{dT}(\tau\alpha)_n K_{\tau\alpha,b} + I_{gT}(\tau\alpha)_n K_{\tau\alpha,g}$$

Where

$T_{\text{tank-Temp}}(\Delta t + t)$ = New tank temperature, °C

$T_{\text{tank-Temp}}(t)$ = Old tank temperature, °C

T_{ambient} = Ambient temperature, °C

$Q_{\text{collector}}$ = Heat generated by the collectors, W

Q_{building} = Heat required for HVAC, W

I_{bT} = Beam radiation on sloped surface, W/m²

I_{dT} = Diffuse radiation on sloped surface, W/m²

I_{gT} = Ground reflective radiation on sloped surface, W/m²

S = Absorbed solar radiation, W/m²

U_L = Collector loss, W/m²°C

F_r = Collector heat removal factor

K_τ = Incident angle modifier

From SRCC solar collector certification report

$$\text{intercept} = F_R(\tau\alpha)_n = a$$

$$\text{Slope} = F_R U_L = b$$

$$\eta = a + bx$$

Where

η = Thermal efficiency of collectors

b_0 = Incident angle modifier slope

Using θ_{beam} , θ_{diffuse} , and θ_{ground} (where θ_{diffuse} and θ_{ground} are usually constant), the Incident angle modifiers K_τ can be written as



$$K_{\tau\alpha,b} = 1 + b_0 \left(\frac{1}{\cos(\theta_{beam})} - 1 \right)$$

$$K_{\tau\alpha,d} = 1 + b_0 \left(\frac{1}{\cos(\theta_{diffuse})} - 1 \right)$$

$$K_{\tau\alpha,g} = 1 + b_0 \left(\frac{1}{\cos(\theta_{ground})} - 1 \right)$$

Our main choice for collectors is the heat pipe evacuated tube collectors from the company SolarUS, however, before selecting these collectors, we must compare other collectors and size the system for the whole year. This comparison is done using the solar fraction, given by

$$SolarFraction = \frac{Energycollectedfromsun}{EnergyrequiredtoruntheHVACsystem}$$

5.6.3 Number of Solar Thermal Collectors

$$Required\ Number\ of\ Collectors = \frac{Total\ Heat\ Required\ to\ Run\ the\ System}{Total\ Heat\ Collected\ By\ the\ Collectors}$$

Total heat required for the heating and cooling system is $5.6 \frac{MBTU}{Month}$ (simulation results)

Amount of Heat Collected by the collectors can be found from SRCC (Solar Rating and Certification Cooperation, <http://www.solar-rating.org/>)

Collector Output Temperature for SolUS SL-30 is $0.81 \frac{BTU\ per\ Pannel}{Month}$
 (http://securedb.fsec.ucf.edu/src/coll_detail?src_id=2010126A)

Required Number of Collectors = 6.7



5.7 HVAC System Control

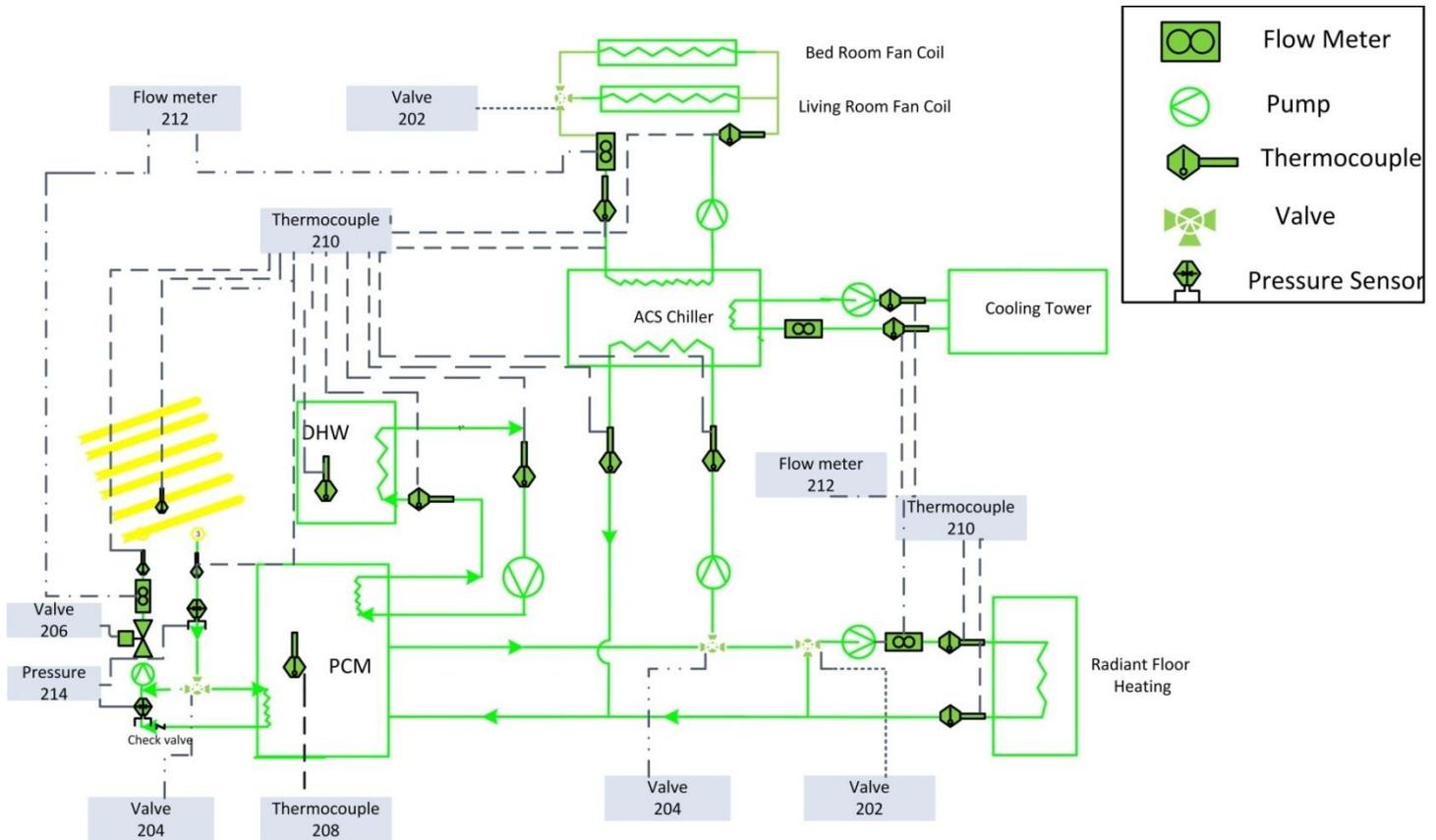
To achieve comfortable levels in the Solar Roof Pod, our design implements a control system that automates heating, cooling and fresh air ventilation. Furthermore, the control system will manage the relationship between the solar thermal collectors and the thermal storage tank. The control for HVAC will be done in conjunction with the pod’s control system. The main graphical user interface will integrate the HVAC and pod’s control system.

5.7.1 HVAC Sensor Placement

The schematic below shows the temperature sensors and valve placements. Eight temperature sensors will be placed in the PCM tank. Since simulations have shown that the PCM tank temperature is not uniform throughout, eight sensors will give more accurate temperature reading. A temperature sensor at the inflow and another at the outflow of the solar collectors will be placed. A temperature sensor in the domestic hot water tank will be placed to monitor for the low-set point temperature.

Valve **202** is a three-way check valve which will open and close for fluid to flow to the PCM tank when given conditions are met. Valve **204** is a three-way check valve which will direct fluid to either to the ACS chiller or to the radiant floor heating, but not both. Valve **206** is a three-way mixing valve which will mix hot and cold fluid to reach comfortable conditions for radiant floor heating.

Figure 5.7.12 - Temperature Sensor Placement



5.7.2 Management of Temperature, Humidity, and CO2

The following figures show the input and output behavior of the HVAC system. The inputs are temperature, CO2, and humidity readings.

Figure 5.13 shows the flow chart for temperature control. For comfort, temperature value is kept within range [71-76] F. If the temperature drops below 71 F, the Controller turns the radiant floor heating on. The Controller shuts of heating once the temperature is higher than 73 F. If the temperature value goes above 76, the Controller calls for Cooling. Once the temperature drops below 74 F, the Controller signals to stop cooling (exact details ahead).

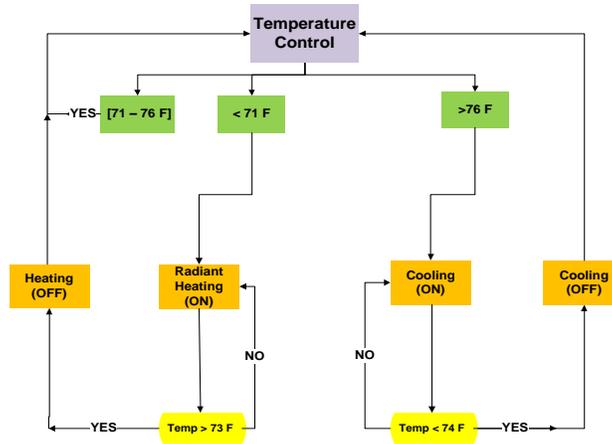


Figure 5.7.13: Monitor and Control for Temperature

Figure 5.14 shows CO2 and humidity control flow charts. The Controller will turn on ventilation if CO2 values are higher than 1000PPM. If the CO2 values are higher than 1500PPM, the Controller will signal for alarm.

For comfort, humidity is kept below 58%. If humidity is higher than 58%, the Controller signals for ventilation with the chiller on. The chilled air through the fan coils will lower the humidity level and once humidity level drops below 50% the Controller signals to stop the chiller and ventilation.

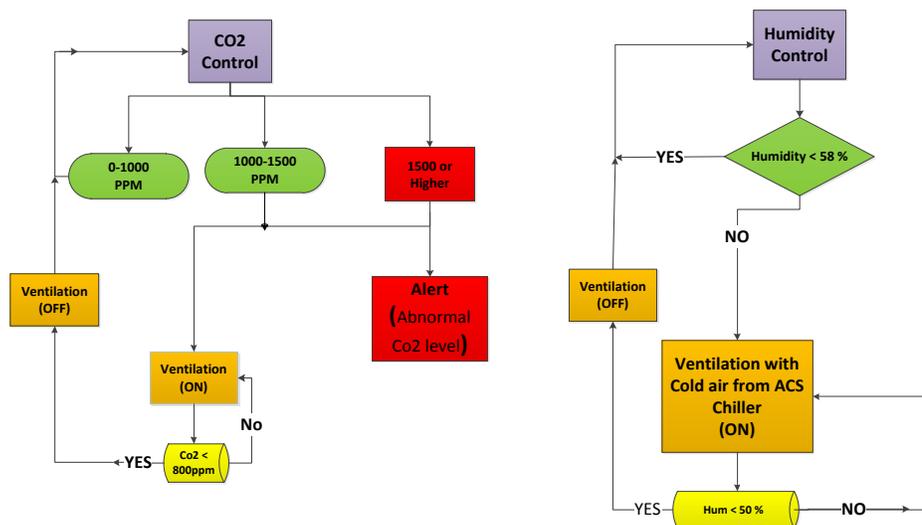


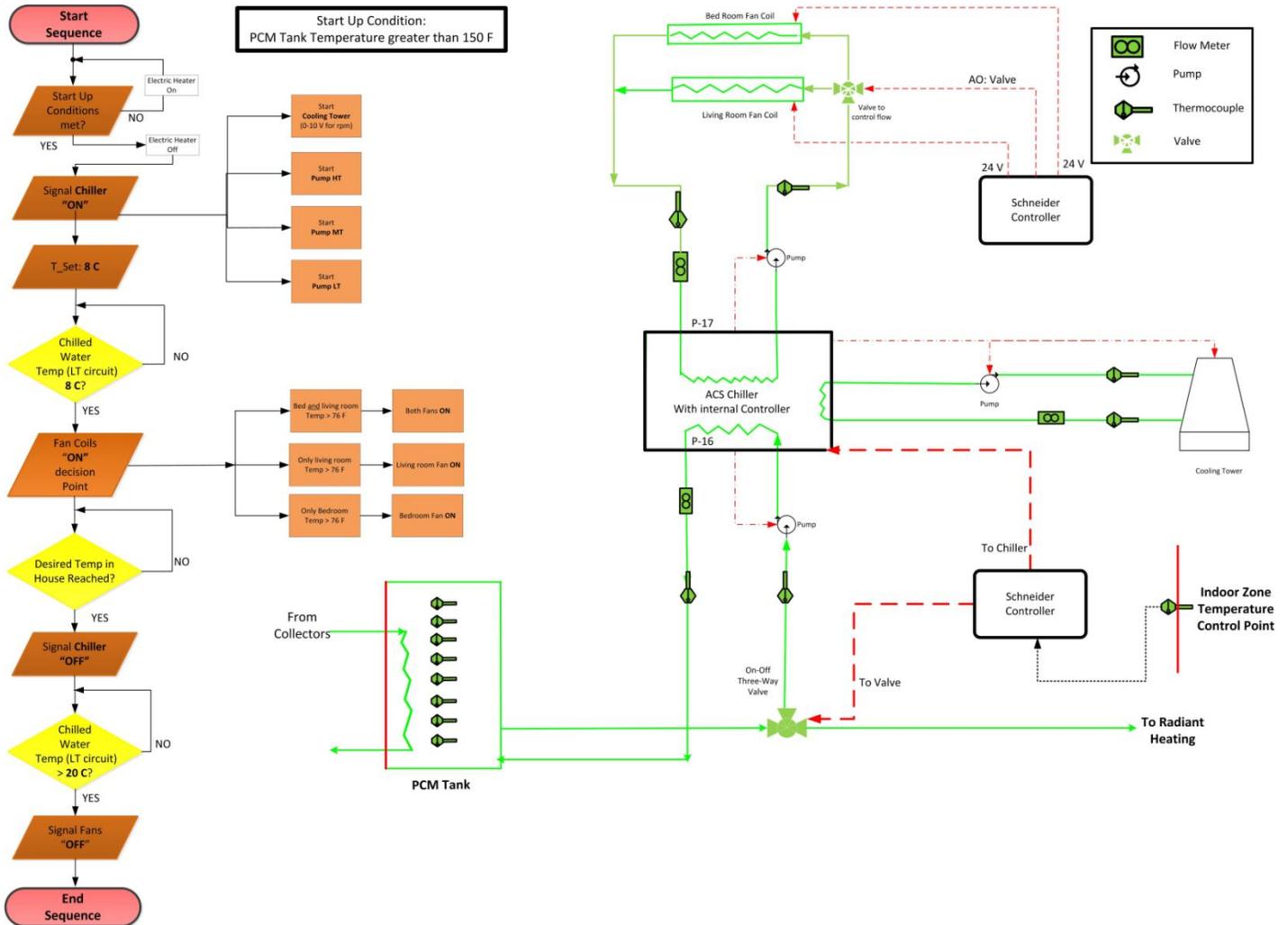
Figure 5.14: Monitoring and Control Carbon dioxide and Humidity



5.7.3 Control Strategy for Cooling

Figure 5.15 shows the steps that the Controller takes to cool the house. The startup condition is that the PCM tank temperature needs to be greater than 150 F to run the ACS chiller. The figure shows the process flow diagram along with the sequence of events that the Controller acts on for automated cooling in the house. Cooling algorithm is run in the controller when the user performs manual override and sets the desired temperature value in the house and also when the system is running in auto mode to maintain the comfort temperature in the house.

Figure 5.7.15: Flow chart for referred start-up sequence for cooling system



At the start of the algorithm the Controller checks the desired cooling load demand. The Controller then checks if the startup condition for the SORTECH’s ACS chiller is met. If the startup condition is not met, the controller signals to start the electrical heater. Once the condition is satisfied, the Controller shuts of the Electrical heater and starts the ACS chiller and sets the temperature value for chilled water circuit. The Chiller has an internal controller that automatically turns on the pumps for hot water circuit (HT), re-cooling circuit (MT) and the cold water circuit (LT). The PFD to the right shows the pumps being controlled by the Chiller.

The controller waits until the water temperature though the LT circuit is reduced down to 8 degrees C. Starting the Fan Coil Units after the chilled water temperature is 8 C allows the Chiller to reach its operating condition faster. Furthermore, once the Fan Coils start, the chiller is able to auto-regulate its output temperature. Then the controller turns on the fan coil only in the room

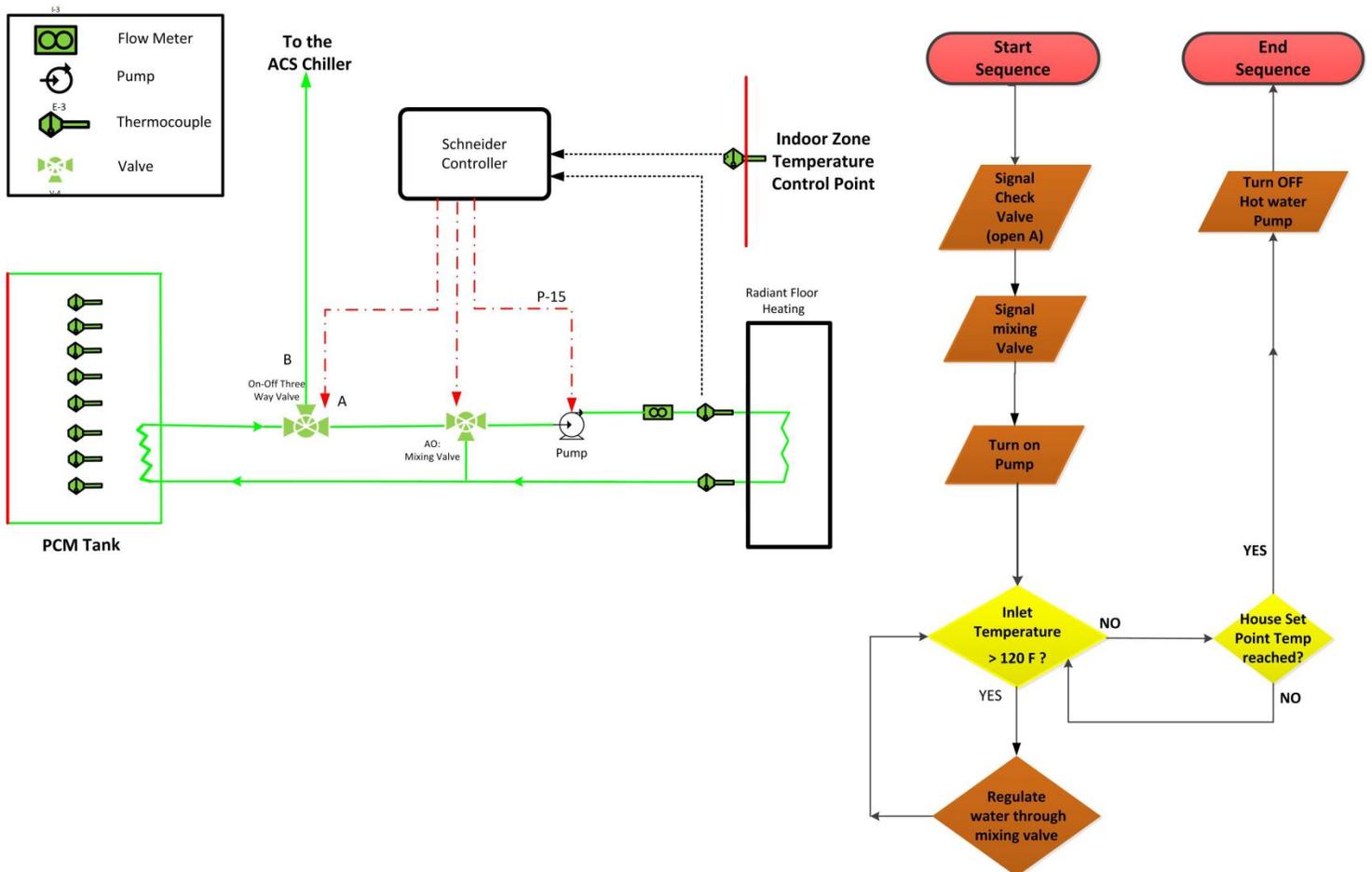


where the temperature is greater than 76 F. If manual override is on, the controller turns on both fan coils. Then the controller turns off the chiller when the desired temperature in the house is reached. After that, the Controller turns off the fan coils when the temperature through LT circuit has reached more than 20 degrees C. The wait for letting the fan coils run until the water temperature reaches 20 C is implemented so as to not waste any possible chilled air from the cold water.

5.7.4 Control Strategy for Heating

Figure 5.16 shows the steps the Controller takes to heat the house. In the figure, left side shows the process flow diagram for heating and the right side shows the control algorithm. Calculations for maximum floor surface temperature are provided in section 5.4.3.

Figure 5.7.16: Flow chart for sequence for Radiant Floor Heating.



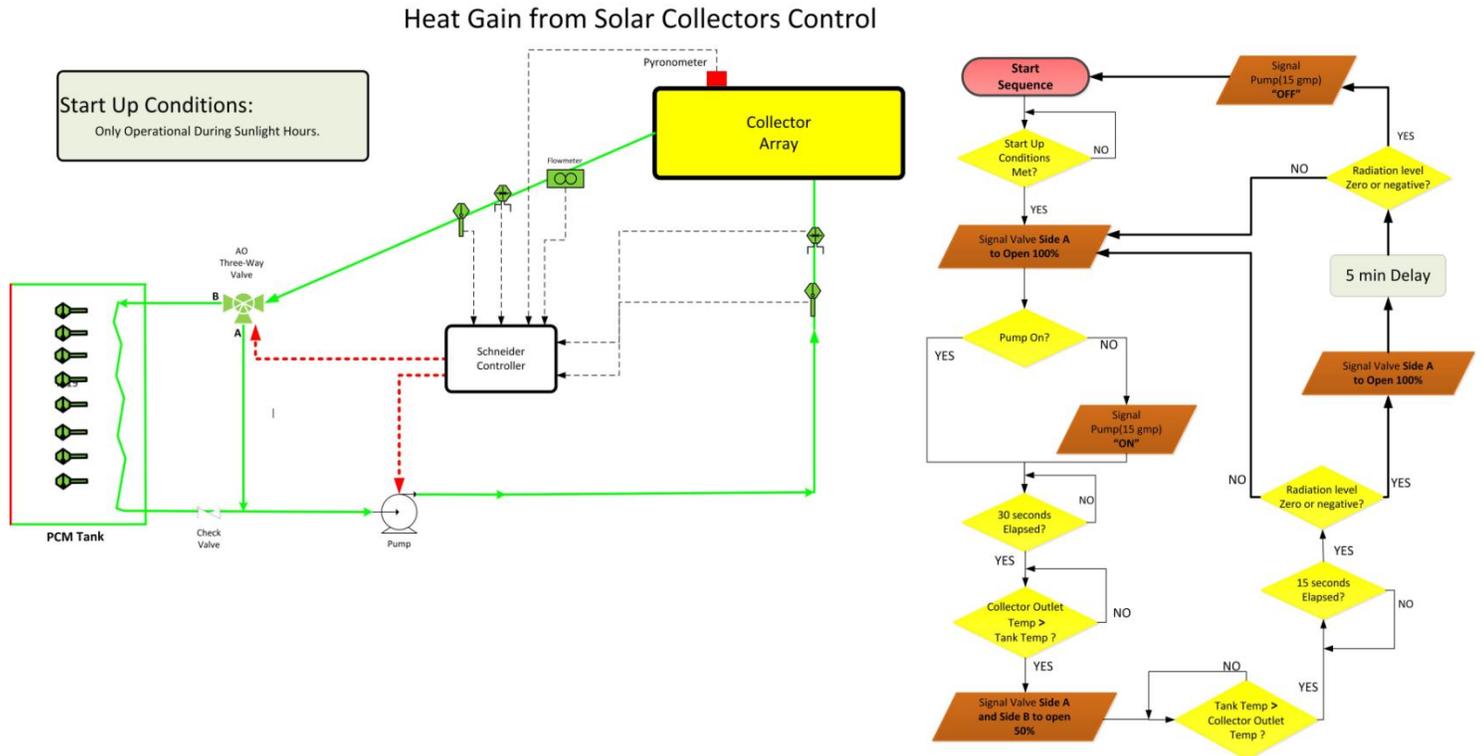
When heating is required, the Controller starts the sequence by powering a controlled check valve. It then activates the mixing valve and starts the pump. The controller then performs PID control over the mixing valve to maintain the inlet temperature to the radiant manifold to be 120 degrees F. Once the house temperature is reached, the controller turns off the pump.



5.7.5 Control Strategy for Fluid Flow between Collectors and PCM Tank.

Figure 5.7.17 shows the algorithm for fluid flow between the solar collectors and PCM tank. The algorithm outlines complete automation of the system from start up to shut down.

Figure 5.7.17: Algorithm for fluid flow between solar collectors and PCM tank.



The controller monitors for the startup condition that the time of operation has to be after sunrise and before sunset. The controller will get sunrise and sunset times from the workstation. The controller waits until the startup condition is satisfied. It then signals analog output to three way valve to open side A 100%. The Controller then starts the pump and then awaits 30 seconds. It then checks if the fluid temperature at the collector outlet is greater than the temperature in the PCM tank. If it true, the controller signals the valve to divert 50% of the fluid to side A and rest to side B. The controller then waits until the tank temperature is greater than collector outlet temperature. Once the condition is true, the controller waits 35 seconds to check if the radiation level readings from the pyronometer have become zero. If it is false, the control sequence goes back to opening valve side A 100% and continues to go through the controlled sequence from before. If is true, the controller signals valve side A to be 100%. It then waits 5 minutes and again checks if the pyronometer gives zero radiation levels. If it is true, the controller then signals the pump to turn off. The controller continues to perform the closed loop circulation to the collectors.



5.7.6 Control Strategy DHW Tank.

Figure 5.18 shows the control algorithm for monitoring and controlling the temperature in the DHW tank. If DHW Tank temperature falls below 115 F, the Controller turns on the DHW circulator pump. The circulator takes hot water from the PCM tank and sends it to the heat exchanger inside the DHW tank. If the PCM tank temperature is too low, the controller turns on the electrical heater inside the DHW tank.

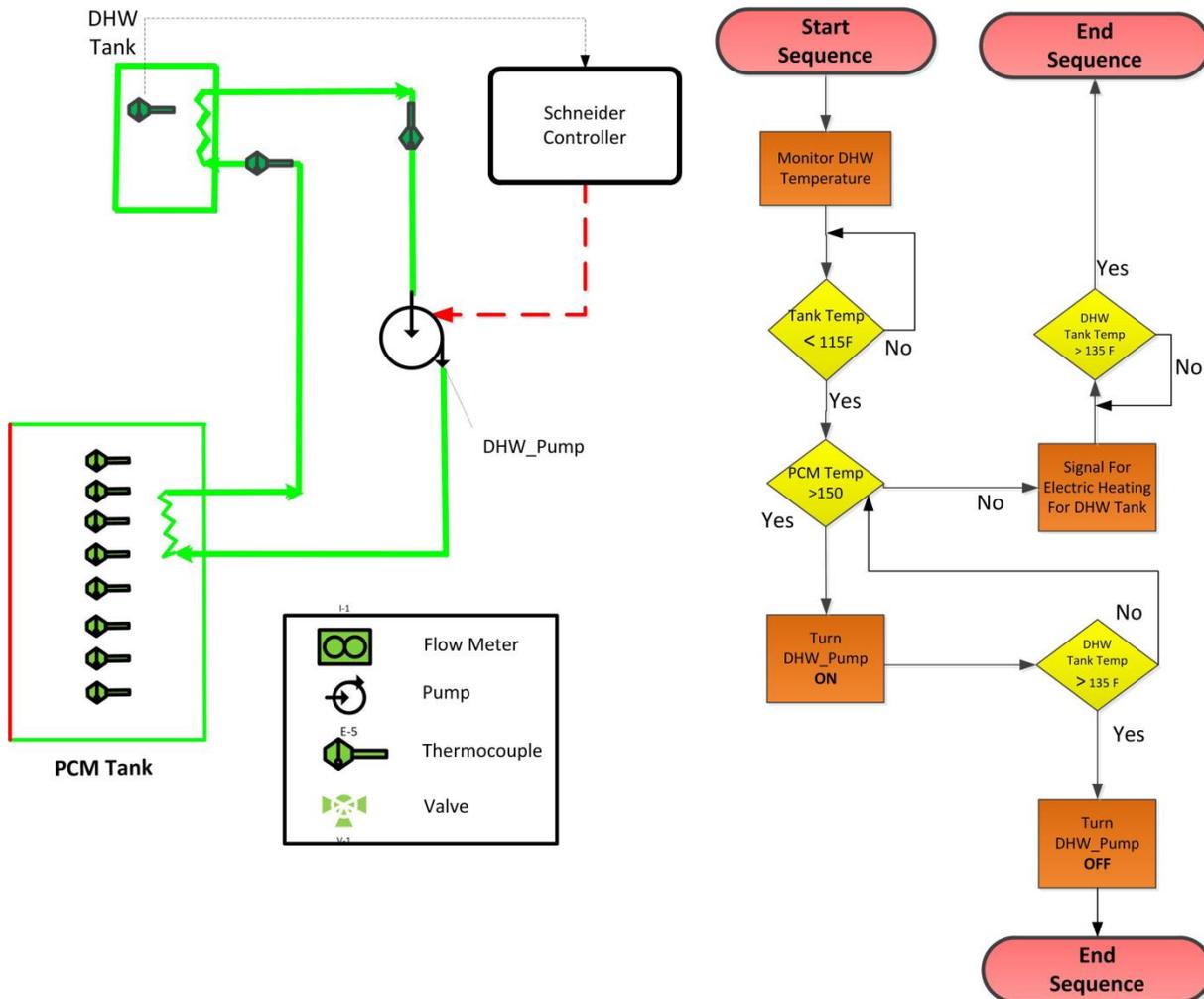


Figure 5.7.18: Monitor and Control for DHW tank and PCM Tank

The controller checks if the domestic hot water tank temperature is below 115 F. If it is, the controller then checks if the PCM tank temperature is above 150 F. If it is not, the controller then signals to turn on the electrical heater installed inside the DHW tank. The heater is kept on until the DHW tank temperature is above 135 F. Once this is true, the controller shuts off the electric heater.

If the PCM tank temperature is above 150 F, the controller turns on the circulator pump. The controller then checks if the DHW tank temperature is above 135 F. If it is true, the controller turns off the pump.



6.0 Hydronics Systems Design

6.1 Introduction

The RoofPod extends its vision of a highly sustainable living space by combining energy and water efficient systems for the water needs. This includes integrated domestic hot water to the solar thermal system, black, gray and storm water collection systems.

A domestic hot water (DHW) will be connected to the PCM thermal storage tank, drawing energy needs directly from the solar thermal system as oppose from natural gas or electricity as conventional homes. The sizing of the PCM tank and solar thermal collectors took into consideration DHW needs.

In addition, wastewater otherwise known as gray water will be recycled from domestic water utilization such as bathroom basin, bathtub, all of which will be reused for landscape irrigation. Such gray water usage helps minimize costly sewage treatments, potential health risks as well as environmental risks. This new found mode of recycling in turn enhances a higher supplying standard in water quality. Wastewater such as black-water will be derived from kitchen sink, toilet, and mechanical room.

For the SD11 competition, the potable water, storage tank will be stored underneath the deck on the northern side of the solar house. Pumps will deliver domestic water through the pipes located underneath the house; distributing water supply unto the entire residential area for water usage. The irrigation system will be designed to derive water supply from either storm water collection and/or gray-water. A control system consisting of sensors will activate the relevant water source to utilize for landscape water use.

This section provides details of the domestic water system of the RoofPod, starting with the water balance based on competition rules, followed by piping design and the irrigation system.

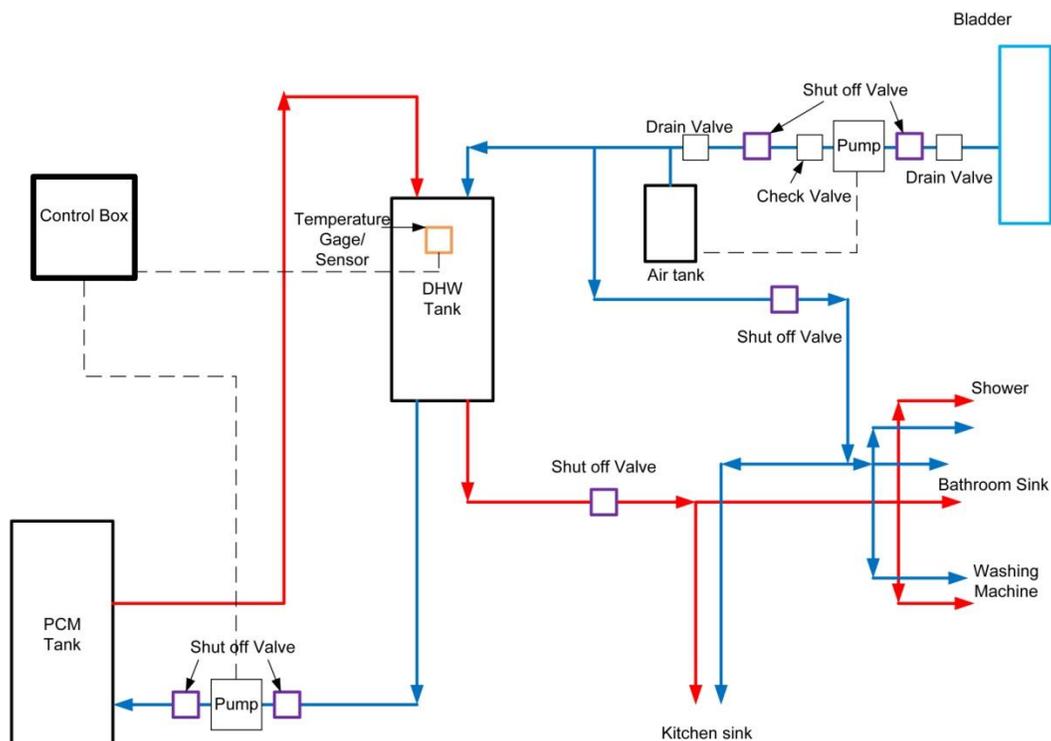


Figure: Domestic Hot Water Overview



6.2 Water Balance

The SD11 competition demands water usage for the following activities;

Table 6.1 - Water Balance for the RoodPod

FUNCTION	WATER USE (GALLONS)	CALCULATIONS		Waste Water Usage	Waste Water Usage
		GAL	EVENTS		
Hot Water Draws	250 Gal	15 Gal x 16 (total tasks) + Tube length 240 Gal + 10 Gal= 250 Gal	Contest 7	Shower Competition Gray Water =250 Gal	
Dishwasher	112.2 Gal	11.2 Gal x10 (total tasks) + Tube length 112 Gal + 0.23 Gal= 112.2 Gal	Contest 8-5		Black Water =112.2 Gal
Clothes Washer	100.2 Gal	12.5 Gal x 8(total tasks) + Tube length: 100g + 0.23= 100.2 Gal	Contest 8-3		Black Water = 100.2 Gal
Fire Protection	257.83 Gal	250 Gal+ Tube length = 250 Gal + 7.83 Gal = 257.83 Gal		Fire Sprinkler System	
Cooking	2.2 Gal	0.5 Gal x 4 (total task) + Tube length: =2 Gal + 0.18 Gal = 2.2 Gal	Contest 9-1		Black Water (from washing food/utensils) = 2.2 Gal
Testing	80.3 Gal	50Gal + Tube length = 50 Gal + 30.3 Gal = 80.3 Gal		Gray water = 80.3 Gal	
Initial Systems Fill	50.3 Gal	20 Gal + Tube length: 20g +30.3g = 50.3 Gal			
Solar Thermal Collectors	30.28 Gal	Tube length = 30.278Gal			
Cooling Tower	62.45 Gal	60 Gal + Tube length = 60 + 2.45g = 62.45 Gal			
Fan Coil	0.33 Gal	Tube length = 0.33 Gal			
fan coil mhccw04	0.5 Gal	Tube length = 0.504975 Gal			
fan coil mhccw06	0.76 Gal	Tube length = 0.757463 Gal			
Radiant Flooring	7 Gal	Tube length			
Safety Factor	80.3 Gal	50g + Tube length 50g + 30.3 Gal= 80.3 Gal			
Total WATER REQUIRED	1228.57 Gallons				
Total GRAY WATER				330.3 Gallons	
Total Black Water					214.6 Gallons



Notes:

1. See Solar Decathlon Rules, Contest Number 7, (www.solardecathlon.org), for shower competition.
2. Competition rules require washing machine to wash the towels 8 times throughout the event. Each run will require 20 gallons of water (number was estimated from the volume of the washing machine).
3. Each run will require 6.2 gallons of water for the dishwasher selected (<http://products.geappliances.com/MarketingObjectRetrieval/Dispatcher?RequestType=PDF&Name=49-55046.pdf>)
4. 4 Cooking events. Each cooking event will consume 5 gallons of water.
5. The area of the RoofPod is one story in height and less than $2000ft^2$, therefore two sprinkler water demand rate times 7 minutes for the dwelling unit, is in accordance with NFPA 13D code, Section 6.1.3 (<http://www.nfpa.org/aboutthecodes>).
6. Cooling tower make up water; this is estimated based on the evaporation rate of a typical cooling tower, less than 2% of total usage (ASHRAE Applications, 1997).

Thus, the supply tank will have a portable water reserve of 1000 Gallons. The sprinkler system will be integrated from the house supply. Details of the final dimensions of the water supply tanks are given in Drawings ME-F101. The drainage tank (Gray Water) is estimated in 560 Gallons, as stated in the following table above.



6.3 Piping System Design

The pipes run from outside of the solar house from a water storage tank supply throughout the entire house, exiting unto a gray water storage bladder tank and septic tank; located on the south end, outside of the house. Grey water will be used for irrigation purposes. Black water collection will be directed towards the septic tank.

The water storage tank will be located underneath the deck located on the north end outside of the house. Therefore in order to accommodate the space restriction, the shape of the water storage tank will be horizontal, bladder tank.

6.3.1 Calculations

Key to a water supply system is to ensure adequate pressure to all fixtures and equipment; as well as achieving the most energy efficient delivery. Inadequate sizing of the pipes causes increase in frictional losses, and higher sizing of pumps. The following steps are necessary in sizing of a piping system;

- Selection of pipe type and diameter
- Estimation of head losses
- Selection of pump system.

General Piping Calculation Method

Adiabatic Hydraulic Equation (see Hodge and Taylor, 1999).

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + \frac{w_s}{g} + \frac{h_f}{g}$$

Where,

γ = specific weight, ρg

g = gravity

w_s = mechanical work in the system

h_f = Frictional losses

$h_f = h_{major} + h_{minor}$

h_{major} = Refers to frictional losses through straight pipe

$h_f = f \frac{L V^2}{D 2g}$

$f \equiv$ Friction factor = $f(Re_D, \frac{\epsilon}{D})$

To get friction factors Swamee & Jain Correlation is recommended (Hodge and Taylor, 1999).

$$f = \frac{0.25}{\left[\log \left(\frac{\epsilon}{3.7D} + \frac{5.74}{Re_D^{0.9}} \right) \right]^2}$$



Assumptions:

- accurate to 1.5% of Colebrook Correlation
- for $4 * 10^3 \leq Re_D \leq 10^8$

$h_{f, minor}$ = Friction Minor Losses

Frictional minor losses refer to losses in connections and conduits. This is expressed in similar form as major losses.

$$h_{f, minor} = K \frac{V^2}{2g}$$

Where,

K = loss coefficients (Taken from tables)

Assuming average velocity to remain the same at the inlet and outlet reference points, the hydraulics equation can be reduced to;

$$h_p = \frac{(p_2 - p_1)}{\gamma} + z_2 - z_1 + h_f$$

Where,

h_p = mechanical work in the system

h_f = Total Frictional losses

Finally, the power of the pump in Hp or kW can be estimated from the flow rate;

$$P = \text{Power(HP)} = Q \Delta P = \rho Q h_p$$

Where Q is the flow rate, $Q = VA$.

A Pump can be selected using the flow rate and required head.



Key Assumptions for Sizing of Piping for Domestic Water

The key assumptions for the sizing of the domestic hot water system are as follows;

- a. Maximum velocity across pipes equal to 6 ft/s (1.8 m/), following ASHRAE Fundamentals (2007), Chapter 36. This upper limit reduces pressure losses and maintains noise levels low.
- b. Maximum flow rates. The following table lists standard flow rates for all simultaneous usages in all fixtures;
- c. It is assumed that the ratio of cold to hot flow rates is 3 to 1; meaning that 75% of the flow rates should be hot to be served at 120°F.

Table 6.2 - Proper Flow Rates and Pressure Required During Flow Rates for Different Fixtures (ASHRAE, 2007, chapter 36)

Item	Description	Flow Pressure (psia)	Flow (GPM)
1	Sink Faucet	10	5.0
1	Dishwasher	22	8.0
2	Bathtub Faucet	5	6.0
3	Laundry	5	5.0
4	Shower	12	9.0
Maximum Pressure/Total Flow Rate		22	33.0

- a. Sizing is estimated based on the following basic pipe distributions for the main and distributed, respectively (see figures below).
- b. All pipes are Copper 3/4" unless specified, following New York City standard piping codes, Sections 605.14.1 through 605.14.4.

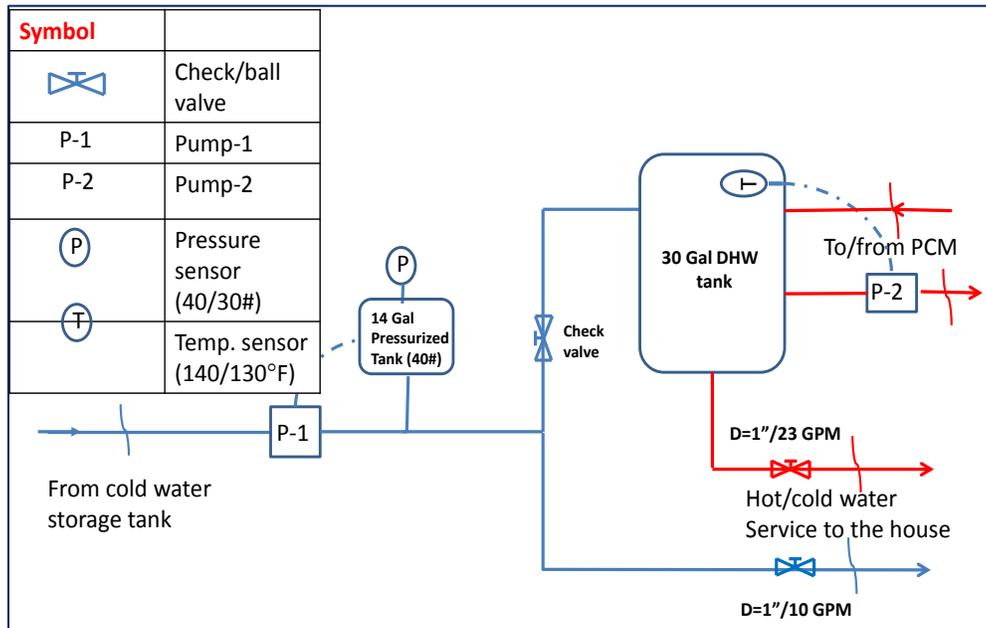


Figure 6.1 - Hot and cold water supplies from Mechanical Room



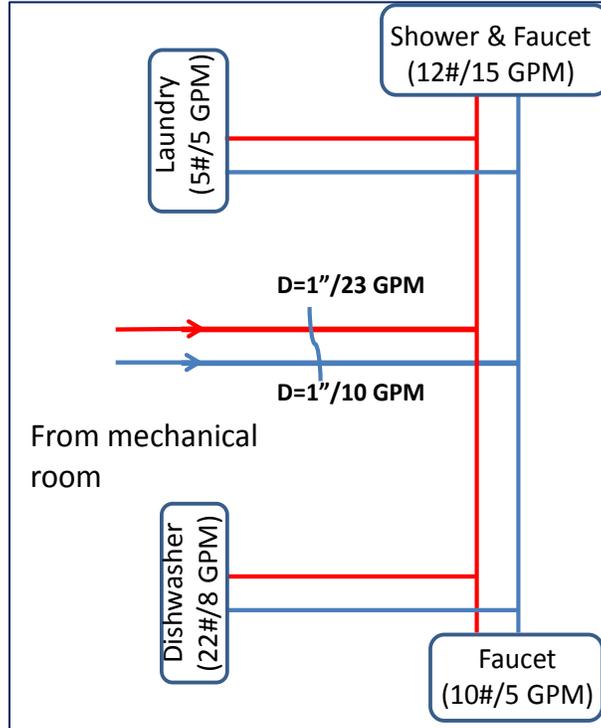


Figure 6.2 - Cold/Water Pipe Distribution inside the RoofPod

Detailed Calculations for Pressure Head (ft)

Following the above assumptions, it is clear that the path of highest pressure drop is the dishwasher. This path will have three branches; main and branch-1 and branch-2 as shown in the figure below. The following table shows the detail calculations for each branch.

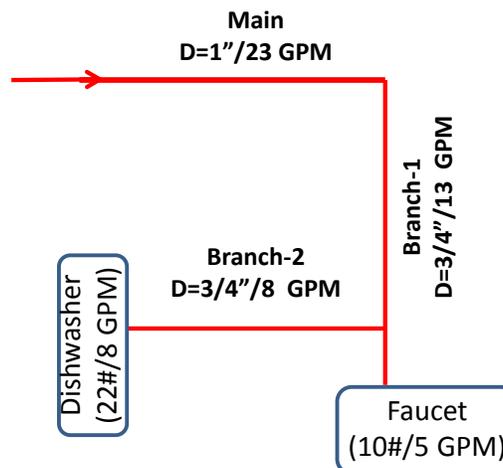


Figure 6.3 - Branch Distribution Used to Estimate Total Pressure Head



Table 6.3 - Detail Figures for Frictional Losses Along Reference Branch

Section	Pipe Diameter [in]	Pipe Length [ft]	Flow Rate [GPM]	Velocity $\frac{ft}{s}$	Reynolds#	Friction Coeff (f)	Total Minor Loss K Coefficient	Total Pressure Head [ft]
Main	1	15	23	9.40	84,200	0.02	<ul style="list-style-type: none"> Tees (2) Elbows (2) Exits (1) Entrance (1) Check Valve (1) Gate Valve (1) K=7.5	15.00
Branch-1	0.75	10	13	9.44	63,451	0.02	<ul style="list-style-type: none"> Tees (1) Exits (1) K=1.5	6.52
Branch-2	0.75	5	5	3.63	24,404	0.02	<ul style="list-style-type: none"> Exits (1) K=1.0	0.60

Thus, total frictional losses for minor and major contributions is equal to 22 feet. The total head of the pump should thus be;

$$hs = \frac{22 \text{ lbf}}{\text{in}^2} * \frac{33 \text{ ft}}{14.7 \text{ psig}} + 22 \text{ ft} = 71 \text{ feet of water}$$

Pump selection.

Pump head <= 75 feet (35psig)

Pump Flow Rate <= 35 GPM

A Bell & Gossett Residential Pump Model 616 PF/VF; 3500 RPM, 4.5 inches in impeller diameter could do the work. (see <http://www.bellgossett.com/literature/files/496.pdf>). The performance curve is shown below.

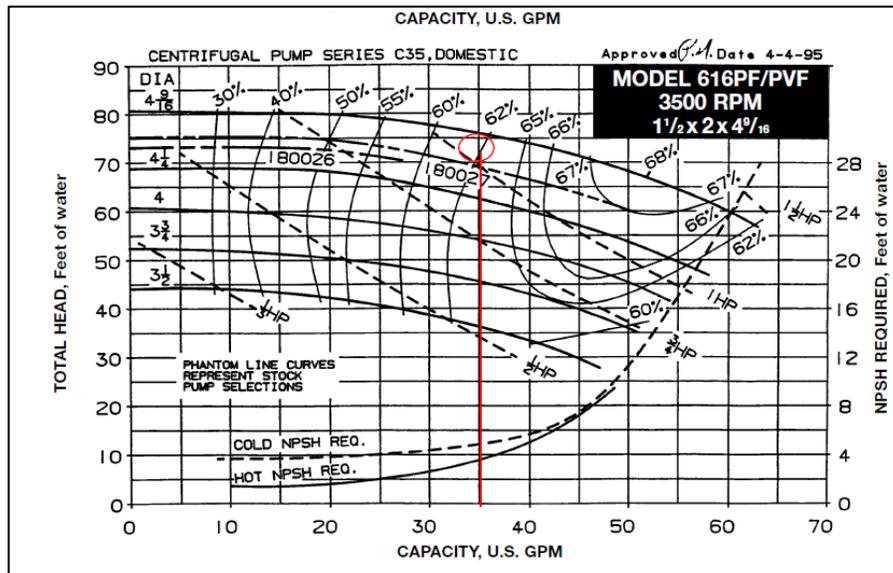


Figure 6.4 - A Bell & Gossett Residential Pump Model 616 PF/VF; 3500 RPM, 4.5 inches in impeller diameter



6.4 Fire Sprinkler System

6.4.1 Introduction

A sprinkler system is mandatory for the Solar Decathlon, according to the event rules. The design for the sprinkler system will follow the National Fire Protection Association (NFPA® 13D), *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, as well as the hydronic design approach presented above. According to NFPA for residential buildings; section 6.1.2 and 6.1.3, a 1-single story residential building with stored water, requires a minimum water supply for two sprinklers for 7 minutes. The code also requires a minimum pipe diameter of 3/4" for copper pipe, (Section 8.4), and to adhere to manufacturers requirements for coverage area and flow rates (Section 8.1.3.1.1).

6.4.2 Sprinkler Selection

Team New York will use Tyco Series LFII Residential, NFPA 13 Optimized Concealed Sprinklers, with 6.9 K-factor (http://tyco-fire.com/TD_TFP/TFP/TFP408_05_2008.pdf). According to Tyco, the required flow rate for this type of sprinkler, minimum pressure at the delivery point, and coverage area are 19 GPM, 6 psia, and 16ft x 16 ft, respectively. The sprinkler design criteria will make use of these values.



Figure 6.5 - Tyco Concealed Sprinkler Selected.

6.4.3 Sprinkler Pipe Sizing and Pump Selection

The key assumptions for the sizing the sprinkler system are as follows;

- Maximum velocity across pipes equal to 6 ft/s (1.8 m/), following ASHRAE Fundamentals (2007), Chapter 36. This upper limit reduces pressure losses and maintains noise levels low.
- Minimum pipe diameter 3/4" following NFPA Standard for Residential Applications.
- Flow rate per sprinkler equal to 19 GPM following manufacturer's recommendation.
- Minimum pressure at the delivery point, 8 psia, following manufacturer's recommendation.
- The total number of sprinklers will be 9 following the manufacturer's recommendation of coverage area of 16 ft x 16 ft, and other restrictions imposed by NY Team.
- The layout of the piping and sprinkler distribution is shown in Figure 7.6. Sizing of the pipe and the selection of the pump will be based on the longest path following this layout.
- The total height between supply and sprinkler line is 10feet.



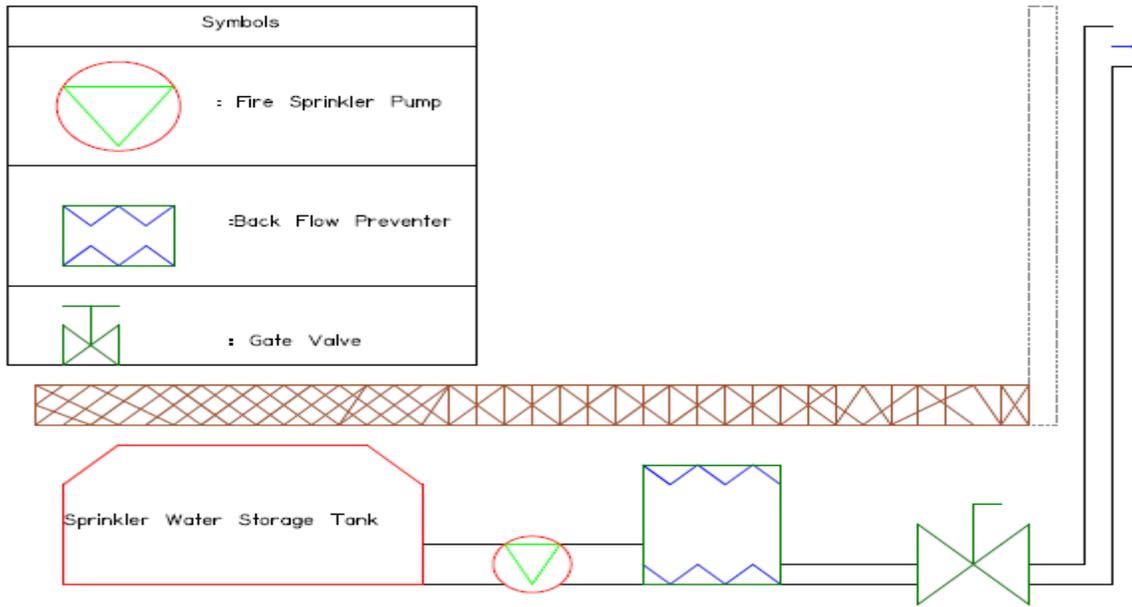


Figure 6.6-Under the Deck Location of Sprinkler Water Storage and system components

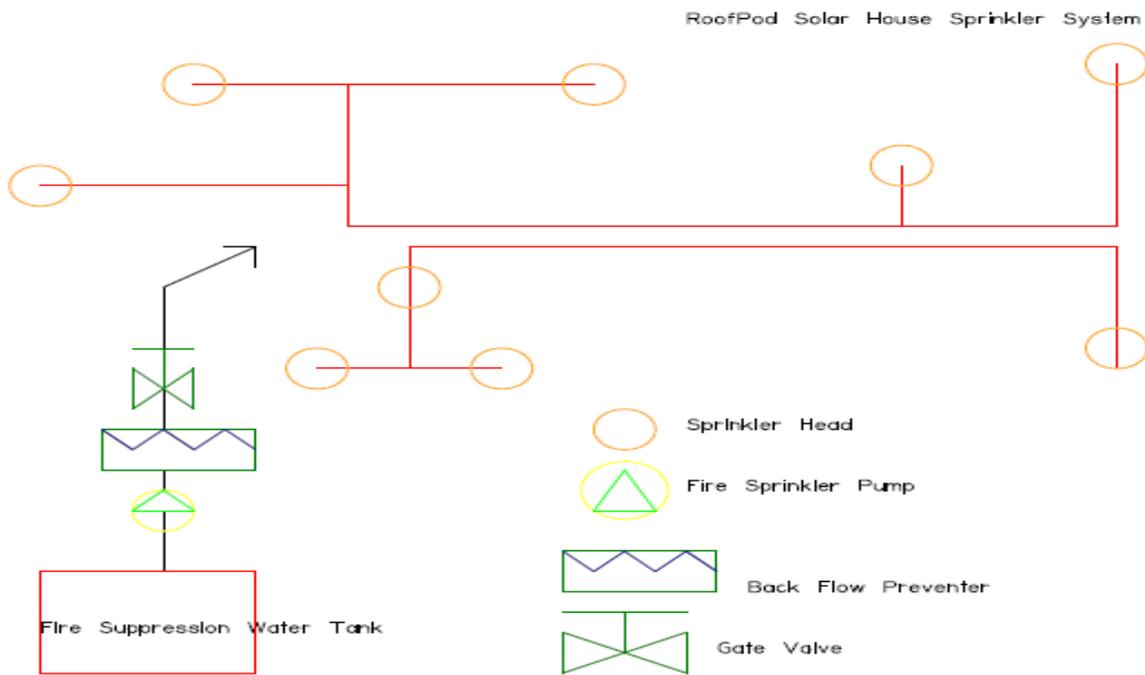


Figure 6.7 - Sprinkler System Layout for the RoofPod



Table 6.4 - Detail Figures for Frictional Losses for Sprinkler Distribution

Section	Pipe Diameter [in]	Pipe Length [ft]	Flow Rate [GPM]	Velocity [ft/s]	Red	Friction Coeff (f)	Total Minor Loss K Coefficient	Total Pressure Head [ft]
Main	2	15	95	9.70	173,880	0.02	<ul style="list-style-type: none"> • Tees (2) • Elbows (2) • Exits (1) • Entrance (1) • Check Valve (1) • Gate Valve (1) • 6.522 	11.67
Branch-1	1.5	10	38	6.90	92,736	0.02	<ul style="list-style-type: none"> • Tees (1) • Exits (1) • 2.26 	2.76
Branch-2	1	5	19	7.76	69,552	0.02	Exits (1) 1	2.03

Thus, total frictional losses for minor and major contributions is equal to 16.5 feet. The total head of the sprinkler's pump should thus be;

$$h_s = \frac{8.0 \text{ lbf}}{\text{in}^2} * \frac{33 \text{ ft}}{14.7 \text{ psig}} + 16.5 + 10 = 44.5 \text{ feet of water}$$

Sprinkler Pump Selection.

Pump head <= 50 feet (35psig)

Pump Flow Rate <= 160 GPM

An ITT Fire Pump, Model A-8685, 3500 RPM, 5.0 inches in impeller diameter could do the work. (see <http://www.acfirepump.com/A-8685.PDF>). The performance curve is shown below.



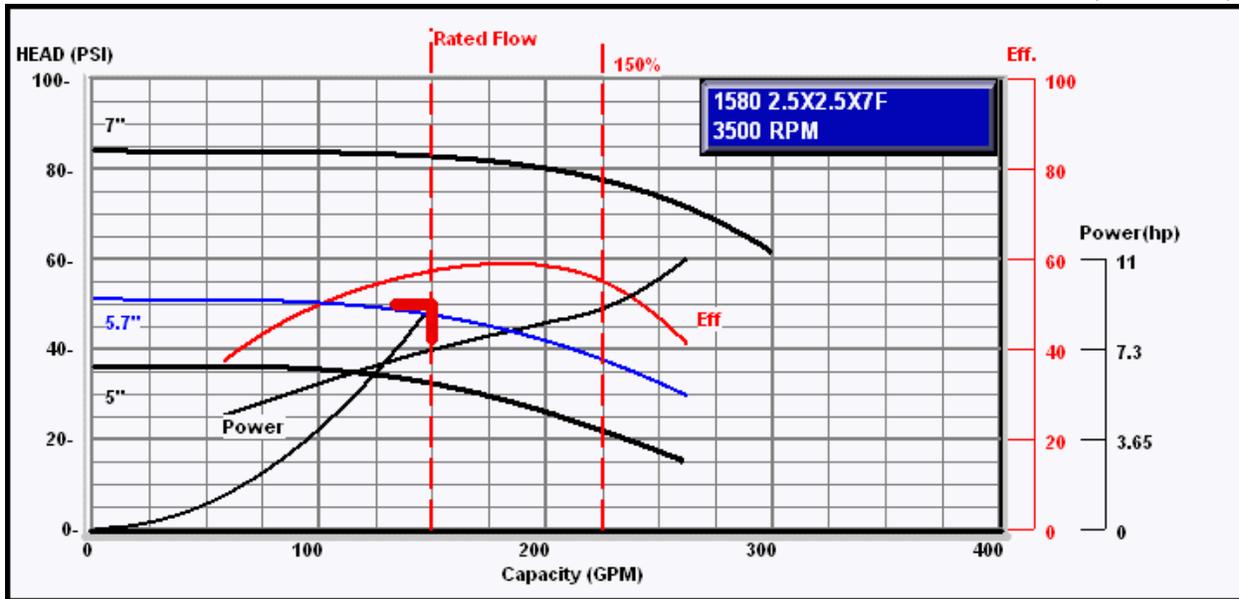


Figure 6.7 - ITT Fire Pump. Model A-8685, 3500 RPM, 5.0 inches in impeller

6.5 Irrigation

The irrigation system is an integrated part of a holistic sustainable building. It is an important aspect because it confronts important issues an urban environment faces, that are storm water runoff and grey-water reuse. The idea is to be able to have full control of the water within our footprint. The main task is to reuse water for watering the plants in the outside patio area, through an automated watering system.

The system has two parts that work together, rain water and grey water (Fig. 6.22). The rainwater is collected from the roof through two drains that lead to a bladder that stores the water underneath the southern part of the deck. The rainwater is collected from the roof through two drains that lead to a 3.5' x 3.5' x 8" 100 gallon bladder that stores the water underneath the southern part of the deck. The black water is collected through a series of drains in the house, such as dish washer, kitchen sink, bathroom sink, shower and clothes washer then is stored in a bladder parallel to the rain water bladder under the deck. A filter is located at the outtake of the grey water bladder. Hence the grey water quality is significantly improved and is appropriate for use in irrigation of the outside plants.

The smart system for irrigation is composed of sensors and is programmed to accommodate different water requirements and conditions. The lead in the chain of triggers is the moisture sensors. They will be programmed to be stimulated once the plants are in need of at least one pint of water to reach their optimal moisture level. The smart irrigation has two water sensors located in both rain and grey water bladders. Each sensor first reads the water level and communicates it to the control system. If the water level in the rainwater tank is at least 1 inch (12.5 gallons) it will open the valve and pump for one hour. On the other hand, if it is not at the appropriate water level, the system moves on to the grey-water level sensor. If there is a sufficient level of water in this tank the valve opens and the pump operates. The grey water will pass through the filter before reaching the plants. At the event that the grey water is at an inefficient level an alert is issued that notifies the resident about it. The control system then issues suggestions for the amount of grey water generation for different tasks in the house that could alleviate this problem. These suggestions will be based on historical data from the home. For example the system may suggest for operation of the washing machine at an earlier time than usual so that the necessary amount of grey water is generated. Fig.6.23 shows the flowchart of the algorithm developed for the irrigation.



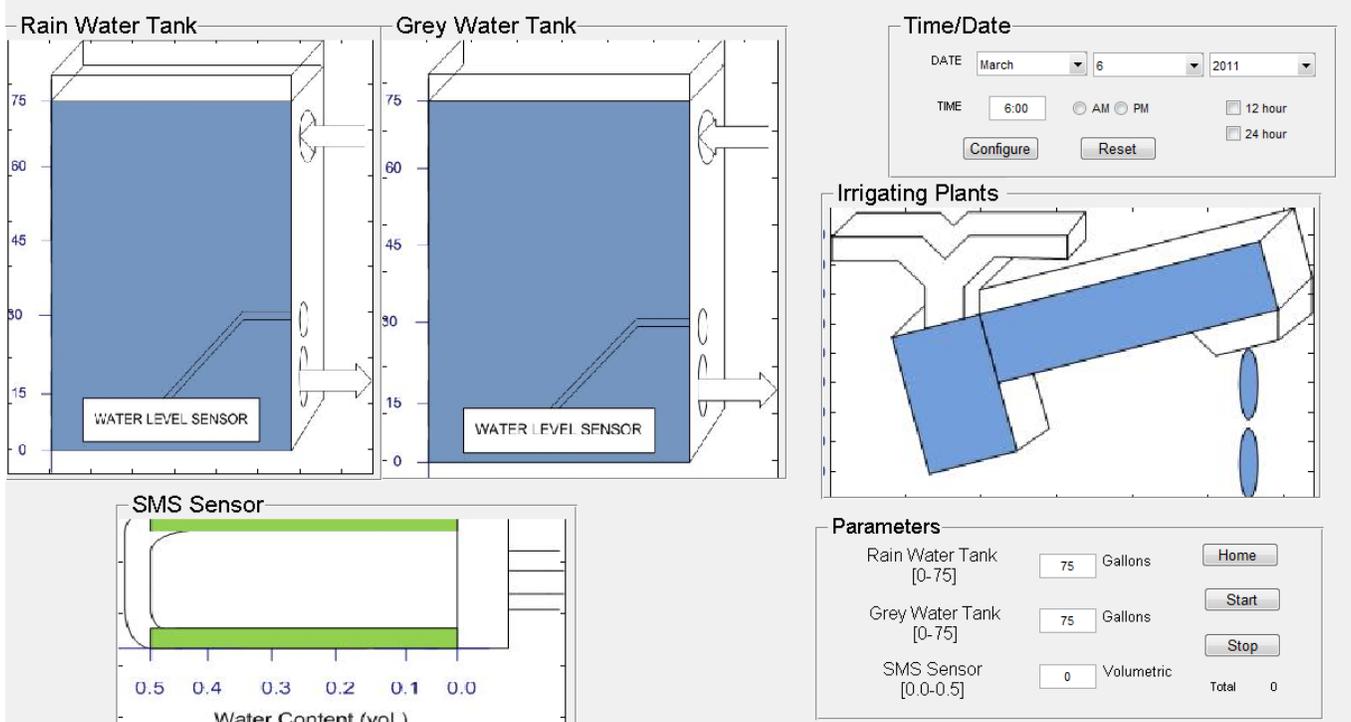


Figure 6.22 - Irrigation GUI

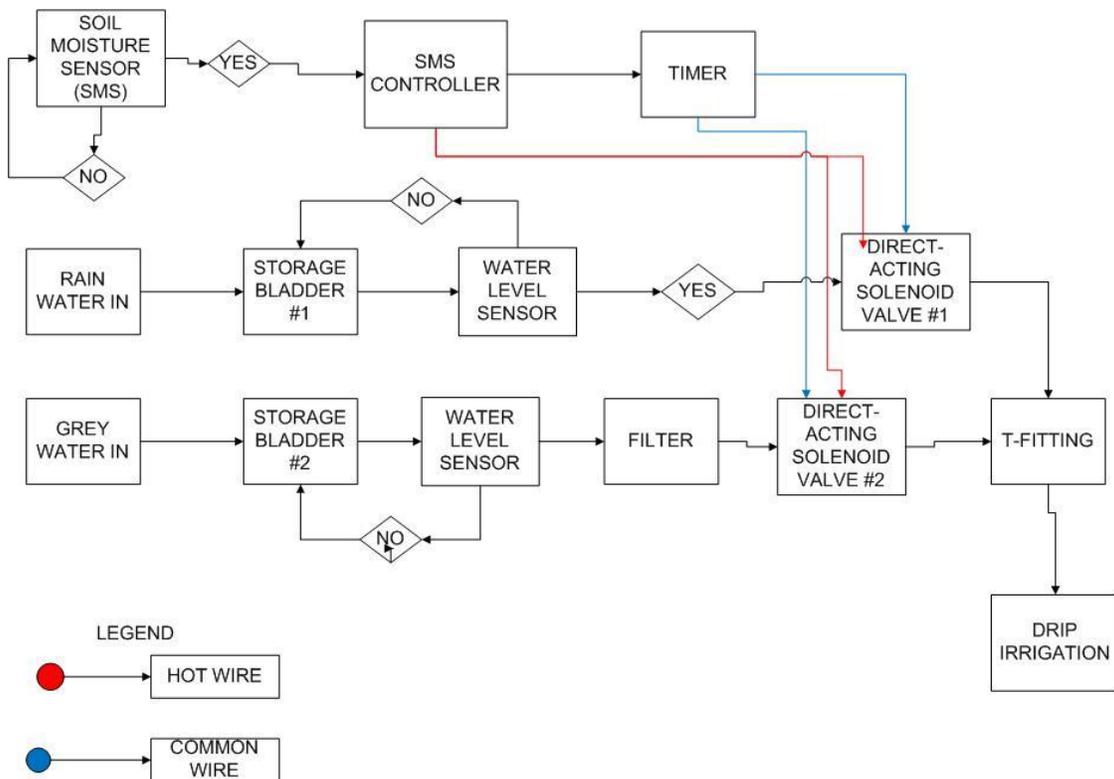


Fig 6.23 - Irrigation Algorithms Flowcharts



6.5.1 Drip Irrigation System Design

The trickle irrigation system will use reusable water source and a back up water source; gray water collection tank and rain water storage tank. A sensor system will control which water source to allocate for irrigation.

Waste water from the shower and HVAC testing will be used towards the gray water tank. Rain water will be collected towards a storage tank located on top of the deck section of the RoofPod solar house.

Table 6.2.1 Proper Flow Rates at Each Section of the Landscape Drip Line

Drip Irrigation Total System Flow			
Ft. of Landscape Drip Line	Number of Inline Emitters	Flow per Inline Emitter	Flow (GPH)
33'-10 3/4"	21	0.6	12.6
33'-10 3/4"	64	0.6	38.4
47'-6"	38	0.6	22.8
23'-5"	44	0.6	26.4

- a. Sizing is estimated based on the following basic pipe distributions for the main and distributed, respectively
- b. All tubes are Copper 3/4" unless specified

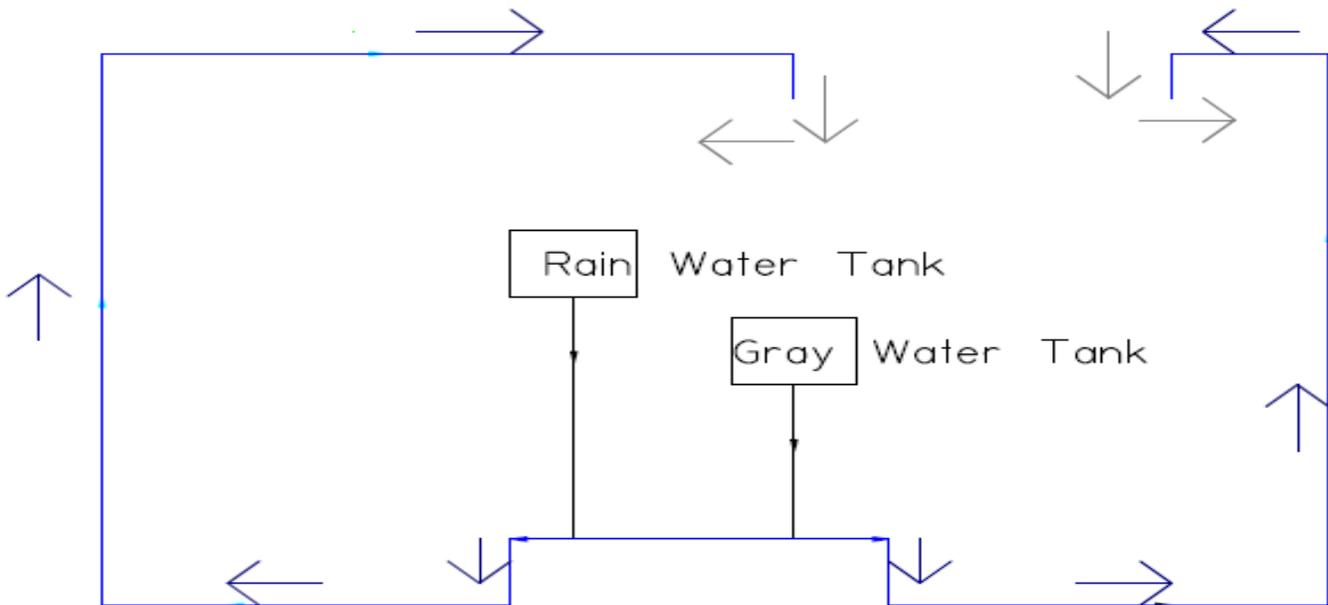


Figure 6.3. Rain Water Tank and Gray Water Tank supplies water to Irrigation area



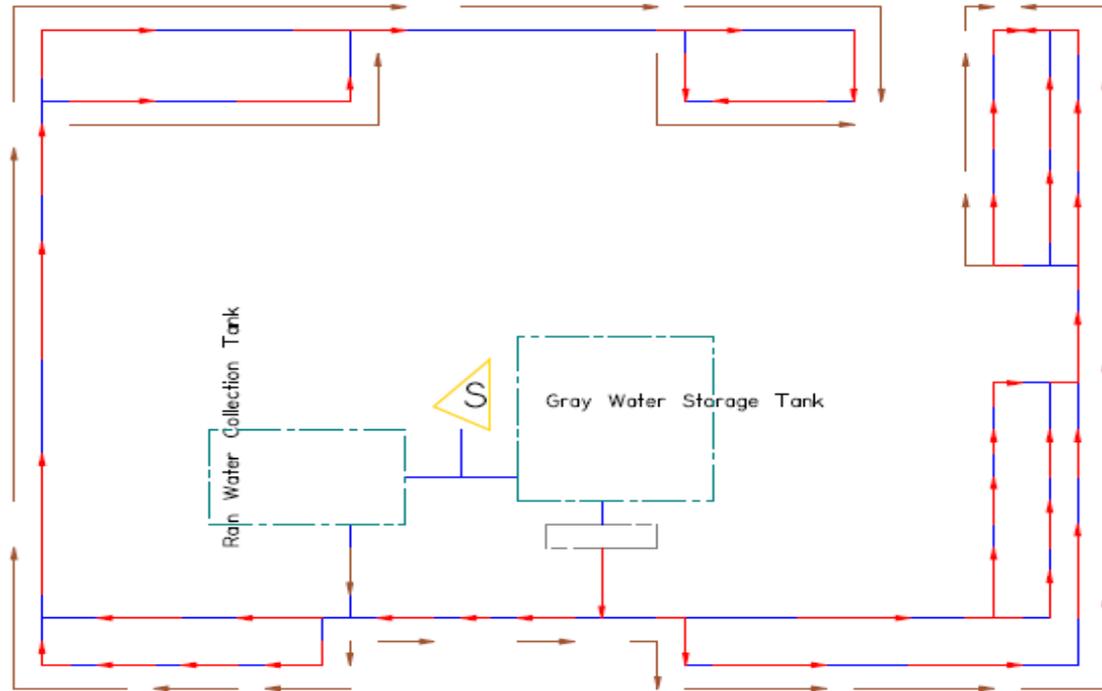


Figure 6.4. Water Pipe Distribution along outskirts of the RoofPod Solar House

A sensor will control from which tank, rain water or gray water, to allocate water for the drip irrigation system. Irrigated water will be distributed from the main pipe line into the drip tubing. The main line pipe will be 1 inch in diameter, in copper hard L strength material. The drip line material will be of copper tubing, with a diameter of 0.75 inches, with a length of 136 feet in its entirety. The direction of the water distribution is indicated by the arrows, shown in Figure 6.4.

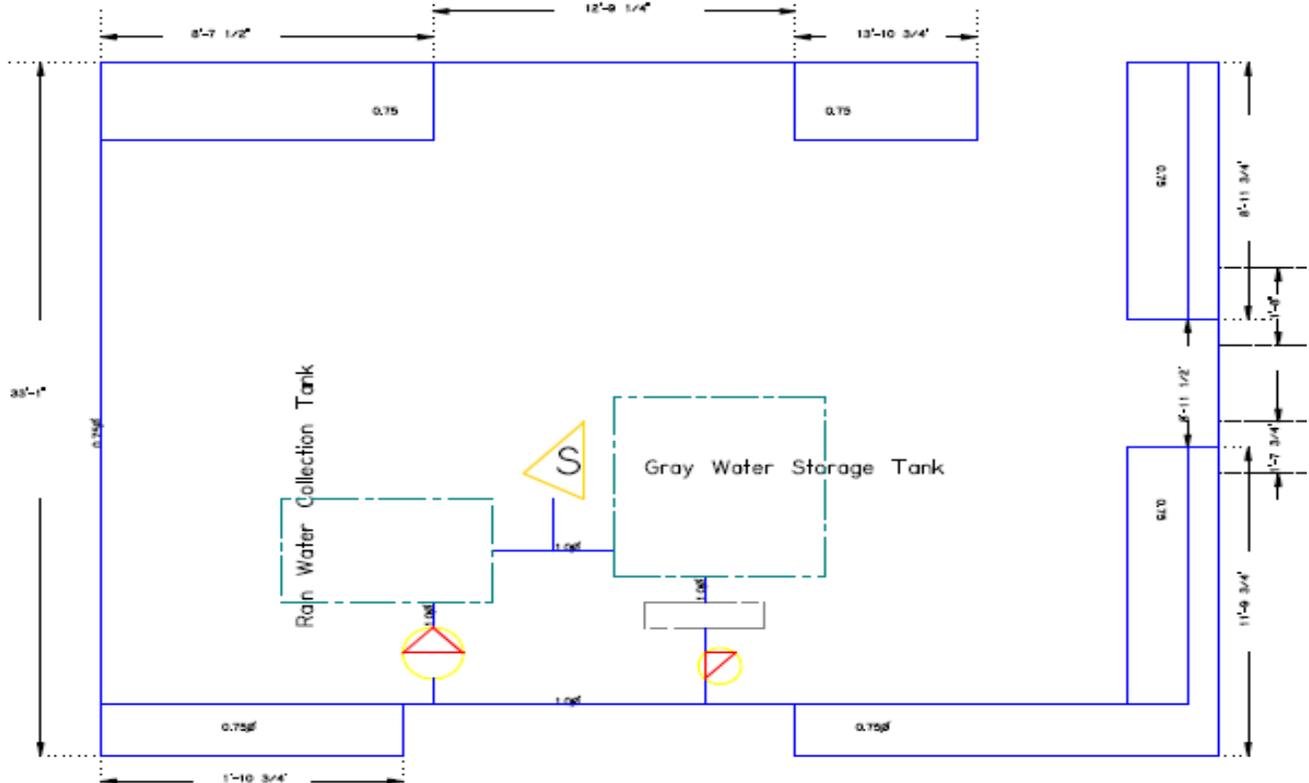


Figure 6.5. Branch Distribution Used to Estimate Total Pressure Head



Table 6.2.2: Detail Figures for Frictional Losses Along Reference Branch

Section	Pipe Diameter [in]	Pipe Length [ft]	Flow Rate [GPM]	Velocity $\left[\frac{ft}{s}\right]$	Reynolds#	Friction Coeff (f)	Total Minor Loss K Coefficient	Total Pressure Head [ft]
Main	1	14	12	6.5	25,980	0.024	<i>Elbows(4)</i> <i>ProjectedInlet (4)</i> <i>Exit(2)</i> <i>TeeLine(3)</i> <i>GateValve(2)</i> <i>CheckValve(1)</i> <i>GlobeValve(6)</i> <i>K = 7.14</i>	4.00
Branch-1	0.75	136	13	9.3	27,879	0.025	<i>Elbows(13)</i> <i>Tee – Line(8)</i> <i>ProjectedInlet(2)</i> <i>GateValve(2)</i> <i>CheckValve(3)</i> <i>GlobeValve(5)</i> <i>Entrance(2)</i> <i>Tee – Branch(7)</i> <i>K = 32.82</i>	24

6.5.2 Drip System

A pressure pump will be used in aiding gray water and rain water distribution; therefore no elevation platform for the gray water collection tank will be used. For gray water distribution, a filter will be used to treat the waste water before dispensing for irrigation usage. The total length of the drip tube is 136 feet, which will run along outside of the house. The duration of irrigation time will be for 140 minutes in total per day. There will be 167 emitters, with a spacing of 18 inches in between each emitter for area coverage of $376ft^3$. Each emitter are 0.6 GPH (1/h) for the landscape drip line.

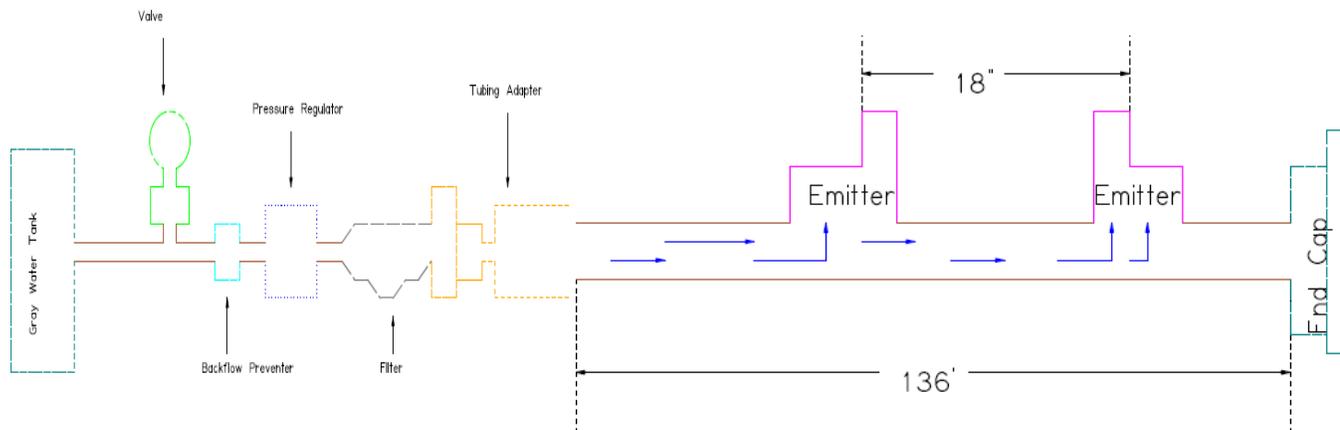


Figure 6.6. Diagram of the Drip Irrigation System



6.5.3 Water Balance for Drip Irrigation

FUNCTION	WATER USE (GALLONS)	CALCULATIONS		Waste Water Usage
		GAL	EVENTS	
Hot Water Draws	250 Gal	15 Gal x 16 (total tasks) + Tube length 240 Gal + 10 Gal = 250 Gal	Contest 7	Shower Competition Gray Water =250 Gal
Testing	80.3 Gal	50Gal + Tube length = 50 Gal + 30.3 Gal = 80.3 Gal		Gray water = 80.3 Gal
Total GRAY WATER:				330.3 Gallons

Table 6.2.3. Daily Gray Water Availability for Drip Irrigation System

Gray Water Source Availability Per Day									
Function	Day 6-7	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	Day 16	Day 17
Hot Water Draw		16 Gal	32 Gal	32 Gal	48 Gal	32 Gal	32 Gal	32 Gal	32 Gal
Testing	80.3 Gal								
Available Gray Water	80.3 Gal	16 Gal	32 Gal	32 Gal	48 Gal	32 Gal	32 Gal	32 Gal	32 Gal
GPM	0.0558	0.011	0.022	0.022	0.0334	0.022	0.022	0.022	0.022

Table 6.2.4. Approximation of Daily Rain Water Availability for Drip Irrigation System

Rain Water Availability Approximation Per Day									
Function	Day 6-7	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	Day 16	Day 17
Available Rain Water	56 Gal								
GPM	0.039								



6.5.4 Drip Irrigation Design

The drip line will irrigate 24 small containers of different plant types. The small containers will be set up in a row formation. The rows of plants will surround the four sides of the RoofPod solar house. The cultivation will include various plant seeds which will serve for different efficient purposes, such as for cooking, seasoning, and food consumption. In turn, the design will provide a sound resource of future financial savings and robust health enabler due to organic food intake.

Table 6.2.5. The Drip Irrigation Design for Each Distinctive Plant Type
Drip Irrigation Design

Plant List			Drip Device Selection				
Plant Type	Daily Water Requirement (G)	Quantity of Plant Type	Drip Device	Flow Rate (GPH)	Number of Drip Emitter per Plant	Total Flow per Plant	Number of Drip Emitter for Plant Type
Shrub	0.3	10	Landscape Drip Line	0.6	1	0.6	10
City Pickers	0.3	10	Landscape Drip Line	0.6	1	0.6	10
Dill Seed	0.3	10	Landscape Drip Line	0.6	1	0.6	10
Basil Seed	0.3	10	Landscape Drip Line	0.6	1	0.6	10
Morning Glory Seed	0.3	10	Landscape Drip Line	0.6	1	0.6	10
Moss Rose Seed	0.3	10	Landscape Drip Line	0.6	1	0.6	10
Carrot Seed	0.4	18	Landscape Drip Line	0.6	1	0.6	18
Tomato Seed	0.4	18	Landscape Drip Line	0.6	1	0.6	18
Corn Seed	0.4	18	Landscape Drip Line	0.6	1	0.6	18
Squash Seed	0.4	18	Landscape Drip Line	0.6	1	0.6	18
Jiffy Peat Pellets	0.4	18	Landscape Drip Line	0.6	1	0.6	18
Sunflower	0.4	18	Landscape Drip Line	0.6	1	0.6	18



7.0 Energy Management System Design

7.1 Energy Management System Overview

Home control systems have been implemented to modern houses with a goal to make occupant s' life easier simpler, safer, more fun and comfortable. However, a home control system can offer more than the aforementioned advantages. The occupant of a house can manage the amount of energy that is being consumed by proper monitoring of critical parameters (e.g., temperature, humidity) and control of a series of functions (e.g., HVAC, lighting, ventilation) necessary in everyday life use. Automating the house operations reduces the amount of manual labor, improve energy performance and produce consistent results. Hence, the goal of the Energy Management Systems is to monitor the heating, ventilation, cooling, lighting, and electric loads in the house and through automated control over these systems to reduce energy consumption while maintaining the full functionality and comfort in the house. The monitoring system is used to acquire and save the data. The control actions are performed by the main control unit without the need of the continuous user input. Within the process all applicable local, state and national codes that regulate the installation and operation of the control system are followed, this minimizes the risk of potential safety problems. Safety is an important factor in the design as well as the implementation of the control process and care is applied. Applicable sections will be followed. This includes the National Fire Protection Association (NFPA) and the codes of the National Electrical Manufacturers Association (NEMA). The automated control system is also approved and register with testing laboratories like Underwriters Laboratories (UL). Through the Energy Management System the occupant will be able to control lights, HVAC, appliances, windows, blinds, and irrigation.

7.2 System Description

7.2.1 Monitoring System

The development of a home management system has emerged and developed as a new method that can aid in the conservation of energy. The Solar Roof Pod has a unique monitoring platform that has the potential of obtaining and storing data, and through proper processing and algorithms, can demonstrate and maintain high energy efficiency performance. Noveda Technologies' SunFlow Monitor and Energy-Flow Monitor are the main components that are used to collect and display real-time energy production and generation. In addition, the Carbon Footprint Monitor is a powerful software application, which delivers detailed information of carbon emissions reduction initiatives. Multiple sensors and control units provide accurate analysis of energy generation and consumption.



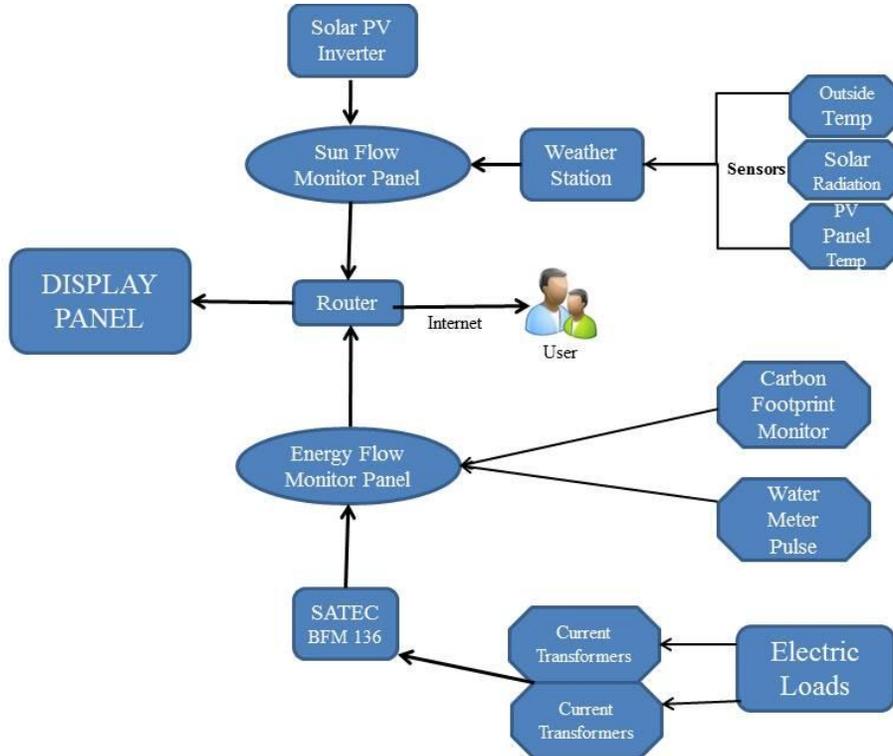


Figure 7.1 - Monitoring System Diagram

The following sections describe the functionality of the Noveda monitoring system in more detail and in particular as it pertain to the monitoring of energy generation and consumption, the collection and logging of data for better understanding of the house requirements, needs and plan of action, consumption of water, and tracking of the carbon footprint of the house.

7.2.1.1 Energy Generation

The Solar Roof Pod uses Noveda Technologies’ SunFlow Monitor to present energy generation and consumption levels. The monitoring platform displays real-time diagnostics of system’s performance in a dynamic user-friendly graphical interface. The SunFlow Monitor combines detailed analysis of the energy production in a flexible data export to demonstrate efficiency of the system (Fig 7.2). It highlights the different parameter monitoring as well as the different display option for a better understanding of the Solar Roof Pod energy requirements and potential energy savings strategies.

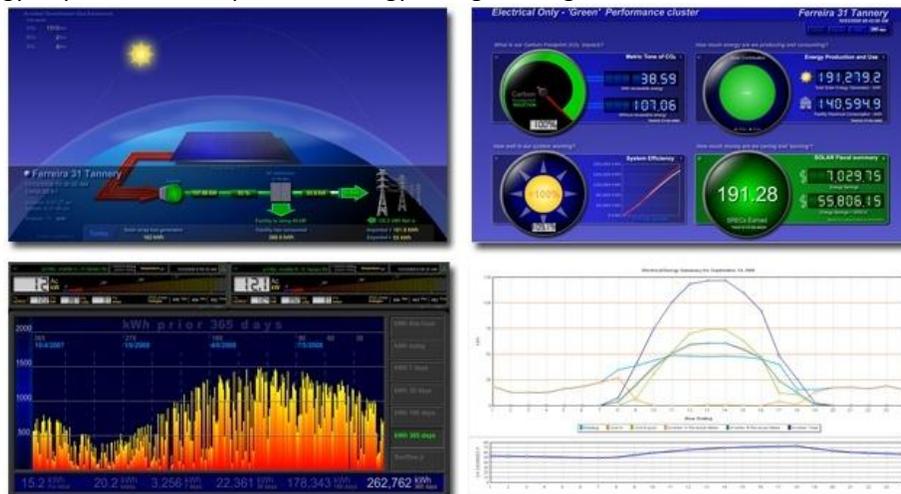


Figure 7.2 - Sample Sun Flow screen shot displays



The Sun Flow Monitor uses a robust microcontroller unit (MCU) to evaluate various collected data through gateways. A variety of sensors collect data, which are then stored and processed to evaluate energy production and consumption from the micro-inverters and the grid. The data is received through terminal blocks and processed using Noveda's TAC controller. The SunFlow Monitor displays detailed information and complete real-time energy data from the collected energy generation data, thus providing the occupant with detail real time information of the buildings energy performance.

7.2.1.2 Energy Consumption

In addition to the energy generation data, Noveda Technologies' EnergyFlow Monitor provides real-time monitoring and management resources for optimizing energy production and the home's performance. The Solar Roof pod precisely tracks and analyzes specific Solar Roof Pod's components. The system has the ability to decrease energy consumption and lower energy costs by pin-pointing to the occupant the operations that consume the most and in particular what habits of the occupant can be corrected to provide lower energy consumption. Hence, the EnergyFlow Monitor will be able to educate and train the homeowners to developing greener habits.

The monitoring platform will send immediate notifications through text messaging and website. These notifications depend on user-defined parameters.



Figure 7.3 - Sample Energy Flow screen shot displays

The EnergyFlow Monitor uses a microcontroller unit (MCU) to accurately analyze and optimize energy consumption through the entire house. Current transformers collect energy consumption data stored in a data logger, SATEC BFM 136. The EnergyFlow Monitor's MCU collects and processes information from the sensor units and displays detailed graphical diagrams that show the energy consumption trends in the house. The user can select different displays that show the energy consumption at different dates and/or times, and can pinpoint on specific dates and/or home operations.

The proper collection of the data and associated processing is accomplished through an automatic data logger, the SATEC Branch Feeder Monitor (BFM136). The SATEC BFM collects energy data from several electrical loads and processed data for the Noveda controller. Automated energy metering allows owners to understand the home's detailed energy consumption in every load of the Solar Roof Pod.



Figure 7.4 - Photograph of the SATEC BFM 136



The meter can monitor energy demand using several phase channels. BFM136 uses 12 three-phase or 36 single-phase channels to collect energy reading and multi-tariff (TOU) data. The Solar Roof Pod processes events and data logging information for accurate metering. The EnergyFlow Monitor uses SATEC BFM136 to process data for web-based energy management display. The compact design allows occupants to access information about several channels of energy consumption reading collected throughout the house. The purpose of installing a wide input data logger is to make the system capable to sub metering consumption from every load in the house, as for example consumption from the lights in every room, and/or appliances.

7.2.1.3 Water Consumption

Water consumption is a key feature that our monitoring system will use to provide energy-efficiency and a greener environment. The Solar Roof Pod integrates several water consumption and leakage detectors into the water supply system, such as the kitchen, bathroom, and mechanical room. The water leakage detectors detect possible failures in the piping system and hence identify water wastage and aid in prevention of it. Occupants are notified of various water causalities, such as high water pressure and corrosion in plumbing. The monitoring platform alerts users from a web-based energy management site and sends text messages via cell phone. Overall the Solar Roof Pod monitors water consumption and leakages, which aid homeowners, develop greener habits. Figure 7.5 shows the water consumption display of our monitoring system.



Figure 7.5 - Sample water consumption screen shot display

7.2.1.4 Carbon Footprint

Besides collecting energy generation and consumption data, the Solar Roof Pod displays real-time tracking and reduction of environment conditions. Noveda Technologies' Carbon Footprint Monitor can display accurate energy efficiency data and carbon footprint reduction accomplishment. The customizable graphical display allows homeowners to view the house's greenhouse gases and carbon emissions that were avoided (Fig. 7.6). The Solar Roof pod integrates sustainability initiatives by providing carbon footprint resources and environmental impact in an easy to understand manner. The Carbon Footprint Monitor can aid homeowners to make greener decisions about future carbon emissions and CO₂ production.

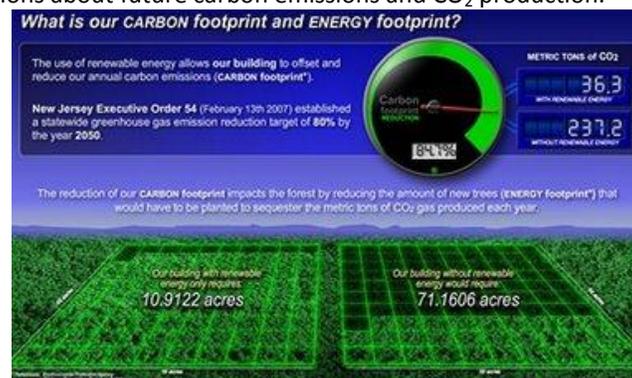


Figure 7.6 - Sample Carbon footprint screen shot display



7.2.2 Control System

The Control System is interfaced with the monitoring system and is responsible for appropriate actions in regards to the operation of lights, HVAC, appliances etc. Hence, the system operation is critical in achieving our goal of reduced power consumption. It consists of high-level sensor fidelity, energy and water efficiency and an innovative home security.

The homeowner has full access control of the control system of the Solar Roof Pod through three different access points:

1. In-house control panel
2. Mobile phone
3. Personal computer

The Control System has several different capabilities. First, it alerts the homeowner if the house is consuming increased levels of energy. Second, it can take an automatic action based on user-defined parameters. Alternatively, it can allow the user to take over and apply manual actions depending on the situation. The cell phone interface is made via text messaging; the homeowner sends text-based commands to request up-to-date information from the home conditions and energy generation/consumption, and receives the requested information via text messages. The idea of sending simple text messages over a phone application is powerful as it is not confined in the use of sophisticated cell phones (smart phones), but also it can be used with any type of cell phone. The personal computer interface is made via internet; the home owner can check the status of the house and can send commands from any personal computer with internet access by interacting into a dedicated website. The control panel will use a Zigbee and/or Bacnet protocol. The homeowner can change any home settings from one room to another room just by a touch of a button. The Energy Management System controls the home's real time energy, water consumption, humidity, and indoor temperature.

Mobile devices can be implemented into smart home automations for easy accessibility. Home automations can control and monitor various features across the home wirelessly. Features, such as windows and blinds, can be controlled wirelessly from these devices. The monitoring system can be viewed by the users to show current energy consumption as well as production of the home. Applications will be developed for these devices as graphical user interfaces (GUI) for an interactive environment for the users. Devices, such as tablets, smart phones and cell phones can be used to implement these aspects.

Users will have access to any control features in their home. They can add or remove control points that they will like to control. The user will have control of certain features, such as heating, cooling, windows, shades and other features based on the preferences. The smart home automation system can be alter control settings automatically or manually from mobile devices. Some basic control features that are included in smart home automations systems are heating, cooling, blinds, windows and irrigation. Heating and cooling controls will allow the user to change indoor temperature and humidity based on their preferences. Blinds and windows controls will alter windows and blinds from open to close or vice-versa. Lights controls will alter dimming levels as we on/off positions in various areas.

The best way to explain our design approach is by using a block diagram that shows how the components are connected. Figure 7.7 shows the overall vision of the control system for the Solar Roof Pod which we consider quite unique and looking forward to demonstrate to the public and judges during the competition.



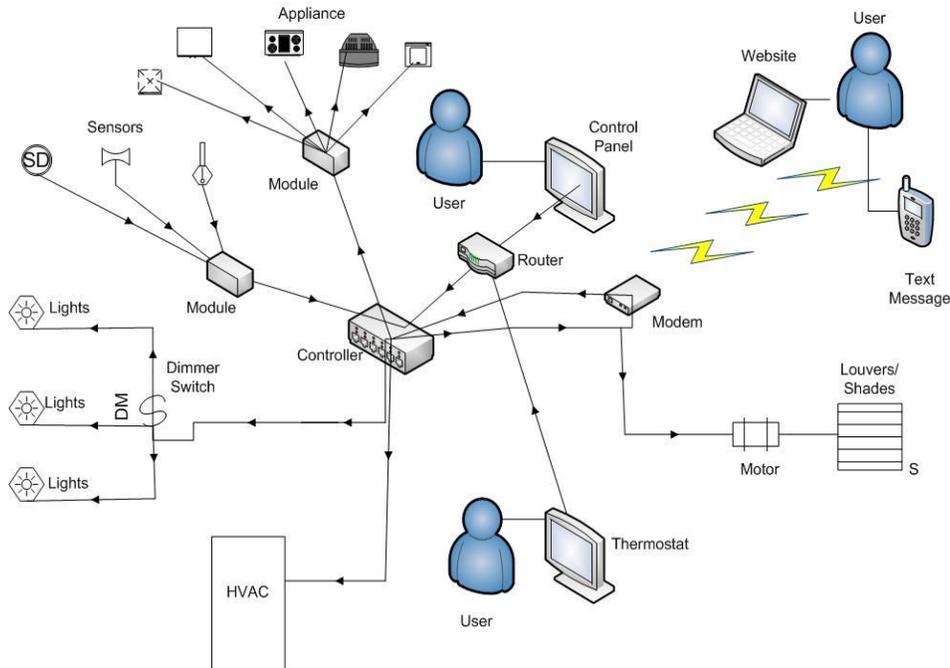


Figure 7.7 - Control System Diagram

The device takes action to comply with user's desire while saving energy. The wide range use of sensors is a key element to the control system. We plan to have sensors for:

- | | |
|----------------------|--|
| 1. Occupancy/Vacancy | 5. Water |
| 2. Light | 6. Air flow |
| 3. Temperature | 7. Wattage consumption for the appliances. |
| 4. Humidity | |

Each type of sensor has a specific function in the house. For example, motion sensors control indoor and outdoor lighting and also provide intrusion alert, in other words the sensors can be used as a security system too. The lights can also be controlled with dimmer switches, so the level of light can be adjusted according to the occasion and according to recommended levels from the standards. Light sensors will control the automatic blinds and/or the lights. By implementing these technologies we will get as much as natural light possible and we will be able to have a good balance of artificial (when needed) and natural lighting. Temperature and humidity sensors communicate data to the controller and take action over the HVAC, as well as the automated operable windows. Another part of our innovation system is to have a smart irrigation system. The moisture of the soil in the pots will be monitored via moisture sensors and depending on preset seasonal settings the controller will allow the proper irrigation strategy. Finally, in compliance with code standards, the Solar Roof Pod will have smoke detectors.

One of the most attractive features about the energy management system is the smart phone application that has been created by our team and it will interface the control and monitoring functionalities under the same software platform. Having this option, the homeowner can be anywhere and be able to check the conditions and/or status of the house by just accessing from a mobile phone that supports the Solar Roof Pod application. Fig. 8 shows a display for the smart phone application, where each icon is associated with one monitoring and/or control command.





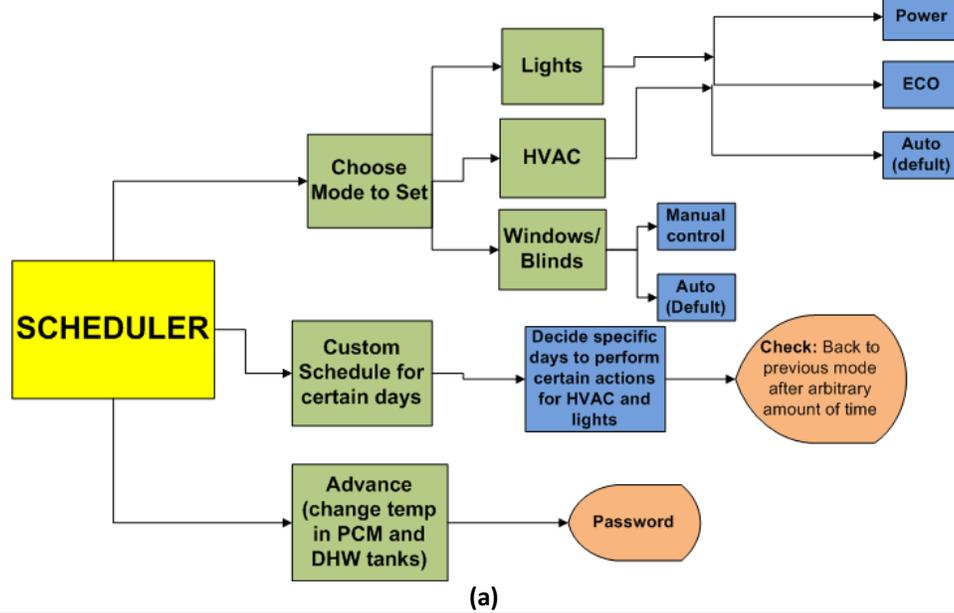
Figure 7.8 - Smart-phone GUI display.

Under user interface (UI) the homeowner would have the option to schedule the HVAC, lights, and either auto or manual control for windows and blinds. Figure 7.9 visually shows the procedure. The user decides the mode which is described in Figure 7.9 (a). For example if HVAC is in power mode, the controller will continue to use ventilation for heating and cooling without any attenuation from the set point temperature. Ventilation through windows is not used. Instead, the Controller always uses the HVAC system for heating and cooling. This mode requires the most energy. If HVAC is in Eco mode, it will be put on standby, where temperatures are allowed to deviate from the set point. For example, HVAC will keep a 5 F deviation from the median [73 F]) which leads to [68, 78]. Eco mode saves energy by sacrificing comfort level. By default the HVAC is in auto. Auto mode simply follows the HVAC algorithm. This mode differs from eco because priority is still given for comfort level of temperature to be with 71 – 76 range and humidity to be less than 60%.

Advance mode is password protected because it would allow technicians manual control of certain HVAC pipe systems. When non-experienced user changes values, it can disturb the entire HVAC system. Custom mode is where the homeowner can set certain days to have certain actions performed from the HVAC and also for lights. For example, if the homeowner has guests coming over and they prefer warmer temperature, the owner can set higher temp settings for the weekend and select back to previous mode under options. The HVAC will return to the previous mode at the end of the weekend (midnight on Sunday).

Regarding the artificial lights, if the home owner wants to keep the lights in certain areas “on” during night he has the option to do so. Furthermore, the homeowner is able to schedule the lights to turn on at a specified time if he or she is away from the house. This feature could be used for security purposes. The windows and blinds can be set to be manually controlled instead of having the algorithms open and close them. The display image for the in-house touch screen panel is shown in Figure 7.9 (b), which shows a top view of the entire house and provides access to each component, its settings and the energy performance parameters. In this particular figure, it shows the performance of the house at outside cold temperature, cloudy conditions, low solar radiation, and low humidity. It can be seen that according to these readings the house starts to heating up, and since cloudy conditions does not allow natural light coming to the house, the necessity of using artificial lights is crucial for visual comfort when the user is present in the house. The display has soft (touch-screen) buttons, where the homeowner can choose to check the lights, windows, HVAC, blinds and irrigation to have a better perspective of the status of each system separately.





(a)



(b)

Figure 7.9 - (a) Overview behavior of the Control System schedule; (b) Roof Pod Graphical User Interface

The distribution of the sensors around the house is shown in Figure 7.10. The types of sensors and switches are divided into groups, identified by five-colors. The blue represents occupancy/vacancy sensors, orange represents day light sensors, purple represents the temperature/humidity temperature, brown represents the CO₂ sensors, red represent smoke detectors, and grey the fire voice alarms and green represents manual/dimmer switch for the lights. The sensors were placed based on two conditions

- (a) Dimensions of where lights are placed in the room and
- (b) Incoming natural light.



Note that not all the lights in the room are controlled. Some parts of the windows consist of a day light sensor occupying the ceiling. This also applies to the entrance and exit since they have glass within them where light can pass through. It can be seen that from Fig. 10 shows the house schematic and the rooms and also the position and type of sensor. There are eight day light sensors, six occupancy/vacancy sensors, and eight manual switches/dimmers around the nine windows marked in red and including entrance/exit marked in white.

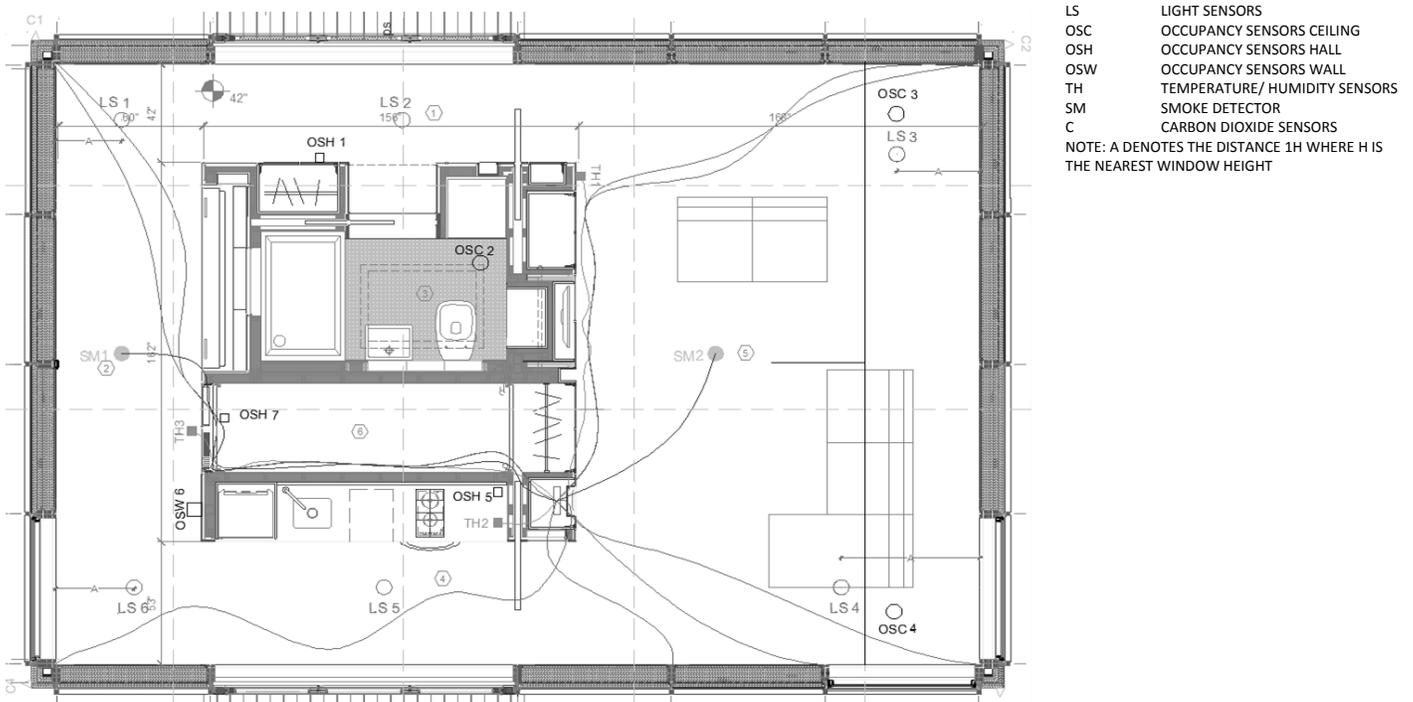


Figure 7.10 - Sensor Location Configuration

7.2.2.1 Lights Control

Lighting accounts as one of the major contributors of energy consumption in residential buildings. By integrating a smart lighting system into the house, the electrical consumption and consequently the electric bills can be reduced from 60% to 40% according to ASHRAE. In general, the lighting control system consists of a device that controls electric lighting alone, or as part of a daylight harvesting system for public, commercial, industrial or residential buildings and facilities. They are often part of sustainable architecture and lighting design for integrated green building energy conservation programs. In our lighting design, we utilize a control system as an interface to interact with the sensors provided by Lutron in order to produce automatic lighting system.

Incorporating sensors throughout the house reduces the operating hours of the lighting, hence reducing the electric consumption. Such sensors include Lutron’s occupancy/vacancy sensors as well as daylight sensors. These sensors are wireless in order to promote wireless technology and show its reliability. The sensors communicate to the smart switches via radio frequency (RF). The combination of sensors and dimmers can potentially reduce energy consumption. In addition, the sensors and in particular daylight sensors allow for efficient use of the natural daylight, which helps accomplish appropriate lighting levels in the indoors environment. Hence natural and artificial lighting operate in complimentary fashion. The amount of energy that the dimmers conserve is proportional to the light level, such that 50% dimmer uses only 60% of the energy, conserving 40%.

The Lutron lighting configuration as seen below is used to save energy as someone leaves the house. In order to use the “Zone Setup” mode on the GRAFIK Eye QS system, press and hold the top and bottom button for 3 seconds to enter programming mode. Then using the master buttons to highlight the “Load Type” then press OK. Using the zone raise/ lower buttons to choose the load



type for that zone and then press OK. After this is done, the info screen will display a confirmation screen that the load type selected is saved. To exit the programming mode, just press the top and bottom button again for 3 seconds.

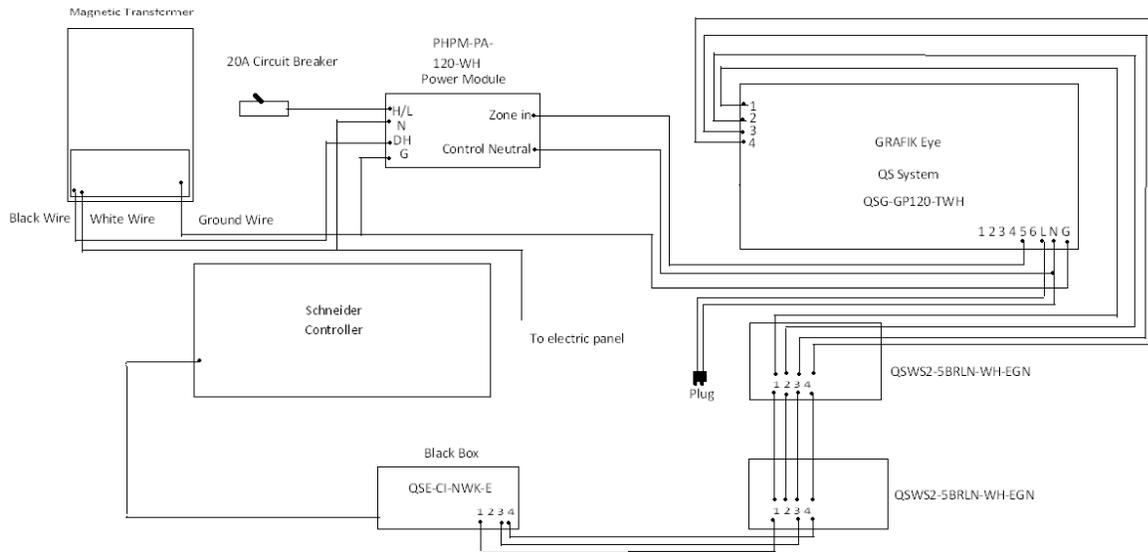


Figure 1 Lutron Lighting Configuration

The living space is composed of the entrance/exit, hallways, kitchen, bathroom, living room and mechanical room. Each living space consists of certain amount of lights and contains one occupancy/vacancy sensor. The Solar Roof Pod has been design to have nine windows. There are either two or three windows from each axis point north, east, south, and west. The day light sensors are placed between windows. If two or more windows are closely apart at each side of the building only one-day light sensor is placed. If the distance exceeds more than 3 feet, then each window has its own day light sensor within that axis. Each set of lights shares one manual switch/dimmer. If the day light sensors force the artificial lighting to be dimmed excessively, the user can take over the control and based on preference and comfort adjust the lighting either with the manual switch/dimmer or by using the touch screen panel. A more detail status of the lights in every room is presented through a graphical user interface (GUI) in the touch screen panel, as shown in Figure 7.11. This GUI presents the status (e.g., level of dimming) of each light in the Solar Roof Pod.

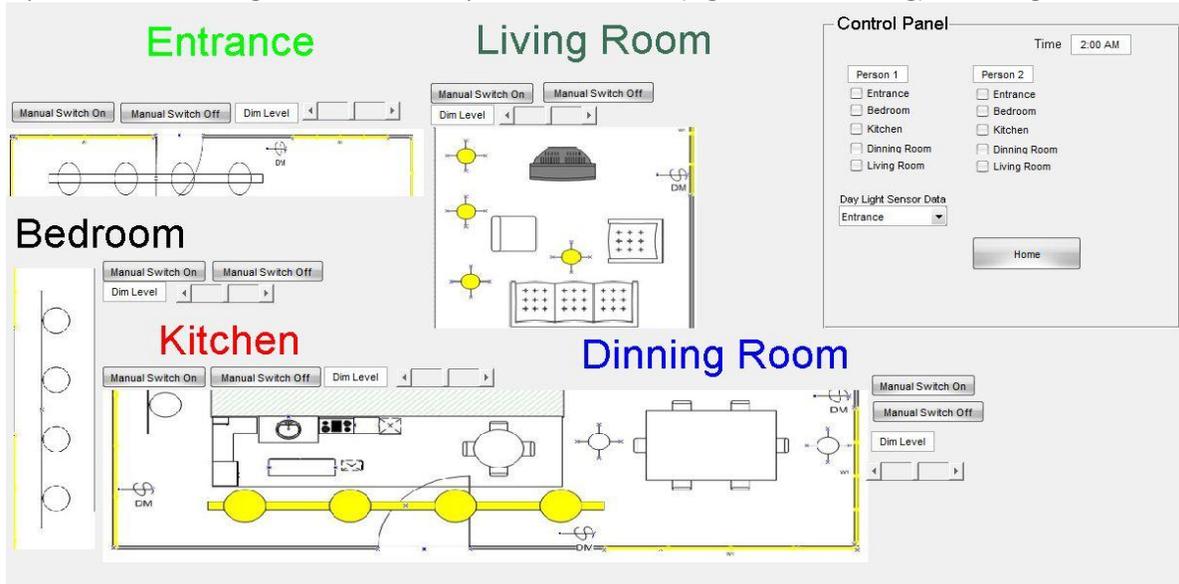


Figure 7.11 - The light automation status and control GUI.



The control of the light is done through the collection of associated data from the lighting and occupancy sensors. An algorithm has been developed to allow for an efficient control of lights. The algorithm first determines if motion is detected within the volume of space it occupies. If such movement is detected, then the data will go straight to the controller and, in response, it will send a signal in order to turn on the lights. If natural light is detected via the day light sensors then it will prompt the lights to dim. And if nothing is detected then no lights will be turned on.

LIST OF SENSORS

- AMBIENT LIGHT
- MOTION/OCCUPANCY

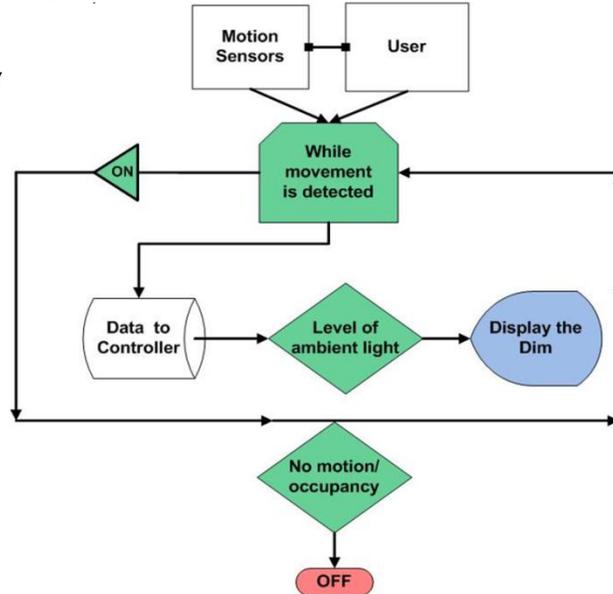


Fig 7.12 - Lights Algorithms Flowcharts

7.2.2.2 HVAC

The HVAC system is a critical one because it consumes the largest amount of energy. It is controlled automatically so that energy savings can be accomplished. Taking into consideration that cooling or heating does not need to be fully “on” in every room or zone in the house energy can be conserved. For details on the input/output behavior, information on the control strategy to achieve part load heating, and dynamic control of fluid flow, please visit the HVAC control section. The main controller can take decisions on the HVAC without the user’s input. The controller collects information from the CO₂, humidity, and temperature sensors in the rooms and temperature in domestic hot water and solar thermal tank to make decisions. The HVAC control requires multiple inputs and outputs. The outputs are either the analog or digital signals the controller sends to regulate a particular component in the HVAC system.

For the competition, the temperature requirement for the indoor temperature is in the [71-76 F] range. The target humidity level is less than 60%. To save energy, the controller will enable natural ventilation if conditions permit. Otherwise it will send a signal to operate the active thermally driven HVAC. Manual control for setting temperature and humidity values will be an option through the in house control panel. To illustrate certain conditions for the HVAC, a graphical user interface is shown in the Figure 7.13. The GUI represents a state when the house is being cooled. The temperature is 78 F therefore cold air is pumped throughout the house to lower the temperature. The ACS chiller is used to pump cold air to the fan coils through which air distributes throughout the house. Also the GUI shows that the collector temperature is greater than the PCM tank temperature. Hence GUI shows the “thermal pump on” state.



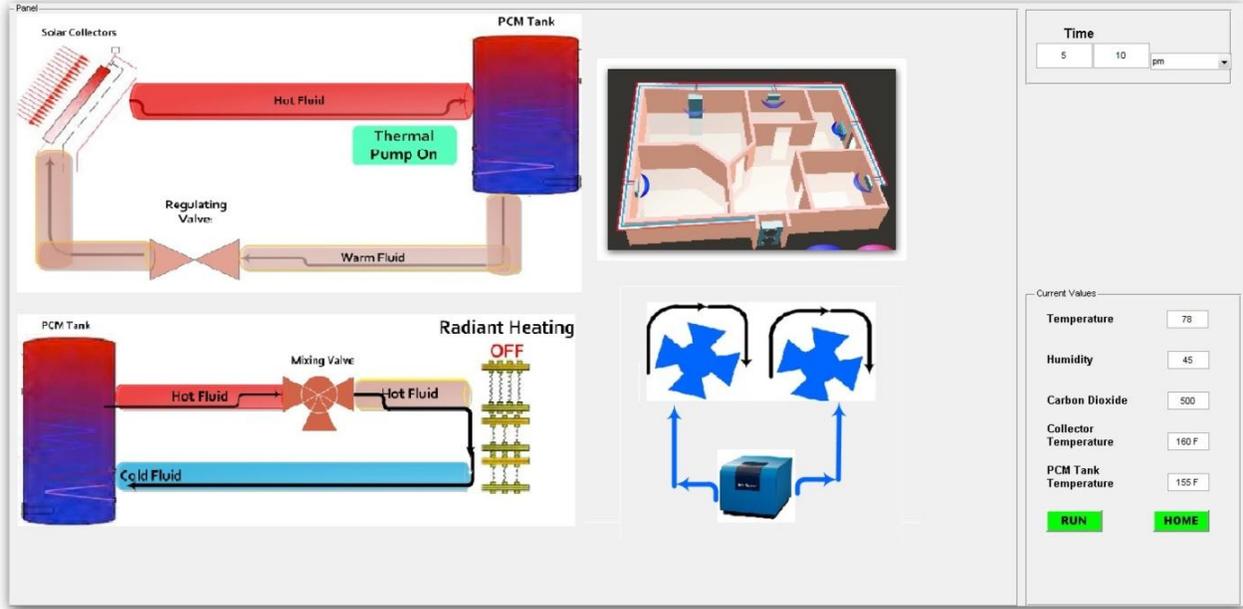


Figure 7.13 - HVAC GUI

The details of the algorithm developed to control the HVAC is shown in Figure 7.14. In the algorithm flowchart the different decision steps are highlighted.

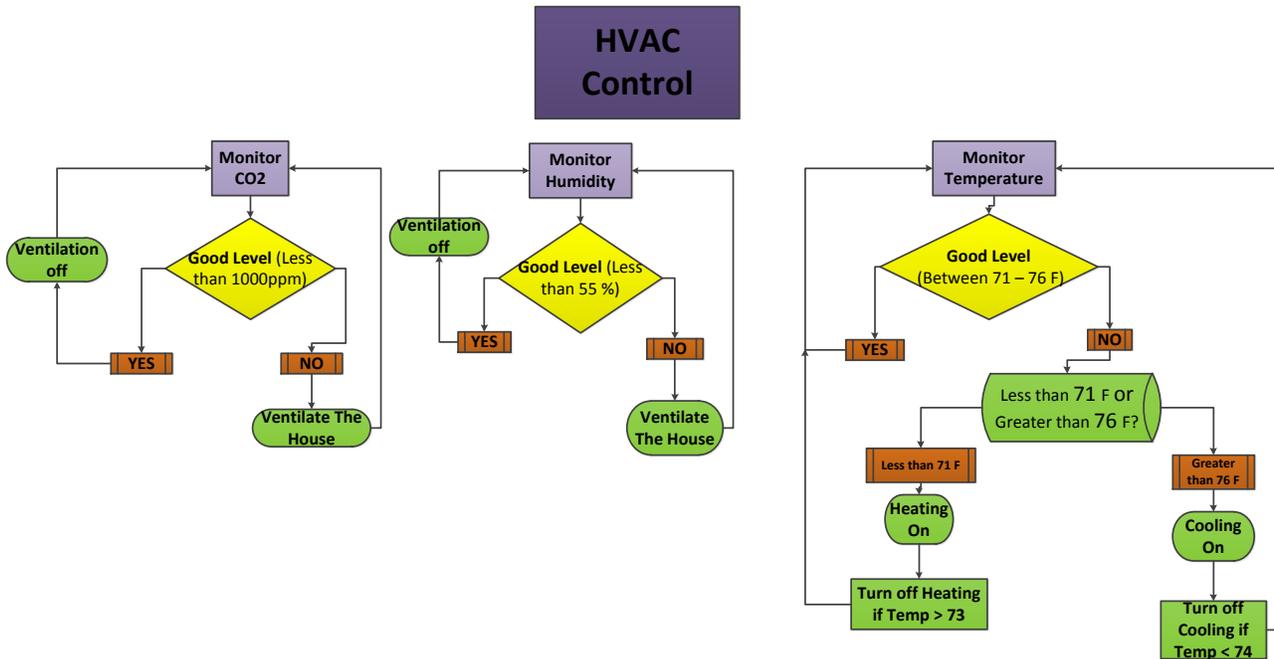


Figure 7.14 - HVAC Algorithms Flowcharts

For more development and in depth look at the HVAC system controls, please refer to *Section 5.7 HVAC System Control Strategy*.



7.2.2.3 Blinds

The idea of implementing automated blinds as one of the features of the house will greatly improve the energy savings of the Solar Roof Pod because it leverages the natural light as well as thermal energy to balance the artificial lighting as well as internal temperature. The automated blinds system consists of several components. First there is a solar radiometer, which will be mounted, on the roof. This sensor detects the amount of natural light in the vicinity, determines the profile angle of the sun and compares those readings with a prebuilt light analysis database. Then the system compares the measurements and the stored data and performs different functions based on preset decision points. The control system adjusts the blind positions on the window automatically by monitoring the real-time sky conditions over the course over the year. Figure 7.15 shows the comparison between the two input data.

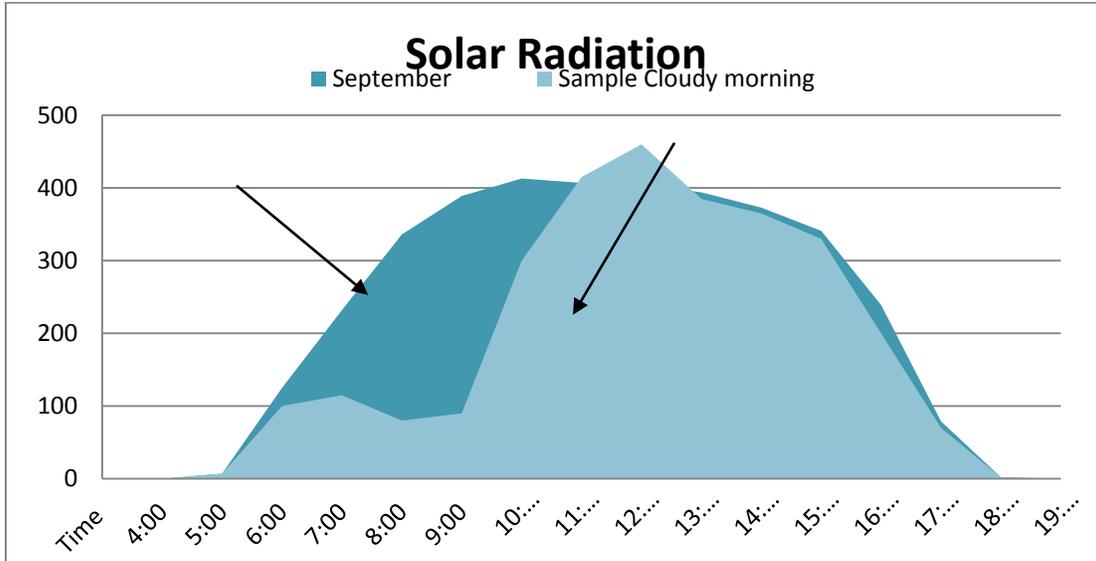


Figure 7.15 - Solar Radiation Curve. Theoretical and Measured Values

The unit allows both manual and automatic control for the blind system. The benefits of having automated blinds is that maximizes or optimizes the amount of natural light and view thru the window by appropriate control of the blinds tilt angle as well as elevation of the blind system in the window opening. During sunny days the blinds will be completely down and will only be opening and closing. During cloudy days the blinds will move vertically to up and down position and keep the blinds will remain in the open position. For example during the warm and sunny summer season, blinds can be adjusted to block direct radiation in the interior of the room, especially when the occupants are not present. Hence, blinds functionality provides lower heating load and hence the HVAC needs are reduced. On the other hand, during the winter and depending on the sky conditions, the system can adjust the blinds to allow direct or indirect sunlight to penetrate in the building and hence help keep the interior at a higher temperature and reduce the HVAC needs. Figure 7.16 shows a detailed graphical interface for the 3 windows with automated blinds that will be implemented as well as the position in the house.

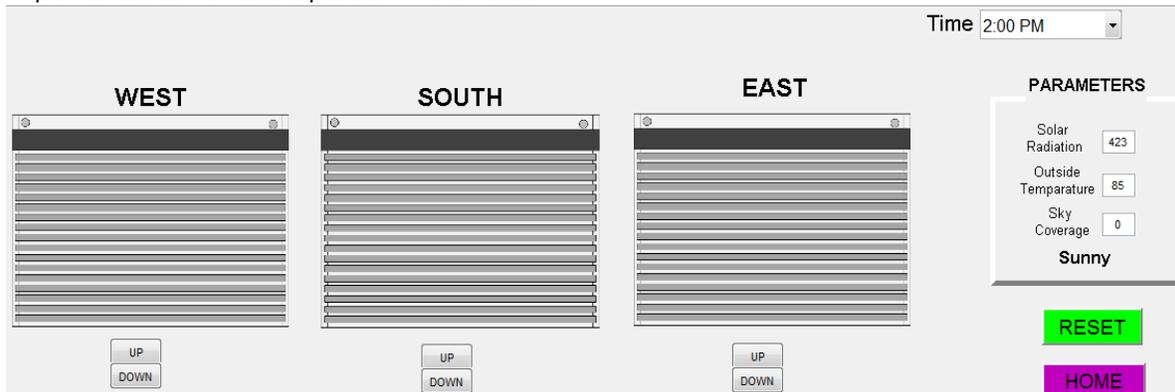


Figure 7.16 - Automated Blinds GUI



Note that by having automated blinds we can save energy by balancing natural and artificial lighting (e.g., dimming the lights as needed) and adjusting the HVAC at a comfortable level automatically. An algorithm flowchart has been created to illustrate certain conditions that need to meet in order to operate the blinds. The blinds will work as a separate system and based on the output, the other sub systems controls will accommodate their behavior. During the entire competition the operation of this system will be shown to the public. It has been created an algorithm flowchart to illustrate certain conditions that need to meet in order to operate the blinds

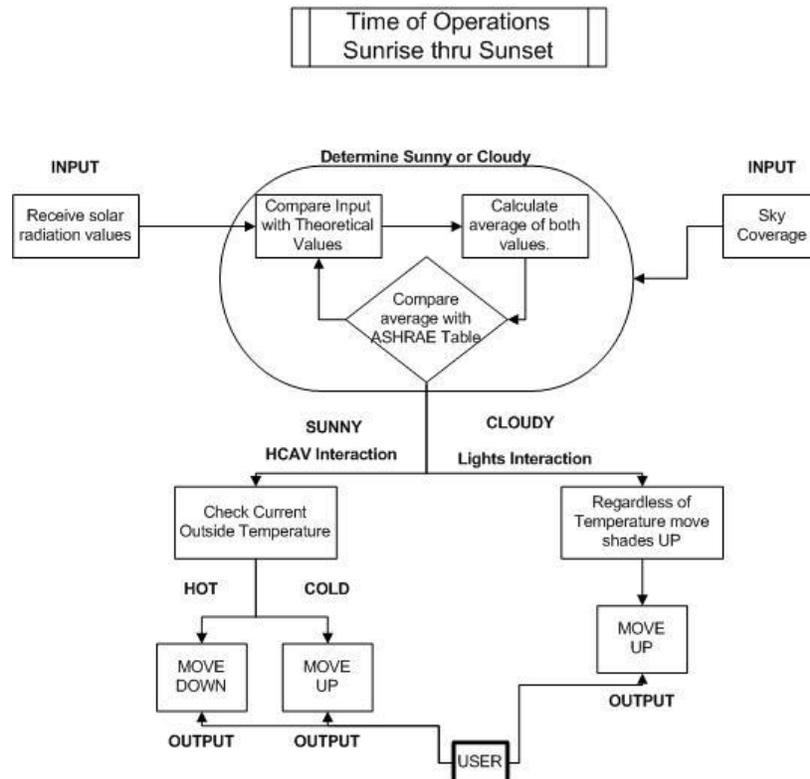


Figure7.17 - Blinds Algorithm Flowchart

7.2.2.4 Motorized Windows

The automated motorized window is an innovative idea. The main purpose of having motorized windows is for fresh air ventilation. This automated feature will also have an impact in the operation of the HVAC system. The idea for this house is to use as much as natural resources as possible. By taking advantage of the natural air energy savings can be accomplished by turning off the HVAC when the outside conditions are appropriate. In Figure 7.18 the concept of natural air ventilation is shown.

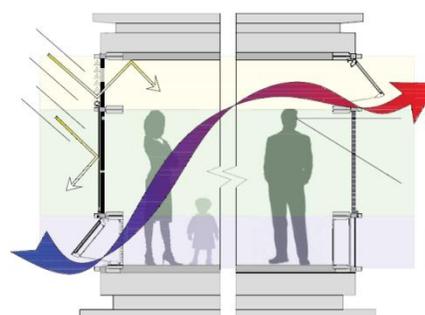
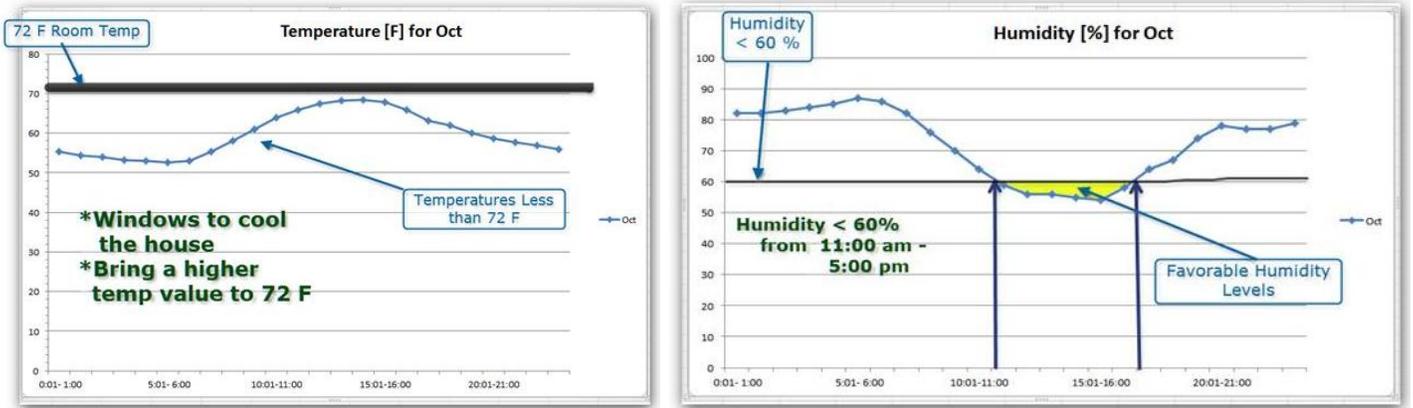


Figure 7.18 - Window Ventilation Design.



To have successful window automation, information from the inside and outside is needed. For this automation part we will be using carbon dioxide detectors in every face of the house to monitor the outdoors air quality. Temperature and humidity sensors for the inside conditions and a weather station for ambient outside conditions will also be used. Another type of sensor that is crucial is the wind sensor because this will determine whether or not wind conditions are favorable for the ventilation system performance. Air circulation through windows becomes useful when temperature in the house is greater than 72 degrees and humidity is below 60 percent. Figures show temperature outside to be less than 72 degrees and the humidity to be less than 60 percent and thus, through the simulation, windows can be opened between 11 am through 5 pm (Figure 7.19).



(a)

(b)

Fig 7.19 - Weather simulation data

The windows will not open fully for safety issues (child safety) but rather until a certain level. In Figure 7.20 a graphical user interface for the specific behavior of each automated window is depicted. It displays four (4) operable windows and the current status of each one. Figure 7.21 depicts the flowchart of the algorithm, which will operate under certain conditions for the automated windows.

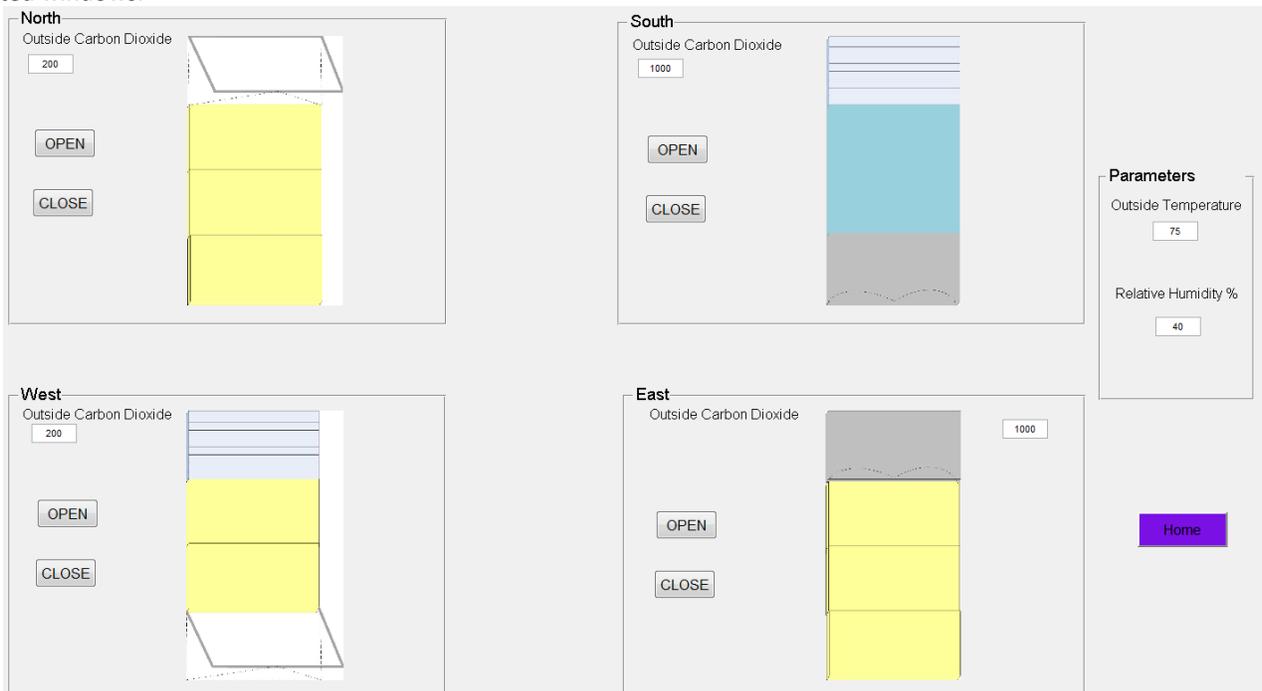


Figure 7.20 - Automated Windows GUI



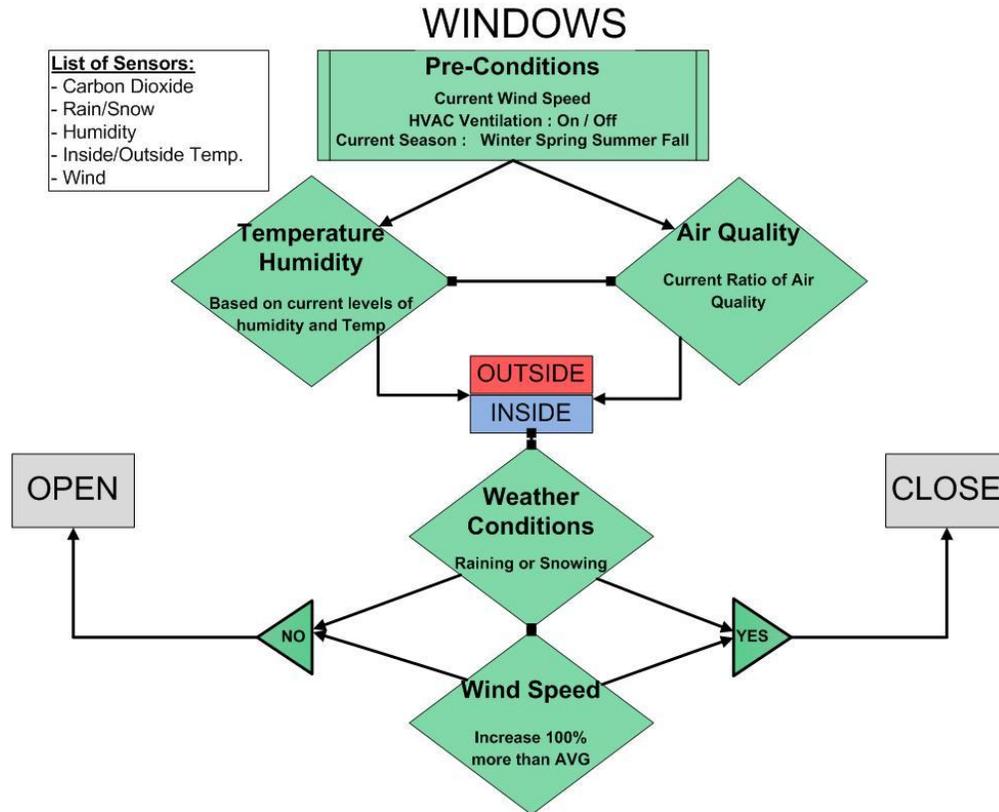


Fig 7.21 - Windows Algorithms Flowcharts

The skylight of the Solar Roof Pod is a special mechanically driven roof window that is located inside the bathroom. The skylight's operability has been integrated with the Schneider Controller to allow automation through infrared sensors which will act as the communication link between the two modules. A friendly graphical user interface which can be accessed via the wireless touch panel, has been implemented to give users control and maximum comfort. With just a simple touch, the user can open or close the skylight to preference. A rain water sensor has also been mounted along the side exterior to the skylight, to automatically close in the event of rain fall, thus providing safety against water damage.



Figure 2 Skylight



7.2.2.5 Irrigation

The irrigation system is an integrated part of a holistic sustainable building. It is an important aspect because it confronts important issues an urban environment faces, that are storm water runoff and grey-water reuse. The idea is to be able to have full control of the water within our footprint. The main task is to reuse water for watering the plants in the outside patio area, through an automated watering system.

The system has two parts that work together, rain water and grey water (Figure 7.22). The rainwater is collected from the roof through two drains that lead to a bladder that stores the water underneath the southern part of the deck. The rainwater is collected from the roof through two drains that lead to a 3.5' x 3.5' x 8" 100 gallon bladder that stores the water underneath the southern part of the deck. The black water is collected through a series of drains in the house, such as dish washer, kitchen sink, bathroom sink, shower and clothes washer then is stored in a bladder parallel to the rain water bladder under the deck. A filter is located at the outtake of the grey water bladder. Hence the grey water quality is significantly improved and is appropriate for use in irrigation of the outside plants.

The smart system for irrigation is composed of sensors and is programmed to accommodate different water requirements and conditions. The lead in the chain of triggers is the moisture sensors. They will be programmed to be stimulated once the plants are in need of at least one pint of water to reach their optimal moisture level. The smart irrigation has two water sensors located in both rain and grey water bladders. Each sensor first reads the water level and communicates it to the control system. If the water level in the rainwater tank is at least 1 inch (12.5 gallons) it will open the valve and pump for one hour. On the other hand, if it is not at the appropriate water level, the system moves on to the grey-water level sensor. If there is a sufficient level of water in this tank the valve opens and the pump operates. The grey water will pass through the filter before reaching the plants. At the event that the grey water is at an inefficient level an alert is issued that notifies the resident about it. The control system then issues suggestions for the amount of grey water generation for different tasks in the house that could alleviate this problem. These suggestions will be based on historical data from the home. For example the system may suggest for operation of the washing machine at an earlier time than usual so that the necessary amount of grey water is generated. Figure 7.23 shows the flowchart of the algorithm developed for the irrigation.

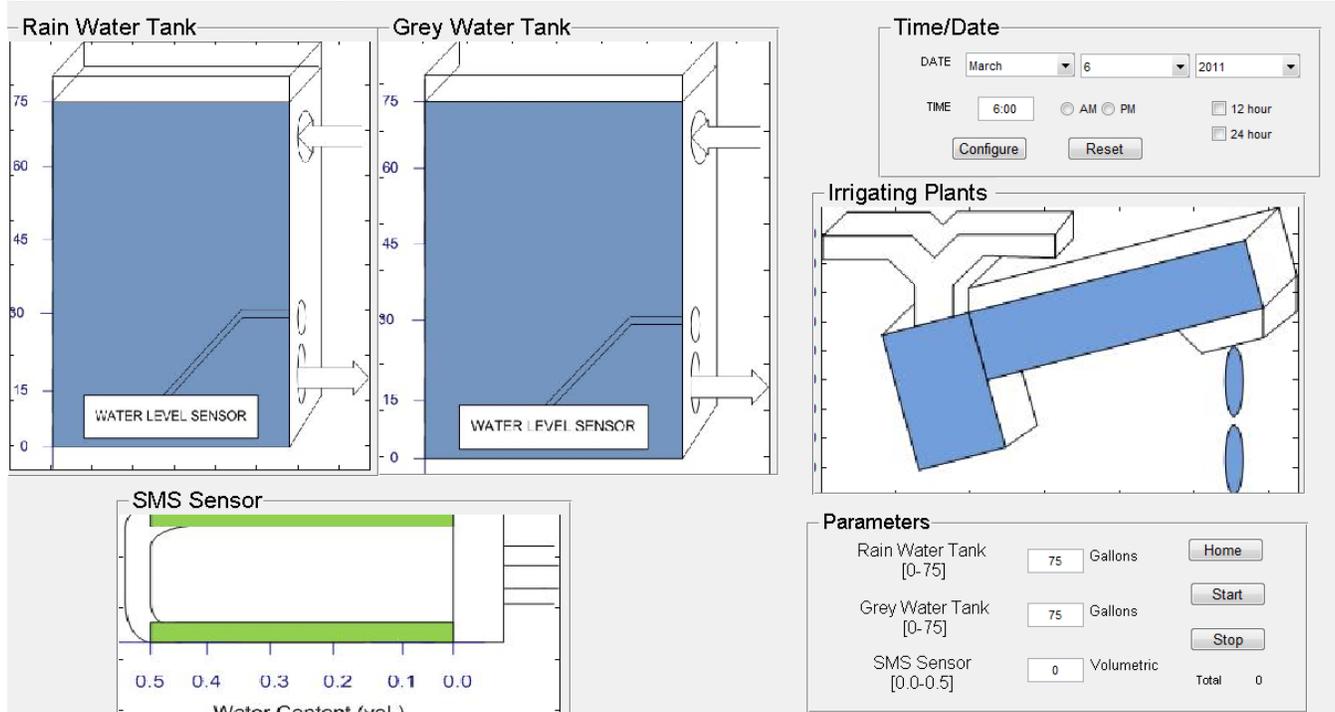


Figure 7.22 - Irrigation GUI



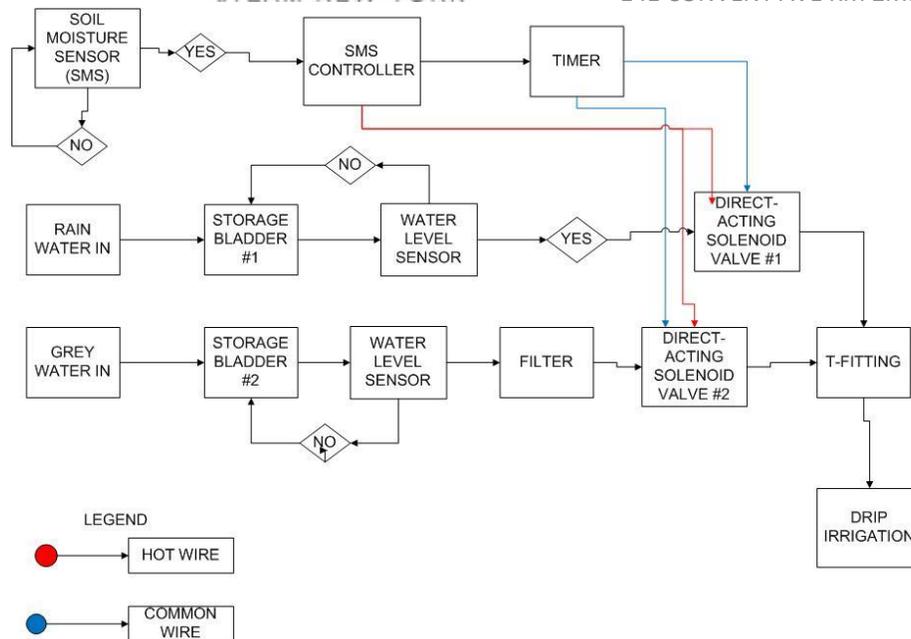


Fig 7.23 - Irrigation Algorithms Flowcharts

7.2.2.6 Connection between Modules

All wires that must be connected between modules must be routed through two junction boxes, one in each side of the house. Any device that must be connected directly to the Electrical closet located in the south module must go through these two junction boxes. One of them is located in the ceiling of the bathroom, and the other one is located in the ceiling of the mechanical room. However, any other sensor or device that is being wired should favor (when possible) the south module to avoid more connection between the junction boxes. For simplicity the connection will be done using 4-pin connectors, and also to save time when assembling or disassembling the house. The following diagram shows an approximate area of the connection.

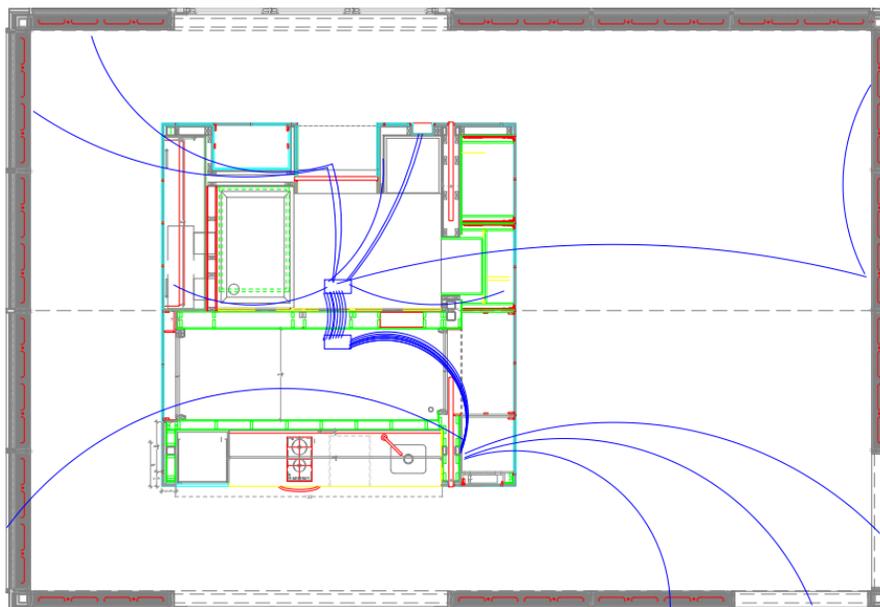


Fig 3 – Connection of Low Voltage wiring



8.0 Structural Design

8.1 Mounting Structure Design

8.2 Approach to Mounting Structure Design

The overall objective of the Mounting Structure Team is to design and analyze a truss and clamping system that would be able to support 40 photovoltaic panels and 6 solar thermal panels located on top of the solar Roof Pod. The truss and clamp system should be able to withstand the dead load resulting from the combined weight of the Photovoltaic and Solar Thermal Panels, as well as live loads resulting from wind loads, and snow (or rain) loads typical to high-rise New York City Residential Buildings.

The (truss system) space frame is a special three dimensional structure composed of axial and pin connected members, designed specifically to carry loads at the nodes. Directionally the space frame on top of the Solar Roof Pod is a latitudinal structure. It is composed of 30 joints and 83 axial members, with a concentration of joints and members where the load is heaviest. The space frame is mounted on the roof at six mounting points, which represent connection to the six structural columns which will be essentially supporting the weight of the roof structure. Structural calculations for the space frame are obtained using the SolidWorks software to calculate stress, strain, and displacement.

The Solarmount rail system (Unirac rail) is used to mount the solar panels and the thermal panels on the space-frame. The rails, called here HD-beams, are attached to the truss system. For stability and the rigidity of the system, the beams are laid in opposite direction to the space-frame. There are two HD-beams per panel. The system of beams is oriented north to south (longitudinally). Conventional beam analysis is also employed here in order to find regions of maximum strength, stress, strain and deformation.

The clamping system serves the purpose of connecting the PV panels to each other, and securing attachment to the beams. The solarmount mounting system provides end-clamps for the exterior edge of the panels and mid-clamps between two panels. The clamps are used to connect the photovoltaic panels to the HD-beams. The thermal panels are bolted to the beams since their design is different. Analysis is run using Cosmos Works software to show maximum shear stress, strain, and deformation under the loading conditions stated above.

8.3 Design

The Structural calculations were completed by Team New York's Structural Team and submitted to the Engineering Team Leader of The Grove School of Engineering. The calculations and drawings below are of the Solar RoofPod Space and Clamping System. Calculations detail the analysis of the space frame and clamping system to include maximum and minimum deformation, stress and strain under the given load conditions of dead and live loads. Below are results from CosmosWorks Simulations which display maximum and minimum deformation, stress and strain. These Calculations and Analysis were completed entirely by the Structural Team of The City College of New York.

8.3.1 Space Frame

8.3.1.1 Task



The design task consisted of the design of a structure to hold Photovoltaic and Solar Thermal Panels above the roof of the Solar Roof Pod. The structure must be aesthetically pleasing while maintaining all functionality. A large design consideration is the transport and construction of the structure. It will be built by students, thus it has to be easily constructed with minimal tools. The space-frame would be anchored to the building at six locations and will have to cantilever out over the building.

8.3.1.2 Design

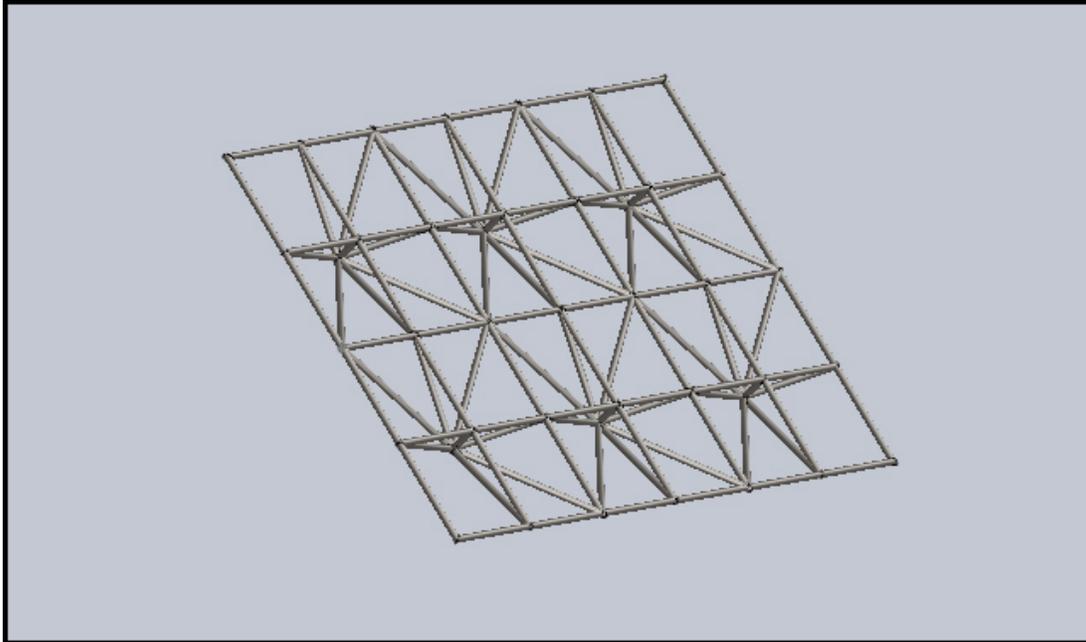


Figure 8.1–Space Frame Design

8.3.1.3 Analysis

Finite Elements Analysis (FEA) uses numerical techniques to analyze engineering design. It is popularly used in the Mechanical Engineering because it facilitates solving for stress, strain and deflection of complex curves or surfaces.

In SolidWorks™, the feature that runs FEA is known as CosmosWorks. In operating CosmosWorks, it is crucial to first define the boundary conditions of the model. These include the total loads on the model and any restraining forces. Once the boundary conditions are defined and set, the CosmosWorks runs analysis to produce maximum and minimum deflection, strain and stress. Below are the results from CosmosWorks.

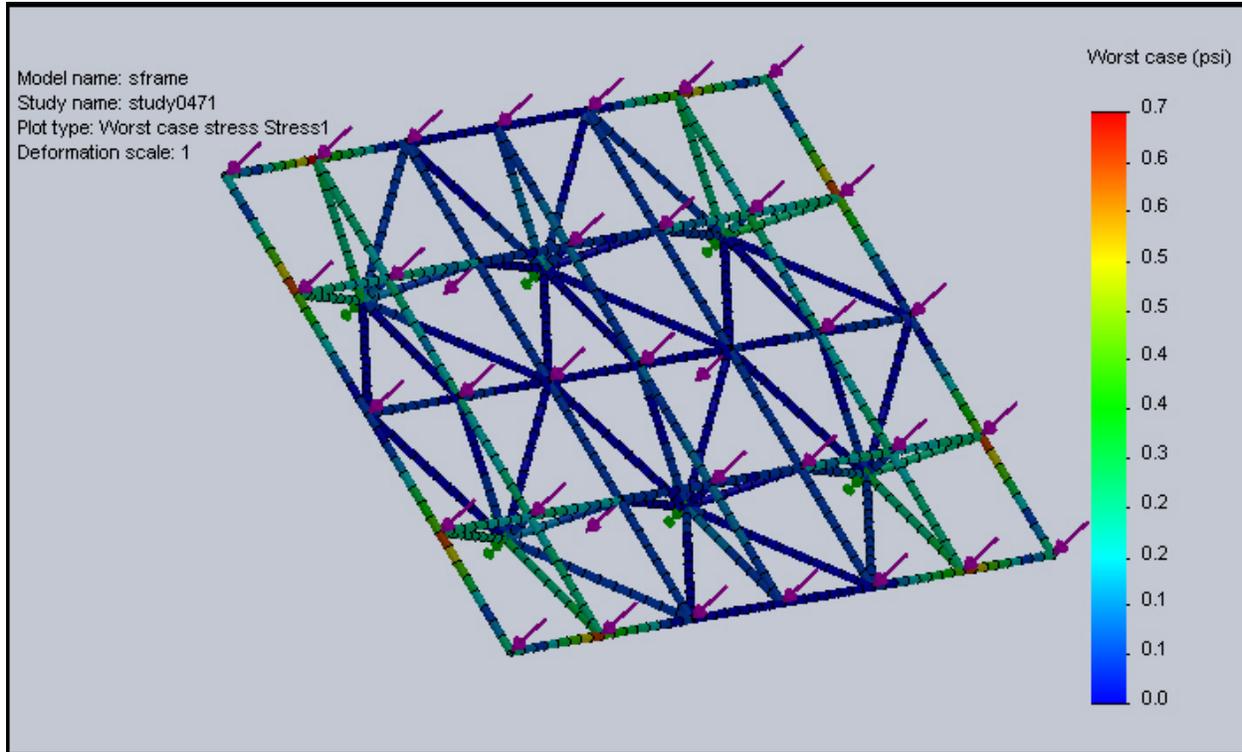


Figure 8.1 - Maximum Stress

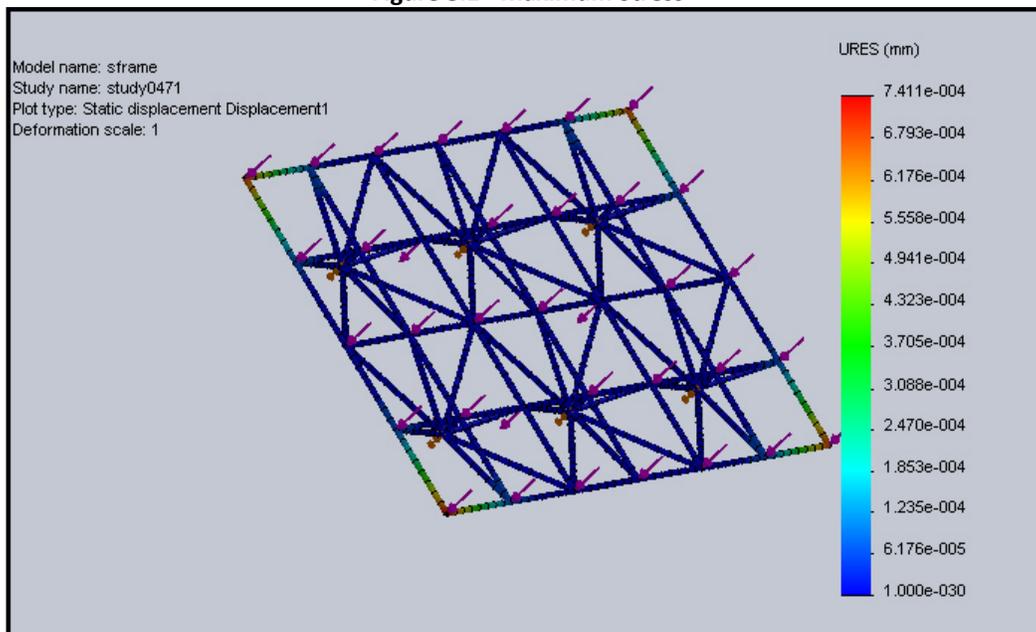


Figure 8.2 - Maximum Deflection



The load was 52.2 psi distributed across the top of the frame with the six mounting locations fixed at their positions. The Yield Stress of the steel used is 50 ksi and the highest forces achieved were 1.167 ksi. The Maximum Deflection was found to be 0.064 inches, well below 2% deflection. The next step in analyzing this frame will be flow calculations, to analyze how the wind will uplift the frame and all of its panels.

8.3.1.4 Secondary Systems and Analysis

The space-frame has multiple 3 inch HD-beams which hold the solar panels.

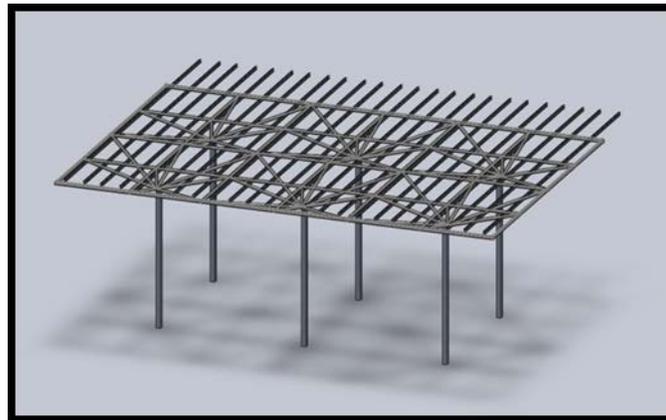
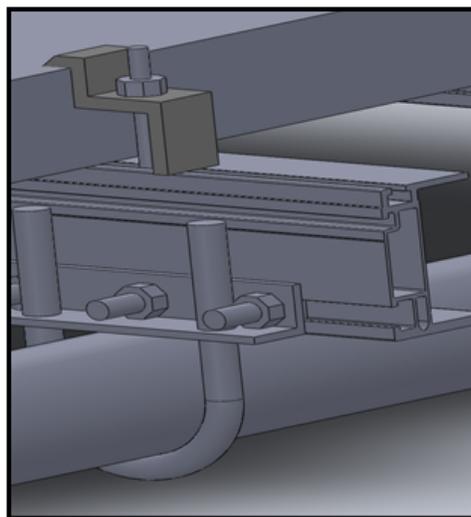


Figure 8.4 - Beam Arrangement on Space Frame

The six columns are attached to the bottom of the space-frame using a bracket system that ties in directly with the nodes located on the bottom of the frame.



Figures 8.5 - The HD-beams are attached using standard pipe hangers



The HD beam was run through an F.E. analysis in SolidWorks with appropriate loading found in the UNIRAC calculations. The Aluminum alloy 6105-T5 was approximated by AL 6063-T83 which has properties reasonably close to the HD Beam material.

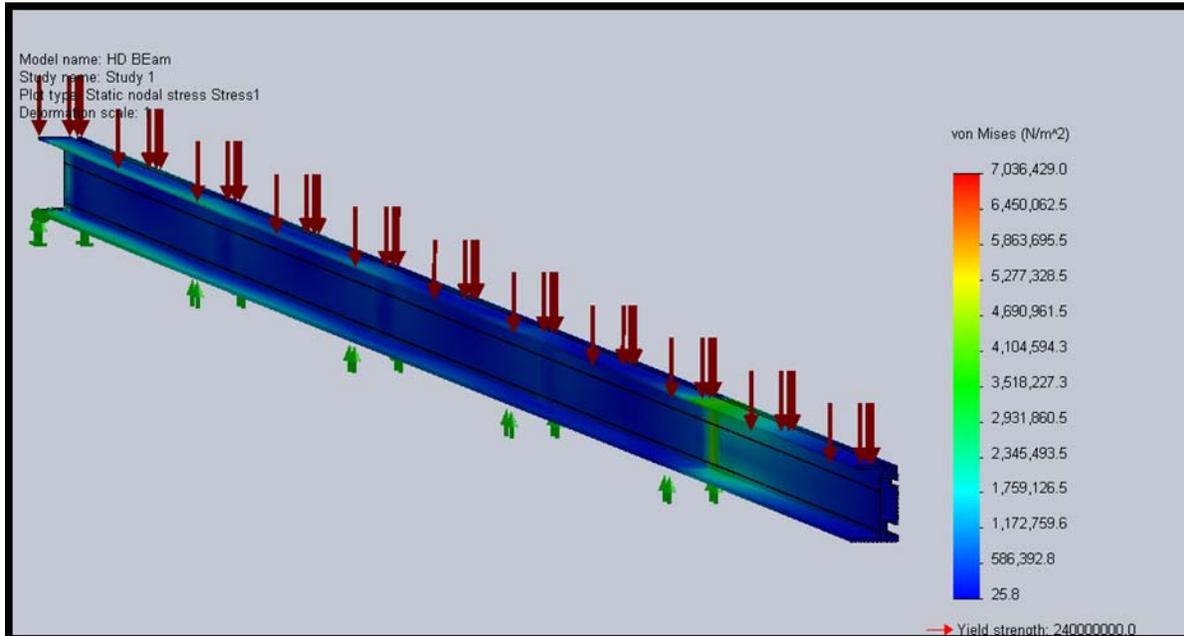


Figure 8.6– Minimized Finite Element Analysis of the HD-beam using CosmosWorks

This graphic shows the results of the test, the green arrows are boundary conditions while the red arrows are the loading on the beam. The Beam experiences a maximum stress of $7 \times 10^6 \text{ N/m}^2$ while the yield strength is well above that at $2.4 \times 10^8 \text{ N/m}^2$.

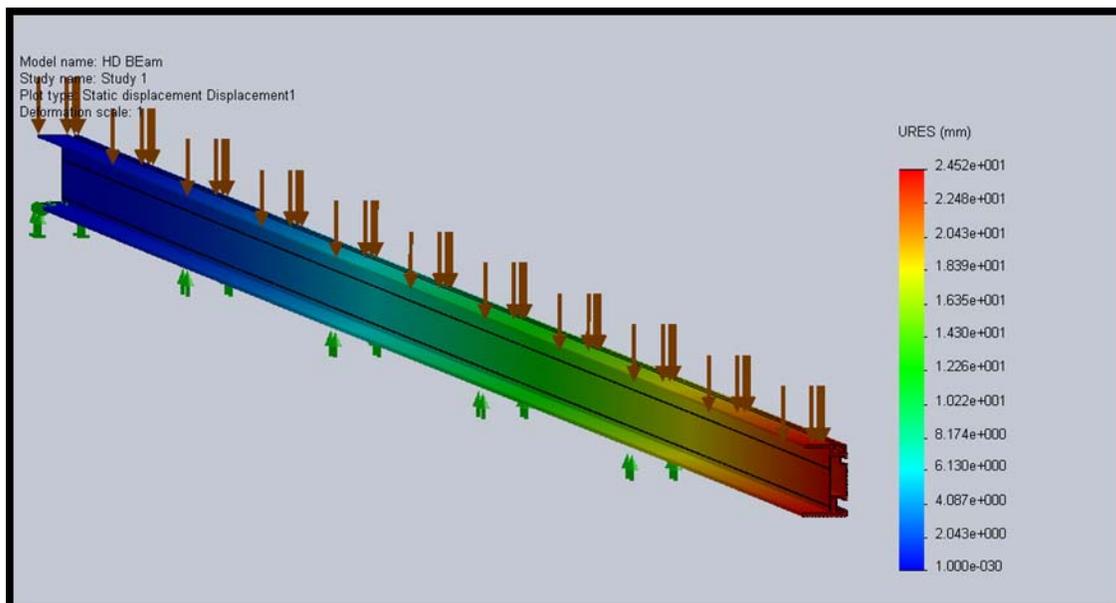


Figure 8.7 – Maximum deflection of the beam

This graphic represents the maximum deflection of the beam. The beam will deflect, under the most extreme loading condition, around 2.45mm.



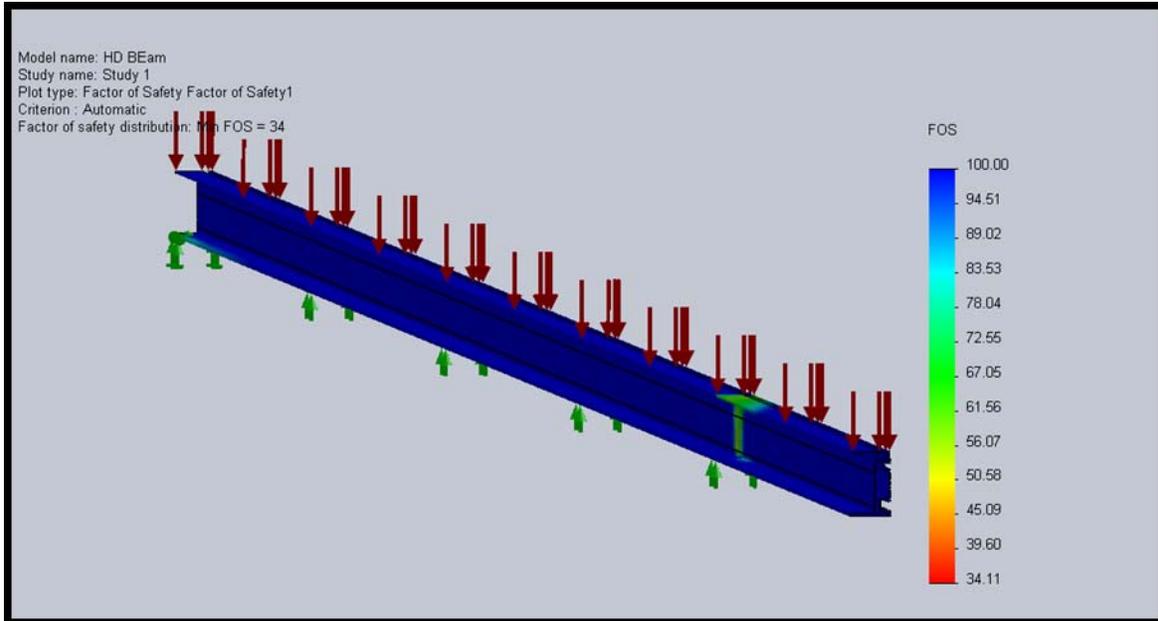


Figure 8.8 – Factor of Safety of the beam

This graphic represents the Factor of Safety (FS) of the beam under the extreme loading conditions. The lowest FS is 34.11 which is well within reason.

In conclusion, it appears that the HD-beam will be able to easily hold the weight of one panel held lengthwise over the edge of the Triodetic space-frame.

8.3.1.5 Additional Analysis of Beam with Overhang

The load and restraints on the HD-beam mounted on the space frame is very unique. It has 5 restraints located at the points of contact of the beam on the space frame, shown with green arrows in Fig 8-9. It also has load at 11 points on the HD beam due to the weight of the photovoltaic panels, shown with red arrows in Fig. 8-9. The Overhang refers to the portion of the beam that extends beyond the space frame. Below is a replicated model.

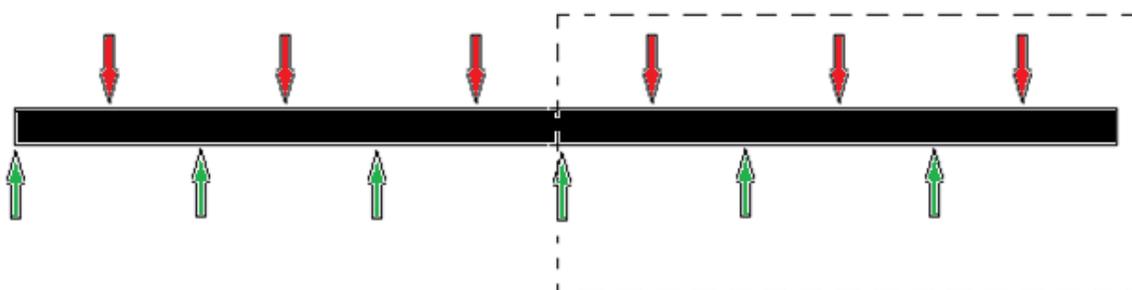
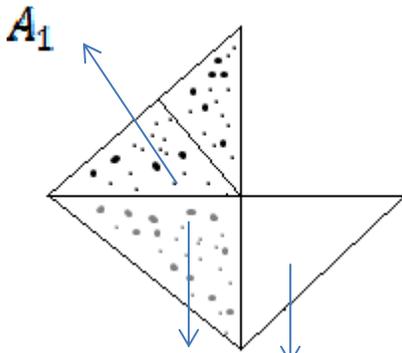


Figure 8.9 – Loading on beam with overhang



$$w \approx 20.2 \text{ lbs} \approx 0.0202 \text{ kip}$$

Moment of Inertia Calculation

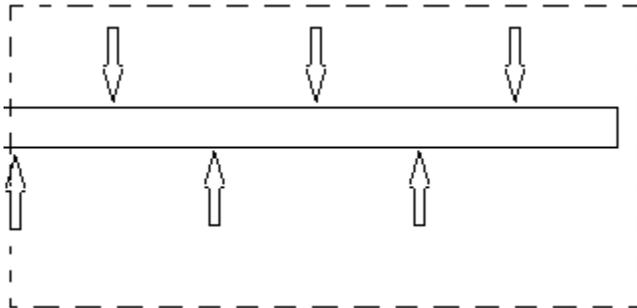


$$E = 29 \times 10^3 \text{ ksi}$$

$$I_x = 0.4609 \text{ in}^4$$

$$EI = 12266.1 \text{ kip} \cdot \text{in}^2 = 92.8 \text{ kip} \cdot \text{ft}^2$$

Sectioned Beam with Overhang



$$A_1 = \frac{1}{2} \left(\frac{3wL^4}{8EI} \right) L = \frac{3}{16} \left(\frac{wL^5}{EI} \right) = 0.00002$$

$$A_2 = -\frac{1}{3} \left(\frac{1}{2} \frac{wL^4}{EI} \right) L = -\frac{1}{6} \left(\frac{wL^5}{EI} \right) = -0.0054$$

$$A_3 = -\frac{1}{3} \left(\frac{1}{2} \frac{wL^4}{EI} \right) L = -\frac{1}{6} \left(\frac{wL^5}{EI} \right) = -0.0054$$

$$\theta_{B/A} = A_1 \frac{L}{2} + A_2 \frac{L}{4} - \frac{1}{16} \frac{wL^5}{EI} - \frac{1}{24} \frac{wL^5}{EI} = \frac{1}{48} \frac{wL^5}{EI} = \frac{1}{48} \frac{(0.0202)(8.2)^5}{92.8} = 0.0034 \text{ ft}$$

$$\theta_B = \frac{\theta_{B/A}}{L} = 0.00013 \text{ rad}$$



$$t_{D/A} = A_1 \left(\frac{L}{3} + L \right) + A_2 \left(\frac{L}{4} + L \right) + A_3 \left(\frac{3}{4} + L \right) = -0.01436 \text{ ft}$$

$$Y_D = t_{D/A} - \frac{x_D}{L} t_{D/A} = -0.1436 - \frac{5.3}{5.3} * 0.0034 = -0.01774 \text{ ft} = -.2129 \text{ in}$$

8.3.2 Conclusion

For the rest of the design process the use of this design will be used, it provides everything the architects demand while providing all the best parts of the previous designs. The tilt angle for the pv panels will be provided by the frame itself and no complicated system for attachment of members will be necessary.

8.4 Roof Mounting System

8.4.1 Task

The task at hand is the selection of a clamping system that would be able to fasten Photovoltaic Panels and Solar Thermal Panels onto HD beams of the Solar RoofPod. The system selected must be easy to assemble, must have stability on the roof (secure), be able to withstand maximum loading conditions, be cost efficient and be aesthetically compatible with the framework of the house.

A clamp, a device used to grip or hold other objects, can be used to clamp wood, paper, plastic or some metals. One crucial task in the Solar Roof Pod was to find a secure way to fasten the photovoltaic and the solar thermal panels onto the HD beams located on top of the space frame.

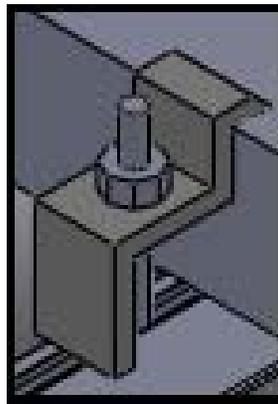


Figure 8.10 End Clamp with nut and bolt



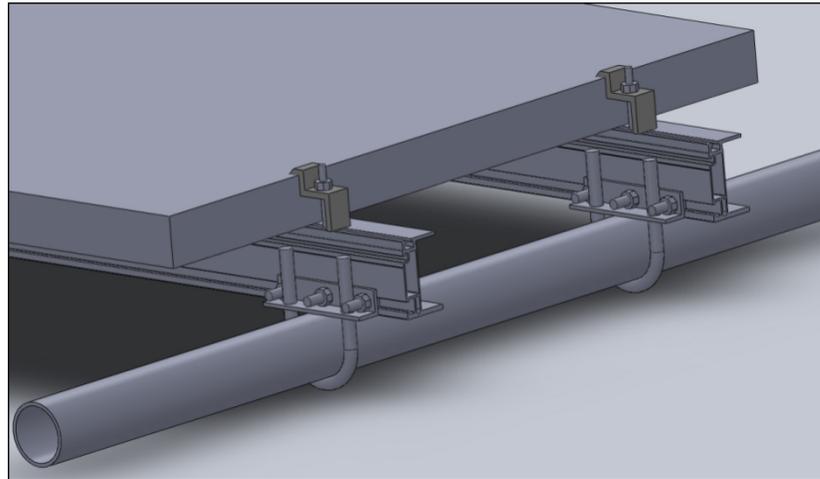


Figure 8.11 - Closer View of Clamp Attached to HD-Beam and PV panel

8.4.2.1 Design Criteria

There are four design criteria necessary for the Clamping system. First, the clamps must be able to withstand the loading from the PV and Solar Thermal Panels, as well as the wind and snow loads. Next, they must also be easy to assemble and use. Third, they must be cost efficient. Last they must fit the aesthetics of the Roof.

8.4.2.2 Chosen Design

The requirement of the Structural group for the mounting system was the analysis of the Design shown in section 8.4.3 of the clamping system. Below it is shown first a rough calculation of stress analysis of the components of the end-clamp. After this step, the FEM model of the clamp is produced. All these results, as shown, fall within the allowed stress of each of the end clamps.

8.4.3 Rough Analysis of Clamping System

Pertinent Formulas used are for stress, strain and moments of inertia.



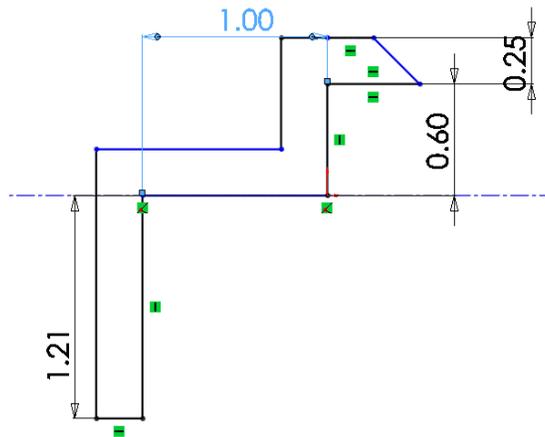


Figure 8.12 - Side View of End-Clamp with Dimensions

$$M_{top} = (34.1 \text{ lbs})(0.60 \text{ in}) = 20.46 \text{ lb in} \quad M_c = 0$$

Area, in ²	\bar{y} , in	$\bar{y}A$, in ³	
$.5(.40)(.25) = .050$	.725	.036	$\bar{Y} \Sigma A = \Sigma \bar{y}A$
$(.40)(.25) = .100$.725	.073		$\bar{Y}(.916) = .414$
$(.25)(.85) = .213$	.425	.091	$\bar{Y} = .452 \text{ in}$
$(1.00)(.25) = .250$	.125	.031	
$(1.21)(.25) = .303$	.605	.183	
Σ	.916	.414	

$$I_x' = \Sigma(.0001736 + .000520 + .12794 + .001302 + .036908) = .051698 \text{ in}^4 \approx 0.52 \text{ in}^4$$

Maximum Tensile Stress

$$\sigma_T = \frac{M_T}{I} = \frac{20.46 \text{ lb} \cdot \text{in} \cdot \text{in} \cdot .60 \text{ in}}{0.052 \text{ in}^4} = 236.077 \frac{\text{lb}}{\text{in}^2}$$

Maximum Compressive Stress

$$\sigma_C = \frac{M_C}{I} = \frac{20.46 \text{ lb} \cdot \text{in} \cdot \text{in} \cdot 1.21 \text{ in}}{0.052 \text{ in}^4} = 476 \frac{\text{lb}}{\text{in}^2}$$

Maximum Strain

$$\epsilon = \frac{\sigma_T}{E} = 8.554 \times 10^{-4}$$



8.4.3.1 FEM Results

For FEM results, the load is composed of the PV panels and wind load, and the restraint is provided by the bolt which attaches the end-clamp to the HD-beams. As shown below, the greatest areas of deformation occur at the tip of the end clamp (S-clip) which is in direct contact with the load (indicated in red). The least deformation occurs at the end of the lower end of the S-clip and it is indicated in blue. As indicated below, the end clamp deforms by less than 2 millimeters after the application of maximum loading.

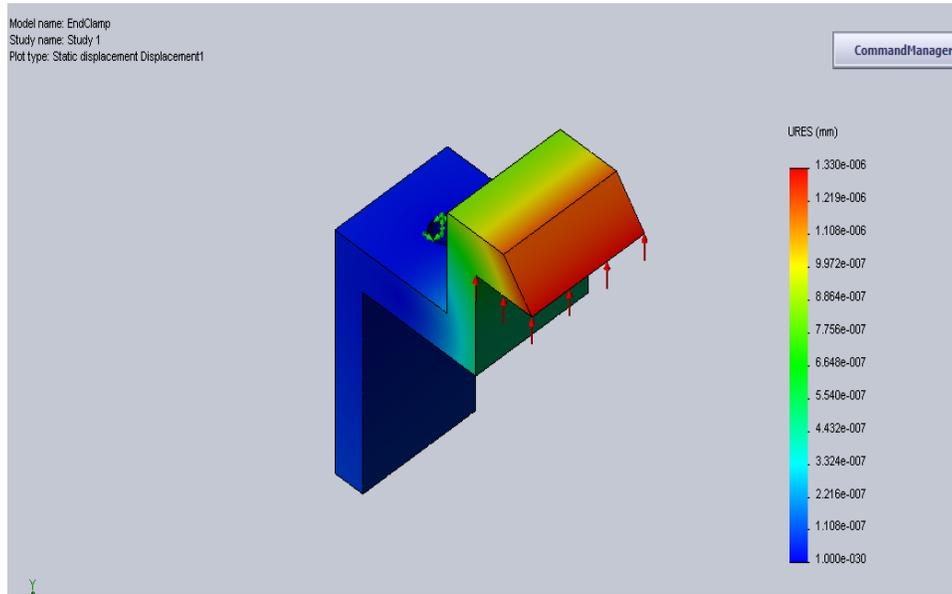


Figure 8.13 - Isometric view of End Clamp showing applied loading and restraining forces

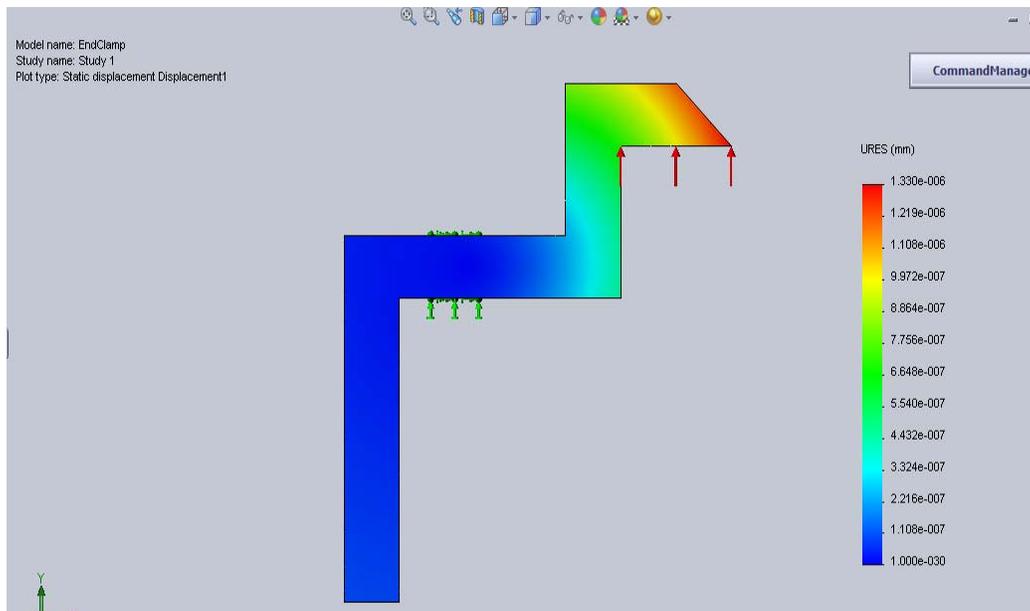


Figure 8.14 - Side view of End Clamp showing applied loading and restraining forces



As verified by the FEM results, there are different stress concentrations in the end clamp once it is fastened for mounting. The results above indicate that stress levels are higher around the part of the clip which is affixed to the PV panel. Table 8.1 shows the ultimate load that the S-clips can withstand. Table 8.2 shows the manufacturer of the end clamps, the quantity of end clamps need for the entire assembly and the total cost.

Table 8.1 - Loading conditions for S-clip

Applied Load Direction	Average Ultimate lbs(N)	Allowable Load lbs (N)	Factor of Safety FS	Design Loads lbs(N)	Resistance Factor Φ
Sliding, X \pm	283 (1259)	104 (463)	2.72	157 (698)	0.555
Tension, Y+	332 (1477)	88 (391)	3.77	133 (592)	0.401
Transverse, Z \pm	1367 (6081)	533 (2371)	2.56	806 (3585)	0.590

Table 8.2 - Manufacturer and End Clamp Information

CLAMPING SYSTEM INFORMATION	
Manufacturer	Unirac Inc.
Contact Information	Unirac, Inc. 1411 Broadway Boulevard NE Albuquerque NM 87102-1545 USA
End Clamp Quantity	40



8.4.4 Mounting System for Solar Thermal Panels

A separate mounting structure was to be designed for supporting the solar thermal panels on the Solar Roof Pod. In order to accommodate for the efficiency, aesthetic and flexible panel arrangement on the roof, the following solution was evaluated. The solar thermal mounting system would have an array of panels which would be cantilevered east and west from the main solar thermal racking unit. This way, even more space will be created on the roof to accommodate space for wiring, cables etc. Below is a simplified model of the racking system. The following test was done in order to ensure that the structure would be stable enough to withstand all loading condition. The following solution was proposed:

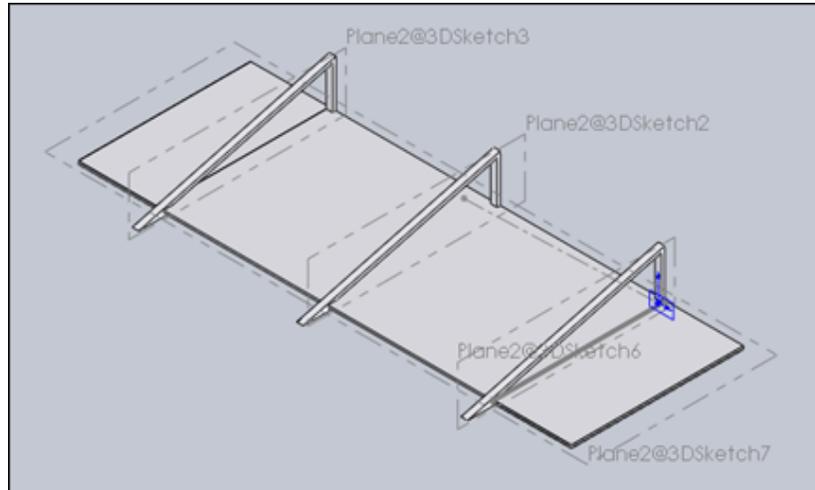


Figure 8.15 - Isometric view of Solar Thermal Mounting System

The Load is represented by the two panels which will be cantilevered East and West of the mounting structure and the Restraints are represented by the green arrows, on the inner core of the rectangular platform. The material chosen for the frame is Aluminum Alloy 6063-T83. Its yield strength is $2.34 \times 10^8 \text{ N/m}^2$. Its tensile strength is $2.55 \times 10^8 \text{ N/m}^2$. Upon the application of the two panels, comprising a total of 303.8 N/m^2 , the maximum stress was 1.17 N/m^2 which is 6 orders of magnitude below the yield strength of the material. The maximum displacement is $1.22 \times 10^{-5} \text{ m}$. Thus, the mounting structure will be stable.



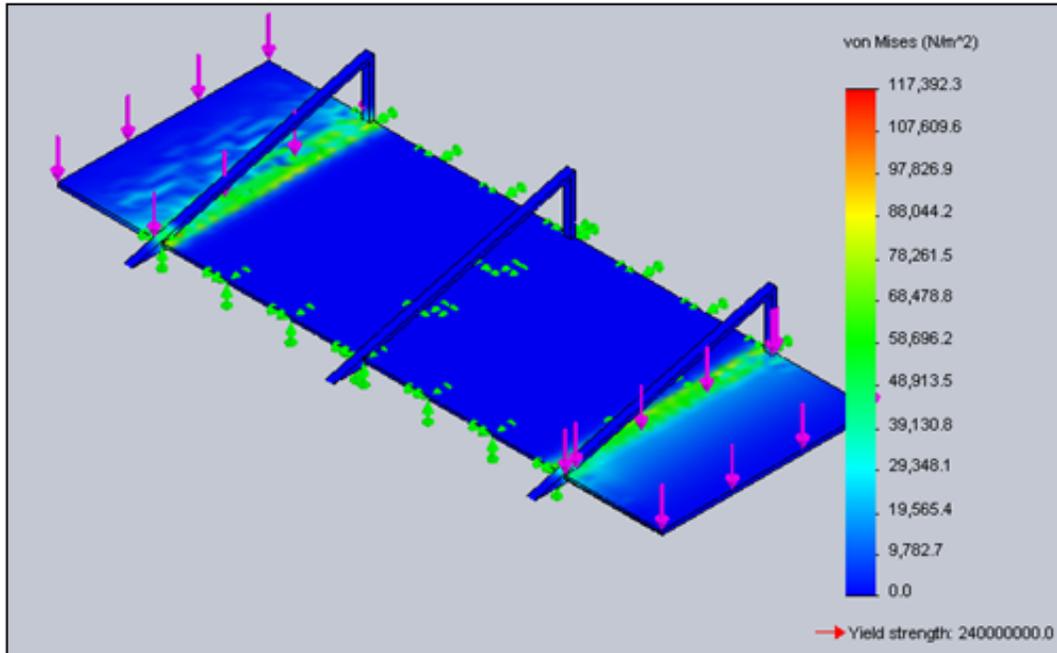


Figure 8.16 - Static Nodal Stress Analysis by FEM using CosmosWorks

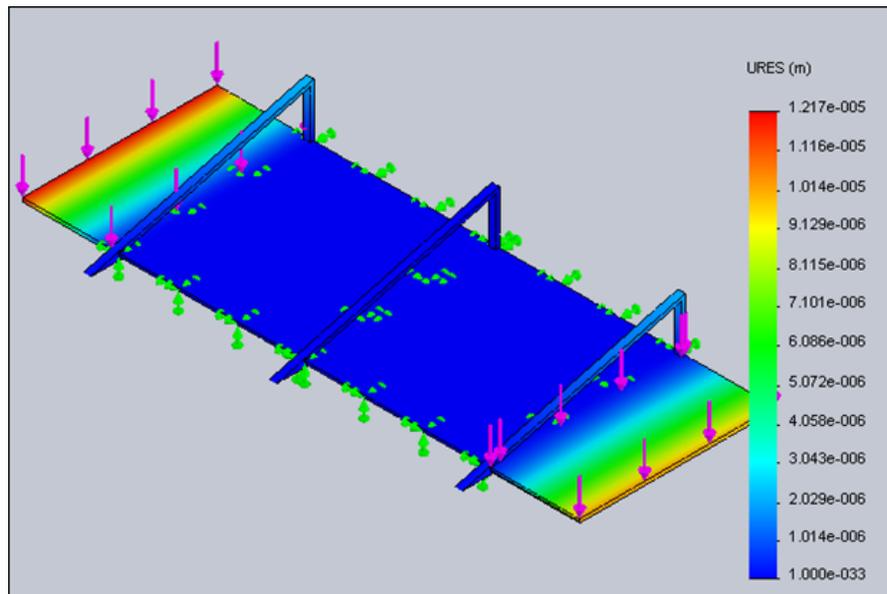


Figure 8.17-Displacement Study of Mounting Structure



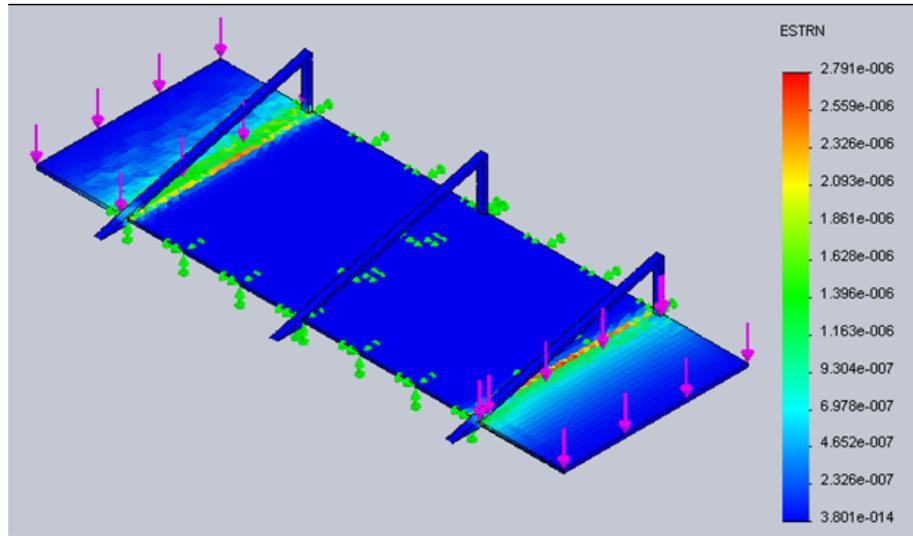


Figure 8.18- FEM Strain Study of Mounting Structure using CosmosWorks

8.4.4 Conclusions

For the design chosen, basic mechanics analysis for calculations of stress, strain, moments and moments of inertia were made. FEM results along with rough calculations show that the S-clamps are stable enough to be used to withstand maximum loading on the Solar Roof Pod. Further attention that would need to be taken into account for the system is the prevention of cracks at the clamp panel interface for which possible solutions are a fillet or inward round at the edge. For the mounting structure, FEM analysis proves that the structure would be strong enough to withstand the cantilever of 2 additional PV panels.

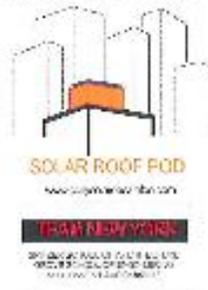


Structural Calculations

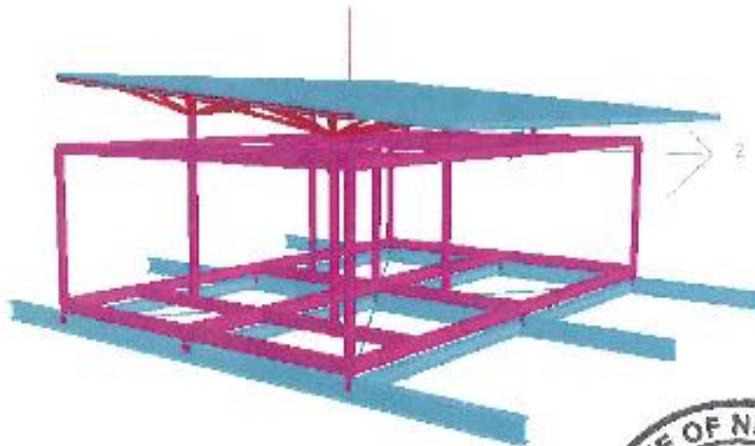
Dominick R. Pilla Associates PC
CONSULTING ENGINEERING + ARCHITECTURE

STRUCTURAL CALCULATION REPORT

FOR
TEAM NEW YORK SOLAR POD
WASHINGTON, DC



DATE ISSUED: MAY 02, 2011



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Appendix A Wind load analysis

Appendix B Thermasteel panel validation and design

Appendix C Calculation Results by STAAD

Appendix D Bearing pad design

Appendix E Overturning and sliding analysis

1 Executive Summary

The team CCNY's solar pod is composed of two equal-size modules which can be built and transported separately and assembled along the middle longitudinal plane in field. Each module is built as a rigid box by welding perimeter steel tubes and framed by one-way floor and roof Thermasteel panels. In each module 2 temporary posts are installed 1'-8" away from the ends at the middle longitudinal plane. Those temporary posts are to provide each module's stability during transportation and will be removed after the two modules are assembled together by splicing the transverse edge beam at each side and connecting the middle double longitudinal beams. Therefore, the assembled pod remains a rigid frame system to resist gravity and lateral loads.

The team CCNY's solar pod is supported by twelve 6 5/8"-high tubes on three dunnage girders, which are braced by steel beams perpendicularly and steel rods cross bracing. The dunnage girders are supported by jacks bearing on grade, 6 of which are directly under the pod. The pod supports a space frame on the roof for solar panels by six tubes pinned on roof transfer beams. The space frame is tilted from north to south at an approximate slope of 5 degree. Facility and other equipment are isolated from the pod's structure.

The team CCNY's solar pod, the space frame and dunnage girders are modeled together using the finite element program STAAD. Two models are created based on loads per 2009 Solar Decathlon Building Code and relevant local jurisdiction building code regarding two different project sites: (1) built site in New York City, NY; (2) exhibition site in Washington DC. Each structural model has 11 basic load cases and 16 load combinations. Unity check per ASD method is performed for those members. The foundation, floor/roof panels, typical deck and ramp structure are also analyzed and designed. The results are:

- 1) The present pod framing members are satisfactory.
- 2) The footing is designed for an allowable soil pressure of 1,500 psf. Bearing pads consisting of 5x5 timbers are required under the 6 supports to spread concentrated forces.
- 3) No uplift force occurs at supports under wind loads in Washington DC. No anchor or tie-down is required.
- 4) Uplift forces occur at 4 supports at the south under wind load in New York, NY. The maximum uplift force is at the middle southern support with 2.2 kips. It is less than 400 lbs at other three locations. Anchors or tie-downs are required.
- 5) The solar panel supporting space frame system is adequate to resist the gravity loads and wind uplift loads.

2 Loading Condition

The design loads are analyzed based on 2009 Solar Decathlon Building Code (2009 SDBC), 2006 International Building Code (2006 IBC), 2008 New York City Construction Load (2008 NYCBC), and 2005 ASCE 7 “Minimum design loads for buildings and other structures”.

2.1 Dead Load

Self-weight of space frame:	3.0 psf
Trellis system (solar panel, mount clamp, etc):	5.0 psf
Roof (roof panel, ceiling, insulation):	15 psf
Floor (floor panel, finish, etc):	15 psf

2.2 Live Load

Roof:	20 psf
Floor:	50 psf
Deck & ramp:	100 psf

2.3 Snow Load

When exhibited in Washington DC, snow load is not required.

When exhibited on the Marshak roof at City College of New York, the design flat snow load is 20 psf per 2008 NYCBC on top of space frame system including the 5’-4” overhang at the southern end. Both balanced snow load case, unbalanced load case and 3 other cases of partial snow load conditions on the space frame (ASCE 7, see Fig. 1) are analyzed and combined with other design loads per 2006 IBC.

2.4 Wind Load

In 2009 SDBC it is stated that the design wind speed in Washington DC shall be 60 mph with a C exposure. The design wind load is calculated per ASCE 7 and the results are attached in *Appendix A*. Following is the summary of the results.

Design wind force on wall of MWFRS	=	7.36	psf
Design wind force on roof of MWFRS	=	-6.16	psf
Design wind force on wall component	=	13.18	psf
Design wind force on roof component	=	-23.84	psf
Design wind force on parapet	=	25.30	psf

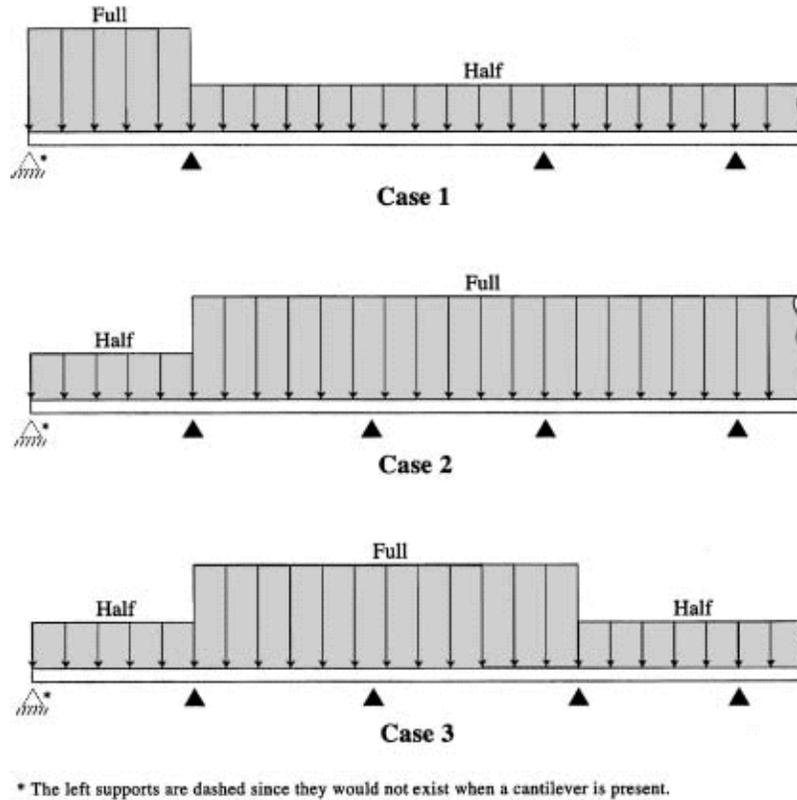


Fig. 1 Partial snow load cases on the space frame

Per 2008 NYCBC, the design wind load on this building shall be 20 psf for main wind-force-resisting system, and 30 psf for components and cladding.

Three wind load cases are considered in the calculation: (1) full wind load acting on longitudinal direction only; (2) full wind load on transverse direction only; (3) 75% of wind load on both directions simultaneously (see Fig. 2).

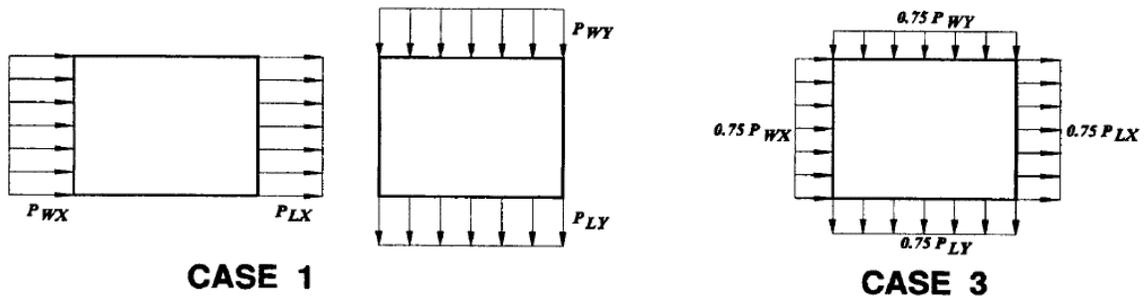


Fig. 2 Design wind load cases

2.5 Load Combination

The following load combinations are considered.

- LC 1. D
- LC 2. D + L
- LC 3. D + 0.75 (Lr or S +L)
- LC 4. D + 0.75 (W + L + Lr or S)
- LC 5. 0.6 D + W

In total there are 11 basic load cases and 16 load combinations considered in the calculation report.

3 Building Modeling

The whole building structure is modeled using the finite element software STAAD. The solar panel space frame, the main building members and the dunnage girders supporting the building are included as shown in Fig. 3. At the splice plan, the double roof/floor beams and columns are simplified as one beam with equivalent moment of inertia. Wall, floor and roof components are neglected and the wind, floor and roof area loads are applied on the relevant beams as line load by multiplying the tributary width.

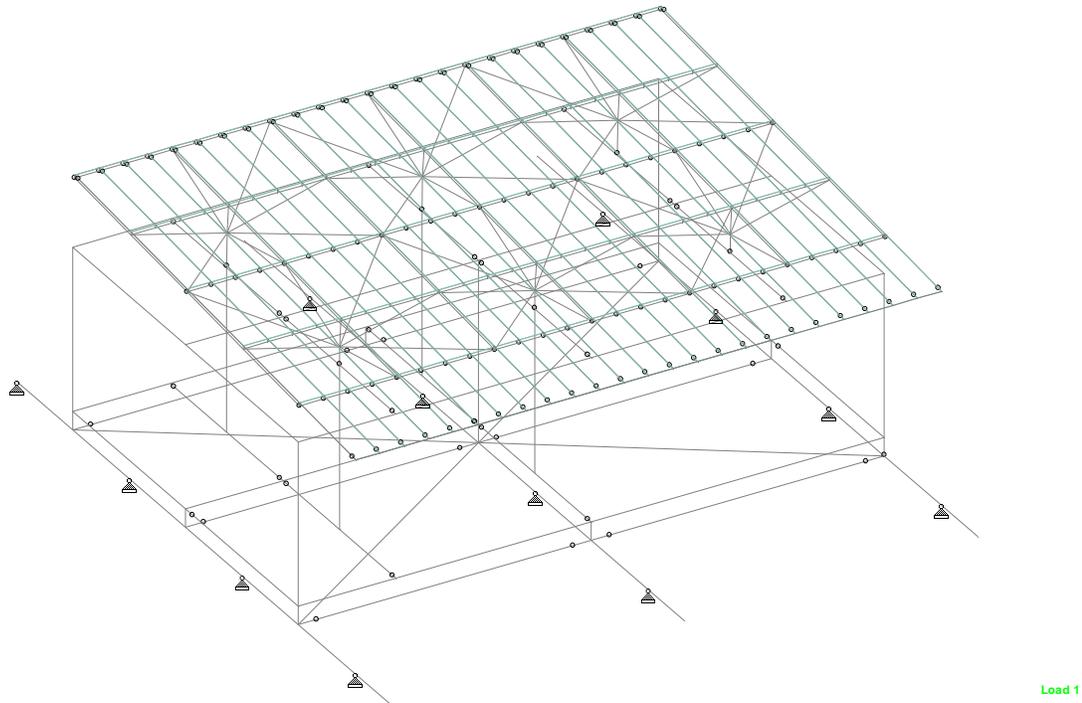


Fig. 3 Main building structural model

The floor/roof components, typical deck and ramp structure are analyzed separately and detail calculations are attached in *Appendix B* and *C* respectively.

A 3D rendering image of the model is shown in Fig. 4 & 5.

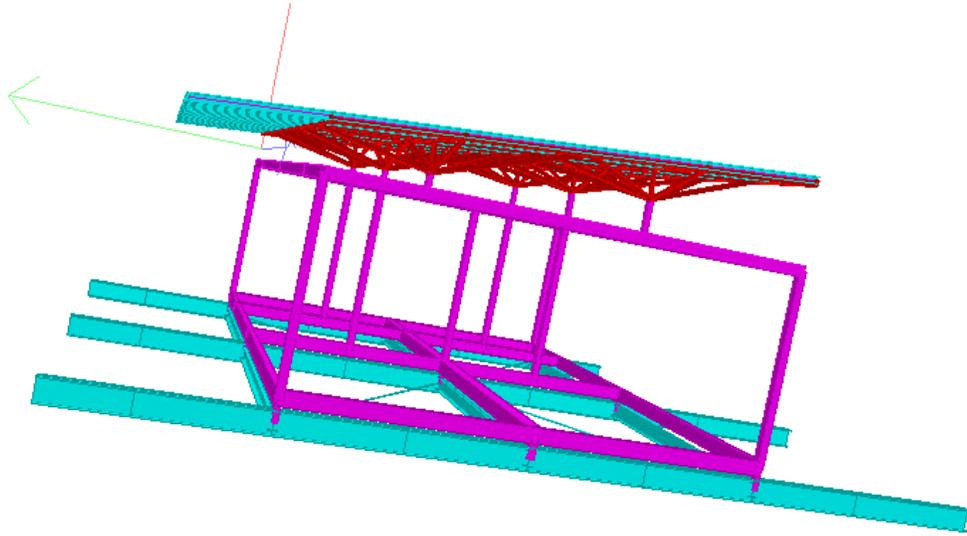


Fig. 4 Structural model rendering – side view

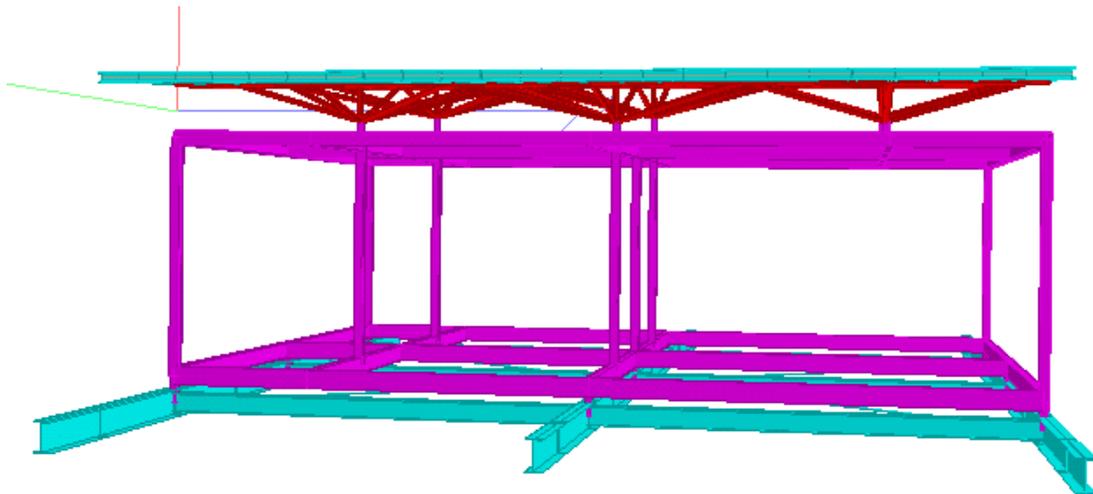


Fig. 5 Structural model rendering – front view

4 Calculation Results

4.1 Main building structure

Unity check per ASD design is performed using STAAD for all main building structures for loads in NY and Washington DC. No fail member is found (Fig. 4). Detailed calculation results are attached in *Appendix D*.

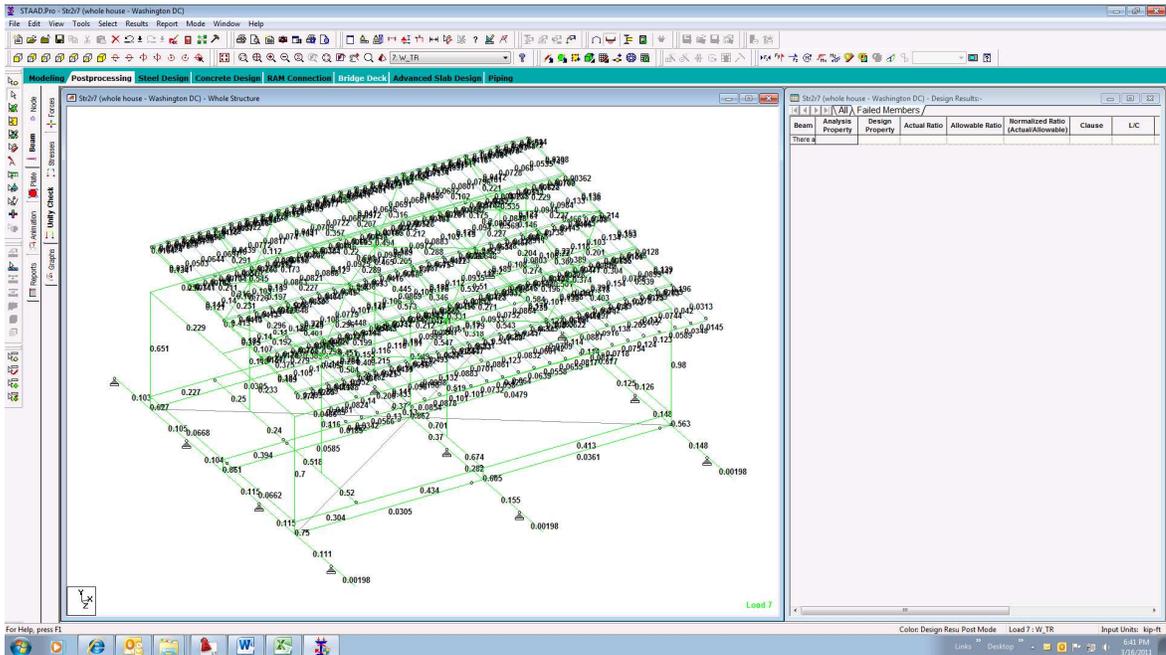


Fig. 6 Unity check results

The maximum movement in horizontal plan of the main building system is 0.101 in, equivalent to 1/1080 of the building height. The deflection of structural members also meets the code requirement.

4.2 Foundation

Gravity loads, load combination 4, controls the footing design. The maximum load reactions at the supports are shown in Fig. 5. It is clear that the six supports under the building have much higher forces (7~22 kips) to resist than others, which will yield very large base plate (> 2' square) in order to limit the bearing pressure within the given allowable soil pressure of 1,500 psf at the exhibition site in Washington DC. Therefore, a bearing pad with 5x5 timber beam tied together by 1/2"-diameter rods is designed under the steel base plates to spread the forces at each of those six support locations.

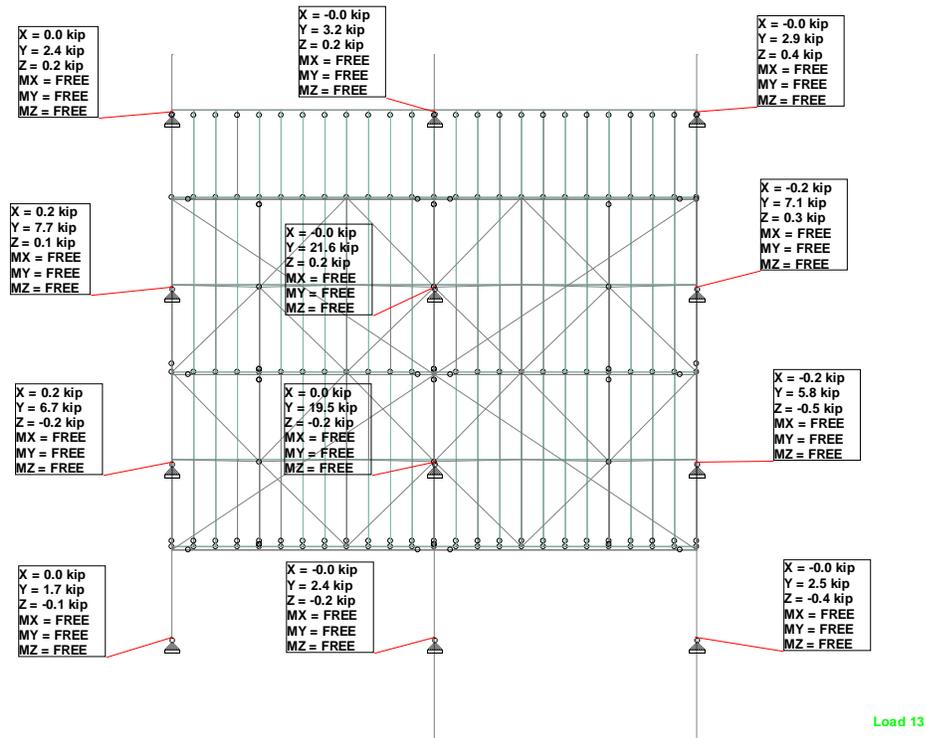


Fig. 7 Maximum reaction under gravity load (LC4)

At all other support locations, steel base plates are designed for an allowable soil bearing pressure of 1,500 psf.

4.3 Uplift

Wind load cases, load combination 5, govern the uplift design. And the wind load 3, i.e. 75% of wind load on both directions simultaneously, yields the critical forces which can be reviewed at each support. A positive value of vertical reaction (+Y) denotes compression force and a negative value denotes uplift force.

Under wind load in Washington DC, no uplift force occurs at the supports (Fig. 8).

Under wind load in NYC, uplift forces occur at 4 supports (Fig. 9), especially the southern middle support under the building which is -2.2 kips. Therefore, anchor or tie-down detail is required when the building stays in NYC.

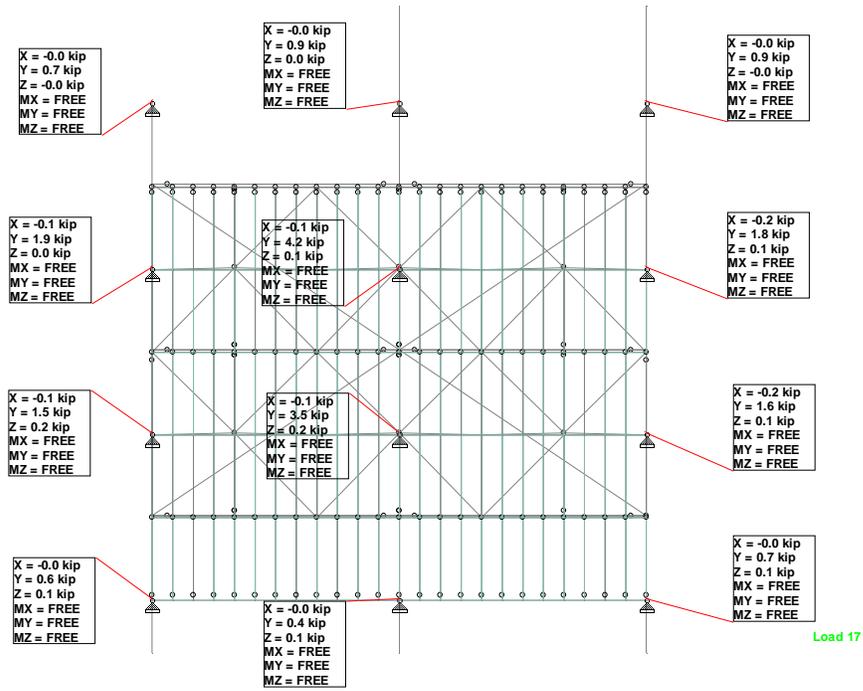


Fig. 8 Reaction check for uplift force (Washington DC)

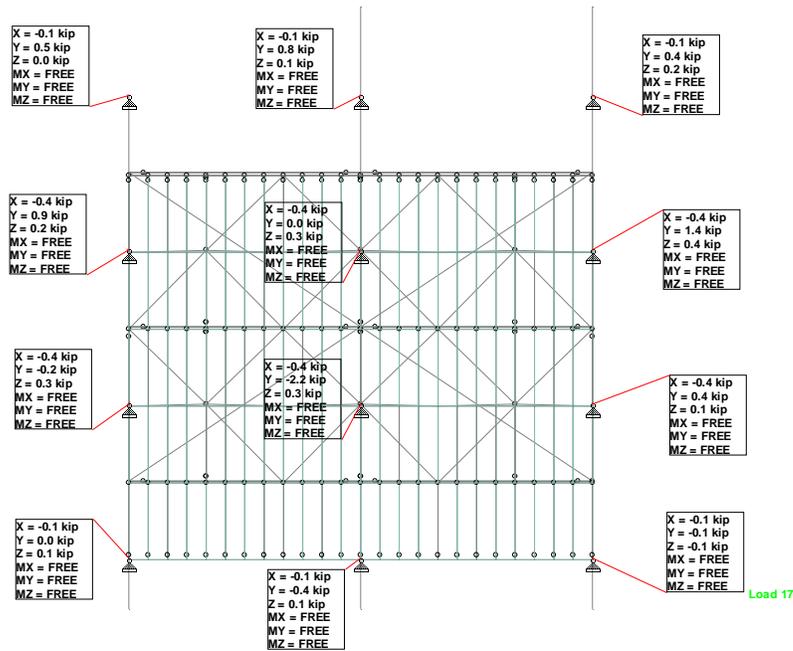


Fig. 9 Reaction check for uplift force (NYC)

4.4 ThermaSteel panels on floor and roof

The *ThermaSteel™* panel, manufactured by Thermasteel Corporation VA, is a typical 4' wide one-way modified expanded polystyrene (EPS) panel reinforced by light-gauge steel studs at top and bottom, as well as perimeter edges. The bond between EPS and studs yields a composite action so that the top and bottom studs can work together. The panel is mostly used for enclosure walls and can resist transverse forces.

By using classic composite beam theory, the panel design is validated for two transverse force tests provided by the manufacture (*Appendix B*). The results show that the ratio of calculated deflection to average test value is 91.1% in one test combined with axial load, and 95.5% in another transverse pressure test. The ratio of calculated ultimate force to test value is 94.6% for the first test and 148.2% for the second test. The large offset of second test prediction is due to the 22 Ga stud failed by buckling.

The design by composite beam theory is overall satisfying. The floor and roof panel design results to meet the deflection requirement are listed as follows:

Floor panel: 7.5" thick panel with 358J18 @ 16" O.C. studs and density 1.15 pcf EPS (min. shear modulus of 370 psi)

Roof panel: 7.5" thick panel with 358J20 @ 16" O.C. studs and density 1.0 pcf EPS

4.5 Deck and ramp

Typical ramp module is framed by 2x6 wood joist with a typical span of 5'-4" and a spacing of 16" o.c. Typical deck module is 5'-4" square which is framed by C-joists. All members are analyzed and proved to be adequate.

4.6 Space frame for solar panel support

A space frame is designed to support solar panels on roof. The space frame is connected with the roof structure by six short tube posts. An optimization analysis shows the perimeter frame member shall be 2 7/8"-diameter tubes with 0.148" wall thickness. All space frame members shall be 2 1/2"-diameter tube with 0.148" wall thickness. The space frame design is incorporated in the building model and the results shows the design meet the code requirements. The space frame members and joints are to be provided by Triodetic Inc.

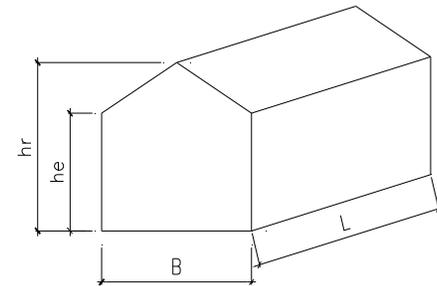
Appendix A Wind load calculation

Wind load analysis (IRC 2006) **SHEET #: W-01**

DOMINCK R. PILLA ASSOCIATES, PC 23 DEPEW AVE, NYACK, NY 10960 TEL: 845 727 7793 FAX : 845 727 6377	PROJECT: CCNY Solar Decathlon Washington DC LOCATION: Washington DC DATA: 3/1/2009	PAGE: 2 DESIGN: xt REVIEW: drp
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INPUT

Exposure category (A,,B, C or D)	=	C	
Importance factor (0.87, 1.0 or 1.15)	<i>I</i> =	1	Category II
Basic wind speed	<i>V</i> =	60	mph
Topographic factor (Sec.6.5.7.2)	<i>K_{zt}</i> =	1	Flat
Building height to eave	<i>he</i> =	14.33	ft
Building height to ridge	<i>hr</i> =	14.33	ft
Building length	<i>L</i> =	33	ft
Building width	<i>B</i> =	22	ft
Parapet wall height	<i>hp</i> =	1	ft



DESIGN SUMMARY

Design wind force on wall of MWFRS	=	7.36	psf	
Design wind force on roof of MWFRS	=	-6.16	psf	(upward)
Design wind force on wall component	=	13.18	psf	
Design wind force on roof component	=	-23.84	psf	(upward)
Design wind force on parapet	=	25.30	psf	

ANALYSIS

Velocity pressures

$$q_h = 0.00256 K_h K_{zt} K_d V^2 I = 6.65856 \text{ psf}$$

where: q_h = velocity pressure at mean roof height, h. (Eq. 6-15)

$$K_h = \text{velocity pressure exposure coefficient evaluated at height, h. (Tab. 6-3)} = 0.85$$

$$K_d = \text{wind directionality factor. (Tab. 6-4)} = 0.85$$

Design pressures for MWFRS (main wind force resist system)

$p = q G C_p - q_i (G C_{pi})$

where: p = pressure for low-rise buildings of all height. (Eq. 6-18)
 G = gust effect factor

C_p = external pressure coefficient. (Fig. 6-6)

$G C_{pi}$ = product of gust effect factor and internal pressure coefficient. (Tab. 6-5)

= 0.85

= 0.18 or -0.18

a) transverse wind direction

	L/B	Cp	GCp	q	G Cpi	qi	p	net p (psf)	total force (k)
windward wall	1.50	0.8	0.68	6.65856	0.18	6.65856	3.33	6.23	2344
leeward wall		0.8	0.68	6.65856	-0.18	6.65856	5.73		
		-0.3	-0.26	6.65856	0.18	6.65856	-2.90		
side wall		-0.3	-0.26	6.65856	-0.18	6.65856	-0.50		
		-0.7	-0.60	6.65856	0.18	6.65856	-5.16		
roof		-0.7	-0.60	6.65856	-0.18	6.65856	-2.76		
overhang		-1.3	-1.11	6.65856	-0.18	6.65856	-6.16		
		-2.1	-1.79	6.65856	-0.18	6.65856	-10.69		

b) longitudinal wind direction

	L/B	Cp	GCp	q	G Cpi	qi	p	net p (psf)	total force (k)
windward wall	0.67	0.8	0.68	6.65856	0.18	6.65856	3.33	7.36	4051
leeward wall		0.8	0.68	6.65856	-0.18	6.65856	5.73		
		-0.5	-0.43	6.65856	0.18	6.65856	-4.03		
side wall		-0.5	-0.43	6.65856	-0.18	6.65856	-1.63		
		-0.7	-0.60	6.65856	0.18	6.65856	-5.16		
		-0.7	-0.60	6.65856	-0.18	6.65856	-2.76		

Design pressures for Parapet (MWFRS)

$p_p = q_p (G C_{pn})$

= 9.99 psf

where: p_p = pressure for parapet. (Eq. 6-20)
 q_p = velocity pressure at top of parapet wall.
 $G C_{p,n}$ = combined net pressure coefficient.

$$= -7.32 \text{ psf}$$

$$= 6.65856 \text{ psf}$$

$$= 1.5 \text{ (windward)}$$

$$= -1.1 \text{ (leeward)}$$

Design pressures for CAC (components and claddings)

$p = q G C_p - q_i (G C_{pi})$

where: p = pressure for components and claddings (Eq. 6-23)
 A = effective wind area on wall
 $G C_p$ = external pressure coefficient relevant to A . (Fig. 6-14)
 $G C_{pi}$ = product of gust effect factor and internal pressure coefficient. (Tab. 6-5)

$$= 0.18 \text{ or}$$

$$= -0.18$$

	A	GCp	q	GCpi	qi	p		
wall (zone 5)	10	-1.8	6.65856	0.18	6.65856	-13.18	psf	(outward)
		0.9	6.65856	-0.18	6.65856	7.19	psf	(inward)
roof (zone 3)	10	-2.6	6.65856	0.18	6.65856	-18.51	psf	(upward)
(overhang)	10	-3.4	6.65856	0.18	6.65856	-23.84	psf	(upward)
parapet (zone 5)	8	0.9	6.65856	-1.8	6.65856	17.98	psf	(outward) CASE B
(zone 4)	14	0.9	6.65856	-2.9	6.65856	25.30	psf	(inward) CASE A

Design pressures for Parapet (CAC)

$p = q_p [G C_p - (G C_{pi})]$

Appendix B ThermaSteel panel Validation and design

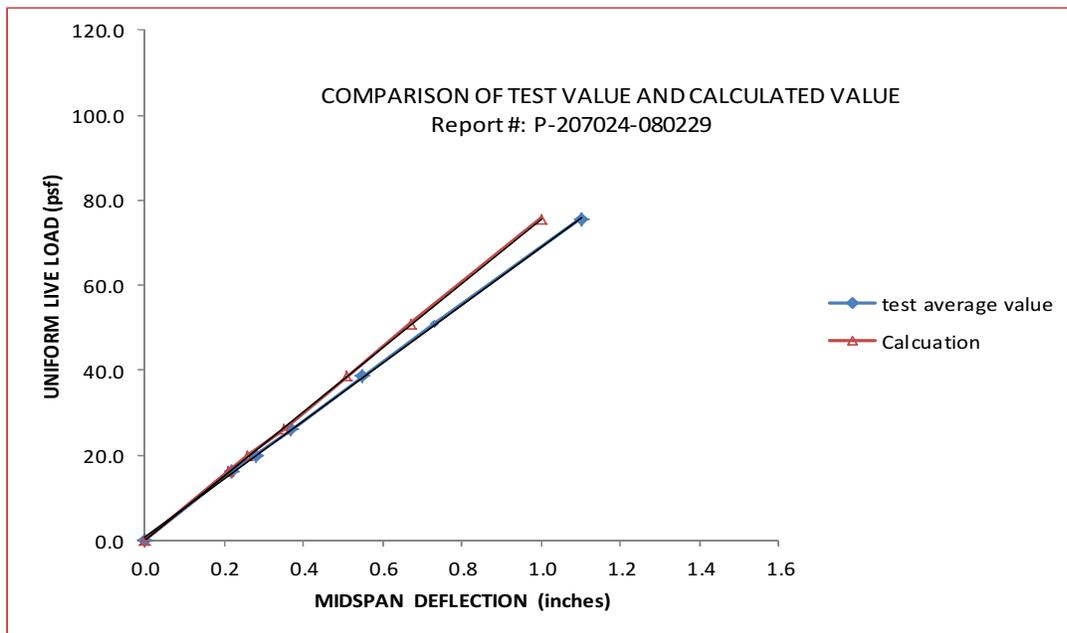


Fig B-1: Validation of thermasteel panel test #P-207024-080229

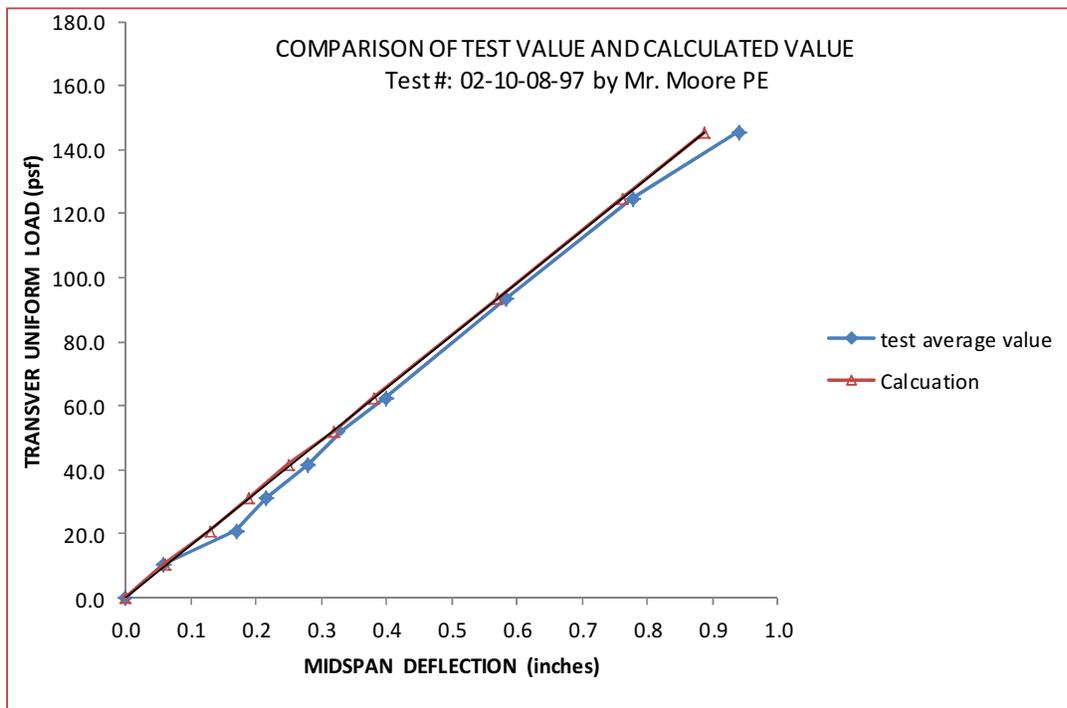


Fig B-2: Validation of thermasteel panel test #02-10-97

Validation of Thermasteel Panel Design				SHEET #: O-12	
DOMINCK R. PILLA ASSOCIATES, PC 23 DEPEW AVE, NYACK, NY 10960 TEL: 845 727 7793 FAX : 845 727 6377		PROJECT: CCNY Solar Decathlon LOCATION: Test P-207024-080229 DATA: 1/10/2011	Prj # 10-050	PAGE: 1 / 1 DESIGN: xt REVIEW: drp	
INPUT DATA					
Panel Depth	d =	5.5	in		
Studs	single design gauge	358J18		spacing	s = 16 in
	depth	b = 3.625	in	flange width	h = 2 in
	return	r = 0.5	in	netual	
	area	A = 0.385	in ²	axis	a = 0.696 in
	stength	fy = 33	ksi	moment of inetia	ly = 0.227 in ⁴
	Double composite section				
	Y =	2.054	in	E =	29000 ksi
	m.i.	Ix = 3.704	in ⁴	section modulus	Sx = 1.347 in ³
EPS (Expanded Polystyrene)					
	area	A = 88.00	in ²	density	1.0 pcf
		E = 200	psi	shear modulus	G = 300 psi
Span	L =	11	ft		
Loading	axial	P = 4.524	k		
	transverse	q = 75.6	psf	Ultimate	q = 159.64 psf
	linear l	100.80	plf		212.85 plf
	moment	M = 1.52	k-ft	M _{test} =	3.22 k-ft
Validation of deflection under q					
tested	$\Delta_{test} =$	1.1	in		
theory	$\Delta_{cal} =$	$5qL^4/384EIx + qL^2/8GA$			
		= 1.00	in		
error	$\Delta_{cal} / \Delta_{test} =$	91.11	%		
Validation of ultimate strength under q-ult					
axial	fa =	5.88	ksi		
bending	fb = fy-fa =	27.12	ksi		
	M _{cal} =fb sx				
moment	=	3.04	k-ft		
error	M _{cal} /M _{test} =	94.56	%		

Validation of Thermasteel Panel Design				SHEET #: O-12	
DOMINCK R. PILLA ASSOCIATES, PC 23 DEPEW AVE, NYACK, NY 10960 TEL: 845 727 7793 FAX : 845 727 6377		PROJECT: CCNY Solar Decathlon LOCATION: Test 02-10-08-97 by Joseph H. Moore PE DATA: 1/10/2011	Prj # 10-050	PAGE: 1 / 1 DESIGN: xt REVIEW: drp	
INPUT DATA					
Panel Depth	d =	7.5 in			
Studs	single design gauge	22 Ga 3.5" joist	spacing	s =	16 in
	depth	b = 3.5 in	flange width	h =	1.25 in
	return	r = 0.25 in	netual axis	a =	0.337 in
	area	A = 0.195 in ²	moment of inetia	ly =	0.04 in ⁴
	strength	fy = 33 ksi			
	Double composite section				
	Y =	3.413 in	E =	29000 ksi	
	m.i. lx =	4.624 in ⁴	section modulus	Sx =	1.233 in ³
EPS (Expanded Polystyrene)	area	A = 120.00 in ²	density	1.0 pcf	
	E =	200 psi	shear modulus	G =	300 psi
Span	L =	9.083 ft			
Loading	axial	P = 0 k			
	transverse	q = 62.4 psf	Ultimate	q =	166.4 psf
	linear l	83.20 plf			221.87 plf
	moment	M = 0.86 k-ft	M _{test} =		2.29 k-ft
Validation of deflection under q					
tested	$\Delta_{test} =$	0.399 in			
theory	$\Delta_{cal} =$	$5qL^4/384EIx + qL^2/8GA$			
	=	0.3810 in			
error	$\Delta_{cal} / \Delta_{test} =$	95.49 %			
Validation of ultimate strength under q-ult					
axial	fa =	0.00 ksi			
bending	fb = fy-fa =	33.00 ksi			
moment	M _{cal} =fb sx =	3.39 k-ft			
error	M _{cal} /M _{test} =	148.21 %			

Validation of Thermasteel Panel Design				SHEET #: O-12	
DOMINCK R. PILLA ASSOCIATES, PC 23 DEPEW AVE, NYACK, NY 10960 TEL: 845 727 7793 FAX : 845 727 6377		PROJECT: CCNY Solar Decathlon LOCATION FLOOR DATA: 1/10/2011	Prj # 10-050	PAGE: 1 / 1 DESIGN: xt REVIEW: drp	
INPUT DATA					
Panel Depth	d =	7.5	in		
Studs	single design gauge	358J18		spacing	s = 16 in
	depth	b = 3.625	in	flange width	h = 2 in
	return	r = 0.5	in	netual axis	a = 0.696 in
	area	A = 0.385	in ²	moment of inetia	ly = 0.227 in ⁴
	stength	fy = 33	ksi		
	Double composite section				
	Y =	3.054	in	E =	29000 ksi
	m.i.	Ix = 7.637	in ⁴	section modulus	Sx = 2.037 in ³
	EPS (Expanded Polystyrene)				
	area	A = 120.00	in ²	density	1.15 pcf
		E = 250	psi	shear modulus	G = 370 psi
Span	L =	10.5	ft		
Loading	axial	P = 0	k		
	transverse	q = 70	psf	live load	q = 50 psf
	linear load	93.33	plf		66.67 plf
	moment	M = 1.29	k-ft		
deflection under live load					
	allowable	$\Delta_{all} =$	0.35 in	L/360	
	calculation	$\Delta_{cal} =$	$5q \cdot L^4 / 384EIx + q \cdot L^2 / 8GA$		conclusion:
		=	0.33 in		O.K.
deflection under total load					
	allowable	$\Delta_{all} =$	0.525 in	L/360	
	calculation	$\Delta_{cal} =$	$5qL^4 / 384EIx + qL^2 / 8GA$		conclusion:
		=	0.46 in		O.K.

Appendix C Calculation results by STAAD

C.1 Calculation results for New York, NY

C.2 Calculation results for Washington DC

Appendix D Bearing pad design

BEARING PAD LOAD DESIGN

Jack Location	Trib. Area (sf)	Area Load (psf)	Load (lbs)	Pod Load (lbs)	Bearing Pad (sf)	soil pressure (psf)	BP Type
B 2	47.9	115	5509	0	4	1377	B5
B 4	43.2	115	4968	0	4	1242	B5
B 6	43.2	115	4968	0	4	1242	B5
B 8	19.5	115	2243	0	2	1121	B6
C 2	28.4	115	3266	2000	4	1317	B5
C 4	14.2	115	1633	6900	6.25	1365	B4
C 6	14.2	115	1633	7200	6.25	1413	B4
C 8	28.4	115	3266	2300	4	1392	B5
D 2	78.2	115	8993	0	6.72	1338	B3
D 8	24.9	115	2864	0	2	1432	B6
E 2	14.2	115	1633	0	1.5	1089	B7
E 8	24.9	115	2864	0	2	1432	B6
F 2	80.2	115	9223	2500	9	1303	B2
F 4	0	115	0	19200	13.44	1429	B1
F 6	0	115	0	19900	13.44	1481	B1
F 8	24.9	115	2864	2600	4	1366	B5
G 2	14.2	115	1633	0	1.5	1089	B7
G 8	24.9	115	2864	0	2	1432	B6
H 2	14.2	115	1633	0	1.5	1089	B7
H 8	24.9	115	2864	0	2	1432	B6
I 2	63.9	115	7349	2700	6.72	1495	B3
I 4	22.7	115	2611	6200	6.25	1410	B4
I 6	22.7	115	2611	6700	6.25	1490	B4
I 8	22.7	115	2611	2800	4	1353	B5
J 2	78.2	115	8993	0	6.25	1439	B4
J 4	42.6	115	4899	0	4	1225	B5
J 6	42.6	115	4899	0	4	1225	B5
J 8	19.5	115	2243	0	2	1121	B6
K 4	14.2	115	1633	0	1.5	1089	B7
K 6	14.2	115	1633	0	1.5	1089	B7

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Bearing Pad Design

Material: APA STRUCTURAL w/ EXP 1.

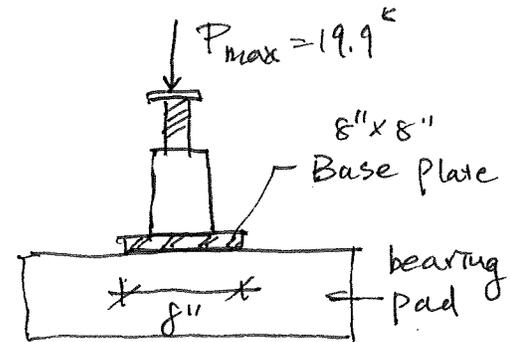
$$F_b = 2000 \text{ psi}$$

$$F_{c1} = 340 \text{ psi}$$

$$F_v = 190 \text{ psi}$$

* Check for bearing:
 ← base plate

$$P_a = F_{c1} (8") (8") = 21.8 \text{ k}$$



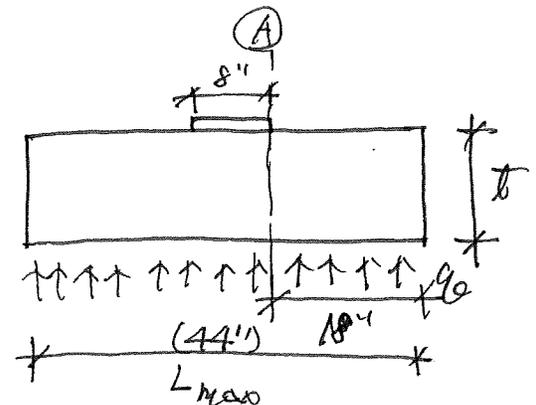
The maximum jack reaction is 19.9 k. O.K.

* Check for bending:

$$q_{max} = 1500 \text{ psf} = 10.42 \text{ psi}$$

$$M_{@section A} = \frac{1}{2} (10.42) 18^2 = 1688 \text{ lbs-in/in}$$

$$t_{min} = \sqrt{\frac{M}{\frac{\phi}{6} (2000)}} = 2.25" \quad \checkmark$$



* Check for shear

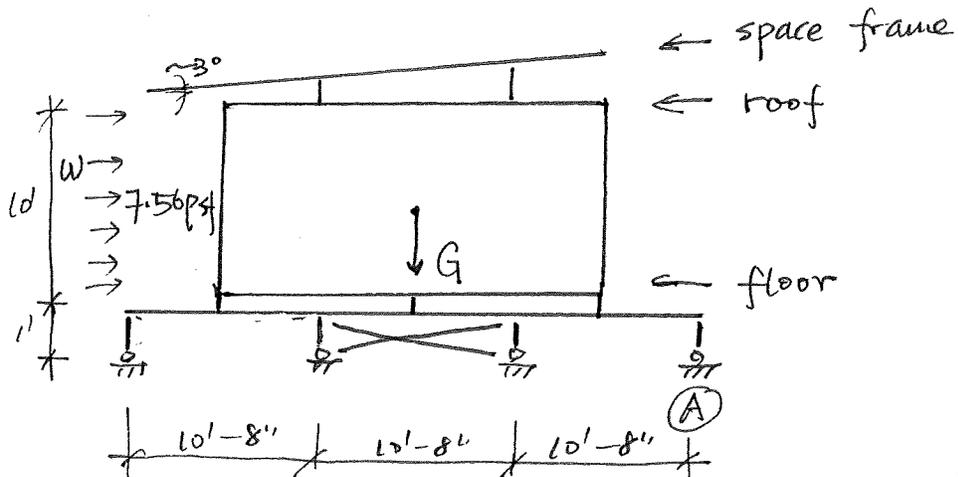
$$V_{r,max} = (18") (10.42) = 187.6 \text{ lbs}$$

$$V_u = (190) (1) (2.25) / 1.5 = 285 \text{ lbs} > V_{r,max} \quad \text{O.K.}$$

Appendix E Overturning and sliding analysis

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Overturning Analysis



Dead loads:

$$\text{Space frame: } 6 \text{ psf } (27.3') (33') = 5.4 \text{ Kips}$$

$$\text{Roof: } 15 \text{ psf } (22') (33') = 10.9 \text{ Kips}$$

$$\text{Floor: } 20 \text{ psf } (22') (33') = 14.5 \text{ Kips}$$

$$\Sigma G = 30.8 \text{ Kips}$$

Wind load:

$$H = (7.56 \text{ psf}) (10') (33') = 2.5 \text{ Kips}$$

Take moment @ point (A).

Overturning moment $M_o = H \cdot (1' + \frac{10'}{2}) = 15 \text{ K-ft}$

Resisting moment $M_r = G(16') = 493 \text{ K-ft}$

Safety factor: $SF = \frac{M_r}{M_o} = \frac{493}{15} = 32.9 \checkmark \text{ O.K.}$

Sliding Analysis.

Assume friction coefficient between wood and soil

$$f = 0.2$$

Friction: $F = f \cdot G = 0.2(308) = 6.2 \text{ kips}$

sliding: $H = 2.5 \text{ kips}$

Safety factor: $SF = \frac{F}{H} = \frac{6.2}{2.5} = 2.48 \checkmark \text{ O.K.}$

9.0 Sustainability Assessment

9.1 Introduction

As an addition to the design and construction of the RoofPod, a sustainability assessment was performed. This assessment uses LEED standards for homes as a guideline to show that our house was promoting sustainable practices. LEED is a recognized national brand that allows homes to differentiate themselves as one of the best in the market. By using this tool we were able to obtain a green rating that shows the performance level of the house. The green rating is out of 136 possible points. The performance level is indicated by four performance tiers each with different possible point ranges.

Table 9.1. LEED for Homes Certification Levels¹

LEED for Homes Certification Levels	Number of LEED for Homes points Required
Certified	45-59
Silver	60-74
Gold	75-89
Platinum	90-136
Total available points	136

But before obtaining this green rating the house performance was measured in eight different categories. These categories are as follows:

- Innovation & Design Process (ID)
- Location & Linkages (LL)
- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy & Atmosphere (EA)
- Materials & Resources (MR)
- Indoor Environmental Quality (EQ)
- Awareness & Education (AE)

Some of these categories demand that the project have a minimum number of points.

Credit category	Prerequisites (mandatory) measures	Minimum point requirements	Maximum points available
Innovation & Design Process (ID)	3	0	11
Location & Linkages (LL)	0	0	10
Sustainable Sites (SS)	2	5	22
Water Efficiency (WE)	0	3	15
Energy & Atmosphere (EA)	2	0	38
Materials & Resources (MR)	3	2	16
Indoor Environmental Quality (EQ)	7	6	21
Awareness & Education (AE)	1	0	3
Total	18	16	136

Table 9.2. Prerequisites and Minimum Point Requirements²

¹Homes Reference Guide. Washington, D.C.: Council, 2008. Page iv

²Homes Reference Guide. Washington, D.C.: Council, 2008. Page ix
U.S. D.O.E Solar Decathlon
Sustainability Assessment



9.2 Roof Pod Assessment

In the case of the RoofPod, the award level thresholds needed to be adjusted. This is called the Home Size Adjustment, which takes into account the size of the home. It is known that a large home consumes more materials and energy than a smaller home throughout its life cycle so this adjustment takes into account that factor making it either harder or easier for the home to reach LEED certification. The RoofPod being of relatively a small size was adjusted to a threshold of -7.5 points. These points are then subtracted from the LEED certification levels mentioned in Table 1. For example, the home would only need a minimum of 37.5 points to qualify for the certified level.

Table 9.3. Adjustments made to the levels based on the size of the RoofPod.

Threshold Adjustment	
LEED for Homes Certification Levels	Number of LEED for Homes Points Required
Certified	37.5-51.5
Silver	52.5-66.5
Gold	67.5-81.5
Platinum	82.5-128.5
Total Available Points	128.5

9.2.1 Innovation and Design

In the innovation and design category, any special methods or unique credits take effect here since these are not addressed within the rating system. Our RoofPod met with the prerequisites in this category which included finding out the intended target LEED award level we wanted to reach and the credits that were selected to meet this target. Another important part of this category is the emphasis on the integration of the project team. In our case our team is all actively involved in creating a sustainable and energy efficient home as well as bringing in different skill sets. We also conducted meetings at a weekly basis to review the projects status and discuss any situations that may have been encountered. These all gave us points in the integrated project planning section within the innovation and design category. Another important credit earned in this section was that our homes orientation was built for solar design. The roof has a minimum of 450 square feet of south facing area that is oriented appropriately for solar applications.

9.2.2 Location and Linkages

In location and linkages the location of the house is key. The house needs to be placed in an area where it is socially and environmentally responsible. It is important that when placing the house in an area, we keep in mind that we are not interfering in any sensitive sites. For example we cannot develop land that may affect the habitat of a threatened or endangered species or land that has elevation below the 100 year floodplain as defined by FEMA. In our case, the Roofpod is being constructed loft style on the roof of existing buildings. So the points in this section were easily awarded. Another important section was the community resources/transit. The idea of this section is to encourage development patterns within the neighborhood for walking, biking and public transit. Right now our Roofpod will be located within the campus where it is readily accessible to all sorts of transit, once again the points in this section was easily awarded.



9.2.3 Sustainable Sites and Water Efficiency

Sustainable Sites ensures that the usage of the entire property minimizes the project's impact on the site. This category simply tries to minimize the environmental damage to the lot itself, emphasis on landscaping, local heat island effects, and surface water management. Points were awarded in each of those sections. In water efficiency the house was evaluated in how water efficient the house is both indoors and outdoors. The Roofpod is using a rainwater harvesting system that will provide irrigation to the outside landscape.

9.2.4 Energy and Atmosphere

Energy and atmosphere looks into how energy efficient the house really is. This takes a close look at the envelope and the heating and cooling design of the home. Energy Star plays a role in this section of the assessment. It either needs to meet Energy Star performance requirements or exceed them. Lighting and appliances are also taken into account and these also need to be Energy Star labeled. The roofpod met Energy Star standards and therefore was awarded a total of 34 out of 34 points for that section. 9.2.5 Materials, Resources and Indoor Environmental Quality

9.2.5 Materials and Resources

Materials and resources wants to check how efficiently the materials used were as well as what type of materials were selected that were environmentally friendly and how waste during construction was managed. Most of the material that is being used to build the RoofPod was donated and are all environmentally preferable materials. The indoor environmental quality category requires that the home reduce the creation of and exposure to pollutants in turn improving the indoor air quality for the neighborhood. The Solar Roof Pod integrates sustainability initiatives by providing carbon footprint resources and environmental impact.

9.2.6 Awareness and Education

Finally, in the awareness and education category, we are supposed to provide the new homeowners with the proper education about the house. This means that we explain the operation and maintenance of any of the green features that it may have. Overall the house scored a total of 88 points which means it qualifies for a Platinum certification. This assessment was simply done with input from all the teams' designs and innovations. It was conducted as a way to quantify how sustainable the Solar RoofPod can be.



COMcheck Report



COMcheck Software Version 3.8.1 Envelope Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : **CCNY TEAM NY SOLAR ROOF POD**

Construction Site:
181 Convent Ave.
New York, NY 10031

Owner/Agent:
Richard Slawski
CCNY Campus Facilities
160 Convent Ave
New York, NY 10031
212 650 7061
rslawski@ccny.cuny.edu

Designer/Contractor:
Domick Pilia
Dominck R Pilia Architecture -
Engineering
23 Nepew Avenue
Nyack , NY 10960
212 650 7061
www.drpilia.com

Section 2: General Information

Building Location (for weather data): **New York, New York**
Climate Zone: **4a**
Building Type for Envelope Requirements: **Residential**
Vertical Glazing / Wall Area Pct.: **26%**
Skylight Glazing / Roof Area Pct.: **1%**

Activity Type(s)	Floor Area
Multifamily	1000

Section 3: Requirements Checklist

Envelope **PASSES**: Design 13% better than code.

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor ^(a)
Roof 1: Other Roof (b)	790	—	—	0.022	0.027
Skylight 1: Metal Frame:Double Pane, Clear, SHGC 0.70	8	—	—	0.194	0.600
Exterior Wall 1: Other Wood Framed Wall (b)	170	—	—	0.020	0.064
Window 4: Other Window, Clear, SHGC 0.30	33	—	—	0.194	0.400
Exterior Wall 2: Other Wood Framed Wall (b)	170	—	—	0.020	0.064
Window 3: Other Window, Clear, SHGC 0.30	33	—	—	0.194	0.400
Exterior Wall 3: Other Wood Framed Wall (b)	250	—	—	0.020	0.064
Window 2: Other Window, Clear, SHGC 0.30	21	—	—	0.194	0.400
Exterior Wall 4: Other Wood Framed Wall (b)	250	—	—	0.020	0.064
Window 1: Metal Frame:Double Pane, Clear, SHGC 0.30	130	—	—	0.194	0.550
Floor 1: Other Floor (b)	790	—	—	0.020	0.033

(a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.

(b) 'Other' components require supporting documentation for proposed U-factors.

Air Leakage, Component Certification, and Vapor Retarder Requirements:

- 1. All joints and penetrations are caulked, gasketed or covered with a moisture vapor-permeable wrapping material installed in accordance with the manufacturer's installation instructions.
- 2. Windows, doors, and skylights certified as meeting leakage requirements.



- 3. Component R-values & U-factors labeled as certified.
- 4. No roof insulation is installed on a suspended ceiling with removable ceiling panels.
- 5. 'Other' components have supporting documentation for proposed U-Factors.
- 6. Insulation installed according to manufacturer's instructions, in substantial contact with the surface being insulated, and in a manner that achieves the rated R-value without compressing the insulation.
- 7. Stair, elevator shaft vents, and other outdoor air intake and exhaust openings in the building envelope are equipped with motorized dampers.
- 8. Cargo doors and loading dock doors are weather sealed.
- 9. Recessed lighting fixtures installed in the building envelope are Type IC rated as meeting ASTM E283, are sealed with gasket or caulk.
- 10. Building entrance doors have a vestibule equipped with closing devices.
 - Exceptions:*
 - Building entrances with revolving doors.
 - Doors that open directly from a space less than 3000 sq. ft. in area.

Section 4: Compliance Statement

Compliance Statement: The proposed envelope design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed envelope system has been designed to meet the 2009 IECC requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in the Requirements Checklist.

Name - Title

Signature

Date



COMcheck Software Version 3.8.1

Interior Lighting Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**

Project Title : CCNY TEAM NY SOLAR ROOF POD

Construction Site:

181 Convent Ave.
New York, NY 10031

Owner/Agent:

Richard Slawski
CCNY Campus Facilities
160 Convent Ave
New York, NY 10031
212 650 7061
rslawski@ccny.cuny.edu

Designer/Contractor:

Domiick Pilla
Dominck R Pilla Architecture -
Engineering
23 Nepew Avenue
Nyack , NY 10960
212 650 7061
www.drpilla.com

Section 2: Interior Lighting and Power Calculation

A Area Category	B Floor Area (ft2)	C Allowed Watts / ft2	D Allowed Watts (B x C)
Multifamily	1000	0.7	700
Total Allowed Watts =			700

Section 3: Interior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
Multifamily (1000 sq.ft.)				
Compact Fluorescent 1: Quad 2-pin 22W / Electronic	2	1	20	20
Compact Fluorescent 2: Triple 4-pin 32W / Electronic	2	2	30	60
Compact Fluorescent 3: kitchen / Spiral 20W / Electronic	1	1	40	40
Halogen 1: wall washer / Halogen 80W	2	2	80	160
Compact Fluorescent 4: living bedroom / Twin Tube 8/9W / Electronic	2	1	6	6
Compact Fluorescent 5: bathroom mirror / Spiral 15W / Electronic	1	1	15	15
Compact Fluorescent 6: Twin Tube 8/9W / Electronic	3	1	9	9
Total Proposed Watts =				310

Section 4: Requirements Checklist

Lighting Wattage:

1. Total proposed watts must be less than or equal to total allowed watts.

Allowed Watts	Proposed Watts	Complies
700	310	YES

Controls, Switching, and Wiring:

2. Daylight zones under skylights more than 15 feet from the perimeter have lighting controls separate from daylight zones adjacent to vertical fenestration.
3. Daylight zones have individual lighting controls independent from that of the general area lighting.

Exceptions:

- Contiguous daylight zones spanning no more than two orientations are allowed to be controlled by a single controlling device.
- Daylight spaces enclosed by walls or ceiling height partitions and containing two or fewer light fixtures are not required to have a separate switch for general area lighting.
- 4. Independent controls for each space (switch/occupancy sensor).

Exceptions:

- Areas designated as security or emergency areas that must be continuously illuminated.
- Lighting in stairways or corridors that are elements of the means of egress.
- 5. Master switch at entry to hotel/motel guest room.
- 6. Individual dwelling units separately metered.
- 7. Medical task lighting or art/history display lighting claimed to be exempt from compliance has a control device independent of the control of the nonexempt lighting.
- 8. Each space required to have a manual control also allows for reducing the connected lighting load by at least 50 percent by either controlling all luminaires, dual switching of alternate rows of luminaires, alternate luminaires, or alternate lamps, switching the middle lamp luminaires independently of other lamps, or switching each luminaire or each lamp.

Exceptions:

- Only one luminaire in space.
- An occupant-sensing device controls the area.
- The area is a corridor, storeroom, restroom, public lobby or sleeping unit.
- Areas that use less than 0.6 Watts/sq.ft.
- 9. Automatic lighting shutoff control in buildings larger than 5,000 sq.ft.

Exceptions:

- Sleeping units, patient care areas; and spaces where automatic shutoff would endanger safety or security.
- 10. Photocell/astronomical time switch on exterior lights.

Exceptions:

- Lighting intended for 24 hour use.
- 11. Tandem wired one-lamp and three-lamp ballasted luminaires (No single-lamp ballasts).

Exceptions:

- Electronic high-frequency ballasts; Luminaires on emergency circuits or with no available pair.

Interior Lighting PASSES: Design 56% better than code.

Section 5: Compliance Statement

Compliance Statement: The proposed lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2009 IECC requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in the Requirements Checklist.

Name - Title

Signature

Date



Exterior Lighting Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**
 Project Title : CCNY TEAM NY SOLAR ROOF POD
 Exterior Lighting Zone: **2 (Residentially zoned area)**

Construction Site: 181 Convent Ave. New York, NY 10031	Owner/Agent: Richard Slawski CCNY Campus Facilities 160 Convent Ave New York, NY 10031 212 650 7061 rslawski@ccny.cuny.edu	Designer/Contractor: Domiick Pilla Dominck R Pilla Architecture - Engineering 23 Nepew Avenue Nyack , NY 10960 212 650 7061 www.drpilla.com
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Section 2: Exterior Lighting Area/Surface Power Calculation

A Exterior Area/Surface	B Quantity	C Allowed Watts / Unit	D Tradable Wattage	E Allowed Watts (B x C)	F Proposed Watts
2840 (Entry canopy)	6 ft2	0.25	Yes	2	530
				Total Tradable Watts* =	2
				Total Allowed Watts =	2
				Total Allowed Supplemental Watts** =	600

* Wattage tradeoffs are only allowed between tradable areas/surfaces.
 ** A supplemental allowance equal to 600 watts may be applied toward compliance of both non-tradable and tradable areas/surfaces.

Section 3: Exterior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
2840 (Entry canopy 6 ft2): Tradable Wattage				
Compact Fluorescent 1: Triple 4-pin 32W / Electronic	4	1	300	300
Compact Fluorescent 2: Quad 2-pin 28W / Electronic	2	1	150	150
Compact Fluorescent 3: Quad 4-pin 18W / Electronic	1	1	80	80
Total Tradable Proposed Watts =				530

Section 4: Requirements Checklist

Lighting Wattage:

- 1. Within each non-tradable area/surface, total proposed watts must be less than or equal to total allowed watts. Across all tradable areas/surfaces, total proposed watts must be less than or equal to total allowed watts.

Compliance: Passes using supplemental allowance watts.

Controls, Switching, and Wiring:

- 2. All exemption claims are associated with fixtures that have a control device independent of the control of the nonexempt lighting.
- 3. Lighting not designated for dusk-to-dawn operation is controlled by either a a photosensor (with time switch), or an astronomical time switch.

- 4. Lighting designated for dusk-to-dawn operation is controlled by an astronomical time switch or photosensor.
- 5. All time switches are capable of retaining programming and the time setting during loss of power for a period of at least 10 hours.

Exterior Lighting Efficacy:

- 6. All exterior building grounds luminaires that operate at greater than 100W have minimum efficacy of 60 lumen/watt.

Exceptions:

- Lighting that has been claimed as exempt and is identified as such in Section 3 table above.
- Lighting that is specifically designated as required by a health or life safety statute, ordinance, or regulation.
- Emergency lighting that is automatically off during normal building operation.
- Lighting that is controlled by motion sensor.

Exterior Lighting PASSES: Design 0.0% better than code.

Section 5: Compliance Statement

Compliance Statement: The proposed exterior lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2009 IECC requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in the Requirements Checklist.

Name - Title

Signature

Date



COMcheck Software Version 3.8.1

Mechanical Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**

Project Title : CCNY TEAM NY SOLAR ROOF POD

Construction Site:

181 Convent Ave.
New York, NY 10031

Owner/Agent:

Richard Slawski
CCNY Campus Facilities
160 Convent Ave
New York, NY 10031
212 650 7061
rslawski@ccny.cuny.edu

Designer/Contractor:

Domiick Pilla
Dominck R Pilla Architecture -
Engineering
23 Nepew Avenue
Nyack , NY 10960
212 650 7061
www.drpilla.com

Section 2: General Information

Building Location (for weather data):

New York, New York

Climate Zone:

4a

Section 3: Mechanical Systems List

Quantity System Type & Description

Section 4: Requirements Checklist



COMcheck Software Version 3.8.1

Mechanical Requirements Description

2009 IECC

Construction Specifications

Division 00 – Procurement and Contracting Requirements – Not Used

Division 01 - General Requirements – Not Used

Division 02 – Existing Conditions – Not Used

Division 03 – Concrete – Not Used

Division 04 – Masonry – Not Used

Division 05 – Metals

05 12 00	Structural Steel
05 40 00	Cold Formed Metal Framing
05 50 00	Metal Fabrications
05 73 23	Exterior Decorative Metal Railings

Division 06 – Wood, Plastics, and Composites

06 10 00	Rough Carpentry
06 16 00	Sheathing
06 20 13	Exterior Finish Carpentry
06 40 23	Interior Architectural Woodwork

Division 07 – Thermal and Moisture Protection

07 21 00	Thermal Insulation
07 27 26	Air Barriers
07 42 21	Insulated Metal Infill Panel
07 45 13	Structural Re-Enforced Insulated Panel System
07 54 23	Thermoplastic –Polyolefin Roofing
07 62 00	Sheet Metal Flashing and Trim
07 92 00	Joint Sealants

Division 08 – Openings

08 14 17	Wood Doors
08 42 00	Entrances
08 44 21	Timber Glazed Curtain Wall
08 63 00	Metal Framed Skylight
08 81 00	Glass Glazing

Division 09 – Finishes

09 21 18	Gypsum Board Assemblies
09 30 13	Ceramic Tiling
09 64 29	Cork Flooring
09 91 23	Interior Painting



Division 10 – Specialties

- 10 44 00 Fire Protection Specialties
- 10 71 14 Exterior Sun Control Devices

Division 11 – Equipment

- 11 31 13 Residential Appliances

Division 12 – Furnishings

- 12 58 29.33 Murphy-Bed

Division 13 – Special Construction

- 13 32 00 Space Frames

Division 14 – Conveying Equipment – Not Used

Division 21 – Fire Suppression

- 21 13 00 Fire Suppression Sprinkler Head
- 21 32 00 Fire Suppression Sprinkler Pump

Division 22 – Plumbing

- 22 05 00 Common Work Results for Plumbing

Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)

- 23 64 16.16 Water-Cooled Centrifugal Water Chillers
- 23 65 13.13 Open-Circuit Forced Draft Cooling Tower
- 23 82 19 Fan Coil Units
- 23 83 16 Radiant-Heating Hydronic Piping

Division 25 – Integrated Automation

- 25 13 00 Integrated Automation Control and Monitoring Network
- 25 14 00 Integrated Automation Local Control Units
- 25 36 00 Integrated Automation Instrumentation and Terminal Devices for Electrical System

Division 26 – Electrical

- 26 09 00 Instruction and Control for Electrical Systems
- 26 24 16 Panelboards
- 26 27 13 Electricity Metering
- 26 27 26 Wiring Devices
- 26 28 13 Fuses
- 26 31 00 Photovoltaic Components
- 26 51 00 Lighting
- 26 51 00.01 Lighting Fixture Cuts

Division 27 – Communications

- 27 20 00 Data Communication

Division 28 – Electronic Safety and Security



28 40 00 Electronic Monitoring and Control

Division 31 – Earthwork

31 39 13 Foundation Jacks

Division 32 – Exterior Improvements

32 93 33 Plants and Planters

Division 33 – Utilities – Not Used

Division 34 – Transportation – Not Used

Division 35 – Waterway and Marine Construction – Not Used

Division 40 – Process Integration – Not Used

Division 41 – Material Processing and Handling Equipment

41 62 19 Truck Trailers

41 65 16 Mobile Generators

Division 42 – Process Heating, Cooling, and Drying Equipment – Not Used

Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment

43 41 16 Liquid Storage

Division 44 – Pollution Control Equipment – Not Used



SECTION 05 12 00

STRUCTURAL STEEL

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. Provide all labor, materials, equipment, services, etc., necessary or required for the work of this Section, as indicated on the drawings, herein specified, and as required by the existing conditions for proper performance and completion, and in accordance with the requirements of the Contract Documents. Items of work shall consist generally of, but not be limited to, the following:
 - 1. Provide all beams, girders, hangers, hung lintels, angles, base plates, channels, angles and other structural steel shown on plans or herein specified. Furnish steel electrodes for welded work, shop and field paint, erection plans and shop details.
 - 2. Provide all necessary beams, channels, angles and plates required to support wood, block, and provide all necessary connections, base plates, etc., to carry all loads safely and to comply with local requirements.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 07- Fireproofing

1.4 CODES

- A. The latest edition of the AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including the "Commentary" and Supplements thereto as issued.
- B. The latest edition of the AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation AWS D 1.1 "Structural Welding Code".

1.5 SUBMITTALS

- A. Shop drawings:
 - 1. All shop drawings shall be submitted for approval to the Engineer. The use of the Architect's drawings, structural or architectural, for reproduction as a base for shop drawings shall not be permitted.
 - 2. Shop drawings shall be based on current AISC Specifications.
 - 3. Submit shop drawings of all structural steel indicating all necessary details for fabrication and erection to include size and weight of members, type, size, and location of shop and field connections, locations and details of all anchors, base plates, and bearing beads.
 - 4. All welds, both shop and field, shall be indicated using AWS "Welding Symbols" A2.0, latest edition.
 - 5. Submit descriptive data to illustrate the structural steel erection procedure, including the sequence of erection and temporary staying and bracing.



6. Submit written description, as required, to illustrate each welding procedure to be performed in the work.
7. Ordering or fabricating any material prior to approval of shop drawings will be entirely the Contractor's risk. The approval of shop drawings will be for size and arrangement of principal and auxiliary members and strength of connections. Any errors in dimensions shown on shop drawings shall be the Contractor's responsibility.

PART 2 - PRODUCTS

2.1 MATERIALS-GENERAL

- A. Material to be incorporated into the work shall be free from rust pitting. Materials shall conform to the latest edition of the standard specifications as listed below:

2.2 STRUCTURAL STEEL SHAPES, PLATES AND BARS

- A. Structural steel shapes, plates and bars shall conform to the following:
- B. ASTM A 36 , Fy 36.0 ksi minimum yield strength for steel plate, channel and angles
- C. ASTM A500 Gr. B, Fy 46.0 ksi minimum yield strength for steel tube
- D. ASTM A992 Fy 50.0 ksi minimum yield strength for wide flange beam

2.3 ANCHOR BOLTS

- A. Anchor bolts shall conform to Section 1C of ASTM A307.

2.4 STANDARD THREAD FASTENERS

- A. Standard bolts and nuts shall conform to ASTM A307, Grade A.
- B. Plain washers shall conform to ANSI Standard B27.2.
- C. Beveled washers shall conform to ANSI Standard B27.4.

2.5 HIGH STRENGTH THREADED FASTENERS

- A. Bolts shall conform to ASTM A490 or ASTM A325.
- B. Nuts shall conform to ASTM A563, Grade DH, or ASTM A194, Grade 2H.
- C. Washers: Washers shall conform to ASTM A325,

2.6 FILLER METAL FOR WELDING

- A. Filler metal for welding of structural steel shall conform to the following AWS Specifications. Classification and Series of electrodes shall be as required by the type and strength of structural steel being welded. Submit listing of proposed electrodes intended for use to the Architect for approval prior to welding of structural steel.
 1. Electrodes for Manual Shielded Metal-Arc Welding: "Specifications for Mild Steel Covered Arc Welding Electrodes" AWS A5.1 or, "Specifications for Low Alloy Steel Covered Arc Welding Electrodes: AWS A5,5, Class E70XX.



2. Electrodes and Flux for Submerged-Arc Welding: "Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding" AWS A5.17, Class FX7-EXXX.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Workmanship shall be in accordance with the American Institute of Steel Construction Specifications for Fabrication and Erection.
- B. The Contractor for steel work will be required to provide all necessary holes in the steel work for the attachment to it of materials of other trades. He shall examine all structural, architectural and mechanical drawings and make every effort to ascertain that these holes have been considered and provided for, as no claims for extra work or allowance for such work will be considered or allowed.
- C. Workmanship is to be of the best quality. All rivets, welds, bolts, joints and materials are to be subject to inspection by the Architect and must be approved. The Contractor must afford the Architect opportunity to inspect the work at all times during working hours at the building or at the mills, where the parts are in making.
- D. This Contractor will be held responsible to coordinate his work with the work of other trades in the building and shall see that his work is properly adjusted and perfect to the work of other trades in the building.

3.2 CONNECTIONS

- A. Shop connections shall be riveted, welded, or bolted, except where welded connections are called for specifically.
- B. Field connections shall be bolted with ASTM A307 unfinished bolts, ASTM A325 high strength bolts, or welded.
- C. Provide standard American Institute of Steel Construction framed beam connections wherever possible.
- D. Arrange connections to avoid eccentricity insofar as possible. One sided connections shall be avoided.
- E. All welding shall be by the electric arc method.
- F. Welding shall conform to the requirements of the latest edition of the American Welding Society Code for Arc-Welding in Building Construction and to the New York City Building Code. Inspection of welds and qualifications for welders shall be as in paragraph 3.05.

3.3 PAINTING

- A. Structural steel shall receive one shop coat of red lead and oil paint, applied to a dry film thickness of 2 mils. State on shop drawings which brand of paint is to be used.
- B. Prior to painting, clean all steel in accordance with SSPC-SP-2, "Hand Tool Cleaning."
- C. All steel which is to be encased in exterior masonry shall receive an additional coat of black asphaltum paint applied according to manufacturer's directions.
- D. All exposed surfaces of baseplate, anchor bolts and portions of columns up to 4" below the finished floor, shall be painted with an approved bitumastic paint similar to Koeper's Bitumastic Superservice Black", with dry film thickness of 12 to 15 mils.



3.4 ERECTION

- A. Comply with AISC Code and Specifications, and maintain work in safe and stable condition during erection. Provide temporary bracing and shoring as required; remove when final connections are placed.
- B. Billets, base plates and bearing plates shall be set to proper line and grade and left for grouting under another Section of this Specification. Leveling plates are not permitted.
- C. Light drifting necessary to draw holes together will be permitted, but drifting of unfair holes will not be permitted. Twist drills shall be used to enlarge holes as necessary to make connections. Reaming that weakens the members or makes it impossible to fill the holes properly or to adjust accurately after reaming, will not be allowed and shall be cause for rejection.
- D. Flame cutting of structural steel in the field will not be permitted. The use of burnt holes for riveted or bolted connections will under no circumstances be permitted, and violation of this clause will be sufficient cause for the rejection of any pieces in which burnt holes exist.

3.5 TESTS AND INSPECTION

- A. Affidavits from the steel mill attesting to the strength and composition of the structural steel shall be filed by the Contractor with the Building Department as required by the New York City Building Code.
- B. All shop and field welding is to be performed by a welder qualified under Section C27-616 of the New York City Building Code and by the American Welding Society.
- C. All controlled inspections of welding and high-strength bolting in both shop and field is to be performed by a testing laboratory and professional engineer selected and paid for by the Contractor but approved by the Architect. Said engineer shall file form TR-1 with the Building Department.

3.6 BEARING PLATES AND GROUTING

- A. Prior to grouting bearing plates, remove all loose or foreign material.
- B. Bearing plates shall be set and shimmed to elevations as required.

END OF SECTION



SECTION 05 40 00**COLD-FORMED METAL FRAMING****PART 1 - GENERAL****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
1. Exterior non-load-bearing wall framing.
- B. Related Sections include the following:
1. Division 06 Section 06 16 00 "Sheathing" for wall sheathing.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated on Drawings.
 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/600 of the wall height.
 3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4 inch (19 mm).
- B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
 2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.



1.4 SUBMITTALS

- A. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
 - 1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed the professional engineer licensed in the State of Connecticut responsible for their preparation.
- C. Welding certificates.
- D. Qualification Data: For professional engineer and testing agency.
- E. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
 - 1. Steel sheet.
 - 2. Expansion anchors.
 - 3. Power-actuated anchors.
 - 4. Mechanical fasteners.
 - 5. Vertical deflection clips.
 - 6. Horizontal drift deflection clips
 - 7. Miscellaneous structural clips and accessories.
- F. Research/Evaluation Reports: For cold-formed metal framing.

1.5 QUALITY ASSURANCE

- A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
- B. Professional Engineer Qualifications: A professional engineer licensed in the State of Connecticut and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.
- D. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.
- E. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- F. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.



- G. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
- H. Preinstallation Conference: Conduct conference at Project site to schedule and coordinate all trades involved with exterior envelope. Attendees shall include erector, Contractor, mason contractor, sheathing contractor, Architect and Structural Engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Dale/Incor.
 - 2. Dietrich Metal Framing; a Worthington Industries Company.
 - 3. MarinoWare; a division of Ware Industries.
 - 4. Super Stud Building Products, Inc.

2.2 MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: G90 (Z275).

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 16 gage [0.056 inch].
 - 2. Flange Width: 1-5/8 inches (41 mm).
- B. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0966 inch (2.45 mm).
 - 2. Flange Width: Two inches minimum.

2.4 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.



- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
1. Supplementary framing.
 2. Bracing, bridging, and solid blocking.
 3. Web stiffeners.
 4. Anchor clips.
 5. End clips.
 6. Foundation clips.
 7. Stud kickers, knee braces, and girts.
 8. Hole reinforcing plates.
 9. Backer plates.

2.5 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 capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent 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.
- F. Welding Electrodes: Comply with AWS standards.

2.6 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
- 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.

2.7 FABRICATION

- A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
1. Fabricate framing assemblies using jigs or templates.
 2. Cut framing members by sawing or shearing; do not torch cut.



3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
 4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
- C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.

3.3 INSTALLATION, GENERAL

- A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.



1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
- D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
1. Cut framing members by sawing or shearing; do not torch cut.
 2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- H. Install insulation, specified in Division 7 Section 07210 "Building 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.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
- J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to bottom track, unless otherwise indicated. Space studs as follows:
1. Stud Spacing 16 inches (610 mm) on center.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.



- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single-leg deflection tracks and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - a. Install solid blocking at 96-inch (2440-mm) centers.
 - 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION



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SECTION 05 50 00

METAL FABICATIONS

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. Work Included: The Work of this Section shall include, but not be limited to, the following:
1. Cutting, fitting, drilling and tapping work of this Project to accommodate work of other sections or other materials as required for attaching and installing work of this Project.
 2. Steel framing and supports
 3. Steel supports for wood frame construction
 4. Metal components for deck floor ramp
 5. Miscellaneous steel trim
- B. Related Work:
1. Division 051000 "Structural Metal Framing
 2. Division 06 "Miscellaneous Rough Carpentry".
 3. Division 06: "Exterior Architectural Woodwork": For coordination with wood deck components
 4. Division 05 "Decorative Metal Railings"

1.3 QUALITY ASSURANCE

- A. Materials and work shall conform to the latest edition of reference standards specified herein and to applicable codes and requirements of local authorities having jurisdiction, including the following:
1. The National Association of Architectural Metal Manufacturers (NAAMM)
 - a. Metal Finishes Manual.
 - b. Metal Products Outline Manual.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel," D1.3 "Structural Welding Code - Sheet Steel", and D1.2 "Structural Welding Code - Aluminum."
1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Structural Performance: Design, engineer, fabricate and install the following metal fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Comply with the "Performance Criteria" specified hereinafter.
- D. Conflicting Requirements: In the event of conflict between pertinent codes and regulations and the requirements of the referenced standards or these specifications, the provisions of the more stringent shall govern.



E. Qualifications

1. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.
2. Installer Qualifications: Arrange for installation of metal fabrications specified in this section by same firm that fabricated them.

1.4 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site.
- B. Shop Drawings: Submit shop drawings for work specified herein for approval and obtain approval prior to fabrication and shipment of materials to the job site.
1. Shop drawings shall show locations of work in the Project, elevations and profiles. Indicate materials, sizes, shapes, thicknesses, sizes and locations of structural subframes and reinforcing, location and installation requirements for fasteners and anchors and joints and connection to other work.
 2. Where installed metal fabrications are indicated to comply with specified design loadings, submit with shop drawings calculations in reference to structural properties of members, assemblies and connections prior to fabrication of any parts of the work and provide additional structural members or increase gauge and weight of finished metals required for the proper erection and structural stability of the work.
 3. Calculations shall be prepared and stamped by a Professional Engineer registered in the State of New York.
 4. Welding shall be indicated on shop drawings using AWS symbols and showing length, size and spacing (if not continuous). Auxiliary views shall be shown to clarify welding. Notes such as 1/4 inch (6.4 mm) weld, weld and tack weld are not acceptable.
 5. Coordinate with glass for stainless steel shoes and header for metal and glass partitions at Conference Rooms
- C. Samples: Samples of materials specified herein and shall be submitted for approval, and approval obtained before materials are delivered to the site. Samples shall include the following:

1.5 DELIVERY, STORAGE AND HANDLING

- A. Exercise proper care in the handling of work so as not to injure the finished surfaces, and take proper precautions to protect the work from damage after it is in place.
- B. Deliver materials to the job site ready for use, and fabricated in as large sections and assemblies as practical. Assemblies shall be identical to submitted and reviewed shop drawings, samples and certificates.
- C. Store materials under cover in a dry and clean location off the ground. Take every precaution not to damage or mar prime coats or galvanizing. Remove materials which are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials at no additional cost.

1.6 PROJECT CONDITIONS

- A. Check actual locations of walls and other construction to which metal fabrication must fit, by accurate field measurements before fabrication. Show recorded measurements on final shop drawings and coordinate fabrication schedule with construction progress to avoid delay of Work.



PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Products

1. Structural Steel Shapes: ASTM A36.
2. Steel Plates: ASTM A283 Grade C.
3. Steel Tubing
 - a. Cold-Formed Steel Tubing: ASTM A500, Grade A, unless otherwise indicated or required for design loading.
 - b. Hot-Formed Steel Tubing: ASTM A501.
 - c. For exterior installations and where indicated, provide hot-dip galvanized coating per ASTM A53.
4. Steel Pipe: ASTM A53, Schedule 40.
5. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304
6. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304

B. Fastening and Anchorage Devices

1. Select fasteners for the type, grade and class required.
2. Concrete Inserts: Threaded or wedge type, galvanized ferrous castings, either malleable iron ASTM A47 or cast steel ASTM A27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A153.
3. Drilled-In Expansion Anchors: Expansion anchors complying with FS FF-S-325, Group VIII (anchors, expansion, [nondrilling]), Type I (internally threaded tubular expansion anchor); and machine bolts complying with FS FF-B-575, Grade 5.
4. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as required.
5. Machine Screws: FS FF-S-92.
6. Nuts and Bolts: ASTM A307.
7. Lag Bolts: FS FF-B-561, square head type.
8. Lock Washers: FS FF-S-84, helical spring type carbon steel.
9. Wood Screws: FS FF-S-111, flat head carbon steel.
10. Plain Washers: FS FF-W-92, round, carbon steel.

C. Applied Coatings

1. Interior Ferrous Metal Primer: One of the following:
 - a. "4-55, Versare" by Tnemec Company, Inc.
 - b. "GP-818" by Carboline Co.
 - c. "Dulux, 67-Y-834" by E.I. DuPont de Nemours.
 - d. No. 5205 Glid-Guard Tank and Structural Primer by Glidden Coatings and Resins Co.
 - e. Pitt-Guard Direct-To-Rust (DTR) Coating by PPG Industries, Inc., Pittsburgh Paints
2. Dielectric Separator: "Bitumastic 50" by Kop-Coat, Inc. or "Jennite J-16" by Maintenance Inc.

D. Grout and Anchoring Cement

1. Nonshrink Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with CE CRD-C 621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.



2. Grout shall be one of the following:

- a. "Bonsal Construction Grout", W.R. Bonsal Co.
- b. "Euco N-S Grout", Euclid Chemical Co.
- c. "Crystex", L&M Construction Chemicals, Inc.
- d. "Masterflow 713", Master Builders, Inc.
- e. "Sealtight 588 Grout", W.R. Meadows, Inc.
- f. "SonogROUT", Sonneborn Building Products Div.
- g. "Five Star Grout", U.S. Grout Corp.

- E. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for the metal alloy to be welded.
- F. Miscellaneous Items: Provide miscellaneous items best suited for intended use, as required to fulfill the requirements. Provide materials which are non-corrosive and compatible with contiguous work.

2.2 FABRICATION, GENERAL

- A. Miscellaneous metal work shall be of the design, gauge, dimensions and location indicated and as required for work shown. Miscellaneous metal work and finishes shall be first class in every particular and in accordance with trade practice. Insofar as practicable, fabrication, assembly and fitting of the work shall be executed in the shop with the various parts or assemblies ready for erection at the building. Work that cannot be shop assembled shall be given a trial fit at the shop to insure a proper and expeditious field assembly.
- B. In the event that shop-fabricated miscellaneous metal items do not fit the field condition, the item shall be returned to the shop for correction, including reglvanizing or priming where required.
- C. Removable members shall be carefully machined and fitted and shall be secured by screws or bolts of proper size and approved spacing. Structural supports, hangers and built-in reinforcement wholly concealed within the finished assemblies shall be as indicated or required.
- D. Shear saw and punch metal accurately, cleanly, sharply and free of burrs, without deforming adjacent surfaces or metals. Flame cutting will be permitted only if cut edges are ground back to clean, smooth edges.
- E. Drill or cleanly punch holes; do not burn.
- F. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- G. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- H. Remove sharp or rough areas on exposed traffic surfaces.
- I. Weld corners and seams continuously to comply with AWS recommendation and the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.



- J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- K. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- L. Rough Hardware
 - 1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures.
 - 2. Fabricate items to sizes, shapes and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.
- M. Coordination: Accurately cut, fit, drill and tap work of this section to accommodate and fit work of other trades. Furnish or obtain, as applicable, templates and drawings to or from applicable trades for proper coordination of this work.

2.3 SHOP PAINTING

- A. Shop paint ferrous and non-ferrous miscellaneous metals. Painting shall be done in dry weather or under cover, and steel or iron surfaces shall be free from moisture or frost. No materials shall be shipped or delivered until the shop coat has dried. Shop paint all miscellaneous metals except the following:
 - 1. Galvanized Items.
 - 2. Surfaces and Edges To Be Field Welded
 - 3. Items Embedded In Concrete, Masonry, Mortar Or Grout
- B. Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning", prior to any additional surface preparation specified.
- C. Clean and prepare metal surfaces before applying shop coat. Remove rust and mill scale in accordance with SSPC SP-3 "Power Tool Cleaning", unless more stringent preparation is required by the paint manufacturer.
- D. Immediately after surface preparation, apply primer in accordance with manufacturer's instructions. Use painting methods which will result in full coverage and dry film thickness specified.
- E. Apply one shop coat of primer to fabricated metal items. Surfaces which will be concealed in the finished construction or will not be accessible to finish painting shall receive an additional shop coat of the specified paint to which a small amount of tinting has been added for color differentiation. Touchup marred and abraded surfaces with the specified paint.
- F. Repaint areas of shop coat damaged during handling or installation with paint similar to that applied in the shop.

2.4 FABRICATION SPECIFIC ITEMS

- A. Steel Supports and Structural Steel
 - 1. Miscellaneous Steel and Structural Steel (Not Otherwise Indicated on Structural Steel Drawings)



- a. Furnish and install steel framing, posts, bracing, brackets, columns, beams, girders, plates, angles, channels, closures, brackets and miscellaneous steel indicated on the drawings or described in this specification.
- b. Miscellaneous steel and Structural Steel shall include required support steel for the work of this section, and for the work of other sections.
- c. Steel members shall be of such shapes and sizes indicated on the drawings and details or as required to suit the condition and shall be provided with necessary supports and reinforcing such as hangers, braces, struts, clip angles, anchors, bolts, nuts, welds, etc., as required to properly support and rigidly fasten and anchor same in place and to steel, concrete, masonry and other connecting and adjoining work.
- d. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed. Space anchors 12 inches (305 mm) on center and provide minimum anchor units of 1-1/4 inches by 1/4 inches by 8 inches (31.75 mm by 6.4 mm by 200 mm) steel straps.
- e. Steel shall be of domestic source conforming to ASTM A36 and the "Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.

2.5 DECK FLOOR RAMP METAL COMPONENTS

- A. Manufacturer: McNichols, Traction Tread, M207201312
- B. Characteristics of Grating Plank
 1. Material: Galvanized steel.
 2. Gauge: 13.
 3. Sizing: 7 inch traction tread.
 4. Channel Depth: 2 inches
 5. Percentage Open Area: 6
 6. Finish: Mill
 7. Surface Pattern: Manufacturer's standard

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Examine the Contract Documents in order to insure the completeness of the work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, with particular attention given to the installation of items embedded in concrete and masonry so as not to delay job progress.
- C. Provide templates as required to related trade for location of support and anchorage items.
- D. Dissimilar Materials: Isolate aluminum from masonry, concrete, wood and dissimilar metals by coating with heavy-bodied bituminous paint or by using a non-absorbent gasket. Fasteners shall be selected to prevent galvanic action.



3.3 INSTALLATION

- A. Install work of this section square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints (except as indicated otherwise or to allow for thermal movement). Provide attachment devices as required for secure and rigid installation.
- B. Exposed joints shall be close fitting, and bolts and screws, where exposed, shall be cut off flush with nuts or other adjacent metal. Cutting, drilling, punching and tapping required for the installation and attachment of other work to miscellaneous metal work, except where specified in connection with work under other sections, shall be performed as required.
- C. Metal work built-in with concrete or masonry shall be formed for anchorage, or be provided with suitable anchors, expansion shields or other anchoring devices indicated on drawings or required. Such metal work shall be furnished in ample time for setting and securing in place.
- D. Where indicated, install miscellaneous metal items in sleeves (furnished under this section) embedded in concrete with setting grout specified herein.
- E. Unless otherwise indicated, joints shall be as strong and rigid as adjoining sections. Welding shall be continuous along entire line of contact, except where spot welding is indicated or permitted. Where exposed, welds shall be ground smooth. Where bolted or riveted connections are indicated, such connections may be welded at the Contractor's option.
- F. Where welding is required, it shall conform to requirements for shielded metal arc welding of the Standard Code for Arc and Gas Welding of the American Welding Society. Exposed welds shall be flush and ground smooth.
- G. Threaded connections shall be made up tight so that threads are entirely concealed. Abutting bars shall be so shouldered and headed, doveled and pinned. Small bars shall pass through larger bars and be pinned. Rivet, bolts and screw heads shall be flat and countersunk in exposed work and elsewhere as required. Removable members shall be carefully machined and fitted and secured, by means of screws or bolts of proper size and approved spacing.
- H. Bolts, brackets, sleeves and other items embedded in concrete shall be galvanized.
- I. Except where otherwise indicated, miscellaneous metal work shall be fastened to concrete with expansion bolts and to hollow block with toggle bolts. Fastening to wood plugs in concrete or masonry will not be permitted. Holes for plugs or bolts shall be drilled to the exact diameter of the plug or bolt, using a percussion drill for concrete and a rotary drill for masonry. Screws shall be threaded full length to the head of the screw.
- J. Provide for adjustments of miscellaneous metal items, with particular attention given to miscellaneous steel supporting the work of other sections, as required during the construction process.
- K. Follow manufacturer's instructions for metal ramp component installation and coordinate with wood deck construction.

END OF SECTION



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SECTION 05 73 23

EXTERIOR DECORATIVE METAL RAILINGS

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. Aluminum decorative railings with stainless-steel, wire-cable infill.
 2. Stainless steel handrails
 3. Wood railing cap
- B. Related Sections:
1. Division 05 Section "Metal Fabrications"

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
1. Stainless Steel: 60 percent of minimum yield strength.
 2. Aluminum : Mminimum yield strength as required by authority having jurisdiction.
- C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.



1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 SUBMITTALS

- A. Product Data: For the following:
 1. Manufacturer's product lines of railings assembled from standard components.
 2. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Verification: For each type of exposed finish required.
 1. Sections of linear railing member, including handrails, top rails and cables.
 2. Fittings and brackets.
 3. Welded connections.
 4. Assembled Samples of railing systems, made from full-size. Show method of finishing members at intersections. .
- D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Qualification Data: For qualified professional engineer and testing agency.
- F. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.
 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.6, "Structural Welding Code - Stainless Steel."
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 1. Build mockups railing consisting of 2 vertical support , top rail, cables, and anchorage system components that are full height of 1 corner condition, as designated by Architect.



2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference as designated by Owner's Representative.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Schedule installation so attachments are made only to completed construction. Do not support railings temporarily by any means that do not suit structural performance requirements.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.
- C. Aluminum
 1. Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52: Yield strength for Alloy 6063-T6 is 25 ksi (172 MPa).
 2. Provide Standard Weight (Schedule 40) pipe, unless otherwise indicated.
 3. Yield strength for Alloy 6063-T832 is 35 to 36 ksi (240 to 250 MPa).
 4. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.
 5. Yield strength for Alloy 6061-T6 is 32 to 35 ksi (220 to 240 MPa). Note that 6061-T6 is not suitable for bending, is somewhat less corrosion resistant than 6063, and does not anodize as well as 6063; however, 6063 is not available in plate and sheet form.
 6. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
 7. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
 8. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.2 STAINLESS STEEL

- A. Tubing: ASTM A 554, [Grade MT 304] [Grade MT 316] [Grade MT 316L].
- B. Pipe: ASTM A 312/A 312M, [Grade TP 304] [Grade TP 316] [Grade TP 316L].
- C. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, [Type 304] [Type 316] [Type 316L].
- D. Bars and Shapes: ASTM A 276, [Type 304] [Type 316] [Type 316L].
- E. Wire Rope and Fittings System: Manufactured by Hansen Architectural System or approved equal.
 1. Wire Rope: Wire rope made from wire complying with ASTM A 492, Type 316.



2. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

2.3 STAINLESS STEEL HANDRAILS

- A. As shown on Drawings

2.4 WOOD RAILING

- A. As shown on Drawings

2.5 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 1. Stainless-Steel Components: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work exposed fasteners are the standard fastening method for railings indicated.
- D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- C. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.7 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads. Refer to Drawings for dimensions and posts, fittings and cables.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.



- C. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
- D. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- E. Form work true to line and level with accurate angles and surfaces.
- F. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- G. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
 - 5. Remove flux immediately.
 - 6. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.
- I. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Close exposed ends of hollow railing members with prefabricated end fittings.
- K. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- M. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- N. For railing vertical supports set in concrete, provide connection as shown on Drawing..

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.



- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections (if any): Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.3 ANCHORING POSTS

- A. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than vertical supports for them installing into concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Cover anchorage joint with flange of same metal as vertical support.



- C. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.4 ATTACHING RAILINGS

- A. Anchor railing ends into deck as shown on Drawings

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Payment for these services will be made by Owner.
- B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Railings will be tested according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.
- C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and will comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 CLEANING

- A. Clean stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION



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SECTION 06 10 00

ROUGH CARPENTRY

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. Work Included: The work of this section shall include, but not be limited to, the following:
1. Wood nailers, blocking, furring and grounds.
 2. Anchors, fasteners and rough hardware required to erect, apply and install the work of this section.
 3. Exterior grade plywood or oriented strand board supports in walls.
- B. Related Work:
1. Division 05 "Metal Fabrications".
 2. Division 06 "Architectural Woodwork".
 3. Division 07 "TPO Roofing"
 4. Division 08 "Glazed Curtain Wall".

1.3 QUALITY ASSURANCE

- A. Materials and work shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.
- B. Lumber grades shall conform to the grading rules of the Association having jurisdiction and shall bear the official grade and trademark of the Inspection Bureau of the Association and a mark of mill identification. Moisture content of rough lumber shall not exceed 19 percent. Treated lumber shall be marked and certified by processor.
- C. Certificates: Materials and work requiring certificates, whether specified herein or required by authorities having jurisdiction, shall be submitted for approval.

1.4 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein and obtain approval before materials are delivered to the job site.
- B. Certificates: Submit the following certificates to show compliance with the specifications. Obtain approval prior to delivery of materials.



1. Material Certificates: Where dimensional lumber is provided to comply with minimum allowable unit stresses, submit listing of species and grade selected for each use, and submit evidence of compliance with specified requirements. Compliance may be in form of a signed copy of applicable portion of lumber producer's grading rules showing design values for selected species and grade. Design values shall be as approved by the Board of Review of American Lumber Standards Committee.
2. Wood Treatment Data: Submit chemical treatment manufacturer's instructions for handling, storing, installation and finishing of treated material.
 - a. Pressure Treatment: Include certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.
 - b. Fire Retardant Treatment: Include certification by treating plant that treatment material complies with governing ordinances and that treatment will not bleed through finished surfaces.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store lumber and plywood on the site and in stacks to insure drainage and free air circulation. Cover stacks with tarpaulins or other watertight covering. Store grounds and similar small sized lumber inside the building as soon as possible after delivery.
- B. Materials shall be stored in a dry location off the ground, in such a manner as to prevent damage or intrusion of foreign matter. Materials which have become damaged or otherwise unfit for use during delivery, or storage, shall be replaced at no additional expense to the Project

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber and Plywood
 1. General
 - a. Lumber Standards: Manufacture lumber to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.
 - b. Grade Stamps: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
 - c. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.
 - d. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches (50 mm) or less in nominal thickness, unless otherwise indicated.
 2. Lumber
 - a. Provide wood for support or attachment of other work including rooftop equipment curbs and support bases, cant strips, bucks nailers, blocking, furring, grounds, stripping and similar members. Provide lumber of sizes indicated, worked into shapes shown.
 - b. Grade: Standard Grade light framing size lumber of any species or board size lumber as required. No. 3 Common or Standard grade boards per WCLIB or WWPA rules or No. 3 boards per SPIB rules.



3. Plywood

- a. Plywood shall comply with PS 1 "U.S. Product Standard for Construction and Industrial Plywood" for plywood panels and, for products not manufactured under PS 1 provisions, with American Plywood Association (APA) "Performance Standard and Policies for Structural-Use Panels", Form NO. E445.
- b. Factory mark each construction panel with APA trademark evidencing compliance with applicable grade requirements.
- c. Concealed APA Performance Rated Panels: Where construction panels will be used for the following concealed types of applications, provide APA Performance-Rated Panels complying with requirements indicated for grade designation, exposure durability classification and thickness.

B. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.

1. Manufacturers: Subject to compliance with requirements, provide products by available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Louisiana-Pacific Corporation.
 - b. Weyerhaeuser Company.
2. Extreme Fiber Stress in Bending, Edgewise: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
3. Modulus of Elasticity, Edgewise: 2,200,000 psi (15 100 MPa).

C. Fire Retardant Treated Materials

1. Fire retardant treated wood shall be pressure process impregnated in accordance with requirements of the American Wood Preservers Association Standard for the specific wood to be treated, shall conform to applicable codes and ordinances and shall meet the Fire Hazard Classification requirements of codes and ordinances.
2. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - a. Use treatment that does not promote corrosion of metal fasteners.
 - b. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 1) Application: Support for Stainless steel panels
 - c. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
3. There shall be no fabrication of the material after treatment, such as cuffing, shaping, or grooving for splines or ring connectors so as to expose untreated surfaces, except that the material may be cut to length, shaped, or grooved if the exposed surfaces or edges are tightly butted against other material that is noncombustible or that is fire retardant treated, so that no untreated wood is left exposed to



danger of ignition. Holes may be bored or cut for plumbing or heating pipes and for electric outlets only if the openings are covered with tightly-fitted noncombustible escutcheons or cover plates. The allowable working stresses of the material shall be 90 percent of the allowable stresses for untreated lumber of like classification.

4. Fire retardant treatments shall not contain monoammonium phosphate or diammonium phosphate.
5. Fire retardant treatments shall be by Hoover Treated Wood Products or approved equal.

D. Rough Hardware

1. Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, spikes, expansion shields, bolts, nuts, washers, strap irons, and anchoring devices. Provide metal hangers and framing anchors of the size and type recommended by the manufacturer for each use including recommending nails.
2. Where rough carpentry work is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners and anchorages with a hot-dip zinc coating in accordance with ASTM A153.
3. Furnish to the masonry trade anchors, bolts, wall plates corrugated wall plugs, nailing blocks, wood, etc., which are required for the proper fastening and installation of the work of this section to masonry.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.
- B. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.

3.3 INSTALLATION/APPLICATION/ERECTION

- A. Carpentry includes lumber and fastenings necessary for the connection to other work, including drilling and tapping of steel.
- B. Provide materials and labor for erecting and maintaining protection around the work of other trades.
- C. Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other work.
- D. Set carpentry work to required levels and lines, with members plumb and true to line and cut and fitted.
- E. Securely attach carpentry work to substrate by anchoring and fastening as shown and as required by recognized standards.
- F. Wood Treatments
 1. Lumber used in conjunction with roofing, sheet metal, metal fascias, exterior work, or in contact with masonry shall be pressure preservative impregnated, unless required by building code to be fire retardant.



2. Interior wood shall be fire retardant treated.

G. Wood Nailers, Blocking, Furring and Grounds

1. Provide wood nailers, blocking, furring, curbs, bucks, and grounds required for the work of the various sections of these specifications, unless otherwise specified.
2. Wood for nailers, blocking, furring and grounds shall be dressed on 4 sides, and of sufficient number, size and fastenings to support the work properly. Secure members with approved type anchors of fastenings not to exceed 2 feet (610 mm) o.c. shimmed plumb, level and true.
3. Install plywood linings of plywood material specified herein, for equipment where indicated.
4. Blocking shall be as required for the proper installation of the finished work and for items in various sections as required. Blocking, edgings, stops, nailing strips, etc., shall be continuous, unless distinctly noted otherwise. Provide blocking as required to install equipment.
5. Fastening for wood grounds, furring and blocking shall be of metal and of type and spacing suited to conditions. Hardened steel nails, expansion screws, toggle bolts, self-clinching nails, metal plugs, inserts or similar fastenings shall be used, of suitable type and size to draw the members into place and securely hold same.

H. Plywood and Oriented Strand Board

1. Lumber shall conform to requirements of local codes and authorities having jurisdiction.
2. Exterior Grade Plywood: Install as support for stainless steel panels.

3.4 CLEANING AND ADJUSTMENTS

- A. Keep the premises in a neat, safe, and orderly condition during execution of this portion of the work, free from accumulation of sawdust, cut-ends, and debris.

B. Sweeping

1. At the end of each working day, or more often if necessary, thoroughly sweep surfaces where refuse from this portion of the work has settled.
2. Remove the refuse to the area of the job site set aside for its storage.
3. Upon completion of this portion of the work, thoroughly broom clean surfaces.

END OF SECTION



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SECTION 06 16 00

SHEATHING

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. This Section includes the following:
 - 1. Wall sheathing.
 - 2. Sheathing joint-and-penetration treatment.
- B. Related Sections include the following:
 - 1. Division 05 Section "Cold Formed Metal Framing".
 - 2. Division 07 Section "Applied Air/Vapor Barriers"

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- 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." And/or GA-600, "Fire Resistance Design Manual."
- B. Mock-ups: Mock-up for Composite Wall Panels will include sheathing materials as specified under this and as specified under Division 07 Section "Composite Wall Panels"

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WALL SHEATHING

- A. Available Products: Subject to compliance with requirements, gypsum sheathing boards that may be incorporated in the Work include, but are not limited to, the following:



1. Glass-Mat Gypsum Board: Dens-Glass Gold Exterior Sheathing; Georgia-Pacific Corp.
- B. Glass-Mat Gypsum Board: Gypsum board designed as an exterior substrate for a weather barrier, consisting of a noncombustible water-resistant core, essentially gypsum, surfaced with glass mats on face and back, partially or completely embedded in core, and with unsurfaced square edges. Comply with ASTM C 1177 and requirements indicated below:
 1. Type and Thickness: Type X, 5/8 inch (13 mm) thick.
 2. Size: 48 by 96 inches (1219 by 2438 mm) for vertical installation.

2.2 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
- B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
 1. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, attach sheathing to comply with ASTM C 954.

2.3 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing Board: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing, and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
- B. Sheathing Tape for Glass-Mat Gypsum Sheathing Board: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing board and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 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. Securely attach to substrate by fastening as indicated, complying with the following:
 1. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
- D. Coordinate wall 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.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.



- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 2. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
 - 3. Install boards with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.
- C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
 - 1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.

3.3 SHEATHING JOINT-AND-PENETRATION TREATMENT

- A. Seal sheathing joints according to sheathing manufacturer's written instructions.
 - 1. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing board joints, and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings. Sealant shall be compatible with fluid applied air/vapor barrier.
 - 2. Coordinate installation Applied Membrane Air/Vapor Barriers.

END OF SECTION



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SECTION 06 20 13**EXTERIOR FINISH CARPENTRY****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. Work Included: The Work of this Section shall include, but not be limited to, the following:
1. Ramp Joist
 2. Ramp Deck
 3. Planter Supports
 4. Exterior Mullions for Curtain Wall
- B. Related Work:
1. Division 05 - Structural Steel
 2. Division 08 - Timber Glazed Curtain Walls
 3. Division 32- Planting and Planters

1.3 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site.
- B. Shop Drawings: Submit shop drawings for work specified herein for approval and obtain approval prior to fabrication and shipment of materials to the job site.
- C. Samples: Samples of materials specified herein and shall be submitted for approval, and approval obtained before materials are delivered to the site. Samples shall include the following:

1.4 QUALITY ASSURANCE

- A. Samples for Verification:
1. For each species and cut of lumber and panel products, with 1/2 of exposed surface finished; 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.

1.5 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, reinforcements, and other related units of Work specified in other Sections to ensure that exterior architectural woodwork can be supported and installed as indicated.



PART 2 - PRODUCTS

2.1 CEDAR MANUFACTURER'S

- A. ROSENWACH, SiteCraft, LIC, New York

2.2 MATERIALS

- A. Cedar
 - 1. Ramp Joist (2" x 4").
 - 2. Ramp Deck (5/4" x 4" or 5/4" x 6").
 - 3. Rails (2" x 4").
 - 4. Planters Support (2" x 3").
- B. Cypress: For exterior curtain wall mullions

2.3 CHARACTERISTICS AND FINISHES

- A. Cedar: Restored wood from roof water tanks
- B. Cypress: To match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.
- B. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- C. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Examine the Contract Documents in order to insure the completeness of the work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, with particular attention given to the installation of items embedded in concrete and masonry so as not to delay job progress.
- C. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting.
- D. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting.

3.3 INSTALLATION



- A. Install work of this section square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints (except as indicated otherwise or to allow for thermal movement). Provide attachment devices as required for secure and rigid installation.
 - 1. Scribe and cut exterior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended.
 - 2. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
- B. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.

3.3 CLEANING, ADJUSTMENT, PROTECTION

- A. Replace exterior finish carpentry that is damaged or does not comply with requirements. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.
- B. Clean exterior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Protect installed products from damage from weather and other causes during construction.
- D. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION



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SECTION 06 20 13.23

WOOD COOLING EQUIPMENT ENCLOSURE

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. This Section includes the following:
 - 1. Wood cooling equipment enclosure fabricated from reclaimed roof water tank planks
- B. Related Sections include the following:
 - 1. Structural Drawings: Steel support

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Show basic wood structure with metal banding
 - 2. Show connection of tank top to side structure.
 - 3. Show plank details.
 - 4. Show coordination with steel supports
- B. Samples for Initial Selection:
 - 1. Available types of reclaimed wood, show range of variation, range of 3 each 12 inches long, include possible finish types
 - 2. Typical available type of metal banding, 12 inches long
- C. Samples for Verification:
 - 1. Reclaimed wood as chosen by Architect with wood, finish, and banding, two 2 foot planks with 1 band.
- E. Product Certificates: For each type of product, signed by product manufacturer.
- F. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- G. Qualification Data: For Fabricator.



1.04 QUALITY ASSURANCE

- A. Coordinate the work of this Section with the historic restoration work of this Project.
- B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.
- C. Installer Qualifications: Fabricator of products.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination".

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.01 MATERIAL SOURCE AND FABRICATOR

- A. The Rosenwach Group:
 - 1. . 40-25 Crescent Street • Long Island City, NY 11101
 - 2. T: 718.729.4900 • F: 718.482.0661
 - 3. info@rosenwachgroup.com

2.02 MATERIALS

- A. Wood planks and other lumber reclaimed from New York City water tanks.
 - 1. Single type of specie for whole banquette assembly, chosen by Architect from suppliers available species.
- B. Metal Banding to match banding used on New York City water tanks. \
 - 1. Chosen by Architect's from typical available types of metal

2.03 FABRICATION

- A. Fabricate in accordance with approved Shop Drawings



- B. Shop fabricate as much as possible in consideration of shipping and building entry and transport limits
- C. Finish: As determined by Architect in conjunction with fabricator.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install unit in accordance with approved Shop Drawings
- B. Coordinate installation with steel support supports

3.02 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION



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SECTION 06 40 23

INTERIOR ARCHITECTURAL WOODWORK

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. This Section includes the following:
1. Interior standing and running trim.
 2. Transparent wood panels
 3. Solid-surfacing-material countertops.
 4. Fan coil unit MDF cover
 5. Curtain wall mullion covers
 6. Closet shelving.
 7. Shop finishing of interior woodwork,
 8. Hardware
- B. Related Sections include the following:
1. Division 08 Section – Glazing
 2. Division 22-Section – Plumbing Fixtures

1.3 SUBMITTALS

- A. Product Data: For panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, stone surfacing material, fire-retardant-treated materials, cabinet hardware and accessories, and finishing materials and processes.
1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
1. Show details full size.
 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 3. Show locations and sizes of cutouts and holes for faucets, and other items installed in architectural woodwork.
 4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
 5. Show locations and dimensions of reveals in paneling.



C. Samples for Initial Selection:

1. Shop-applied finishes, including pickling
2. Solid surfacing countertops

D. Samples for Verification:

1. Lumber with or for transparent finish, not less than 5 inches (125 mm) wide by 24 inches (600 mm) long, for each species and cut, finished on 1 side and 1 edge.
2. Veneer-faced panel products with or for transparent finish, 12 by 24 inches (300 by 600 mm), for each species and cut. Include at least one face-veneer seam and finish as specified.
3. Lumber and panel products with shop-applied opaque finish, 5 sq. in. (125 mm).
4. Countertop materials, 6 inches (150 mm) square.
5. Corner pieces as follows:
 - a. Joints for standing trim. Exposed cabinet hardware and accessories, one unit for each type and finish.
 - b. Include statement indicating costs for each certified wood product.

E. Product Certificates: For each type of product, signed by product manufacturer.

F. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

G. Qualification Data: For Fabricator.

1.4 QUALITY ASSURANCE

A. Coordinate the work of this Section with the historic restoration work of this Project.

B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.

C. Installer Qualifications: Fabricator of products.

D. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers and wood doors with face veneers that are sequence matched with woodwork and transparent-finished wood doors that are required to be of same species as woodwork.

E. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide AWI Quality Certification Program labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.

F. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.



- G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 2. Specific mock-ups to be determined by Architect.

1.5 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Hardboard: AHA A135.4.
- C. Ultra-Light MDF
1. Manufacturer: Flake Board Lite™ MDF
 2. 30 percent lighter than standard MDF
 3. A CARB Phase 1 Compliant and EPP Certified ultra light MDF panel
- D. Bamboo Plywood: "Neapolitan Pure, 3/4 inch thick "Plyboo", with no added urea formaldehyde.
- E. Birch Plywood: DOC PS 1

2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
1. Mill lumber before or after treatment as determined by application of product and manufacture's instructions.



2.3 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 120 degrees of opening, self-closing screw mounted: Hafale 329.03.503 and other type where indicated for corners by Hafale
- C. Hinged Stay Flaps: For desk, 365.60,.00 Series
- D. Catches: Magnetic catches, BHMA A156.9, B03141]
- E. Shelf Rests: BHMA A156.9, B04013; metal.
- F. Drawer Slides: BHMA A156.9, B05091.y Hafele as shown on Drawings
 - 1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted full-extension type; zinc-plated steel with polymer rollers. Location determined by applications
 - 2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
- G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
- H. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.
- I. Pull out Waste Bins: Clip-on frame, metal lid, suitable as shelf, 130,000 cycle tested, • Load Capacity: 55 kg (120 lbs.), ull extension with overtravel, Hafale 502.74. Series
- J. Sliding Door Turn-away System: Left and right with fittings. 271.95.200 Series by Hafele.
- K. Edge Pulls: As shown on Hardware Schedule by Outwater
- L. Pivot/Slide System: Hafale 25/30 system

2.4 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- C. Adhesive for Bonding for Bonding Edges: In compliance with VOC requirements described under this Specification.

2.5 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium grade interior woodwork complying with referenced quality standard.



- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch (19 mm) Thick or Less: 1/16 inch (1.5 mm).
 - 2. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).
 - 3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch (1.5 mm).
- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.

2.6 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Grade: Premium.
- B. Wood Species and Cut: Poplar to match Architect's sample
- C. For trim items wider than available lumber, use veneered construction. Do not glue for width.
- D. For rails wider or thicker than available lumber, use veneered construction. Do not glue for width or thickness.
- E. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
- F. Assemble casings in plant except where limitations of access to place of installation require field assembly.
- G. Transition pieces
- H. Interior Curtain Wall Mullions: Pickled finish poplar
- I. Toe Kick: 3/4 inch birch plywood

2.7 TRANSPARENT CABINETS AND WOOD FAN COIL UNIT ENCLOSURES

- A. Grade: Premium.
- B. AWI Type of Cabinet Construction: As shown on Drawings.



1. Plywood: "Plyboo"

C. Semiexposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other Than Drawer Bodies: Compatible species to that indicated for exposed surfaces, stained to match.
2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

D. Interior Shelving: 3/4 inch MDF or shop standard.

2.8 FLUSH WOOD PANELING

A. Grade: Premium.

B. Wood Species and Cut:

C. Matching of Adjacent Veneer Leaves: As shown on Drawings

D. Reveals: Provide reveals where shown on Drawings. Sizes of reveals vary from 1/8 inch to 1/4 inch to 1/2 inch. Exposed edges of the reveals shall be finished either by solid wood to match veneer or with same veneer as panels.

E. Perimeter Paneling: Birch plywood with cork pin-up boards by Marmoleum where indicated on Drawings

F. Pickled Finish Paneling: Poplar veneer over birch plywood.

2.9 SOLID-SURFACING-MATERIAL COUNTERTOPS

A. Quality Standard: Comply with AWI Section 400 requirements for countertops.

B. Grade: Premium.

C. Solid-Surfacing-Material Thickness: As indicated.

D. Fabricate tops in one piece with shop-applied backsplashes and edges, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

E. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

F. Manufacturer: Ice Stone

1. 100 percent recycled glass in 100 percent concrete matrix
2. Color and Pattern: To match Architect's sample

2.10 CLOSET SHELVING

A. Shelving: Made from 3/4 inch (19 mm) thick

1. Softwood Boards: Prime or D finish
2. Finish: Clear low VOC lacquer
3. Finish: Clear low VOC lacquer



- B. Closet Hanger Rod: Stainless steel type 304 1 1/2 inch diameter, satin finish.

2.11 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- C. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing opaque-finished architectural woodwork.
- D. General: Drawings indicate items that are required to be shop finished. Finish such items at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing architectural woodwork not indicated to be shop finished.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces.
- E. Finishes for Paneling and Trim:
 - 1. Grade: Premium.
 - 2. Transparent Pickled Finish System: Oil based Pickled Oak finish 260 and pre stain conditioner manufactured by Minwax
 - 3. Mullion Finish: Urethane
 - 4. Interior Wood other than Pickled: Shellac

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing



nails or finishing screws]for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

- G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches (900 mm) long, except where shorter single-length pieces are necessary.
1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
 2. Install wall railings on indicated metal brackets securely fastened to wall framing.
 3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).
- H. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 2. Maintain veneer sequence matching of cabinets with transparent finish.
 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. as shown on approved Shop Drawings.
- I. Paneling: Anchor paneling to supporting substrate to match existing.
1. Install flush paneling with no more than 1/16 inch in 96-inch (1.5 mm in 2400-mm) vertical cup or bow and 1/8 inch in 96-inch (3 mm in 2400-mm) horizontal variation from a true plane.
 2. Install reveals as shown on Drawings and approved Shop Drawings.
- J. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
1. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 2. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c. and to walls with adhesive].
 3. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
 4. Install stone countertops in accordance with stone distributor's instructions and approved Shop Drawings and in accordance with Marble Institutes of America's guide specifications.
- K. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION



SECTION 07 21 00**THERMAL INSULATION****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. Work Included: The Work of this Section shall include, but not be limited to, the following:
1. Spray polyurethane foam insulation
 2. Rigid XPS board
- B. Related Work:
1. Division 06 40 13 - Exterior Architectural Woodwork

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Metal Products Outline Manual.

1.4 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site.
- B. Samples: Samples of materials specified herein and shall be submitted for approval, and approval obtained before materials are delivered to the site. Samples shall include the following:

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. The Dow Chemical Company, Dow Building Solutions

2.2 SPRAY POLYURETHANE FOAM INSULATION

- A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
1. Basis of Design: STYROFOAM™ Brand Spray Polyurethane Foam Insulation, RS Series by Dow Chemical or Subject to compliance with requirements, provide products by one of the following] BASF Corporation or Henry Company:
 2. Minimum density of 1.5 lb/cu. ft. (24 kg/cu. m), thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F (43 K x m/W at 24 deg C).



2.3 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 1. Basis of Design: STYROFOAM™ XPS BlueCor by Dow Chemical or subject to compliance with requirements, provide products by one of the following; DiversiFoam Products or Owens Corning.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Examine the Contract Documents in order to insure the completeness of the work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, with particular attention given to the installation of items embedded in concrete and masonry so as not to delay job progress.

3.3 INSTALLATION

- A. Install work of this section square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints (except as indicated otherwise or to allow for thermal movement). Provide attachment devices as required for secure and rigid installation.
- B. Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.
 - 1. Spray equipment must be capable of delivering the proper ratio (1:1 by volume) of polymeric isocyanate and polyol blend at adequate temperatures and spray pressures. Substrate must be at least 5 degrees above dew point, with best processing results when ambient humidity is below 80 percent. Substrate must also be free of moisture (dew or frost), grease, oil, solvents and other materials that would adversely affect adhesion of the polyurethane foam.

3.3 CLEANING, ADJUSTMENT, PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation

END OF SECTION



SECTION 07 27 26

AIR BARRIERS

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. This Section includes the following:
 - 1. Peel and stick air barrier.
- B. Related Sections include the following:
 - 1. Division 06 Section "Sheathing".
 - 2. Division 07 Section "Joint Sealants".

1.3 DEFINITIONS

- A. ABAA: Air Barrier Association of America.
- B. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

1.5 SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.
- B. Shop Drawings: Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 1. Include details of interfaces with other materials that form part of air barrier.
 - 2. Include details of mockups.
- C. Product Certificates: For air barriers, certifying compatibility of air barrier and accessory materials with Project materials that connect to or that come in contact with the barrier; signed by product manufacturer.
- D. Qualification Data: For Applicator.



- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for air barriers.

1.6 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm experienced in applying air barrier materials similar in material, design,.
- B. Mockups: Before beginning installation of air barrier, coordinate with the building of mockups of exterior wall panel wall system shown on Drawings
 - 1. Coordinate construction of mockup to permit inspection by Architect before external insulation and panel is installed.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 AIR BARRIER

- A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier membrane: Synthetic polymer
 - 1. Basis of Design Product: Subject to compliance with requirements, Blue Skin VP 160as manufactured by Henry Company, El Segundo, CA 90245.
 - 2. Physical and Performance Properties:
 - a. Compatibility: With substrate and insulation.
 - b. Membrane Air Permeance: Not to exceed 0.004 cfm/ sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178
 - c. Average Dry Breaking Force: 127 lbf/565 N MD
 - d. Dry Tensile Strength: 41lbf/182 N MD

2.2 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by air barrier manufacturer for intended use and compatible with air barrier membrane.
- B. Sealant: HE925 BES by Henry.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.



3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.
- B. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

3.3 JOINT TREATMENT

- A. Sheathing: Fill joints greater than 1/4 inch (6 mm) with sealant according to ASTM C 1193 and with air barrier manufacturer's written instructions. Apply first layer of fluid air barrier membrane at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air barrier membrane over joint reinforcing strip.

3.4 AIR BARRIER MEMBRANE INSTALLATION

- A. Apply air barrier membrane within manufacturer's recommended application temperature ranges.
- B. Do not cover air barrier until it has been inspected by Architect.
- C. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

3.5 FIELD QUALITY CONTROL

- A. Inspections: Air barrier materials and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 - 1. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2. Continuous structural support of air barrier system has been provided.
 - 3. Substrate is smooth, clean and free of cavities, protrusions, and mortar droppings.
 - 4. Site conditions for application temperature and dryness of substrates have been maintained.
 - 5. Maximum exposure time of materials to UV deterioration has not been exceeded.
 - 6. All penetrations have been sealed.

3.6 CLEANING AND PROTECTION

- A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace air barrier exposed for more than 30 days.
 - 2. Protect air barrier from contact with creosote, uncured coal-tar products, TPO, EPDM, flexible PVC membranes, and sealants not approved by air barrier manufacturer.

END OF SECTION



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SECTION 07 42 21

INSULATED METAL INFILL PANEL

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 Insulated metal wall panels used as the exterior cladding, partially glazed into curtain wall system.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural performance: provide exterior/interior wall cladding assemblies capable of withstanding the effects of load and stresses from wind loads.
- B. Design panel system to accommodate tolerance of plus or minus 1/8" in any direction and plus or minus 1/16" in panel thickness.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's product literature for the panel specified. Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- B. Shop Drawings: Show how panels shall be glazed into curtain wall and show panels with be trimmed and attached where not glazed into curtain wall and at corners
- C. Samples for initial selections: Typical panel sample shall be submitted by the manufacturer to the architect for inspection and approval.
- D. Installing contractor shall furnish shop drawings, installation, handling, storage, cleaning, and all materials required for setting.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum of 5 years experience in manufacturing wall panels similar to those specified.
- B. Installer Qualifications: Acceptable to manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with Division 1 Product Requirements Sections.
- B. Ordering: Comply with manufacturer's ordering instructions, and lead-time requirements to avoid construction delays.
- C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.



1. Store materials in accordance with manufacturer's recommendations.
2. Handle materials carefully to avoid damage to materials and finishes.
3. Installing contractor shall be responsible for handling, storage and cleaning.

1.7 WARRANTY

- A. Project warranty refers to Conditions of the Contract for project warranty provisions. Manufacturer's warranty: submit, for Owner's acceptance, manufacturer's standard warranty documents executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights owner may have under Contract Documents.
- B. The Contractor shall warrant the materials to be free of faults and defects in accordance with the General Conditions, except that the warranty shall be extended by paint manufacturer's standard multi-year warranty. The warranty shall be in writing and shall be signed by the manufacturer.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers: Subject to compliance with requirements, provide products manufactured by: Firestone Metal Products, Unaclad Series 5000 – Glazed Insulated Wall Panel, or approved equal

2.2 MATERIALS

- A. The overall panel thickness shall be as shown on Drawings
- B. Exterior skin shall be chosen by Architect from manufacturer's full line of options including custom finishes
- C. Stabilizer sheet under both faces shall be 1/8 Tempered Hardboard or 3mm Polyethylene
- D. The insulating core material shall Expanded polystyrene core foam or Polyisocyanurate foam)
- E. Interior skin shall name or number) from manufacturer's standard color selection.
- F. Insulated panels shall have an overall U value as determined by configuration

2.3 FABRICATION, GENERAL

- A. Composition: Glazed Insulated panels consisting of exterior metal skins, stabilizers and insulated foam core.
- B. Aluminum face sheets" Thickness .013", .032", .040", .050", .063" of 3105 H25 aluminum alloy. (Architect call for face material thickness)
- C. The adhesive used in laminating shall be urethane. The entire composite shall be pressed with maximum pressure under controlled and consistent pressure to develop the maximum possible tensile strength.
- D. Tolerances
 1. Width – plus or minus 1/8"
 2. Length – plus or minus 1/8"
 3. Thickness – plus or minus 1/16"
- E. Panel surfaces shall be free of scratches or marks caused during fabrication.



- F. Ensure that entire project is manufactured from single color coil paint run to ensure color uniformity.
- G. If a metallic color is selected ensure that panel grain is maintained. Under no circumstances are panel blank sizes to be rotated even if material waste is increased.

2.4 ACCESSORIES

- A. Installing contractor shall all materials required for setting.
- B. Include panel manufactures snap/clip on trim system to make corners and end panels where they are not glazed into curtain wall system.

2.5 FINISHES, GENERAL

- A. Comply with NAAMM's Metal Finishes Manual for architectural metal products for recommendations for applying and designating finishes.
- B. Panel Finishes:TBD

PART 3 – EXECUTION

3.1 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation. Panel substructure shall be level and plumb. Panel substructure shall be structurally sound as determined by that subcontractor's engineer. Panel substructure shall be free of defects detrimental to work and erected in accordance with established building tolerances. Coordinate delivery of such items to project site.

3.2 INSTALLATION

- A. Panels shall be installed using standard accepted commercial trade practices which include.
 - 1. Flexible setting blocks at the quarter points of each panel and in a width equal to the panel thickness.
 - 2. Panels to be sealed with Class A grade sealants.
 - 3. Butt Glazing is not recommended.
 - 4. Weep holes, for proper draining of the frames are required on all installations.
S5000
 - 5. The entire panel perimeter should be engaged into the framing system a minimum of ½". (5/8" if panel size has 32 sq. ft. or more)
 - 6. DO NOT use mechanical fasteners through the panel face as such fasteners interfere with thermal expansion and contraction of the panel skin which may cause "Blistering"
- B. Panels shall be erected in accordance with approved shop drawings.
- C. Installing contractor shall furnish all materials required for setting.
- D. Where aluminum materials come in contact with dissimilar materials, an isolation shim or tape shall be installed at fastening locations.

3.3 CLEANING AND PROTECTING

- A. Clean exposed surfaces of wall panels that are not protected by temporary covering to remove fingerprints and soil during construction period.



- B. Clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Protect wall panels from damage during construction. Use temporary protective coverings where needed as approved by the wall panel manufacturer.
- D. Clean and touch up minor abrasions in finished with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION



SECTION 07 45 13

STRUCTURAL RE-ENFORCED INSULATED PANEL SYSTEM

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. This Section includes the following:
 - 1. Panelized composite structure combining light gauge galvanized steel framing and expanded polystyrene insulation for use as floor and roof.
- B. Related Sections:
 - 1. Division 08 Section "Glazed Curtain Wall:
 - 2. Division 23 for radiant floor heating

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Structurally insulated panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Design each structurally insulated panel assembly type, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of insulated structural panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop-, and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:10):
 - a. Anchorage systems.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Structural Insulated Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, battens, closures, and other structurally insulated panel accessories.
 - 2. Trim and Closures: 12 inches (300 mm) long. Include fasteners and other exposed accessories.



3. Accessories: 12-inch- (300-mm-) long Samples for each type of accessory.

a. Composite Panels

- D. Delegated-Design Submittal: For structurally insulated panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Coordination Drawings for Panel Assembly: Exterior elevations, drawn to scale, and coordinating penetrations and mounted items. Show the following:
 - 1. Panels and attachments.
 - 2. Penetrations by pipes and utilities.
- F. Qualification Data: For installer, professional engineer and testing agency.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- H. Maintenance Data: For insulated-core of structurally insulated panels to include in maintenance manuals.
- I. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- C. Source Limitations: Obtain structurally insulated panel from single source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide structurally insulated panels and system components with the following fire-test-response characteristics as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
 - 1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E 119.
 - 2. Fire-test Response Characteristics pr ASTM E 84:
 - a. Flame Spread index: 25 or less
 - b. Smoke developed index: 450 or less
- E. Mockups for Structurally insulated Panel Structure: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
- F. Pre-installation Conference: Conduct conference at location TBD.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, structurally insulated panel Installer, structurally insulated panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects structurally insulated panels including installers of doors, windows, and louvers.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.



3. Review methods and procedures related to structurally insulated panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for structurally insulated panel assembly during and after installation.
8. Review panel observation and repair procedures after structurally insulated panel installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, structurally insulated panels, and other manufactured items so as not to be damaged or deformed. Package structurally insulated panels for protection during transportation and handling.
- B. Unload, store, and erect structurally insulated panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack structurally insulated panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store structurally insulated panels to ensure dryness, with positive slope for drainage of water. Do not store structurally insulated panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on structurally insulated panels for period of structurally insulated panel installation.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of structurally insulated panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of structural members and opening dimensions by field measurements before structurally insulated panel fabrication, and indicate measurements on Shop Drawings.

1.8 COORDINATION

- A. Coordinate structurally insulated panel assemblies with rain drainage work, flashing, trim, and construction of studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Product Therma Steel

2.2 STRUCTURALLY INSULATED-CORE PANEL SYSTEM

- A. Total Panel Thickness: 7 1/2 inches
- B. Core: Modified expanded polystyrene
- D. Glue: The glue bonds insulation and framing



B. Studs and 2 inch x 1 inch top and bottom angles:

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
2. 24 gauge steel
3. Design Thickness: 0.0219 inch
4. Design Weight: 1.0 PSF
5. Modulus of Elasticity: 29, 500 KSI
6. Inside Bend Radius: 3/32 inch
7. Other framing components vary in gauge

2.3 FABRICATION

- A. Each panels has a steel overlap strip along the vertical edge at the outside face to overlap the edge of the next panel approxiamtley 3/4 inch
- B. Fabricate structurally insulated panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, structurally insulated panel supports, and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Follow manufacturer's instructions

3.3 CLEANING AND PROTECTION

- A. Remove temporary bracing
- B. After structurally insulated panel installation, clear channels of obstructions, dirt, and sealant.
- C. Replace structurally insulated panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION



SECTION 07 54 23

THERMOPLASTIC-POLYOLEFIN ROOFING

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 WORK INCLUDED

- A. Furnish and install a mechanically attached roofing system, insulation, flashings, and related metal work, in accordance with Drawings and Specifications, and as approved by Manufacturer.
- B. Related Sections include the following:
 - 1. Division 05 Section "Cold Formed Metal Framing".
 - 2. Division 07 Section "Applied Air/Vapor Barriers"

1.3 REFERENCES

- A. U.L. Class A
- B. Factory Mutual

1.4 SYSTEM DESCRIPTION

- A. White, scrim reinforced Ethylene propylene based elastomeric sheet roofing membrane and system accessories. System to be mechanically attached to roof deck at fastener row spacing of membrane not to exceed 60 inches.

1.5 SUBMITTALS

- A. Submit Manufacturer approved shop drawings showing roof plan with all penetrations and non-typical details and specifications prior to job start.
- B. Submit certification that installer is a Manufacturer Approved Applicator, with a minimum of three years experience with the specified roof system.
- C. Submit U.L. Class A references/ approvals for the assembly to be installed.
- D. Submit samples of roofing membrane, insulation, and related products.
- E. Submit testing or proof of resistance to chemicals or materials that may deteriorate the membrane.

1.6 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in mechanically attached, reinforced, calendared Ethylene Propylene membranes with ten years experience with proposed membrane.
- B. Certify that the manufacturer meets the experience and physical properties specified



- C. Applicator: A company approved by Manufacturer, and specializing in single-ply roofing systems with at least ten (10) installations of similar scope and nature within the past three years. All roofing and related work is to be installed by the contracting company.
- D. Inspection: Upon completion of the installation, a certified technical representative, unrelated to the sales department of the manufacturer, or the contractor shall inspect the roofing system to determine that it has been installed according to the Manufacturer's published specifications and details. Upon approval of the project by Manufacturer, a warranty shall be written.
- E. Changes or deviations from this Specification shall be approved in writing by Manufacturer, and be acceptable to the Architect and Owner.

1.7 DELIVERY, STORAGE, HANDLING

- A. Deliver products to site in unopened containers showing brand names and instructions.
- B. Store and protect temperature sensitive products in 55 to 80 degree F environment prior to usage. Store flammable or toxic material according to label instructions.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Dow Roofing Systems 60 mil white TPO membrane

2.2 MATERIAL

- A. Scrim reinforced Ethylene Propylene . Provide with the following performance characteristics
- B. Physical Properties

Physical property	Test method	Specification
Weight, minimum (Mass)	ASTM D-751	0.24 lbs./ft' (1.41 Kg/M2)
Thickness tolerance	ASTM D-751	60 mil ±10%
Breaking strength, minimum	ASTM D-751, Grab Method	225 lbs.
Tear Strength, minimum	ASTM D-751, Tongue Tear	100 lbf.
Vapor transmission	ASTM E-96	.035 perms
Elongation*	ASTM D-412	500%
Hydrostatic resistance, minimum	ASTM D-751 Method A	350 psi
Ozone resistance*	ASTM D- 1149 70 hrs. @ 100 F.	Pass
Emmaqua® concentrated natural sunlight, 4 million langleys	ASTMG-90	No visible surface cracking or stiffening
Dimensional stability	ASTM D-1204	0.3%
Puncture resistance, minimum	FTM 101 B, Method 2031	450 lbs.
Test performed on nonreinforced material		



2.3 ROOFING SYSTEM

- A. Elastomeric Sheet Material: Membrane shall be 80 mil overall thickness, white Ethylene propylene membrane reinforced with a polyester scrim encapsulated in membrane compound.
- B. Mechanically attached System: Provide membrane manufacturer's approved system of plates and fasteners for attachment of the membrane to substrate at sheet perimeter and at intermediate locations to meet Warranty requirement for wind uplift.

2.4 ACCESSORY MATERIALS

- A. Flashing: Same membrane as Roofing. For field fabricated vent stacks, pipes and corners provided unreinforced 55 mil thick white Ethylene propylene.
- B. Bonding Adhesive: As provided by Manufacturer to hold flashings in place.
- C. Sealant: Provide to serve as a water cut-off mastic, pitch-box sealer, and to caulk Ethylene Propylene membrane edge to metal.
- D. Primer: For preparing contaminated membrane for hot-air welding.
- E. Seam Caulk: Shall be provided for the purpose of sealing any non-encapsulated edge of reinforced membrane.
- F. Sealants: Sealants not a part of the Roofing System shall be compatible with Ethylene Propylene materials and applied according to manufacturer's instructions.
- G. Mechanical Fasteners: Manufacturer provided fasteners designed for use on Project roof deck.
- H. Slip sheets or cover board as may be required for fire ratings, or warranty requirements.
- I. Install per manufacturer's instructions above or below rigid insulation.
- J. Roof Walkways: Provided walkways over membrane at all mechanical units on service side.
- K. Insulation: Rigid roof insulation as specified and shown on drawings. Insulation shall be acceptable to membrane manufacturer. Install tapered insulation as required for positive drainage. Install a minimum ¼" cover board either below or above insulation. Cover board shall be Dens Deck or equal. Insulation R values are to be per 2003 LTTR standards.
- L. Nailers: No. 2 or better, pressure preservative treated lumber using CCA preservatives.
- M. Metal Copings and wall flashings: 24 gauge pre-finished metal for use on project roof. Color choice by Owners representative from standard color finishes. Attach per SMACNA standards and to membrane manufacturers requirements, attachment shall be included in warranty. Note that internal wall flashings not visible from the ground may be manufactured from 24 gauge galvanized metal, or manufacturers termination bar.

PART 3 – EXECUTION

3.1 INSPECTION

- A. The roofing contractor shall be responsible for suitable substrate to accept the New roof system.



- B. Installer of flexible sheet roofing system shall examine substrate and conditions under which roofing work is to be performed and shall notify the Architect and Owner immediately of unsatisfactory conditions. Do not proceed with roofing work until unsatisfactory conditions have been corrected in manner acceptable to installer and manufacturer.

3.2 PREPARATION OF SUBSTRATE

- A. General
 - 1. Deck: Prepare deck to receive roof system. Notify Owners representative immediately of any and all deficiencies that may impact installation or performance of roof system. Start of work shall be considered acceptance of the deck and site conditions.
 - 2. Nailers: Treated for decay resistance. Wood nailers shall be installed at gravel stops or drip edges on outside perimeter of buildings as needed.

3.3 INSTALLATION

- A. General: Comply with manufacturer's written instruction for installation of the flexible sheet membrane.
- B. Insulation: Mechanically fastened in accordance with manufacturers requirements. Insulation to be provided as specified in paragraph 2.04 L.
- C. Attachment: Insulation must be recommended by its manufacturer for mechanical attachment. All boards must be mechanically attached by approved plates and fasteners Install cover boards or slip sheets as required for warranty and code approval.
- D. Roof membrane Installation:
 - 1. Accommodate contours of roof deck to drain across shingled laps of sheets. Do not stretch membrane prior to attachment.
 - 2. Install membrane by unrolling over prepared substrate, Apply fasteners and plates per manufacturers requirements for warranty and FM I-90. Fastener row spacing shall not exceed 76" between fastener rows. Lap adjoining sheets and heat seal, as recommended by the manufacturer. Seal all non-encapsulated edges with seam caulk.
- E. Flashing: Flash perimeter, curb, vents, expansion joints, drains, and other details in compliance with manufacturer's standard published details.
- F. Check and repair seams at the completion of work each day.
- G. Temporarily seal loose edge of membrane with approved overnight seal at the end of each day to comply with manufacturer's instructions, and to maintain a watertight building.
- H. Walkway Protection: Install specified walkway protection, where required, and at roof access areas and around roof mounted equipment.
- I. Inspect roofing and repair of bonding defects, raised or exposed fasteners, loose flashings, or other deficiencies.
- J. Attach new pre-finished metal work at all parapets and walls as required by membrane manufacturer for warranty. All parapet metal work shall have a continuous cleat attachment on the outside face of the parapet wall, or roof edge.



- K. Notify Architect and Owner to arrange for final inspection and acceptance of the work performed. Please note that visual aesthetics are a function of the roof. Excessive wrinkling, patching, and other issues as identified by the owner/architect are the responsibility of the roofing contractor to repair at no additional expense to the owner.

END OF SECTION



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SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

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. Provide labor, materials, equipment and services, and perform operations required for installation of sheet metal flashing and trim and related work as indicated on the drawings and specified herein.
- B. Work Included: Work of this section shall include, but not be limited to, the following:
 - 1. Sheet metal counter flashings.
 - 2. Miscellaneous flashings where indicated on Drawings.
- C. Related Work Specified Elsewhere
 - 1. Division 06 Section "Miscellaneous Rough Carpentry"
 - 2. Division 07 Section "Joint Sealants "
 - 3. Division 07 Section "TPO Roofing".
 - 4. Division 08 Section "Glazed Aluminum Curtain Wall"

1.3 QUALITY ASSURANCE

- A. Materials and work shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.
- B. Fabrication and installation of metal flashing shall comply with the "Architectural Sheet Metal Manual" by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

1.4 SUBMITTALS

- A. Product Data: Copies of manufacturer's latest published literature for materials specified herein shall be submitted for approval, and approval obtained before materials are delivered to the site.
- B. Shop Drawings: Submit shop drawings for work specified herein for approval, and obtain approval before materials are delivered to the job site.
- C. Samples: Samples of materials specified herein shall be submitted for approval, and approval obtained before materials are delivered to the site.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials in strict accordance with manufacturer's recommendations.



PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
 - 1. Exposed Coil-Coated Finishes: Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions
- B. Fasteners: Stainless steel.
- C. Bituminous Coating: SSPC - Paint 12, solvent-type bituminous mastic, nominally free of sulfur, compounded for 15 mil dry film thickness per coat.
- D. Mastic Sealant: Polyisobutylene, nonhardening, nonskinning, nondrying, nonmigrating sealant.
- E. Adhesives: Type recommended by flashing sheet manufacturer for waterproof/weather-resistant seaming and adhesive application of flashing sheet.
- F. Elastomeric Sealant: Generic type recommended by manufacturer of metal and fabricator of component being sealed and complying with requirements for joint sealants as specified in Section "Joint Sealers".
- G. Epoxy Seam Sealer: 2 part noncorrosive metal seam cementing compound, recommended by metal manufacturer for exterior/interior nonmoving joints including riveted joints.
- H. Reglets: Metal or plastic units of type and profile indicated, compatible with flashing indicated, noncorrosive.
- I. Metal Accessories: Provide sheet metal clips, straps, anchoring devices and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gauge required for performance.
- J. Elastic Flashing Filler: Closed-cell polyethylene or other soft closed-cell material recommended by elastic flashing manufacturer as filler under flashing loops to ensure movement with minimum stress on flashing sheet.

2.2 FABRICATION

- A. Shop fabricate work to greatest extent possible. Comply with details shown and with applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry practices. Fabricate for waterproof and weather-resistant performance, with expansion provisions sufficient to permanently prevent leakage, damage or deterioration of the work. Form work to fit substrates. Comply with material manufacturer instructions and recommendations for forming material. Form exposed sheet metal work without excessive oil-canning, buckling and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.
- B. Fabricate nonmoving seams in sheet metal with flat lock seams. For metal other than aluminum, tin edges to be seamed, form seams, and solder. Form aluminum seams with epoxy seam sealer; rivet joints for additional strength where required.



- C. Where lapped or bayonet-type expansion provisions in work cannot be used or would not be sufficiently water/weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- D. Where movable, nonexpansion type joints are indicated or required for proper performance of work, form metal to provide for proper installation of elastomeric sealant, in compliance with SMACNA standards.
- E. Separations: Provide for separation of metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with bituminous coating or other permanent separation as recommended by manufacturer/fabricator.

2.3 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Aluminum
 - 1. Finish: Pre-painted
 - 2. Surface: Smooth, flat.
- B. Counterflashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.032 inch thick.
- C. Roof-Penetration Flashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.028 inch thick.
- D. Custom Gravel Stop:
 - 1. Stainless Steel: 0.050 inch thick
- E. Roof-Drain Flashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.016 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Examine the Contract Drawings and Specifications in order to ensure the completeness of work required under this Section.

3.3 INSTALLATION

- A. Comply with applicable recommendations and details of the "Architectural Sheet Metal Manual" by SMACNA, approved manufacturer's recommendations and approved shop drawings.
- B. Provide for thermal expansion of work for more than 15 feet (4575 mm) continuous length. Maintain a watertight installation at expansion seams. Locate expansion seams at maximum 10 foot (3050 mm) intervals and 2 feet (610 mm) each side of corners and intersections.



- C. Provide watertight expansion joints. Form joints to completely conceal splice plates. When ambient temperature is moderate at the time of installation (40 to 85 degrees F), set joint for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install joints at temperatures below 40 degrees F.
- D. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide neat and uniform seams.
- E. Clean exposed surfaces of every substance which is visible or might cause corrosion of the metal surfaces.
- F. Anchor flashings to substrates as indicated and in accordance with approved shop drawings. Seal penetrations.

3.4 CLEANING AND PROTECTION

- A. Upon completion of the work, remove from the site unused materials, containers, equipment, etc. Protect surfaces and adjacent surfaces from stains, marring or other damage. Repair any damage and leave work and the adjacent surfaces in a clean and undamaged condition.
- B. Protect completed work from damage by subsequent building operations and effects of weather. Protect the work by methods recommended by the manufacturer of installed materials and approved by the Architect.

END OF SECTION



SECTION 07 92 00

JOINT SEALANTS

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. Work Included:
 - 1. Sealants for exterior joints in vertical surfaces and nontraffic horizontal surfaces.
 - 2. Sealants for exterior joints in horizontal traffic surfaces.
 - 3. Sealants for interior joints in vertical surfaces and nontraffic horizontal surfaces.
 - 4. Sealants for interior joints in horizontal traffic surfaces.
 - 5. Other joints as indicated.

1.3 REFERENCES

- A. ASTM C834 - Standard Specification for Latex Sealing Compounds.
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- E. ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- F. ASTM D1565 - Standard Specification for Flexible Cellular Materials--Vinyl Chloride Polymers and Copolymers (Open-Cell Foam).
- G. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
- H. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for concrete Pavements.
- I. ASTM C 1330 - Standard Specification for Cylindrical Sealant Backing For Use With Cold Liquid Applied Sealants.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants, with proper industry standard aspect ratios, that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates. All elastomeric joint sealants shall be chemically compatible with their substrate assemblies.



1.5 SUBMITTALS

- A. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation including required primers, temperature and humidity limits, color availability and cure time.
- B. Schedule: Submit a Schedule of Joint Sealers to be used for the project. Include interior and exterior sealants applied in the field and, where appropriate, applied in the shop. For each sealant listed, include sealant type, applicable substrates, and sealant number (as indicated in the specification).
- C. Samples: Submit three (3) samples, 6-inch long illustrating sealant colors for selection.
- D. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, perimeter conditions requiring special attention, recommended backer rods, and requirements for curing.

1.6 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum five (5) years documented experience, and approved by manufacturer.
- D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field-test their adhesion to joint substrates as follows:
 - 1. Notify Architect seven days in advance of dates and times when test joints will be erected.
 - 2. Arrange for tests to take place with joint sealant manufacturer's technical representative present.
 - 3. Test joint sealants by hand-pull method test or methods recommended in ASTM C 1193.
 - 4. Do not use sealants that fail to adhere to joint substrates during testing.
 - 5. Sealant joints in mockups of assemblies specified in other shall be tested in accordance with this Section.
- E. Preinstallation Conference: Conduct conference at Project site with Contractor, Architect, sealant manufacturer, sealant contractor, wall cladding contractor, curtain wall and window contractor to discuss sealant locations, colors, installation procedures, compatibility of sealants with substrates, co-ordination between trades and scheduling.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site, in original unopened containers, clearly indicating manufacturer's name, brand name, and other identifying information.
- B. Materials shall be stored in a dry location, off the ground and in such a manner as to prevent freezing, damage and the intrusion of foreign matter.
- C. Materials which have become damaged or otherwise unfit for use during delivery, or storage, shall be replaced at the expense of the Contractor.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:



1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturers.
 2. When joint substrates are wet due to rain, frost, condensation, or other causes.
- B. Joint Width Conditions: Do not proceed with installation of joint sealers where joint widths are less than allowed by the joint sealant manufacturer for the application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.9 MOCK-UP

- A. Provide mock-up of sealant joints in conjunction with window, wall, and copings under provisions of Division 01 Section "Quality Assurance".
- B. Construct mock-up with specified sealant types and with other components noted.
- C. Locate where directed.
- D. Subject to Architect's approval mock-up may remain as part of the Work.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.11 COORDINATION

- A. Coordinate the work with all sections referencing this section.

1.12 WARRANTY

- A. Division 01 Section "Warranties".
- B. Correct defective work within a five (5) year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories which fail to achieve watertight seal, discolor, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.1 HIGH PERFORMANCE EXTERIOR SEALANT

- A. Type JS-1: Silicone, One part, neutral cure; ASTM C920, Type S, Grade NS, Class 50, with movement capability of $-50/+50\%$, Uses NT, G, A and O; ASTM C1184 for structural silicone sealants.
 1. 795 Silicone Building Sealant; Dow Corning Corp.
 2. Color as selected by Architect, including standard and custom colors.

2.2 EXTERIOR SEALANT

- A. Type JS-2: Silicone, single component non-acid curing; ASTM C920, Type S, Grade NS, Class 100/50, with movement capability of $-50/+100\%$, Uses T, NT, M, G, A and O. Fire Tests of Building Construction and Materials, UL 263 (ASTM E 119).



1. 790 Silicone Building Sealant; Dow Corning.
2. Color as selected by Architect, including standard and custom colors.

2.3 EXTERIOR EXPANSION JOINT SEALANT

- A. Type JS-4: Precompressed expanding foam sealant with integral low-modulus silicone coating. Provide one of the following:
1. Colorseal; Emseal Joint Systems, Ltd.
 2. Approved equal.

2.4 EXTERIOR METAL LAP JOINT SEALANT

- A. Type JS-5: Butyl or Polyisobutylene, non-drying, non-skinning, non curing; ASTM C920, Grade NS, Class 12-1/2, Uses M, A, and O. Provide one of the following:
1. Chem-Calk 300; Bostik
 2. Approved equal.

2.5 EXTERIOR HORIZONTAL TRAFFIC JOINT SEALANT

- A. Type JS-6: Self-leveling polyurethane, two-part; ASTM C920, Type M, Grade P, Class 25, Uses M, and O with shore A hardness of 30-40. Provide one of the following:
1. Chem-Calk 550; Bostik
 2. Permopol RC 270 SL; PRC
 3. Urexpan NR 201; Pecora
 4. Sikaflex 12SL; Sika Corp.
 5. Sonolastic 2C SL; Sonneborn Building Products

2.6 INTERIOR GENERAL PURPOSE JOINT SEALANT

- A. Type JS-7: Polyurethane, single component, non-sag; ASTM C920, Grade NS, Class 25, Uses M, G, and A. Provide one of the following:
1. Chem-Calk 900; Bostik
 2. Chem-Calk 550; Bostik
 3. Approved equal.

2.7 INTERIOR PAINTABLE JOINT SEALANT

- A. Type JS-8: Acrylic Latex, one-part, non-sag, mildew resistant; ASTM C834, Grade NS, Class 12-1/2, Uses M, G, and A. Provide one of the following:
1. Chem-Calk 600; Bostik
 2. AC-20; Pecora Corp.
 3. Acrylic Latex 834; Tremco



2.8 INTERIOR SANITARY SEALANT

- A. Type JS-9: Silicone, single component, mildew-resistant, Type M, Grade NS, ASTM C 920, Class 25, for sanitary applications.
 - 1. 786; Dow Corning.
 - 2. Silicone Sanitary 1700; General Electric Co.
 - 3. Chem-Calk 1200 Bathroom Calk; Bostik.

2.9 INTERIOR HORIZONTAL TRAFFIC JOINT SEALANT

- A. Type JS-10: Polyurethane, single component self-leveling; ASTM C834, Type S, Grade P, Class 25, Uses M, G, and A. Provide one of the following:
 - 1. Chem-Calk 900; Bostik
 - 2. Approved equal.

2.10 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type 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 type, size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F (minus 32 deg C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- D. 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 where such adhesion would result in sealant failure.

2.11 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces and joint openings are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

- A. Remove loose materials and foreign matter which might impair adhesion of sealant.



- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Protect elements surrounding the work of this section from damage or disfiguration.

3.3 INSTALLATION

- A. Joint widths shall be designed for anticipated movement but shall be a minimum of 3/8 inches wide.
- B. Perform installation in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- C. Perform installation in accordance with ASTM C1193.
- D. Perform acoustical sealant application work in accordance with ASTM C919.
- E. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- F. Install bond breaker where joint backing is not used.
- G. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- I. Tool joints concave unless otherwise indicated.
- J. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.
- K. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as follows:
 - 1. Perform 10 tests for the first 1000 feet (300 m) of joint length for each type of elastomeric sealant and joint substrate.
 - 2. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.
 - 3. Test Method: Test joint sealants by hand-pull method or tests recommended in ASTM C 1193.
 - 4. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.
 - 5. Inspect tested joints and report on whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively, whether sealants filled joint cavities and are free from voids, and whether sealant dimensions and configurations comply with specified requirements.
 - 6. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - 7. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints.



- B. Evaluation of Field-Test Results: Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean adjacent soiled surfaces.

3.6 PROTECTION OF FINISHED WORK

- A. Protect sealants until cured.

3.7 SCHEDULE

- A. JS-1 - Exterior joints as follows:
 - 1. Joints in stone panels.
 - 2. Joints in cast stone panels.
 - 3. Joints in metal panels.
 - 4. Butt joints for insulated glazing units.
 - 5. Structural silicone glazing to adhere insulated glazing units to mullions of curtain wall and ribbon windows.
 - 6. Joints between aluminum and metal panels or stone and cast stone.
- B. JS-2 - Control, Expansion, and Soft Joints in Masonry, and Between Masonry and Adjacent Work:
- C. JS-1 or JS-2 - Exterior Joints for Which No Other Sealant Type is indicated. Colors as selected by Architect.
- D. JS-4 - Exterior Wall Expansion Joints:
- E. JS-5 - Lap Joints in Exterior Sheet Metal Work:
- F. JS-6 - Control and Expansion Joints in Paving:
- G. JS -7 - Interior Joints for Which No Other Sealant is indicated: Colors as selected.
- H. JS-7 or JS-8 - In STC-Rated Walls, Between Metal Stud Track/Runner and Adjacent Construction , Between Outlet Boxes and Gypsum Board:
- I. JS-9 - Joints between Plumbing Fixtures and Walls and Floors, and Between Countertops and Walls: Colors as selected by Architect.
- J. JS-10 - Control and Expansion Joints in Interior Concrete Slabs and Floors: Colors as selected by Architect.

END OF SECTION



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SECTION 08 14 07**WOOD DOORS****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. Work Included: The work of this section shall include, but not be limited to the following:
1. Solid Core Flush Doors.
 2. Hardware for Doors
- B. Related Work Specified Elsewhere
1. Division 06 –Interior Architectural Woodwork:For staining of doors

1.3 REQUIREMENTS OF REGULATORY AGENCIES

- A. Comply with the label requirements of NFPA and UL. Fabricate doors in accordance with requirements of NFPA No. 80 for the class of door opening corresponding to the hourly rating shown.

1.4 QUALITY ASSURANCE

- A. Materials shall conform to the latest edition of reference specifications and industry standards listed below and specified herein and to applicable codes and requirements of local authorities having jurisdiction. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:
1. AWI "Quality Standards, Section 1300, Architectural Flush Doors, Premium Grade"
 2. USDOC "Commercial Standard 171, Hardwood Veneered Doors"
 3. NWWDA "Wood Flush Doors Standard NWWDA I.S.1"
 4. ANSI "Standard for Hardwood and Decorative Plywood ANSI/HPMA HP"

1.5 SUBMITTALS

- A. Samples: Submit samples of door specified showing construction, finish, color and specular gloss selected. Samples shall be 12 inch by 12 inch (305 mm by 305 mm) corner section. Submit samples of acoustical hardware accessories.
1. Submit sample, 8 inch square, of veneer for wood door.
- B. Shop Drawings: Submit shop drawings for all wood doors. Drawings shall show types of material, details of cutouts, location and extent of hardware blocking, sizes, fire ratings, finishes and other pertinent data.



C. Certificates

1. Submit manufacturer's certification that all wood doors are manufactured to requirements of NWWDA I.S.1 Industry Standard for Wood Flush Doors and that they bear the NWWDA Wood Flush Door Certification Hallmark.

- D. Warranty: Submit manufacturer's standard door warranty for the life of the original installation. Warranty shall provide for removal of defective door and replacement and finishing of new door, including installation as originally specified. A representative of the door manufacturer shall inspect the installed doors and shall note on the warranty that no provisions of the guarantee have been nullified in the manufacture and/or installation.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Package prefinished doors and panels in heavy duty cartons at the factory prior to shipment, suitable to protect doors against damage during handling, transit and storage. Mark units with identification for proper location corresponding to the Contract Document door number/location identifications. Doors shall remain in cartons until hanging.
- B. Do not deliver materials in wet weather. Arrange for delivery to coincide with building management operations. Do not upon delivery, piled units directly on concrete slabs or floors without providing ample supports holding them at least 6 inches (150 mm) above slabs or floors. Do not store in basement or subgrade spaces unless temperature and humidity requirements of the manufacturer are strictly adhered to. Store in a dry place, protected from the weather. Stack in accordance with manufacturer's directions.
- C. Do not deliver wood doors until painting wet work, taping and spackling of gypsum board, and similar operations which could damage, soil or deteriorate wood doors, have been completed in installation areas. Store wood doors only in areas meeting requirements specified for installation areas.

1.7 PROJECT CONDITIONS

- A. Do not install wood doors until required temperature and relative humidity have been stabilized and will be maintained in installation areas.
- B. Maintain temperature and humidity in installation areas as required to maintain moisture content of installed wood doors within a 1.0 percent tolerance of optimum moisture content, from date of installation through remainder of construction period. The fabricator of wood doors shall determine optimum moisture content and required temperature and humidity conditions.

1.8 WARRANTY

- A. Warranties shall be in addition to, and not a limitation of other rights the owner may have under the contract documents.
- B. Submit written warranty on manufacturer's standard form signed by the manufacturer agreeing to replace or repair defective doors which have:
1. Delamination in any degree.
 2. Warp or twist of 1/4" or more in any door face.
- C. Contractor shall replace or refinish doors where contractor's work contributed to rejection or voiding of manufacturer's warranty.
1. Solid core interior doors shall be warranted for the life of their installation.



PART 2 - PRODUCTS

2.1 MATERIALS

- A. Particle Board Core: Single thickness slab of 3 ply particle board complying with ANSI A208.1, Grade 1-L-1, average density not less than between 28 to 32 pcf, hot pressed with synthetic resin glue. Linear expansion shall not exceed 0.03% in either direction when tested in accordance with ASTM D1037, Sections 76 through 79. Faces of core slab shall be of 0.010 inch thick flakes, with resin content a minimum of 50% higher than core resin content. Face layer density shall be a minimum of 25% higher than core density.
- B. Top and Bottom Edge Bands: Thoroughly kiln dried hardwood, free from defects which will be visible when finished as specified herein.
- C. Blocking: Manufacturer's standard designed for purpose intended.
- D. Side Edge Bands: Thoroughly kiln dried hardwood, free from defects which will be visible when finished as specified herein
- E. Type II Adhesive: CS35, Type II (water-resistant bond).
- F. Primer: Alkyd type primer sealer as standard with door manufacturer.

2.2 FABRICATION

- A. General: All doors and panels shall be 1-3/4 inch (45 mm) thick unless otherwise shown.
- B. Non Fire Rated Construction: AWI 1300 G-3 PC-5, PC-7 or PC-HPDL.
 - 1. Core: Solid particleboard. Particleboard: ANSI A208.1, Grade LD-1 or Grade LD-2, made with binder containing no urea-formaldehyde resin].
 - 2. Vertical Stiles: Minimum 1-3/8 inch (35 mm) wide after trimming, 2 ply construction without fingerjoints, consisting of 5/8 inch (16 mm) thick outerband (specie matching or compatible with face veneer) and 3/4 inch (20 mm) thick mill option hardwood innerband.
 - 3. Top and Bottom Rails: Minimum 1-3/8 inch (35 mm) wide after trimming, 2 ply construction without fingerjoints.
 - 4. Crossbands: Full width of door with grain running horizontally, tapeless spliced without voids.
 - 5. Face Veneer: As specified, laminated to crossband and edges.
 - 6. Bonding
 - a. Core to stiles, rails and blocking: Type II adhesive.
 - b. Face veneers and crossbands to core and edges: Type I adhesive by hot plate process.
- C. Prefit Doors.
 - 1. Prefit and bevel doors shop to fit openings.
 - 2. Prefit Tolerances: AWI Section 1300

2.3 DOOR TYPES

- A. Doors to receive hardwood face veneers for natural finish (conversion varnish or thermoplastic film) or to receive high density overlay face veneers for polyvinyl fluoride film finish shall be Type I construction.

2.4 FINISHING



- A. General: Comply with applicable provisions and requirements of AWI Section 1500, Factory Finishing, Premium Grade.
- B. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
- C. Transparent veneer and finish to match Architectural Wood Work pickled finish..

2.5 HARDWARE

- A. General: As shown on Hardware Schedule.
- B. Hawa Junior 120 Track suitable for specific installation

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine doors and door frames, adjoining construction and the conditions which the Work is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected. Do not hang doors with an apparent defect.
- B. Ensure frames are solidly anchored, allowing no deflection when doors are installed
- C. Ensure frames are plumb, level, square, and within tolerance.

3.2 INSTALLATION

- A. Do not install doors until all wet work is completed and dried in the areas to receive doors.
- B. Doors shall be conditioned to the average prevailing moisture (humidity) of the locality before hanging. Doors shall not be subjected to abnormal heat, dryness, moisture or humidity. Avoid sudden changes such as forced heat (used to dry out the building).
- C. Cutting, trimming, fitting and machining of factory finished doors will not be permitted.
- D. Cut and trim factory prime finished doors to fit required openings with clearances required at head, jambs and sill for construction indicated. Machine doors and panels for hardware using hardware templates. Touch-up prime coat of paint including stile and rail edges and cutouts.
- E. Install doors in required openings as shown. Install flush panels with concealed fasteners. Provide pilot holes of proper size for screws into particle board core doors. Use stainless steel sheet metal screws into particle board.
- F. Apply hardware in accordance with hardware manufacturer's instructions. Adjust door installation to provide uniform clearance at head and jambs, and to contact stops uniformly. Remove and replace doors which are found to be warped, bowed or otherwise damaged and cannot be properly fitted in frames.

3.3 PROTECTION

- A. Protect doors and hardware during construction. Marred finishes shall be touched-up to perfectly match adjacent surfaces to the satisfaction of the Architect or unit shall be replaced.

END OF SECTION



SECTION 08 42 00

ENTRANCES

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 WORK INCLUDED

- A. Work Included: The Work of this Section shall include, but not be limited to, the following:
 - 1. Engineered folding wood door system.
- B. Related Work:
 - 1. Division 08 44 00 "Curtain Walls
 - 2. Division 08 80 00 "Glass Glazing: For insulated glass.

1.3 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site.
- B. Shop Drawings: Submit shop drawings for work specified herein for approval and obtain approval prior to fabrication and shipment of materials to the job site.
- C. Samples: Samples of materials specified herein and shall be submitted for approval, and approval obtained before materials are delivered to the site.

1.4 QUALITY ASSURANCE:

- A. Manufacturer: Provide complete, precision built, engineered, pre-fitted unit by a single source manufacturer with at least 20 years experience in providing sliding door systems for large openings in the North American market. The manufacturer must have a quality system registration to the ISO9001:2008 standard.
- B. Installer Qualifications: Installer experienced in the installation of manufacturer's products or other similar products for large openings. Installer to provide reference list of at least 3 projects of similar scale and complexity successfully completed in the last 3 years
- C. Performance Requirements: Provide from manufacturer that has independently testes typical units. Testing results to include air infiltration in accordance with ASTM E 283, water penetration in accordance with ASTM E 547, structural loading in accordance with ASTM E 330, and forced entry in accordance with AAMA 1303.5 and CAWM 300-96.
- D. Thermal Performance U value: Unit to be rated, certified and labeled in accordance with NFRC 100, shown in manufacturer's latest published data for the glazing, sill and direction of opening specified.
- E. Solar Heat Gain Coefficient: Unit to rated, certified and labeled in accordance with NFRC 200, shown in manufacturer's latest published data for the glazing, sill, and direction of opening specified. .



1.5 WARRANTY

- A. Provide manufacturer's standard warranty against defects in materials and workmanship.
- B. Warranty Period: Ten years for rollers and for seal failure of insulated glass supplied. For all other components, one year (two years if unit is installed by manufacturer's certified trained installer) from date of delivery by manufacturer.

1.6 SITE CONDITIONS, DELIVERY, STORAGE AND HANDLING

- A. In addition to general delivery, storage and handling requirements specified in Section 01600, comply with the following:
 - 1. Deliver materials to jobs site in sealed, unopened cartons or crates. Protect units from damage. Store material under cover, protected from weather and construction activities.
- B. Condition wood components to average prevailing relative humidity before installation.
- C. Do not subject wood components to extreme nor rapid changes in heat or humidity.
- D. Do not use forced heat to dry out building.
- E. Store flat in dry, well ventilated area out of direct sunlight.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. NANA WALL SYSTEM, INC. Model WD66.

2.2 COMPONENTS

- A. Frame and Panels: From manufacturer's standard profiles, provide head track, side jambs, panels, and glazing stops with dimensions shown on drawings.
 - 1. Provide panels with: Standard one lite
 - 2. Provide stile and rail width/ depth of 3 1/16" (78 mm)
 - 3. Provide standard bottom rail
 - 4. Type of Wood: Vertical Grain Douglas Fir – PEFC OR Solid, three layer, cross grained, kiln dried Douglas Fir - PEFC
 - 5. Construction of wood panels to include close tolerance mortise and tenon, glued and pinned corners.
 - 6. Wood Finish: Finish to be eco-friendly water based, opened pored.
 - 7. Clear sanding sealer for stain
 - 8. Aluminum Extrusion: Extrusions with nominal thickness of .078" (2.0 mm). Alloy specified as AIMg-Si0.5 with strength rated as 6063-T5 or F-22 (European standard). Anodized conforming to AAMA 611.98.
- B. Locking Hardware and Handles:
 - 1. Main entry panel: On the main entry panel for models with a swing panel, provide manufacturer's standard lever handles on the inside and outside, a Schlage compatible lock set with lockable latch, multi-point locking with a dead bolt and rods at the top and primary panel. Rods to be concealed and



not edge mounted. Depression of handles withdraws latch. Lifting of handles engages rod and turn of key or thumb turn engages deadbolt and operates lock. On the secondary swing panel, provide matching dummy lever handles on both sides and concealed flush bolts that operate and rods at the top and bottom for the secondary swing panel.

- a. Stainless Steel lever handles
 2. On all other secondary swing panels and pairs of folding panels, provide manufacturer's standard flat handles and concealed two point locking hardware operated by 180 degree turn of handle between each pair.
 3. Flat handle finish: stainless steel in a titanium finish.
 4. Provide handle height centered at 41 3/8" (1050 mm) from bottom of panel.
 5. Aluminum locking rods with standard fiber glass reinforced polyamide end caps at top and bottom. Rods to have a stroke of 15/16" (24 mm).
 6. keyed alike, if there is more than one unit,.
- C. Folding Hardware: Provide manufacturer's standard combination folding hardware with top, bottom tracks and threshold. All running carriages to be with sealed, self-lubrication, wall bearing multi-rollers.
1. For each pair of folding panels: For top hung system WD66/u, provide upper guide carriage and lower running carriage with fiber glass reinforced polyamide upper running carriage and lower guide carriage.
 2. Threshold: Provide dark bronze anodized, thermally broken with polyamide, low profile saddle sill for resistance against wind driven rain, and drain connections by others necessary.
 3. Provide manufacturer's standard dark bronze anodized aluminum hinges and spines on each edge of panel. For structural strength, hinges to be connected to spine and not directly into wood. Provide stainless steel security hinge pins with set screws.
 4. Adjustment: Provide folding hardware capable of specified amount of compensation and adjustments without needing to remove panels from tracks, in width 1/8" (3 mm) per hinge and in height, 1/4" up and down.
- D. Weather stripping: Provide manufacturer's standard double layer EPDM or brush seals with a two layer polyamide fin at both the inner and outer edge of door panels or on frame for sealing between panels and between panel and frame.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents in order to insure the completeness of the work required under this Section.
- B. Examine surfaces of openings and verify dimensions; verify rough openings are level, plumb, and square, with no unevenness, bowing, or bumps on the floor.
- C. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 INSTALLATION

- A. Install frame in accordance with manufacturer's recommendations and installation instructions. Properly flash and waterproof around perimeter opening.



- B. Installer to provide appropriate anchorage devices and to securely and rigidly fit frame in place, absolutely level, straight, plumb and square. Install frame in proper elevation, plane and location, and in proper alignment with other work.
- C. If necessary, provide drain connections from lower track.
- D. Install panels, handles and lock set in accordance with manufacturer's recommendations and installation instructions.
- E. If necessary, adjust hardware for proper operation.
- F. Finishing: Field finish under section Finish to match Architect's sample.
- G. Accessories: Screens; install in accordance with screen manufacturer's recommendations and installation instructions.

END OF SECTION



SECTION 08 44 21

TIMBER GLAZED CURTAIN WALLS

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. This Section includes the following:
 - 1. Timber framed curtain wall
 - 2. Operable windows within curtain walls
- B. Related Sections:
 - 1. Division 05 "Structural Steel Framing".
 - 2. Division 06: "Rough Carpentry".
 - 3. Division 05: "Interior Architectural Woodwork
 - 4. Division 07 "Flashing and Trim".
 - 5. Division 07 "Joint Sealants".
 - 6. Division 08 "Entrances"
 - 7. Division 08: "Glass Glazing".

1.3 SYSTEMS DESCRIPTION

- A. Air Infiltration: Shall be no more than 0.02 cubic feet/minute/square at 6.24 pounds/square foot when tested in accordance with ASTM E283.
- B. Water infiltration: No penetration when tested at rate of 5 gallons/hour/square foot and 30 pounds/square foot pressure for 15 minutes when tested in accordance with ASTM E331.
- C. Uniform load deflection: In accordance with ASTM E330, a static air pressure difference of 30 pounds/square foot applied in the positive and negative directions. Maximum deflection of L/175.
- D. Uniform load structural: In accordance with ASTM E330, a minimum static air pressure difference of 45 pounds/square foot shall be applied in the positive and negative directions.
- E. Structural Loads: Refer to Structural Drawings.
- F. Glazing impact test with 110.2 pounds force from 48 inches at center and at corner of glass: No fall-out or breakage.
- G. Thermal insulation down to $U_f = 0.7 \text{ W/m}^2\text{K}$
- H. Wind resistance: positive / negative 2500 Pa / 3200 Pa



1.4 SUBMITTALS

- A. Product data for framing system including connectors, anchors, fasteners, gaskets, and other accessories.
- B. Shop drawings showing elevations, profiles, dimensions, tolerances, components, anchorage, structural reinforcing, method of installation, and sealing.
- C. Structural design: Provide design calculations and details for self-supporting curtain wall, entrances and doors.
- D. Certificates that system have been successfully tested as required.
- E. Documentation from manufacturer and installer qualifications required
- F. Samples:
 - 1. Finishes for selection by architect.
 - 2. 8 inches minimum lengths of mullion and transom frames joined and holding 12 inch by 12 inch glass panel
 - 3. Sealant colors.
- G. Manufacturer's assembly, installation, and maintenance instructions.

1.5 QUALITY ASSURANCE

- A. Manufacturer qualifications: Design, engineering, fabrication, supply of all components for aluminum framing system shall be sole responsibility of single manufacturer with 5 years minimum successful experience. Manufacturer shall have successfully completed a minimum of 5 glazed assemblies of scope, type, and size as proposed project.
- B. Installer qualifications: Company experienced in installing aluminum framed glass curtain walls, facades, and skylights with 5 years minimum successful experience and having completed a minimum of 5 installations of similar scope and type as proposed project. Installer shall be acceptable to framing system manufacturer for installing their products.
- C. Single installation responsibility: The following components shall be installed by single installation company.
 - 1. Framing system specified in this section.
 - 2. Sheet metal fabrications and flashings required for joints between aluminum framing and adjacent construction specified in Section 07600 "Flashing and Sheet Metal".
 - 3. Weatherproofing sealants specified in Section 07900 "Joint Sealers".
 - 4. Glazing specified in Section 08800 "Glazing".
- D. Design and develop shop drawings for structural components of framing system under direct supervision of licensed professional structural engineer. Calculations and shop drawings shall bear engineer's seal.
- E. Safety glazing: Comply with ICC IBC and Consumer Product Safety Commission 16 CFR 1201, ANSI Z97.1, and other applicable safety requirements. Each piece of safety glazing shall be permanently labeled with appropriate marking.



PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide glazed THERM + 50 H-I, systems manufactured by RAICO

2.2 CHARACTERISTICS

- A. Supporting Structure: Timber materials authorized by building authorities. Dimensioning of the structural profiles and connections of both curtain walling and interfaces must be in accordance with the latest applicable edition of all relevant current standards, codes, regulations and by-laws.
- B. Connection of Transoms and Mullions: Timber connector system made by RAICO. Other connector systems are only permitted if the equality of their properties can be proven by means of official documents and test results.
- C. Connector Parts: Completely invisible after assembly of the glazing. Posterior repair of openings in the visible areas of the structure is not permitted. Connector system adaptable to transom depths from 60 to 300 mm, both for connections on one side or on both sides of the mullion. Possible posterior assembly and dismantling of transoms.
- D. Mouldings : Grain wood of the transom not to exceed a width of 30 mm, for structural timber profiles of 50 mm at least 10 mm wood must remain on each side. System exercises strain on the inside and the outside of the transom, so that it is pressed against the mullion on the entire depth.
- E. Maximum Permissible Glass Load: Proven by means of test certificates, with a maximum permissible glass load of at least 690 kg. Glass load to be tested and approved in the eccentric position of the glazing. Establish a static calculation of the entire connection.
- F. Widths of Mullions and Transoms: Range from 50 mm, with profile depths according to structural and design requirements. Depending on architectural requirements, combinations with steel or aluminium members must be possible without influence on quality properties including . system widths, visibility of connections, thermal insulation and system function. Dimensions of the profiles must be determined according to structural requirements, the maximum deflection of the glazing shall be 1/300 of the span or 8 mm, whichever is less.

2.3 FINISH OF THE TIMBER STRUCTURE

- A. Surface Treatment: In compliance with corresponding norms and regulations. Apply coating must after timber preservation measures similarly to technical regulations concerning the coating of other exterior building components of timber, and according to instructions given by the supplier of the coating.

2.4 WINDOWS

- A, Provide operable windows manufactured by curtain wall manufacturer.
- B. Type of Window: TBD

2.5 FIXTURE OF THE GLAZING SYSTEM

- A. Extruded Aluminium Base Profile of Glazing System: Screwed to the timber distances of 125 m or less, alternating left and right, with special stainless steel screws. System ensures safe transmission of dead loads up to 450 kg per glass or other infill unit. Posterior screw-fixation of the pressure profiles feasible at



any location into a continuous aluminium screwing channel. Screws of the pressure profiles to be self-sealing at the interior gasket during the screwing process.

B. Gaskets

1. All gaskets must be of black weather- proof EPDM.
2. Interior gaskets must completely cover the interior profiles, avoiding any opening in the sealing plane. Condensate which may arise within the system must be collected by drainage channels within the gaskets, and conducted to the outside in a controlled manner. The gasket design must feature an elevated level of the transom gasket for drainage into the lower level of the mullion gasket via an overlapping connection.
3. The curtain wall system must be designed in such a way that infiltrated water resp. condensate arising within the glazing rebate will be drained to the outside at the base transom in a controlled manner. For this purpose, the system must provide a possibility for drainage towards the outside at the base level, with a continuous transom gasket with flap.
4. Fabrication and installation of the interior gaskets at the connections of the transoms to the mullions must include precise notching executed by use of special tools, for vertical curtain walls without wet sealing.

C. The curtain wall system must be suitable for assembly with glass units with total thicknesses from 6 to 52 mm. A similar requirement applies to spandrel panels made of metal, timber, plastics which must be thermally broken. All opening windows or opening vents must have a thermally broken frame (e.g. WING 63G, 50SK, 50 A or 75B).

D. Transmission of dead loads of glass and other infills must be executed by glass carriers made of glass-fibre reinforced plastic fixed to the screwing channel of the structural profile by 3 self-tapping screws B 5,5. It must be ensured that the water tightness of the system remains conserved at all locations of glass carriers by an installation with self-sealing screws. The system must ensure a safe transmission of dead loads up to 450 kg per glass or other infill unit.

2.6 ACCESSORY MATERIALS

- A.** Exterior Shading Devices: Shop attach exterior sun shades or other devices with special fixation bolts of the curtain wall system. (Installation shall also be possible after assembly of the curtain wall and needs to be self-sealing without wet sealing). Use bolts and sealing sleeve provided by curtain wall manufacturer
- B.** Vapor Control Layer: Use vapor-tight membranes with a minimum Sd- value of 220 m.
- C.** Weather stripping at the exterior zone of the curtain wall must allow vapour transmission with a maximum Sd- value of 3,0 m in order to ensure dehumidification,
1. Weather stripping films must be thoroughly glued to the building with a special glue, and be clamped at the base transom behind the drainage plane. In case of a circumferential installation, it must be ensured that the membranes are within the same level and glued to each other tightly and permanently.

PART 3 - EXECUTION

3.1 PREPARATION

- A.** Coordinate with provision of glazing specified in Section 08800 "Glazing". Ensure dimensions and tolerances are compatible.
- B.** Prior to starting installation, verify that wall openings are ready to receive framing.



- C. Report unacceptable conditions and deficiencies. Do not proceed with installation until corrective action has been performed.

3.2 GENERAL INSTALLATION

- A. Site assemble and erect aluminum framing in accordance with reviewed shop drawings and manufacturer's installation instructions.
- B. Damaged glass: Do not install glass with edge damage or other imperfections.
- C. Make connections to allow for settling and other substructure movement to occur without stresses being transferred to aluminum framing systems.
- D. Do not field cut or alter structural framing without written approval from manufacturer and Architect.
- E. Use anchorage devices to securely attach aluminum framing to substructure and to accommodate construction tolerances and irregularities.
- F. Insulate dissimilar metals with bituminous paint or non-absorptive gasket to prevent corrosion.
- G. Align framing plumb, level, and free of warp or twist.
- H. Seal all framing perimeters with system specific EPDM vapor barriers.

3.3 GLAZING

- A. Protect adjacent surfaces from sealants and glazing materials with masking tape or other means.
- B. Install setting blocks and spacers as recommended by glass façade manufacturer and indicated on reviewed shop drawings.
- C. Provide edge blocking as required to prevent sideway movement of glass in glazing channel.
- D. Ensure glazing pressure plates provide required bite on glass.

3.4 CLEANING

- A. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.
- B. Wash exposed surfaces with solution of mild detergent applied with soft cloth. Take care to remove dirt from corners. Wipe surfaces clean.

END OF SECTION



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SECTION 08 63 00**METAL-FRAMED SKYLIGHTS****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. Production fabricated wood and aluminum; electrically operated curb mounted ventilating skylight.
- B. Related Sections:
1. Division 07 Roofing.
 2. Division 13 Space Frame

1.3 PERFORMANCE REQUIREMENTS

- A. General: Metal-framed skylights shall withstand the effects of the following without failure due to defective manufacture, fabrication, installation, or other defects in construction:
1. Structural loads.
 2. Thermal movements.
 3. Movements of supporting structure.
 4. Dimensional tolerances of support system and other adjacent construction.
 5. Failure includes, but is not limited to, the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Noise or vibration created by wind and by thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Sealant failure.
- B. Delegated Design: Design metal-framed skylights, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Wind Loads: As shown on Structural Drawings
 2. Seismic Loads: As indicated on Drawings
- C. Air Infiltration: Provide metal-framed skylights with maximum air leakage through fixed glazing and framing areas of 0.10 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.
- D. Water infiltration: No water penetration noted when measured in accordance with AAMA/WDMA/101/I.S.2/NAFS-02 and ASTM E 331 with a test pressure differential of 220 Pa (4.5 psf).



- E. Weep drainage system designed to channel water entering joints, condensation occurring in glazing channel, or migrating moisture occurring within system to exterior by means of sanoprene gasket with integrated condensation gutter.
- F. Thermal Performance: Tested, certified, and labeled in accordance with NFRC 100 and 200 procedures, with Comfort Glass (0075) and Comfort Plus Glass (0074) has u-factor values of 0.55 and SHGC ratings of 0.29
- G. Model VCM with Snow Load glazing (0099 10): Tested and certified in accordance with ICC-ES AC17 Acceptance Criteria for Glass Glazed Skylights and Sloped Glass Glazing, Uniform Load testing according to ASTM E 330, Air Leakage Resistance testing according to ASTM E 283.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.
- B. Product Data: Plans, elevations, sections, details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:
 - a. Joinery including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Motor and electrical connections
 - f. Flashing and drainage.
 - 3. Include laboratory mockup Shop Drawings, prepared by a qualified preconstruction testing agency, showing details of laboratory mockup.
 - a. Resubmit Shop Drawings with changes made to details of mockup to successfully complete preconstruction testing.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Fabrication Sample: Of each framing intersection of assemblies, made from 12-inch (305-mm) lengths of full-size components and showing details of the following:
 - 1. Joinery including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- E. Delegated-Design Submittal: For metal-framed skylights indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For qualified Installer
- G. Welding certificates.



- H. Preconstruction Test Reports: Prepared by a qualified preconstruction testing agency.
- I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed skylights.
- J. Field quality-control reports.
- K. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of metal-framed skylights required for this Project.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for skylights' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including testing conducted by an independent testing agency and in-service performance.
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- E. Provide metal-framed skylights that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.
- F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical metal-framed skylights as shown on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- G. Preinstallation Conference: Conduct conference where directed by Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, VELUX America Inc. product Model VCM and VCE venting curb mount skylight as specified in this section and as manufactured by VELUX America Inc



2.2 MATERIALS

- A. Maintenance-free Exterior Aluminum Frame and sash covers: Roll-formed 15 gauge, 1.5-mm (0.06") thick, prefinished umber gray, production engineered and fabricated to fit.
- B. Wood: Kiln-dried, laminated Nordic pine (Specific Gravity 0.51), Pre-finished with white vinyl paint.
- C. Fasteners: (Skylight lens to sash) #8 x 1 ½" Stainless steel wood screw (# per skylight as indicated in manufacture's installation instructions) and #8 x 2 ½", #2 Phillips, pan

2.3 COMPONENTS

- A. Gasketing: Factory applied EPDM, Santoprene, and foam gasket to affect drainage. EPDM weather stripping between the frame and sash, Santoprene weather stripping and condensation drain between the structural glazed unit and the sash, and foam with PSA to provide a weather seal between the VCM/E and the curb.
- B. Fasteners: (Skylight lens to curb) #8 x 1 ½" wood screw, #2 Phillips, pan head, stainless steel (# per skylight as indicated in manufacturer's installation instructions).
- C. Operator: Sash is opened and closed mechanically by means of a one-point skylight chain operator. Operator exists in two main variants – manual and electric. [Manual takes place by means of the operating loop supplied with the skylight and rod control] [Electric operation is controlled by a remote control supplied with the skylight. Operation distance is up to 15m or 50ft, electric operator exist in 3 variants [100v 50Hz], [120v 60Hz], [230 – 240v 50Hz].
- D. Operator Covers: Pre-finished aluminum with white vinyl paint
- E. Sash Hinge: Piano hinge
- F. Flashing Accessories: Type ECL Flashings is a prefabricated step flashing system designed for use with roofing materials ¾" thick and for slopes of 2:12 (10 degrees) to 60 degrees.

2.4 GLASS AND GLAZING MATERIALS

- A. Standard structurally glazed, dual sealed insulating glass unit with 11.1 mm (0.44") air space, stainless steel spacer with desiccant, argon gas, primary seal polyisobutylene, secondary seal silicone.
- B. Type 0099 10 (Snow load Glazing) Laminated Low-E Gas Filled: Exterior lite 3mm (1/8") clear tempered with Low- E2 coating on the surface #2, 11.1 mm (0.44") air space filled with argon gas and a stainless steel spacer, interior lite two plies of 3 mm (1/8") tempered laminated with 0.76 mm (0.030") vinyl interlayer.

2.5 FABRICATION

- A. Fabricate roll-formed aluminum sash frame with mitered corners, molded ASA UV resistant corner keys, silconed for weather tight fit. Fabricated roll-formed aluminum frame with welded corners
- B. Fabricate frame components within minimum tolerances enabling installation and movement of frame and dynamic movement of perimeter sealant.
- C. Weather stripping: Factory applied gaskets. EPDM weather stripping between the frame and sash, Sanoprene weather stripping and condensation drain between the structural glazed unit and the sash, and foam with PSA to provide a weather seal between the VCM/E and the curb.



- D. Permit external drainage channels for migration of moisture to exterior. Provide internal drainage of glazing spaces to exterior through sanoprene gasket with integrated condensation gutter.
- E. Screen: Aluminum screen profile, spring metal clip attachment, 0.28 mm glass fiber thread with PVC coating, charcoal in color.
- F. Fasteners: #8 x 1 ½" 18 threads per inch, self drilling, stainless steel screws.
- G. All units are factory glazed with silicone sealant.

2.6 FINISHES

- A. Exterior surfaces: Maintenance free roll-formed aluminum exterior sash frame with umber gray Kynar 500 polyvinylidene fluoride resin finish. Maintenance free roll-formed exterior frame, painted with umber gray powder coat.
- B. Maintenance free flashing: Roll formed aluminum, umber gray, baked on polyester polyamide primer and finish coats.
- C. Interior Surface: white vinyl paint.
- D. Screens: Frames – white, mesh – charcoal.
- E. Operator – concealed beneath white aluminum covers

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify rough opening dimensions and proper orientation of skylight.

3.2 INSTALLATION

- A. Install skylight in accordance with manufacturer's installation instructions.
- B. Align skylight level, free of warp or twist, maintain dimensional tolerances.
- C. Attach skylight to field-constructed curb with screws furnished by manufacturer to accommodate construction tolerances and other irregularities.
- D. Provide thermal isolation when components penetrate or disrupt building insulation. Pack fibrous insulation in rough opening to maintain continuity of thermal barriers.
- D. Coordinate attachment and seal of perimeter air and vapor barrier material.
- E. Install manufacturer's engineered perimeter flashing in accordance with manufacturer's installation instructions to achieve weather tight.

END OF SECTION



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SECTION 08 81 00

GLASS GLAZING

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 WORK INCLUDED

- A. This Section includes applications for the following:
 - 1. Glazed curtain walls.
 - 2. Glazed entrances.
- B. Related Sections:
 - 1. Division 08 Section "Flush Wood Doors".
 - 2. Division 08 "Entrances"
 - 3. Division 08 "Glazed Curtain Walls".

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement and impact loading (where applicable), without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thicknesses indicated on Drawings are for detailing only. Confirm glass thicknesses by analyzing in-service conditions.

1.4 SUBMITTALS

- A. Product Data for each glass product and glazing material specified.
- B. Samples for verification of the following products, in manufacturer's standard sizes, showing the full range of color, texture, and pattern variations expected. Prepare Samples from the same material to be used for the Work.
- C. Product certificates signed by manufacturers of glass certifying that their products comply with specified requirements.
- D. Sealant compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials have been tested for compatibility and adhesion with glazing sealants; include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.
- E. Product test reports for each type of glazing sealant indicated, evidencing compliance with requirements specified.



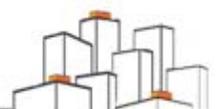
- F. Maintenance Data: For each type of decorative glass and each applied coating to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Glazing Publications: Comply with published recommendations of product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise in this Section or in referenced standards.
1. FGMA Publication: "FGMA Glazing Manual."
 2. FGMA Publication: "FGMA Sealant Manual."
 3. LSGA Publication: "LSGA Design Guide."
 4. State of New York, Department of Labor, Board of Standards and Appeals, Industrial Code Rule 47, "Transparent Glass Doors in Mercantile Establishments and in Public and Commercial Buildings and Storefronts", January 1, 1968.
- B. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of CPSC 16 CFR, Part 1201 for Category I and II materials.
1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or another certification agency acceptable to authorities having jurisdiction.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- E. Single-Source Responsibility: Obtain each type of decorative glass from one source and by a single manufacturer for each product and installation method indicated.

1.6 PERFORMANCE REQUIREMENTS

- A. Design Criteria for Interior Glass: Glass thicknesses shown and heat treatment specified are minimum requirements based upon manufacturer's regularly published literature. The Architect makes no representations as to the accuracy of the literature or the conclusions derived therefrom. Provide glass thicknesses and heat treatment (heat strengthened or fully tempered) as required to meet the following design criteria:
1. Interior Glass: An inward and outward load of 5 psf.
 2. Provide glass, as specified, in locations of use indicated complying with the following requirements: Doors shall receive fully tempered glass.
- B. Glass for Curtain Wall and Entrances; General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
1. Design Wind Pressures: As indicated on Drawings.
 2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.



3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials.

1.9 PROJECT CONDITIONS

A. Field Measurements: Check actual decorative glass openings by accurate field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Space Enclosure and Environmental Limitations: Do not install decorative glass until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.



2.2 PRIMARY FLOAT-GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), unless otherwise indicated, and Quality q3 (glazing select).

2.3 HEAT-TREATED FLOAT GLASS

- A. Uncoated, Clear, Heat-Treated Float Glass: ASTM C 1048, Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), unless otherwise indicated, Quality q3 (glazing select), kind as indicated below:
- B. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Type II, Class 1 (clear), Form 3; Quality-Q6.

2.4 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
 - 2. Spacer: Manufacturer's standard spacer material and construction
 - 3. Desiccant: Molecular sieve or silica gel, or blend of both.
- B. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article.

2.6 SPECIFIC GLASS TYPES

- A. Location of Glass as shown on Drawings.
- B. Manufacturer: ArnoldGlas
- C. Redirecting Light Glass: Dekorex with Retro-therm
 - 1. Total Energy Transmittance: 8 percent
 - 2. Visual Light Transmittance: 56 percent
 - 3. With venetian blinds, Dekorex J
- D. Spandrel Panels: Vaucrex
 - 1. Insulation material is sandwiched between 2 ceramic enamelled glass panels or coated aluminum sheets.
 - 2. U Value: From 0,36 W/m²:K at 24 mm down to 0,17 0 W/m²:K at 40 mm
 - 3. Colors: RAL in combination with Decolite
- E. Bird Protection Glass: Ornilux Mikado 3 arcon N33 0



1. Total Energy Transmittance: 76 percent
2. Light Reflectance: 17percent

2.7. STRIP FILTERED LAMELLAS WITH LOW E GLASS:

- A. Manufacturer: Micro Shade by Photo Solar
- B. Characteristics
 1. Constructed of micro lamellas in a strip of stainless steel
 2. Strip is mounted oin the cavity of a 2 or 3 layer of low E glazing.
 2. Strip Width: 140 mm
 3. External Glass: tempered
 4. Internal Glass: Tempered low E glass
 5. Spacer: Warm edge stainless steel
 6. Gas Filling: Argon

2.8 GLAZING SEALANTS

- A. General: Provide manufacturer's standard sealant of formulation indicated that is recommended for exposed interior applications, complying with the following requirements:
 1. Compatibility: Select glazing sealants of proven compatibility with other materials they will contact, including glass products and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturer's recommendations for selecting glazing sealants that are suitable for applications indicated and conditions existing at time of installation.
 3. Colors: Provide color of exposed joint sealants to comply with the following:
 - a. Match colors indicated by referencing manufacturer's standard designations for these characteristics.

2.9 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials involved for glazing application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.

2.10 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine glass framing, with glazier present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.



2. Minimum required face or edge clearances.

B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined recommendations of manufacturers of glass, sealants, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions as indicated on Drawings provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass from edge damage during handling and installation as follows:

1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar.
2. Remove damaged glass from Project site and legally dispose of off-site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.

D. Provide spacers as follows:

1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances.
2. Provide not less than 1/8-inch bite of spacers on glass and use thickness equal to sealant width.

3.4 SEALANT GLAZING

A. Install continuous spacers between glass lites and glazing stops to maintain glass-face clearance. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces smooth.

3.5 CLEANING AND PROTECTION

A. Protect glass from breakage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.



- C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including by natural causes, accidents, and vandalism, during construction period.
- D. Wash glass on both faces in each area of Project not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION



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SECTION 09 21 18

GYPSUM BOARD ASSEMBLIES

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. This Section includes the following:
1. Gypsum Wallboard Partitions.
 2. Gypsum Wallboard Ceilings.
 3. Metal Framing and Support Systems.
 4. Pre-fabricated Ceiling Suspension Systems.
 5. Accessories including fasteners, anchors, acoustical sealant, insulation, joint compound and tape, and other accessories as required for installation.
- B. Related Sections include the following:
1. Division 09 Sections for wall finishes.

1.3 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval.
- B. Certificates: Submit applicable test certificate conforming to requirements of these specifications and authorities having jurisdiction on fire rated assemblies as required.
- C. Shop Drawings: Submit Shop Drawings for Work not illustrated in manufacturers standard literature. Shop Drawings shall include construction and system details, in large scale detail.
1. Submit plans for locations of wall, ceiling and soffit control joints.
- D. Samples: All standard materials, supports and accessories.

1.4 QUALITY ASSURANCE

- A. Industry Standards: Except as otherwise indicated on the Drawings or specified herein, the current edition industry standards, referred to below, shall apply to work under this Section. Where requirements indicated on the Drawings, or specified herein, differ from the industry standards, the more stringent requirements shall govern.
1. The following latest edition standard specifications for Gypsum Wallboard Systems construction by the Gypsum Association.



- a. GA-201; Using Gypsum Board for Walls and Ceilings.
 - b. GA-216; Recommended Specifications for the Application and Finishing of Gypsum Board.
 - c. GA-505; Gypsum Board Construction Terminology and Definitions.
 - d. Fire Resistance Design Manual.
2. The following standards for the American Society for Testing and Materials:
- a. ASTM C11; Gypsum Board Construction Terminology.
 - b. ASTM C645; Specification for non-load (axial) bearing steel studs, runners (track) and rigid furring channels for screw application of gypsum board.
 - c. ASTM C754; Specification for steel framing members to receive screw-attached gypsum board, backing board or water-resistant board.
 - d. ASTM C840; Specification for Application and Finishing of Gypsum Board.
 - e. ASTM C1002; Specification for steel drill screws for the application of gypsum board.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.
- C. Handle gypsum boards to prevent damage to edges, ends and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Steel Framing and Furring:
 - a. Clark Steel Framing Systems.
 - b. Consolidated Systems, Inc.
 - c. Dale Industries, Inc. - Dale/Incor.
 - d. Dietrich Industries, Inc.
 - e. MarinoWare; Division of Ware Ind.
 - f. National Gypsum Company.
 2. Gypsum Board and Related Products:
 - a. American Gypsum Co.
 - b. G-P Gypsum Corp.
 - c. National Gypsum Company.
 - d. United States Gypsum Co.



2.2 INTERIOR GYPSUM WALLBOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: ASTM C 36.
 - 1. Type X:
 - a. Thickness: 5/8 inch (15.9 mm).
 - b. Long Edges: Tapered.
 - c. Location: Where required for fire-resistance-rated assembly.
- C. Moisture- and Mold-Resistant Type X: Manufacturer's proprietary liner panels with moisture- and mold-resistant core and surfaces; comply with ASTM D 3273.
 - 1. Core: 1 inch (25.4 mm) thick.
 - 2. Long Edges: Double bevel.
- D. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
 - 1. Thickness: 1/2 inch (12.7 mm).
 - 2. Long Edges: Tapered.

2.3 METAL COMPONENTS

- A. Structural Components
 - 1. Runners: ASTM C645, roll formed galvanized steel, channel or angle shape, type, size and gage as recommended by the drywall manufacturer for the wall system indicated.
 - 2. Metal Studs: ASTM C645 roll-formed galvanized steel; where no gauge is indicated, studs shall comply with requirements and recommendations specified and shall not be less than 25 gauge. Provide the following types:
 - a. "ST" and "CWS", for interior partitions, ceilings and column fireproofing.
 - 3. Furring Channels: "Rigid Furring Channel"; ASTM C645, roll-formed galvanized steel, flanged channel type, 7/8 inch deep; for wall furring and ceiling attachment.
 - 4. Concealed Mounting Plate Reinforcements: Galvanized 20 gage, minimum, sheet steel complying with ASTM 366. Provide plates 6 inches wide, minimum width by full length of supported item. Provide concealed mounting plates for all items secured to partitions.
 - a. Verify specific thicknesses, sizes and mounting needs with individual item suppliers.
 - b. For items with requirements which exceed the performance of concealed mounting plate reinforcements, refer to Section "Miscellaneous Metals".

2.4 SUSPENSION SYSTEM FOR CEILINGS

- A. Prefabrication Ceiling Application System: QuikStix manufactured by Armstrong
 - 1. Pre-measured locking tabs need no screws
 - 2. Locking Pocket main tees carry the ceiling load
 - 3. Hanging clip system
 - 4. Knurled face and ScrewStop reverse hem.



5. Pre-engineered steel framing components.
6. Components Include: Locking angle, locking pocket mains, Quikstix Tees, UpTight Clips

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet .
 2. Shapes:
 - a. Cornerbead: Use at outside corners, unless otherwise indicated.
 - b. Bullnose Bead: Use at outside corners
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges .
 - d. L-Bead: L-shaped; exposed long leg receives joint compound; use where indicated .
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound; use at exposed panel edges .
 - f. Expansion (Control) Joint: Use where indicated.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
 1. Interior Gypsum Wallboard: Paper.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by manufacturer.

2.7 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements, provide one of the following:
 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.



2. Acoustical Sealant for Concealed Joints:

- a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.
- b. Pecora Corp.; BA-98.
- c. Tremco, Inc.; Tremco Acoustical Sealant.

- B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- C. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.

2.8 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound Attenuation Blankets: Sound Attenuation Blankets, unfaced mineral-fiber blanket insulation produced by combining mineral fibers manufactured from slag wool or rock wool with thermosetting resins to comply with ASTM C-665 for Type (blankets without membrane facing).
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."
1. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.



3.2 PREPARATION

- A. Examine the Contract Documents in order to ensure the completeness of the Work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, with particular attention given to the installation of items installed in gypsum board, so as not to delay job progress.

3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
 - 1. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
- D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.
- E. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
- F. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.

3.4 INSTALLING STEEL PARTITION FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
 - 1. Where studs are installed directly against exterior walls, install foam-gasket isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. Cut studs 1/2 inch (13 mm) short of full height to provide perimeter relief. Do not fasten studs to top track to allow independent movement of studs and track.



2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.

- a. Terminate partition framing at suspended ceilings where indicated.

- D. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- E. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 1. Install two studs at each jamb, unless otherwise indicated.
 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint.
 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- F. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

3.5 FURRED CEILINGS, AND SUSPENDED CEILINGS

- A. Follow manufacturer's instructions.

3.6 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Form control and expansion joints with space between edges of adjoining gypsum panels.



- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 - 1. Space screws a maximum of 12 inches (304.8 mm) o.c. for vertical applications.

3.7 PANEL APPLICATION METHODS

- A. Single-Layer Application:
 - 1. On partitions/walls, apply gypsum panels vertically (parallel to framing) , unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
- B. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Metal Furring on Walls
 - 1. Furring applied horizontally, directly to masonry, shall be galvanized steel spaced 2 feet o.c. shimmed out and aligned to a true flat plane fastened with power-driven screws 12 inches o.c. Behind horizontal gypsum board joints provide battens and at ceiling install casing bead.
 - 2. Freestanding gypsum board furring shall be of 2-1/2 inches galvanized steel screw studs spaced 2 feet o.c. with horizontal braces between studs. Brace studs to masonry and fasten to masonry with power-driven screws. Studs shall be set in and fastened to top and bottom tracks. Provide battens behind horizontal gypsum board joints.

3.8 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.



- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.

END OF SECTION



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SECTION 09 30 13**CERAMIC TILING****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. Work Included: The work of this Section shall include, but not be limited to, the following:
1. Remove, store, and clean existing tile
 2. install recycled ceramic wall tile.

1.3 QUALITY ASSURANCE

- A. Reference Standards: Except as otherwise indicated on the Drawings or specified herein, the current edition industry standards, referred to below, shall apply to work under this section. Where requirements indicated on the Drawings or specified herein differ from the industry standards, the more stringent requirements shall govern.
1. TCA "Handbook for Ceramic Tile Installation"
 2. ANSI A108.1 "Standard Specifications For Glazed Ceramic Wall Tile, Ceramic Mosaic Tile, Quarry Tile and Paver Tile Installed With Portland Cement Mortar"
 3. ANSI A108.4 "Standard Specifications For Ceramic Tile Installed With Water-Resistant Organic Adhesives"
 4. ANSI A108.5 "Standard Specifications For Ceramic Tile Installed With Dry-Set Portland Cement Mortar"
 5. ANSI 118.4 "Standard Specifications for Latex-Portland Cement Mortar"
 6. ANSI A136.1 "Standard For Organic Adhesives For Installation of Ceramic Tile"
 7. ANSI 137.1 "Standard Specifications for Ceramic Tile"

1.4 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are delivered to the site.
- B. Samples: Submit samples of materials specified herein for approval, and obtain approval before materials are delivered to the site. Submit two (2) samples of each tile material and cured grout sample specified herein and 6 inch square of acoustical mat.
- C. Qualifications: Submit qualifications for acoustical underlayment installer as specified under the Quality Assurance Article of this Section.
- D. Procedures: Submit written explanation with sketches to show installation of acoustical mat.



1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's packaging and store in original containers with seals unbroken and labels intact until time of use, in accordance with manufacturer's instructions.

1.6 PROJECT CONDITIONS

- A. No tile work shall be installed when the ambient temperature is below 40 degrees F, unless special provisions are made for continuous heating the spaces including and surrounding the work. No tile shall be used if it may contain frost. Do not set tile or mortar on surfaces containing frost.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide tile of domestic manufacture, standard grade, complying with TCA/ANSI A137.1, unless otherwise indicated. Tile shall match samples accepted by the Architect. Obtain each material required for any one type and color of tile work from a single source, so as to minimize variations in appearance and quality.
- B. Trim Shapes: Shaped as shown for typical conditions and as required to make a complete installation at all conditions. Match type, class, color and edge of adjoining field units and coordinate sizes with field units. Bullnoses and covers shall have the same radius.

2.2 EXISTING WALL TILE UNITS

- A. Existing "Subway Tiles"
 - 1. Existing location: Fire house used for Decathlon work
 - 2. Color: White

2.3 TILE BEDDING, SETTING AND GROUT MATERIALS

- A. Wall Tile Setting Materials
 - 1. Organic Tile Adhesive: ANSI A136.1, Type 1.
 - 2. Portland Cement Mortar: ANSI A108, comply with standards for mixes.
- B. Grout Materials
 - 1. Grout for Wall Tile: ANSI A118.6.
 - a. Manufactured by Laticrete or approved equal.
 - 2. Grout Colors: To be determined

PART 3 - EXECUTION

3.1 PREPARATION OF EXISTING TILE

- A. Removal of existing tiles
 - 1. Remove tiles from existing location, discard broken and uncleanable tiles.
 - 2. Store tiles as directed until time for installation.
 - 3. Cleaning of tiles: Prior to installation remove remaining mortar, grout and dirt.



3.2 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions. Examine substrates and areas where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing compounds and in accordance with specifications.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Work specified under this section, shall be performed by skilled workmen and shall, except as otherwise specified, complying to the requirements of the "Reference Standards" specified herein.
- B. Surfaces designed to receive tile shall be cleaned of objectionable material so as to assure a satisfactory bond with the setting materials.
- C. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent adhesion or staining of exposed tile surfaces by grout, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of temporary protective coating indicated below, taking care not to coat unexposed tile surfaces:
 - 1. Petroleum paraffin wax or grout release.

3.3 INSTALLATION

- A. Comply with parts of ANSI 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile" that apply to type of setting and grouting materials and methods indicated.
- B. Comply with TCA "Handbook for Ceramic Tile Installation", latest edition, for installation methods specified herein.
- C. General
 - 1. Setting materials, mortar beds, adhesives and grouts shall be of the types specified herein for the various uses. Tile shall be set flush with adjoining units, level, true and plumb. Grout shall be struck or tooled to the depth of the cushion. Excess grout shall be removed before it has set. Plant-mixed grout shall be installed in strict accordance with the printed directions of approved manufacturer.
 - 2. Spacing gauges or other devices shall be used to obtain joints of a uniform width for ceramic wall tile.
 - 3. Broken, cracked, marred or otherwise defective tile or base shall be replaced before the setting material has set. Corners, coves, angles or other trim shapes shall be furnished and installed. Tile shall fit neatly around openings. Cutting, as far as practicable, shall be done by power saws. Cut edges shall be smooth, straight and free from chips. Hand-cut tiles shall be filed or ground smooth on the cut edge.
 - a. Exterior Corners: Use pre-manufactured exterior corners wherever they are provided by the tile manufacturer. Where they are not available then miter tiles to form exterior corners.
 - b. Interior corners: Use square corners.



4. Grouting of joints shall be done on the same day that tile is set, unless otherwise recommended by the tile and/or setting material manufacturers.
5. Grounds, door bucks, saddles, plugs, supports and connections for mechanical or electrical work and fittings shall be in place and pipe chases and other openings shall have been properly closed before the application of tile mortar or adhesives.
6. Pattern: Stack bond.
7. Joint Sizes: As recommended by tile manufacturer.

3.4 CLEANING AND PROTECTION

- A. After tile and grout have set and cured, sponge and wash tile thoroughly with approved neutral cleaner, in accordance with manufacturer's directions. Polish finally with clean dry cloths. Do not use acid or acid cleaners on tile.
- B. Cleaning: Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 1. Remove latex-portland cement grout residue from tile as soon as possible.
 2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.
 3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- C. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.
- D. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensures that tile is without damage or deterioration at time of Substantial Completion.
 1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- E. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION



SECTION 09 62 00

SPECIALTY 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. Work Included: The work of this section shall include, but not be limited to, the following:
 - 1. Floating Cork Floor
 - 2. Recycled Glass Flooring

1.3 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are delivered to the site. Literature shall include manufacturer's written instructions for recommended maintenance practices for each type of resilient material specified.
- B. Samples: Submit samples of materials specified herein for approval, and obtain approval before materials are delivered to the site.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the project site in the manufacturer's unopened containers, clearly marked with manufacturer's label.
- B. Carefully handle materials and store in original containers at not less than 65 degrees F for at least 48 hours before start of installation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the project site in the manufacturer's unopened containers, clearly marked with manufacturer's label.
- B. Carefully handle materials and store in original containers at not less than 65 degrees F for at least 48 hours before start of installation.

PART 2 - PRODUCTS

2.1 CORK FLOOR

- A. Manufacturer: Dura Design Flooring Inc, Uniclic Floating Cork Floor



- B. Size: 11 13/16 inches x 1/2 inch thick x 35 13/16 inches
- C. Edge: Tongue and groove
- D. Top layer: 1/8 cork
- E. Core: High Density Fiberboard, no added urea formaldehyde
- F. Underlayment: 1/8 inch cork
- G. Physical Properties
 - 1. Compressive Recovery: ISO 9727 with loading of 38.5lbs/sq inch.
 - 2. Slip Resistance: ASTM F1679, average 0.630
 - 3. Abrasion Resistance: ASTM D 4060, CS -17 Taber Resistance Wheels
 - 4. Floor Adhesives: Not more than 50 g/L.
 - 5. Color and Pattern: Cleopatra Negra Grain - in the Greige Colorway

2.2 RECYCLED GASS FLOOR

- A. Manufacturer: Ice Stone
- B. Material: 100% recycled glass in a cement matrix
- C. Size: 52.5inches x 1 1/2 inch thick x 96inches, cut to size as shown on Drawing
- D. Sealer: Miracle 511 H2O Plus, Nano 1000 Sealer, Buddy Rhodes National Look Penetrating Sealer and Satin Sealer, Protex by Tenax, or Bulletproof by StoneTech Pro.
- E. Color and Pattern: To match Architect's sample
- F. Finish: Honed

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Acclimatization; Open cork flooring boxes and remove packaging a minimum of 3 days prior to start of installation.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions..
- B. Cork:
 - 1. Cork: Install vapor barrier beneath flooring.
 - 2. Allow 3/8 inch space for expansion at edges of walls and permanent obstructions
- C. Recycled Glass Floor



1. Follow manufacturer's instructions
2. Apply sealer

3.4 PROTECTION, CLEANING AND FINISHING

- A. Follow manufacturer's instructions
- B. Provide and maintain protection for resilient flooring installation to prevent damages. Remove protection when directed or at time of final acceptance of work.

END OF SECTION



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SECTION 09 91 23

INTERIOR PAINTING

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. This Section includes surface preparation and the application of paint systems on the following interior substrates:
1. Gypsum board ceilings
 2. MDF Panels
 3. Other substrates as shown on Drawings and specified under this Section.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 2. Step coats on Samples to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

- A. MPI Standards:
1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).



1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.7 WASTE MANAGEMENT AND DISPOSAL

- A. Paint, and related materials are regarded as hazardous products and are subject to regulations for disposal. Obtain information on these controls from applicable Local government departments having jurisdiction.
- B. Waste materials shall be separated and recycled. Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility. Materials that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- C. Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- D. To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground the, comply with the following procedures:
 1. Retain cleaning water for water-based materials to allow sediments to be filtered out. In no case shall equipment be cleaned using free draining water.
 2. Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 3. Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 4. Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
 5. Empty paint cans are to be dry prior to disposal or recycling (where available).
 6. Close and seal tightly partly used cans of materials including sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.
 7. Set aside and protect surplus and uncontaminated finish materials not required by the Owner and deliver or arrange collection for verifiable re-use or re-manufacturing.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:



1. Benjamin Moore & Co.
2. Envirocoat Technologies Inc.
3. M.A.B. Paints.
4. PPG Architectural Finishes, Inc.
5. Master Coatings Technology.

B. Actual MPI Gloss Designation to be determined by specific manufacturer's product in coordination with architect's sample and environmental requirements.

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints, Coatings, and Primers for Flat Paints: VOC content of not more than 50 g/L. (OTC 100)
2. Nonflat Paints, Coatings, and Primers for Nonflat paints: VOC content of not more than 150 g/L.
3. Primers (not already defined), Sealers, and Undercoaters: VOC content of not more than 200 g/L.

C. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein.
 - b. Acrylonitrile.
 - c. Antimony.
 - d. Benzene.
 - e. Butyl benzyl phthalate.
 - f. Cadmium.
 - g. Di (2-ethylhexyl) phthalate.
 - h. Di-n-butyl phthalate.
 - i. Di-n-octyl phthalate.
 - j. 1,2-dichlorobenzene.
 - k. Diethyl phthalate.
 - l. Dimethyl phthalate.
 - m. Ethylbenzene.
 - n. Formaldehyde.
 - o. Hexavalent chromium.
 - p. Isophorone.
 - q. Lead.
 - r. Mercury.
 - s. Methyl ethyl ketone.



- t. Methyl isobutyl ketone.
- u. Methylene chloride.
- v. Naphthalene.
- w. Toluene (methylbenzene).
- x. 1,1,1-trichloroethane.
- y. Vinyl chloride.

2.3 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer:

- 1. VOC Content: E Range of E3.
- 2. Environmental Performance Rating: EPR 3.

2.4 LATEX PAINTS

A. Institutional Low-Odor/VOC Latex (Flat): (Gloss Level 1 or Gloss Level 2 as determined by specific manufacturer).

- 1. VOC Content: E Range of E3.
- 2. Environmental Performance Rating: Minimum EPR 4 for Gloss 1, minimum EPR 4.5 for Gloss 2

B. Institutional Low-Odor/VOC Latex (Eggshell): (Gloss Level 3 or 2 as determined by specific manufacturer).

- 1. VOC Content: E Range of E3.
- 2. Environmental Performance Rating: EPR 4.5.

C. Institutional Low-Odor/VOC Latex (Semigloss): (Gloss Level 5 or 4 as determined by specific manufacturer).

- 1. VOC Content: E Range of E3.
- 2. Environmental Performance Rating: EPR 5.5.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.



3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
- E. MDF:
 - 1. Prime edges, ends, faces, undersides, and backsides of panels

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- 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.
- E. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces to be coordinated with MEP work:

3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:



1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

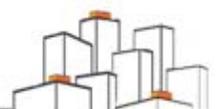
3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Actual MPI Gloss Designation to be determined by specific manufacturer’s product in coordination with architect’s sample and environmental requirements.
- B. Gypsum Board Substrates:
 1. Institutional Low-Odor/VOC Latex System:

Manufacturer	Prime Coat	Base Coat	Top Coat
Gyp			
Benjamin Moore	EcoSpec Interior Latex Primer Sealer (231)	EcoSpec Interior Latex Satint (223)	EcoSpec Interior Satin Flat (223)
MAB	MAB: EnviroPure Interior latex primer/sealer	EnviroPure interior Latex matching topcoat	EnviroPure interior latex (egg-shell)
PPG	9-900 Pure Performance® Interior Latex Primer	9-300 Pittsburgh® Paints; 9-300 Series Pure Performance® Eggshell Interior Latex	9-300 Pittsburgh® Paints; 9-300 Series Pure Performance® Egg-shell Interior Latex.



C. Gypsum Board Ceilings

1. Institutional Low-Odor/VOC Latex System:

Manufacturer	Prime Coat	Base Coat	Top Coat
Gyp			
Benjamin Moore	EcoSpec Interior Latex Primer Sealer (231)	EcoSpec Interior Latex Flat (219)	EcoSpec Interior Latex Flat (219)
MAB	EnviroPure Interior latex primer/sealer.	EnviroPure Eggshell interior latex matching topcoat	EnviroPure interior latex (egg-shell)
PPG	9-900 Pure Performance® Interior Latex Primer	9-100 Pittsburgh® Paints; 9-100 Series Pure Performance® Flat Interior Latex	9-100 Pittsburgh® Paints; 9-100 Series Pure Performance® Interior Latex

D. MDF

1. Prime Coat: Interior latex-based wood primer.
2. Intermediate Coat: Interior latex matching topcoat.
3. Topcoat: Latex: Gloss level as indicated on Drawings.

END OF SECTION



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SECTION 10 44 00

FIRE PROTECTION SPECIALTIES

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. Provide labor, materials, equipment and services, and perform operations required for installation of fire protection specialties and related work as indicated on the drawings or specified herein.
- B. Work Included: The work of this section shall include, but not be limited to, the following:
 - 1. Fire extinguishers and brackets.
- C. Related Work Specified Elsewhere
 - 1. Division 09 Section "Gypsum Wallboard"

1.3 QUALITY ASSURANCE

- A. Materials shall conform to the latest edition of applicable reference specifications, and codes and requirements of local authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are delivered to the site.
- B. Samples: When requested submit samples of materials specified herein for approval, and obtain approval before materials are delivered to the site.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials specified herein in manufacturer's unopened containers, with manufacturer's name and point of origin on each container.
- B. Handle and store in accordance with manufacturer's instructions and recommendations.

1.6 PROJECT CONDITIONS

- A. Do not install work of this section until wet work in the space has been completed and is nominally dry, and until work above finish ceilings has been completed, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.



PART 2 - PRODUCTS

2.1 FIRE PROTECTION SPECIALTIES

- A. Manufacturers
 - 1. Larsen's Manufacturing Company.
 - 2. Approved equal.
 - 3. Model numbers and names specified under this Article reflect Larsen's products.
- B. Fire Extinguishers: Multi-purpose dry chemical, "MP" with 10 pound capacity.
- C. Fire Extinguisher: Brackets.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Coordinate the work of this section with the work of other trades as required to complete the work of this section.

3.3 INSTALLATION

- A. Installations shall be in strict accordance with manufacturer's specifications.
- B. Supports, anchorages and fastenings shall be secure and adequate for use intended.

3.4 ADJUST AND CLEAN

- A. Upon completion, clean exposed surfaces and leave them in a condition entirely satisfactory to the Architect.

END OF SECTION



SECTION 11 31 13

RESIDENTIAL APPLIANCES

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. Work Included: The Work of this Section shall include, but not be limited to, the following:
 - 1. Kitchen Appliances
 - 2. Cleaning Appliances
- B. Related Work:
 - 1. Division 06 Section "Interior Architectural Woodwork" for kitchen and laundry cabinetry.
 - 2. Division 22 Section "Plumbing Fixtures" for kitchen sinks.

1.3 QUALITY ASSURANCE

- A. Installer should be experienced in performing work of this section and some specialization in installation of work similar to that required for this project. Use two or more people to move and install dishwasher and oven.
- B. Compatibility: Any components or parts used for replacement or repair should be from appliance manufacture to ensure compatibility.

1.4 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site.
- B. Evidence; Submit evidence of Energy Star compliance

PART 2 - PRODUCTS

2.1 KITCHEN APPLIANCES

- A. Refrigerator, 24" fully integrated model
 - 1. Product: Liebherr, HC1011
 - 2. Energystar qualified
 - 3. Capacity: 2.4 cu. ft.
 - 4. Fully concealed custom panel
 - 5. http://www.liebherr.us/HG/en-GB/us-hg/products_us-hg.wfw/id-345770-0_20939-0?menuID=108624!345770-0_20939-0



DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Dimensions and Installation Information (in inches)

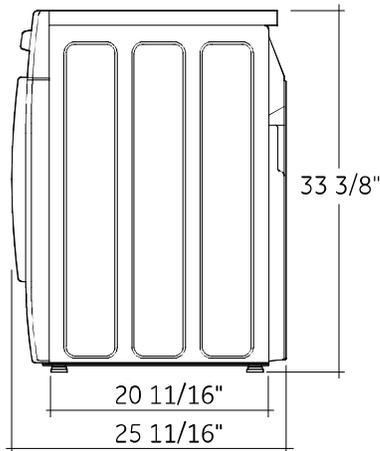
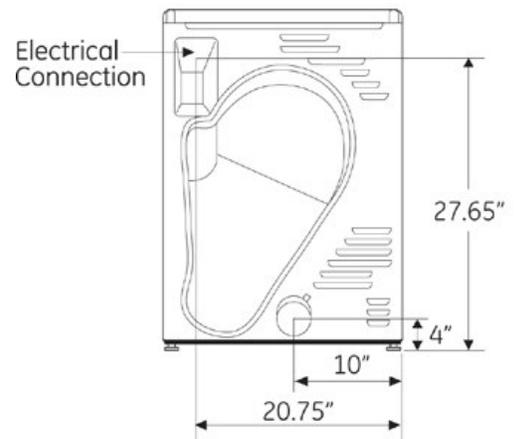
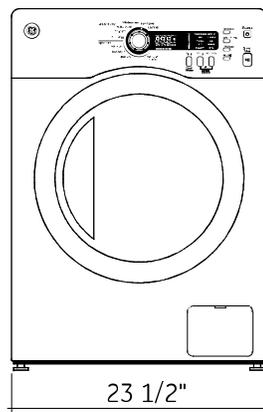
Electric Dryer Rating	
240V	3000W, 12.5A, 60Hz

Exhaust Options: 4-way via rear, right, left and bottom.

Circuit Requirements: An individual, properly grounded branch circuit, protected by a 30-amp circuit breaker or a time-delay fuse, is required.

Note: Dryer wall outlet must be located within 36" of service cord entry and accessible when dryer is mounted in position.

Installation Information: For complete information, see installation instructions packed with your dryer.



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Specification Revised 5/11

360423

DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Special Installation Requirements:

Alcove or Closet Installation:

- Stacking Kit - GE24STACK (not included)
- If your dryer is approved for installation in an alcove or closet, it will be stated on a label on the dryer back.
- The dryer MUST be exhausted to the outside.
- Minimum clearances between dryer cabinet and adjacent walls or other surfaces are: 0" either side, 3" front and rear
- Minimum vertical space from floor to overhead cabinets, ceilings, etc. is 52".
- Closet doors must be louvered or otherwise ventilated and must contain a minimum of 60 sq. in. of open area equally distributed. If this closet contains both a washer and a dryer, doors must contain a minimum of 120 sq. in. of open area equally distributed.
- No other fuel-burning appliance shall be installed in the same closet with a gas dryer.

Bathroom or Bedroom Installation:

- The dryer MUST be exhausted to the outdoors.
- The installation must conform with the local codes, or in the absence of local codes, with the National Electric Code and National Fuel Gas Code, ANSI Z223 for gas dryers.

Minimum Clearance other than Alcove or Closet Installations:

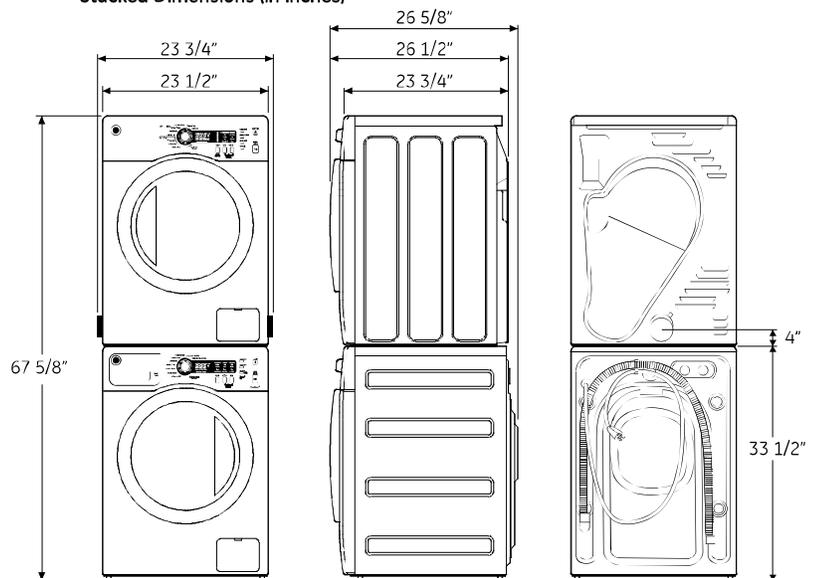
- Minimum clearances to combustible surfaces 0" both sides, 3" rear.

For more information on venting kits and accessories, please call 1-800-GE-CARES.

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Stacked Dimensions (in inches)



Specification Revised 5/11

360423

DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Dryer Exhausting Information – Metal Duct Only

For complete information, see installation instructions packed with your dryer.

Ducting Materials: For best performance, this dryer should be vented with 4" diameter all rigid metal exhaust duct. If rigid metal duct cannot be used, then UL-listed flexible metal (semi-rigid) ducting can be used (Kit WX08X10077). In special installations, it may be necessary to connect the dryer to the house vent using a flexible metal (foil-type) duct. A UL-listed flexible metal (foil-type) duct may be used ONLY in installations where rigid metal or flexible metal (semi-rigid) ducting cannot be used AND where a 4" diameter can be maintained throughout the entire length of the transition duct. Please see installation instruction packed with your dryer for complete instructions when using flexible metal (foil type) ducting.

Exhaust Length Calculation:

1. Determine the number of 90° turns needed for your installation. If you exhaust to the side or bottom of dryer, add one turn.
2. The maximum length of 4" rigid (aluminum or galvanized) duct which can be tolerated is shown in the table.

A turn of 45° or less may be ignored. Two 45° turns within the duct length should be treated as a 90° elbow.

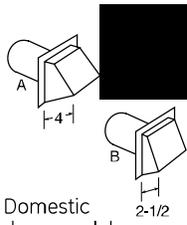
A turn over 45° should be treated as a 90° elbow.

Dryers **must** be exhausted to the outside.

Caution: For personal safety do not terminate exhaust into a chimney, under any enclosed house floor (crawl space), or into an attic, since the accumulated lint could create a fire hazard or moisture could cause damage. Never terminate the exhaust into a common duct or plenum with a kitchen exhaust, since the combination of lint and grease could create a fire hazard.

Exhaust ducts should be terminated in a dampered wall cap to prevent back drafts, bird nesting, etc. The wall cap must also be located at least 12" above the ground or any other obstruction with the opening pointed down.

For more information on venting kits and accessories, please call 1-800-GE-CARES.



		Best performance	
		Maximum length of 4" dia. rigid metal duct	
		Exhaust hood type	
Domestic dryer models	Number of 90° turns	A	B
		4" opening	2-1/2" opening
4.0 cu. ft. capacity models all electric dryers	0	90 ft.	60 ft.
	1	60 ft.	45 ft.
	2	45 ft.	35 ft.
	3	35 ft.	25 ft.

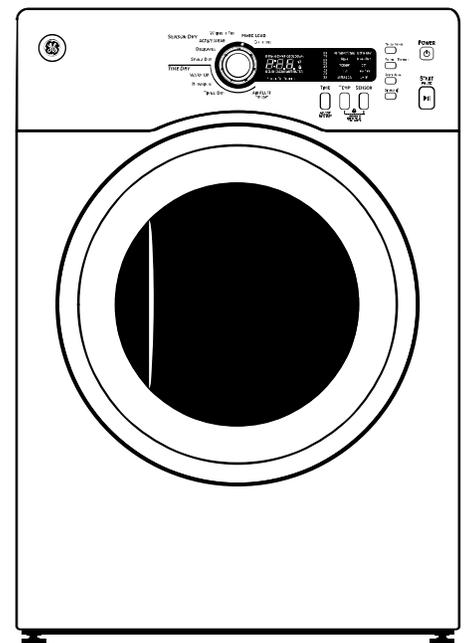


DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Features and Benefits

- 4.0 Cu. Ft. Large Stainless Steel Basket - Handles a king-size comforter or 24 full-size bath towels with ease
- 5 Heat Selections - Offer enhanced drying performance and fabric care
- Sensor Dry™ - Continually monitors moisture content to help prevent clothing wear and tear
- Stainless Steel Drum Interior - Smooth stainless interior helps prevent rust and protect clothes
- Multiple Dry Cycles - Deliver optimal drying results
- Delay Start - Lets you do the laundry on your terms
- Antibacterial Option - Certified by the NSF® to reduce up to 99.9% of certain types of bacteria
- Extended Tumble Plus - Tumble clothes without heat to help prevent creasing and wrinkling
- Speed Dry - Delivers ready-to-go results in minutes
- ADA Compliant
- Model DCVH480EKWW - White on white
- Model DCVH485EKMS - Metallic silver

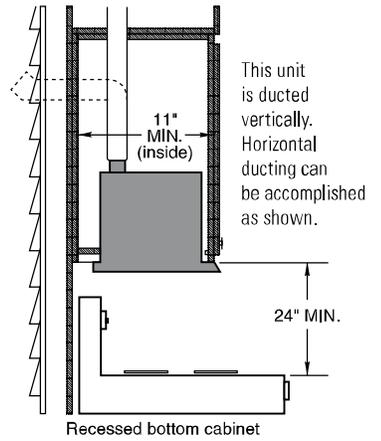
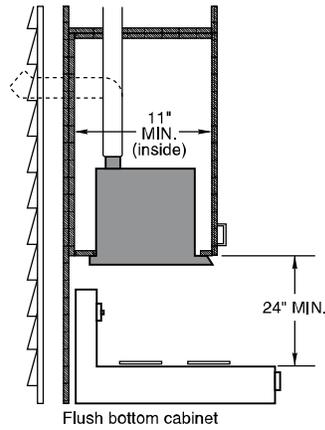
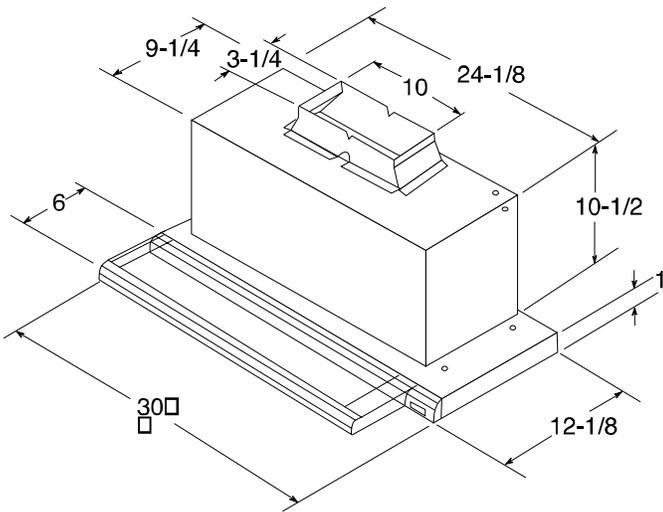




Profile™

JV394S – GE Profile™ Slide-Out Hood

Installation Information and Dimensions (in inches)



Amp Rating	
120V	3.7

Note: Remove glass visor from unit before installing hood in cabinet to protect visor from damage.

Installation Information: Before installing, consult Use & Care/installation instructions [Pub. No. 49-8463] packed with product for current dimensional data.

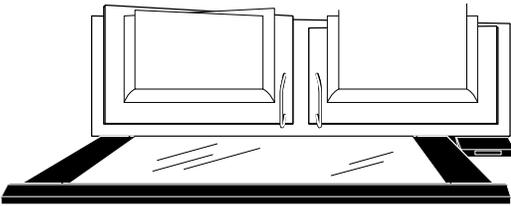


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Profile™

JV394S – GE Profile™ Slide-Out Hood



Features and Benefits

- Black on black Model
- 30" Vented Hood With Cooktop Light
- See-Through Glass Visor Slides In and Out
- 320 CFM Performance With Variable Speed Fan Control
- Auto Heat Sensor
- Compact Housing Leaves Ample Shelf Space Behind Cabinet Doors
- Vertical Exhaust With 3-1/4" x 10" Rectangular Duct
- Sones Rating: Top Exhaust – 4.5
- Also Available In White on white as Model JV395S and Bisque as in Model JV396S

Specification Revised 5/11

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PSB1201NSS

GE Profile Advantium® 120 Volt - 30" Wall Oven

Advantium wall oven/GE Profile cooking tower dimensions and cabinet installation information (in inches)

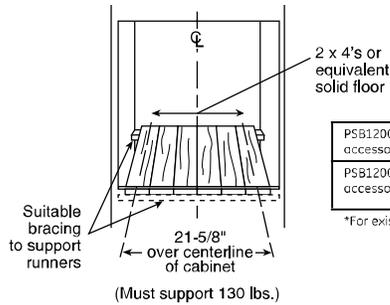
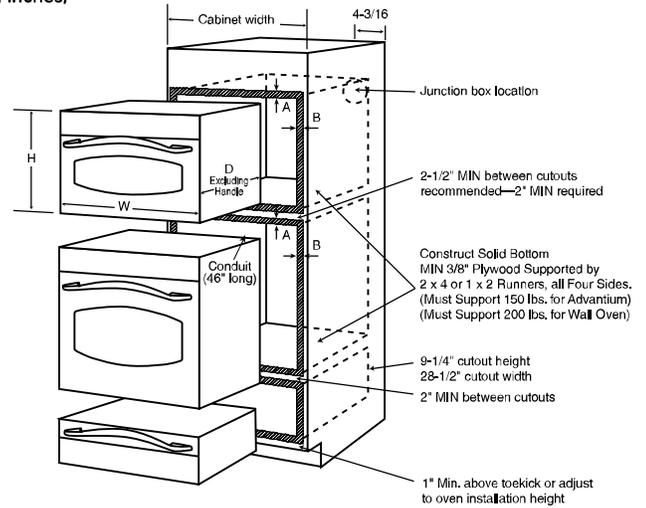
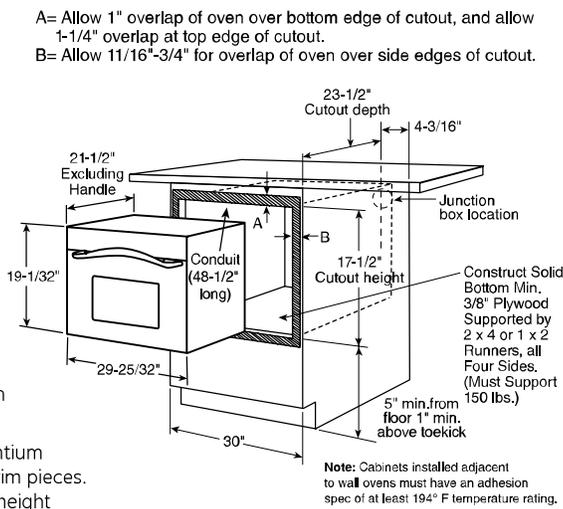
Note: 2" minimum between cutouts when installed above warming drawer or single wall oven.

Installation Information: Before installing, consult installation instructions packed with product for current dimensional data.

Note: PSB1200/1 series Advantium can be installed below GE/GE Profile non-downdraft gas and electric cooktops. It CANNOT be installed below induction or Monogram (2GU3841385) gas cooktops.

Note: PSB1200/1 series Advantium oven comes with two lower trim pieces. One is for use above 36-inch height installations and one is for use below 36-inch installations. Use of the accessory drawer will replace the bottom trim piece for applicable installations. Please see installation instructions for full details.

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	Cabinet Width (inches)	W Width	H Height	D Depth (excluding handle)	X Cutout Width	Y Cutout Height	Z Cutout Depth (minimum)
PSB1200/1 without accessory drawer	30	29-25/32	19-1/8	21-3/4	25-1/8	17-1/2	23-1/2
PSB1200/1 with accessory drawer	30	29-25/32	22-1/4	21-3/4	25-1/4 to 28-1/2*	21	23-1/2

*For existing cutouts a maximum width of 28-1/2" is acceptable



PSB1201NSS

GE Profile Advantium® 120 Volt - 30" Wall Oven

Preparation WITH an Accessory Drawer

Prepare the opening

The Advantium PSB1200/1 series can be installed in combination with other GE/Monogram appliances. Always follow each product's Installation Instructions to complete the installation.

Single Oven Installation:

Order a 30" wide single oven cabinet or cut the opening in a wall to the dimensions shown.

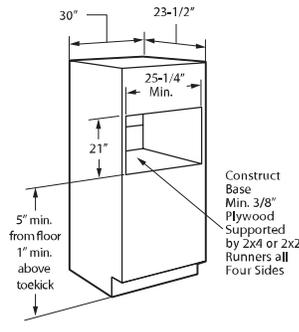
* For existing cutouts, a maximum width of 28-1/2" is acceptable. If the opening is slightly wider, secure a furring strip on each side of the cutout for securing the oven.

- Allow 3/4" to 2-1/8" case trim overlap on the sides and 7/8" overlap on the bottom of the opening for all models. The amount of overlap on the sides depends on the actual cutout width. Allow 1-1/4" case trim overlap on the top for models PSB1200 and PSB1201 and for models ZSC1201 and ZSC1202.

• Oven overlaps will conceal cut edges on all sides of the opening.

Note: PSB1200/1 series Advantium can be installed below GE/GE Profile non-downdraft gas and electric cooktops. It CANNOT be installed below induction or Monogram (2GU3841385) gas cooktops.

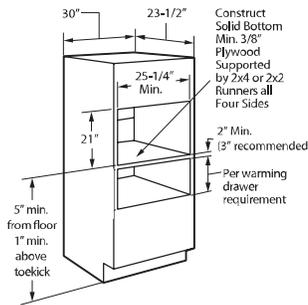
Note: PSB1200/1 series Advantium oven comes with two lower trim pieces. One is for use above 36-inch height installations and one is for use below 36-inch installations. Use of the accessory drawer will replace the bottom trim piece for applicable installations. Please see installation instructions for full details.



Prepare the opening (cont.)

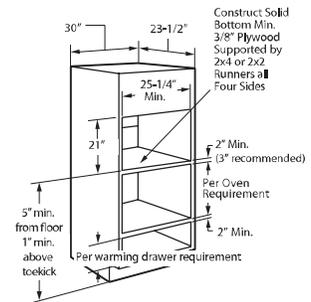
When installed over a single oven or a warming drawer, allow at least 2" between the two openings. This separation will provide clearance for bottom overlap of the Advantium and the other appliance overlaps. Construct a solid oven floor of 3/8" min. thick plywood supported by 2 x 4 or 2 x 2 runners on all sides.

- the support must be level and rigidly mounted, flush with the bottom edge of the cutout.



Note: Additional clearances between the cutouts may be required. Check to be sure the oven supports above the Warming Drawer location do not obstruct the required interior depth and height. See Warming Drawer installation instructions for details.

Installation over a GE/Monogram Oven and Warming Drawer:



Note: Additional clearances between the cutouts may be required. Check to be sure the oven supports above the Warming Drawer location do not obstruct the required interior depth and height. See Warming Drawer installation instructions for details.

CAUTION: For personal safety, the mounting surface must be capable of supporting the cabinet load, in addition to the added weight of this approximate 80-pound oven and 30-pound drawer, plus additional oven loads of up to 50 pounds or a total weight of 160 pounds.

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Specification Created 11/08

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PSB1201NSS

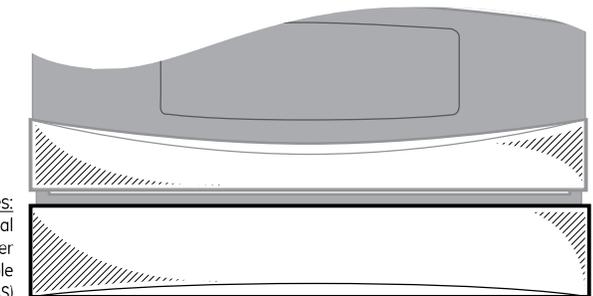
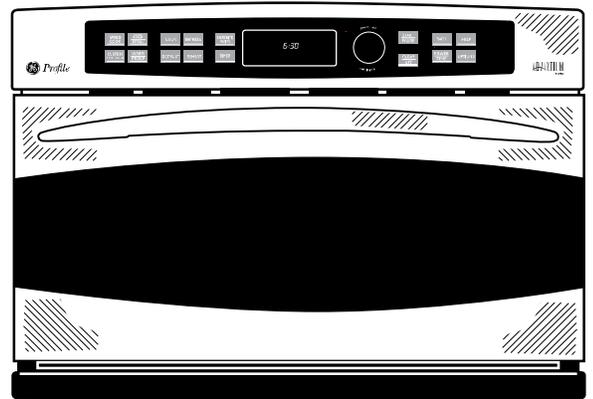
GE Profile Advantium® 120 Volt - 30" Wall Oven

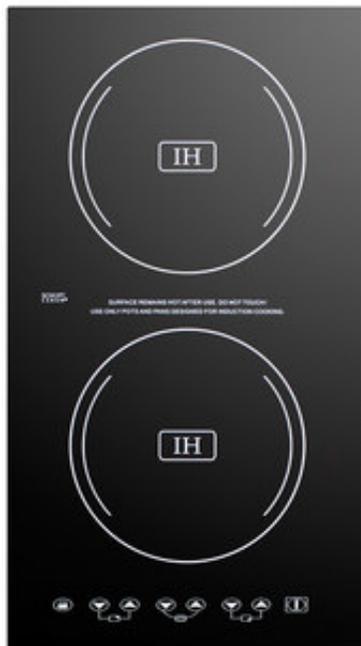
Features and Benefits

- Speedcook Technology - Cooks up to 4 times faster than a conventional oven
- 4 Ovens in 1 to Meet Your Cooking Needs - Speedcook, True European Convection, Warming/Proofing, Sensor Microwave
- Under-the-counter installation - provides installation flexibility to accommodate a variety of kitchen designs
- Saves valuable time by eliminating preheating
- 16" Turntable - Allows complete rotation of a 9" x 13" casserole dish
- Preprogrammed Recipes - Provide quick and easy programming of over 175 speedcook food selections
- Multi-Level Cooking - Removable pedestal rack allows cooking of multiple dishes at once
- Model PSB1201NSS - Stainless steel

Note: PSB1200/1 series Advantium can be installed below GE/GE Profile non-downdraft gas and electric cooktops. It CANNOT be installed below induction or Monogram (2GU3841385) gas cooktops.

For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at ge.com or call GE Answer Center® service, 800.626.2000.





SINC2220

Enjoy the ease, speed, and safety of induction cooking with SUMMIT's SINC line of energy efficient induction cooktops.

The SINC2220 is a two zone built-in cooktop featuring a genuine Ceran™ black glass surface. With 3100 watts of total power, it uses electromagnetic heat generated by your pot or pan to cook in half the time, with half the energy of conventional ranges. Ten variable touch power settings with digital displays make heating precise and easy. Since the smooth surface has no holes or grates, clean-up is simple: all you need is a gentle wipe with a damp cloth.

Designed for the highest quality cooking experience, the SINC2220 is fully equipped for safety. The temperature of the surface does not get nearly as hot as traditional gas or electric elements and there are no open flames or released gas. Features include a child lock, automatic safety switch-off, and a residual heat indicator. Beveled edges blend seamlessly into the counter.

Each purchase of an SINC2220 includes a complimentary set of SUMMIT Induction Cookware. This 7-piece collection includes three pots with heat-resistant glass lids and one 9 1/2 inch skillet. All are constructed with a triple layer bottom, with an aluminum core layered between stainless steel to provide cooking contents with even heat distribution. Safe for use on induction, gas, and electric heat surfaces as well as use in dishwashers and ovens.

SUMMIT's induction cooktops bring the superior performance of upscale restaurant cooking into your own home, with energy savings and pure elegance.

Highlights

- Instantly heats to cook in half the time of standard gas and electric ranges
- Smooth Schott Ceran surface made of durable, low maintenance black glass
- Complimentary 7-piece cookware set included
- Magnetically generated heat produces no open flame and keeps heat confined to cookware
- Ten power settings let you change the cooking power with instant precision

Features

Schott Ceran surface	Smooth surface made of durable and elegant black glass
Beveled edges	Smooth, slightly rounded edges protect you from minor injuries associated with sharp corners
7-piece cookware set	Each purchase includes a complimentary set of induction cookware complete with glass lids
Electromagnetic heat	Heat is produced inside your pan for even cooking with 90% energy efficiency
Energy efficient	84% of the heat created goes directly towards heating cookware contents
Cool surface	Most heat is sent directly to cookware, keeping the surface fairly cool to touch
Automatic pan recognition	Interior coil turns off after 30 seconds if there is no induction cookware on top
Child lock	Prevent accidents with this safety feature
Ten power levels	Get precise control of heating temperature with adjustable touch controls
LED display	Four digit display lets you keep track of power setting
Timer	Program timer between 0-99 minutes
	With no baked-on messes, all you need is a damp cloth to wipe down the

Easy cleanup

surface

Specifications

Cutout Depth:	19.38"
Cutout Width:	10.63"
Height:	3.25"
Width:	11.38"
Depth:	20.13"
Shipping Weight:	36.0 lbs.
Amps:	15.0
Voltage/Frequency:	220 V AC/60 Hz
US Electrical Safety:	ETL
Surface Type:	Glass
Burner Type:	Glasstop
Heating Type:	Induction
Burner Temperature Control:	Digital
Number of Burners:	2
Parts/Labor Warranty:	1 Year

Options

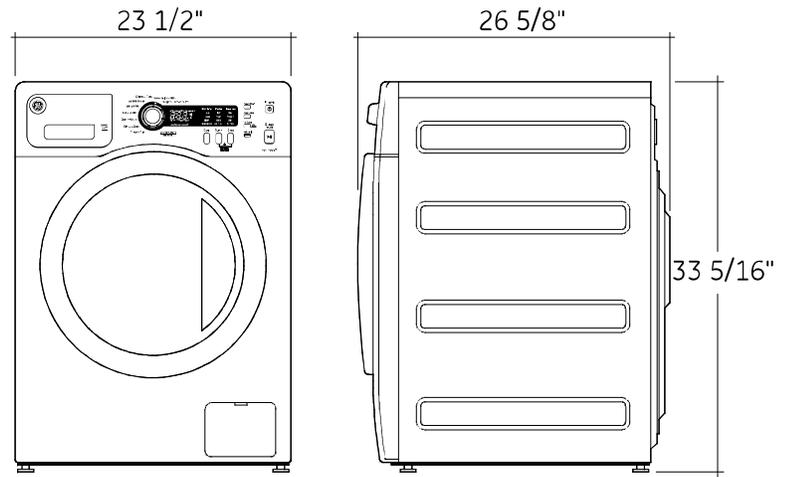
	Cabinet
Standard:	
Black:	Black
	Exterior
Standard Features:	
Cookware:	Complimentary 7-piece set of Induction Cookware included

WCVH4800K/4815K

GE® 2.2 DOE Cu. Ft. Capacity Frontload Washer with Stainless Steel Basket

Dimensions and Installation Information (in inches)

Installation Information: For complete information, see installation instructions packed with your washer.



For answers to your Monogram,® GE Profile™ or GE® appliance questions, visit our website at geappliances.com or call GE Answer Center® service, 800.626.2000.



imagination at work



Specification Revised 4/11

360422

WCVH4800K/4815K

GE® 2.2 DOE Cu. Ft. Capacity Frontload Washer with Stainless Steel Basket

Special Installation Requirements:

Stacked Installation:

- Kit for stacking dryer over washer are is not included with the washer. Order part no. GEFLSTACK.

Alcove or Closet Installation:

- If your dryer is approved for installation in an alcove or closet, it will be stated on a label on the dryer back.
- The dryer MUST be exhausted to the outside with the exception of the condensing dryer.
- Minimum clearances between dryer cabinet and adjacent walls or other surfaces are: 0" either side, 3" front and rear
- Minimum vertical space from floor to overhead cabinets, ceilings, etc. is 52".
- Closet doors must be louvered or otherwise ventilated and must contain a minimum of 60 sq. in. of open area equally distributed. If this closet contains both a washer and a dryer, doors must contain a minimum of 120 sq. in. of open area equally distributed.
- No other fuel-burning appliance shall be installed in the same closet with a gas dryer.

Bathroom or Bedroom Installation:

- The dryer MUST be exhausted to the outdoors with the exception of the condensing dryer.
- The installation must conform with the local codes, or in the absence of local codes, with the National Electric Code and National Fuel Gas Code, ANSI Z223 for gas dryers.

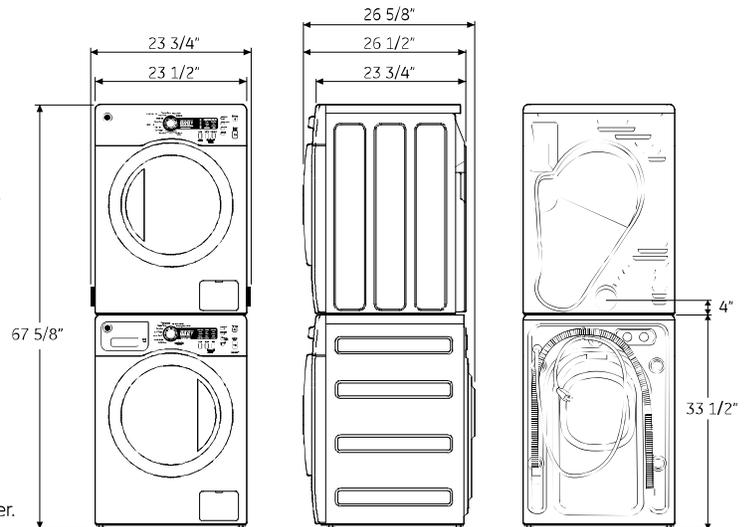
Minimum Clearance other than Alcove or Closet Installations:

- Minimum clearances to combustible surfaces 0" both sides, 3" rear.

For more information on venting kits and accessories, please call 1-800-GE-CARES.

For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at geappliances.com or call GE Answer Center® service, 800.626.2000.

Stacked Dimensions (in inches)



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Specification Revised 4/11

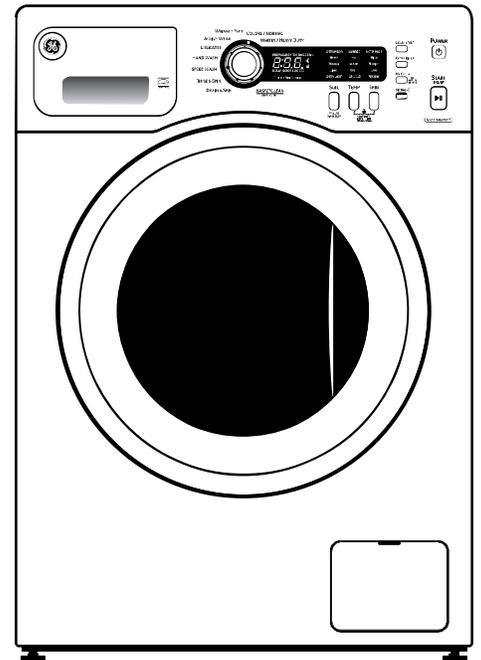
360422

WCVH4800K/4815K

GE® 2.2 DOE Cu. Ft. Capacity Frontload Washer with Stainless Steel Basket

Features and Benefits

- ENERGY STAR® Qualified - Meets or exceeds federal guidelines for energy efficiency for year-round energy and money savings
- HydroMotion™ Wash Action - Reversing wash action offers great cleaning performance with gentle wash motion
- HydroHeater™ - Increases wash temperature to reduce bacteria and provide better cleaning for the really tough stains
- 5 Wash/Spin Speed Combinations - Washer alternates speeds for great clothes care
- Multiple Wash Cycles - Choose from various wash actions for optimal cleaning and clothes care
- 5 Wash/Rinse Temperatures with Sanitize - Multiple settings and a Sanitize wash offer a greater degree of control over fabric cleaning and care
- Automatic Water Levels - Reduce water waste per cycle by filling only enough water to match the load size
- Delay Start Up To 18 Hours - Set the washer or dryer to begin cycles anytime in the next 18 hours
- ADA Compliant
- Model WCVH4800KWW - White on white
- Model WCVH4815KMS - Metallic Silver



Modified Energy Factor (MEF)	2.30
Water Factor (WF)	4.33



Specification Revised 4/11

360422

PDW1800/60N

GE Profile™ 18" Built-In Dishwasher

Dimensions and Installation Information (in inches)

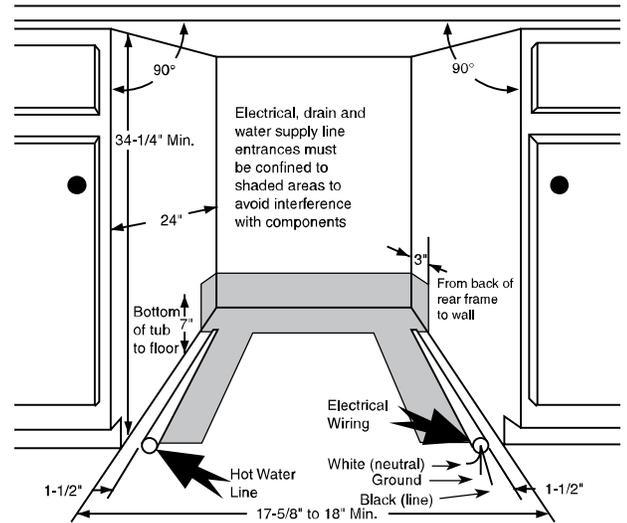
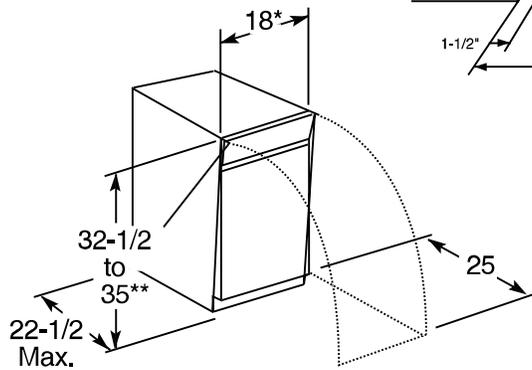
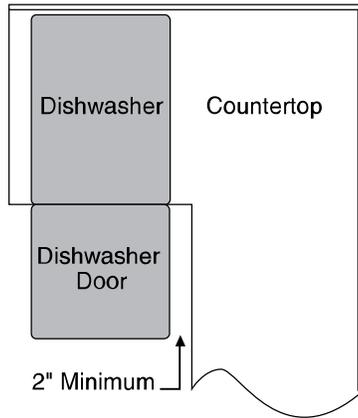
Electrical Rating

Voltage AC.....	120
Hertz.....	60
Total connected load amperage.....	9.0
Calrod® heater watts max.....	550

For use on adequately wired 120-volt, 15-amp circuit having 2-wire service with a separate ground wire. This appliance must be grounded for safe operation.

Note: Dishwasher must not be installed more than 10 feet from sink for proper drainage. All plumbing and electrical work must be in accordance with local codes.

Installation Information: Before installing, consult installation instructions packed with product for current dimensional data.



*Width adjustable from 17-5/8" to 18".
 **Meets ADA countertop height requirement of 34".

For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at ge.com or call GE Answer Center® service, 800.626.2000.



As an ENERGY STAR® partner, GE has determined that this product meets the ENERGY STAR guidelines for energy efficiency.

PDW1800/60N GE Profile™ 18" Built-In Dishwasher

Custom Dishwasher Door Panel Template

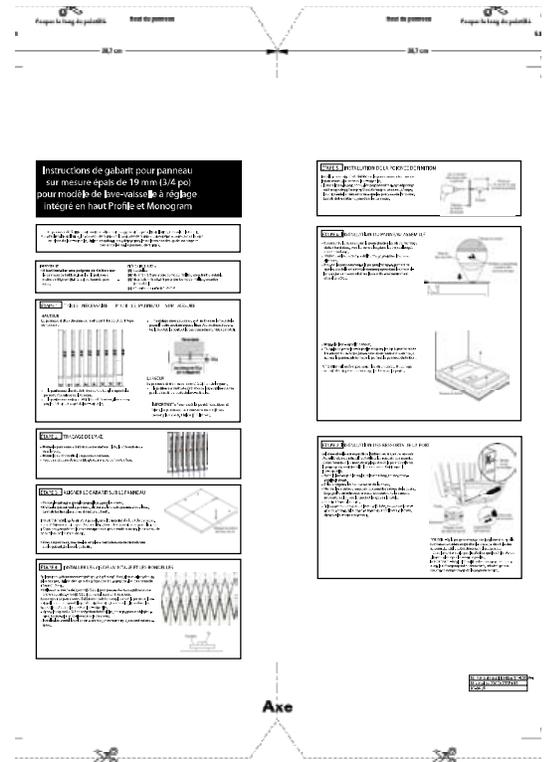
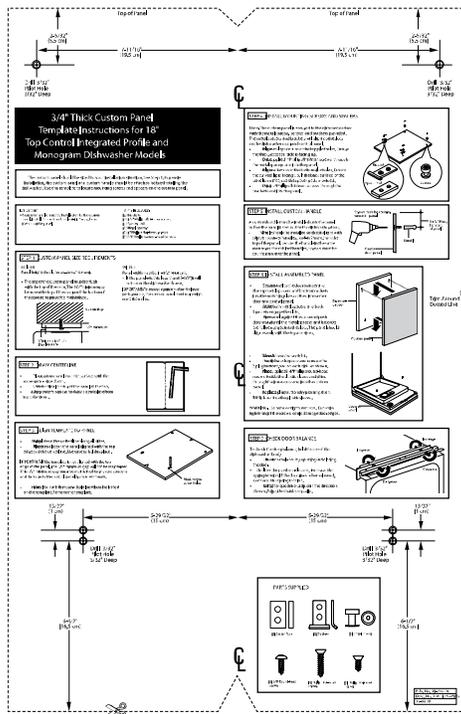
GE Pub. No. 031-30244

**For Reference Only
Not to Scale**

Order GE Pub. No. 031-30244
Call 1-800-626-2000

For a full-size panel template with complete panel installation instructions.

For answers to your Monogram®/GE Profile™ or GE® appliance questions, visit our website at ge.com or call GE Answer Center® service, 800.626.2000.



As an ENERGY STAR® partner, GE has determined that this product meets the ENERGY STAR guidelines for energy efficiency.

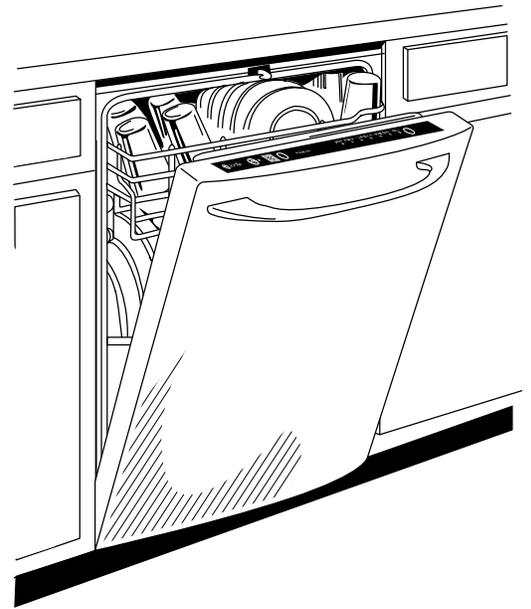
Specification Revised 8/10

250218

PDW1800/60N GE Profile™ 18" Built-In Dishwasher

Features and Benefits

- Bright Annealed Stainless Steel Interior - A lustrous finish and lasting beauty that resists stains and corrosion
- Hidden Electronic Controls - Tucks easy-to-use controls out of sight inside the door's top edge
- SpeedWash Cycle - Saves time by washing dishes faster
- Glasses Cycle - Gently washes glassware; great for entertaining
- Air-Dry Cycle - Washes lightly soiled dishes without a heated dry
- Nylon Racks - Heavy-duty design secures and protects dishes during each cycle
- ADA-compliant - Dishwasher design allows for simple operation and easy access
- 1-24-Hour Delay Start - Offers the ability to start the dishwasher when no one's home
- Model PDW1800NSS -Stainless steel
- Model PDW1800NWW -White
- Model PDW1800NBB -Black
- Model PDW1800NII -Custom panel



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B. Cooktop, Built-in Induction

1. Product: Summit Appliance Division, Felix Storch Inc., SINC 2220
2. 240 Volts
3. 3100 Watts
4. <http://www.summitappliance.com/catalog/model/sinc2220>

C. Wall Oven

1. Product: General Electric Company, GE Profile Advantium PSB1201NSS
2. 30" Stainless Steel, Under-the-counter installation
3. 120 V
4. <http://products.geappliances.com/AppIProducts/Dispatcher?REQUEST=SpecPage&Sku=PSB1201NSS>

D. Dishwasher

1. Product: General Electric Company, GE Profile PDW1800NII
2. 18" Custom Panel
3. ADA Compliant
4. <http://products.geappliances.com/AppIProducts/Dispatcher?REQUEST=SpecPage&Sku=PDW1800NII>

E. \Ventilation Hood

1. Product: General Electric Company, GE Profile 30" Slide Out Hood JV394SBB
2. 300 cfm
3. Compact housing
4. <http://products.geappliances.com/AppIProducts/Dispatcher?REQUEST=SpecPage&Sku=JV394SBB>

2.2 CLEANING APPLIANCES

A. Washer

1. Product: General Electric Company, GE WCVH4815KMS
2. Front load washer
3. 2.6 cu. ft. capacity
4. Energy Star Qualified
5. Metallic Silver

B. Dryer

1. Product: General Electric Company, DCVH 485EKMS
2. Front load dryer
3. 4.0 cu. ft. capacity
4. Energy Star Qualified
5. Vented

2.3 FINISHES

- A. Custom Panels to match adjacent cabinetry. Coordinate finish with architect.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Examine the Contract Documents in order to insure the completeness of the work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, with particular attention given to the installation of items embedded in concrete and masonry so as not to delay job progress.

3.3 INSTALLATION

- A. Install work of this section square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints (except as indicated otherwise or to allow for thermal movement). Provide attachment devices as required for secure and rigid installation.
- B. Install work as per manufacturer's requirements.

3.4 CLEANING, ADJUSTMENT, PROTECTION

- A. Keep protective layer on finished faces until the start of the Solar Decathlon 2011 competition dates.

END OF SECTION

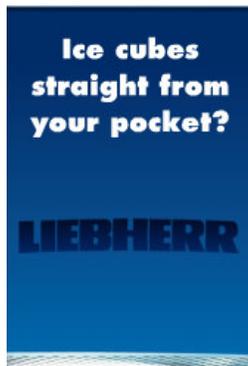


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24" BioFresh Refrigerator
24" Freezer
36" Refrigerator & Freezer
48" Refrigerator & Freezer
48" BioFresh Refrigerator & Freezer


HC 1011

Technical data

Energy Label
Compressors
Regulable cooling circuits
Type of control
SuperCool
SuperFrost
Material door shelves
Interior light, refrigerator compartment
BioFresh
Interior light, BioFresh compartment
NoFrost
FrostSafe-System
IceMaker
Door hinges
Gross weight in pounds
Gross weight [kg]
Net capacity of refrigerator compartment in cubic feet
Total net capacity, refrigerator compartment [l]

Of which is refrigeration only [l]

Net capacity of freezer compartment in cubic feet
Net capacity, freezer compartment [l]
Dimensions, recess

Measurements: height of recess in inches 69 13/16

Measurements: width of recess in inches 22 1/16

Measurements: depth of recess (min.) in inches 21 11/16

Recess requirement in inch 70 3/32

Range of appliance height [cm] 177.2-178.8

Range of appliance width [cm] 56-57

Min. depth [cm] 55

Recess requirement 178 cm

Download

EnergyStar

1

2

Digital temperature display in the MagicEye

✓

quantity-controlled

Glass with stainless steel trim

LED light column

-

-

✓

with completely enclosed, transparent drawers

-

right interchangeable

178.6

81

7.1

200

200

2.4

66

69 13/16

22 1/16

21 11/16

70 3/32

177.2-178.8

56-57

55

178 cm



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SINC2220

3.25" x 11.38" x 20.13" (H x W x D)

Built-in induction cooktop with two zones, 3100 Watts, 220 Volts, and Black Ceran™ smooth-top finish

Highlights:

Instantly heats to cook in half the time of standard gas and electric ranges

Smooth Schott Ceran surface made of durable, low maintenance black glass

Complimentary 7-piece cookware set included

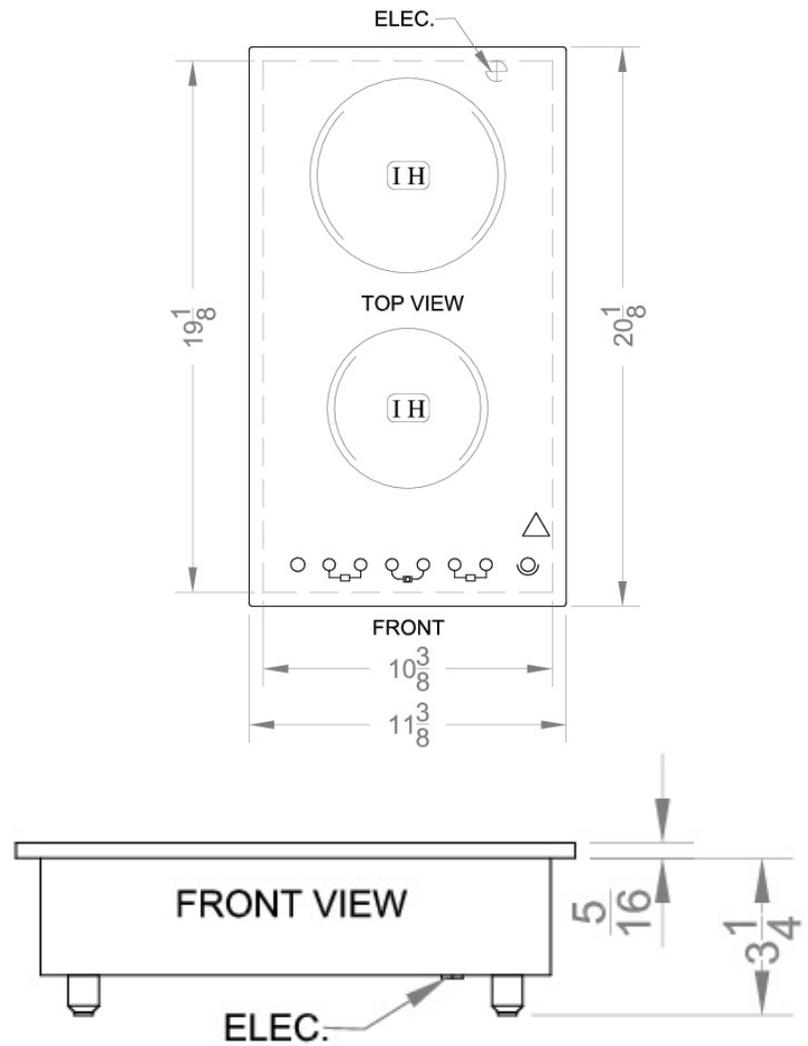
Magnetically generated heat produces no open flame and keeps heat confined to cookware



Schott Ceran surface	Smooth surface made of durable and elegant black glass
Beveled edges	Smooth, slightly rounded edges protect you from minor injuries associated with sharp corners
7-piece cookware set	Each purchase includes a complimentary set of induction cookware complete with glass lids
Electromagnetic heat	Heat is produced inside your pan for even cooking with 90% energy efficiency
Energy efficient	84% of the heat created goes directly towards heating cookware contents
Cool surface	Most heat is sent directly to cookware, keeping the surface fairly cool to touch
Automatic pan recognition	Interior coil turns off after 30 seconds if there is no induction cookware on top
Child lock	Prevent accidents with this safety feature
Ten power levels	Get precise control of heating temperature with adjustable touch controls
LED display	Four digit display lets you keep track of power setting

Specifications:

Height	3.25"
Width	11.38"
Depth	20.13"
Shipping Weight	36.0 lbs.
Voltage/Frequency	220 V AC/60 Hz
US Electrical Safety	ETL
Amps	15.0
Burner Type	Glasstop
Surface Type	Glass
Burner Temperature Control	Digital
Heating Type	Induction
Number of Burners	2
Parts/Labor Warranty	1 Year



MODEL: SINC2220
220V-60HZ 3100W

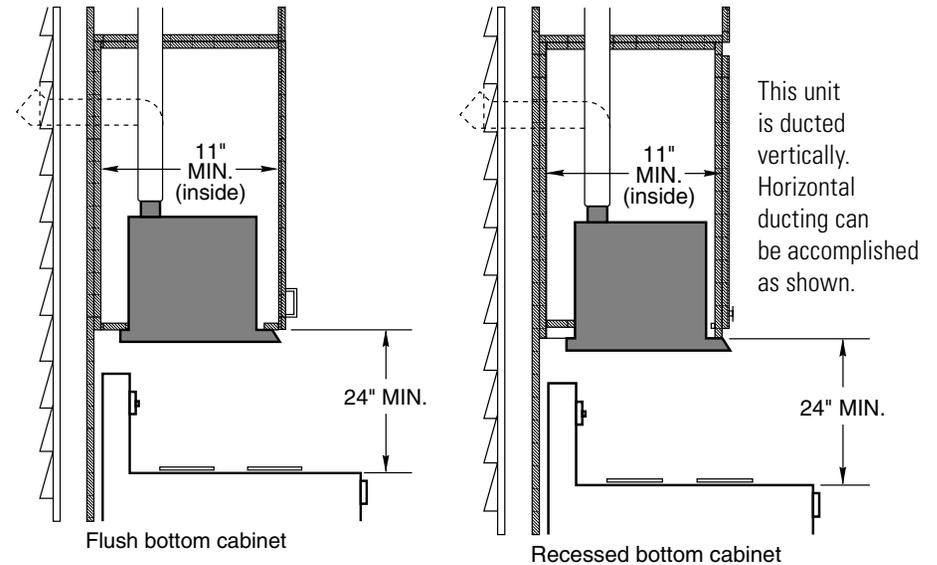
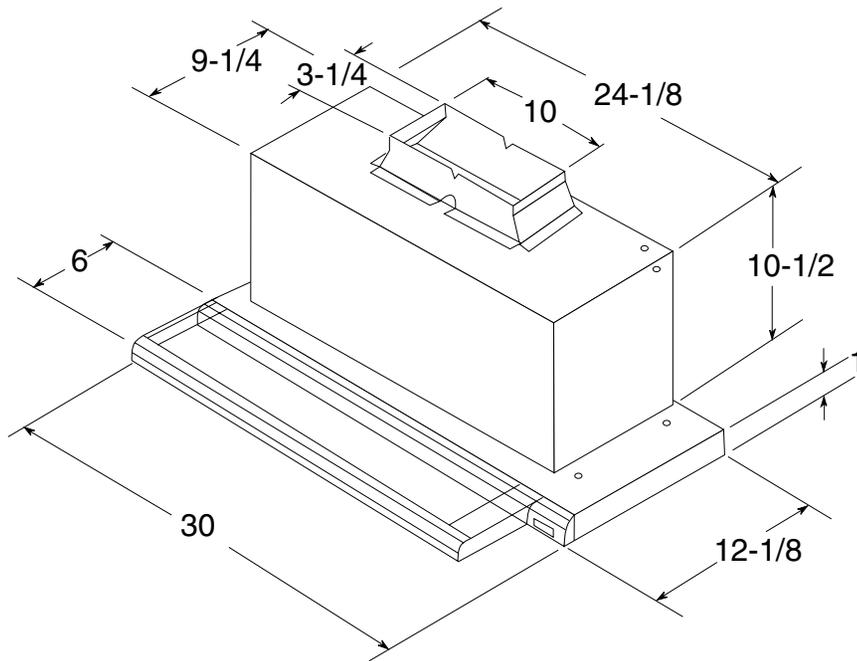
Summit Appliance Division, Felix Storch, Inc.
 770 Garrison Ave • Bronx, NY 10474
 Phone: 718-893-3900 • Fax: 718-842-3093
 Email: info@summitappliance.com



Profile™

JV394S – GE Profile™ Slide-Out Hood

Installation Information and Dimensions (in inches)



Amp Rating	
120V	3.7

Note: Remove glass visor from unit before installing hood in cabinet to protect visor from damage.

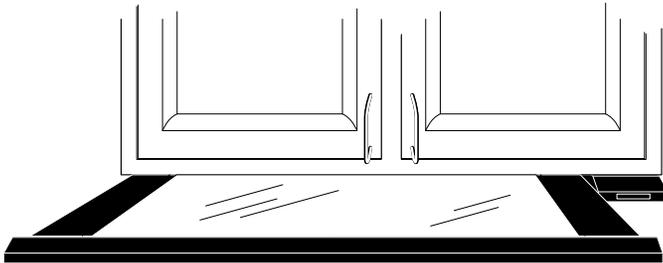
Installation Information: Before installing, consult Use & Care/installation instructions [Pub. No. 49-8463] packed with product for current dimensional data.





Profile™

JV394S – GE Profile™ Slide-Out Hood



Features and Benefits

- Black on black Model
- 30" Vented Hood With Cooktop Light
- See-Through Glass Visor Slides In and Out
- 300 CFM Performance With Variable Speed Fan Control
- Auto Heat Sensor
- Compact Housing Leaves Ample Shelf Space Behind Cabinet Doors
- Vertical Exhaust With 3-1/4" x 10" Rectangular Duct
- Sones Rating: Top Exhaust – 4.5
- Also Available In White on white as Model JV395S and Bisque as in Model JV396S

PSB1001NSS

GE Profile Advantium® 120 Volt - 27" Wall Oven

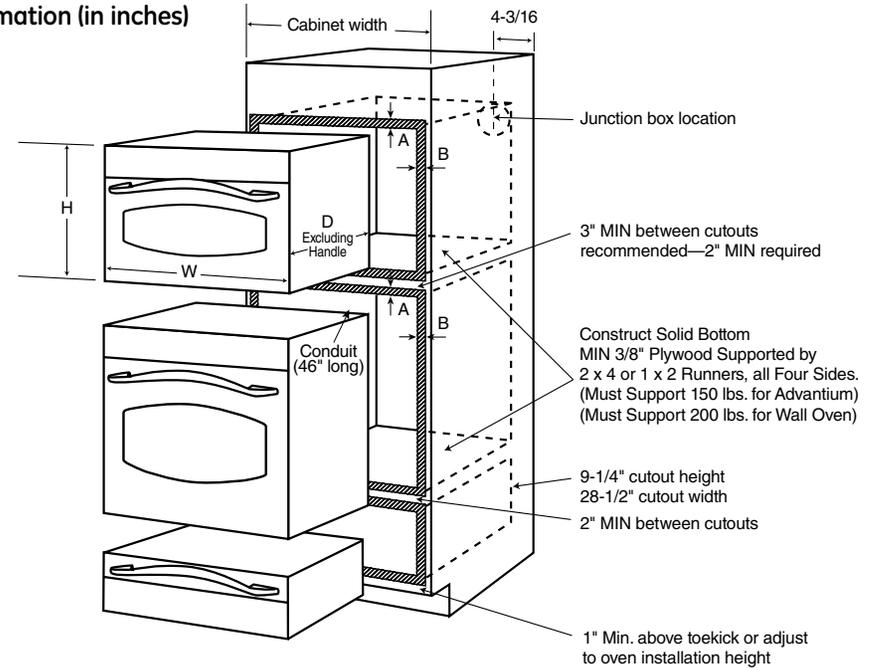
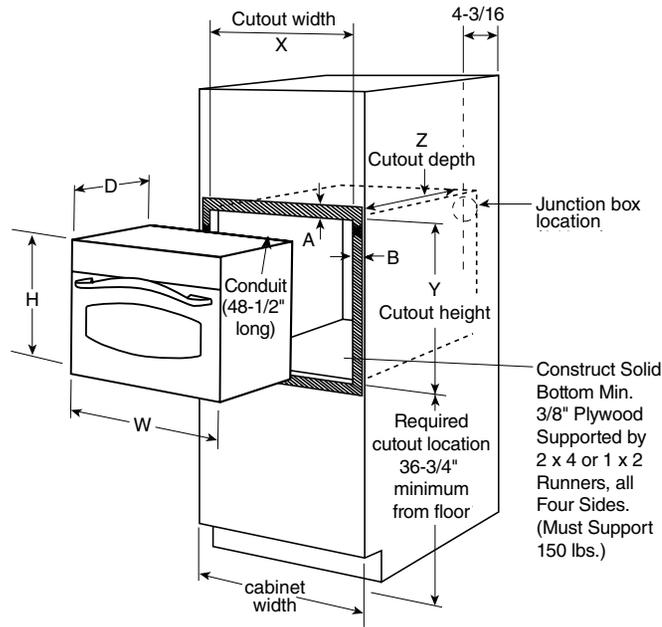
Advantium wall oven/GE Profile cooking tower dimensions and cabinet installation information (in inches)

Note: Cabinets installed adjacent to wall ovens must have an adhesion spec of at least a 194°F temperature rating.

Note: 2" minimum between cutouts when installed above warming drawer or single wall oven.

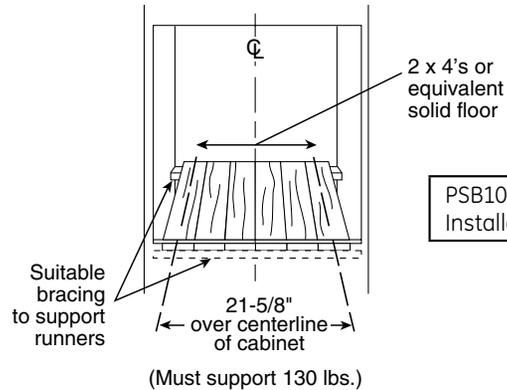
Installation Information:

Before installing, consult installation instructions packed with product for current dimensional data.



A=Allow 1" overlap of oven over top and bottom edges of cutout.
B=Allow 11/16"-3/4" for overlap of oven over side edges of cutout.

A=Allow 1" overlap of oven over top and bottom edges of cutout.
B=Allow 11/16"-3/4" for overlap of oven over side edges of cutout.



	Cabinet Width	W Width	H Height	D Depth (excluding handle)	X Cutout Width	Y Cutout Height	Z Cutout Depth minimum
PSB1001/1:27" Installation	27	26-3/4	19-1/32	21-1/2	25-1/4	17-1/2	23-1/2

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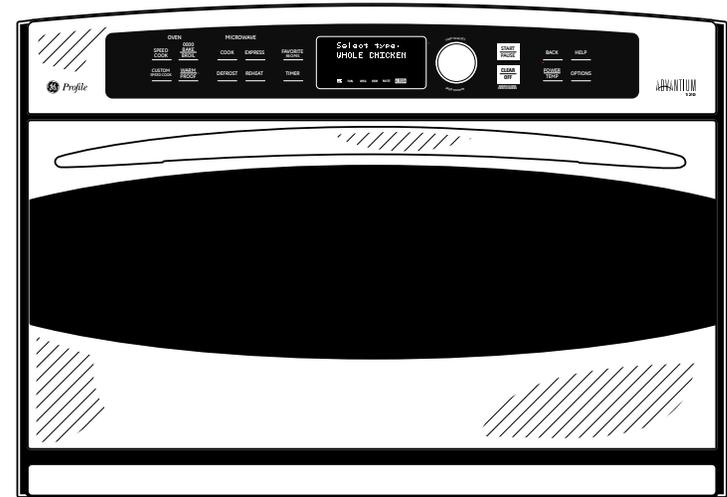


PSB1001NSS

GE Profile Advantium® 120 Volt - 27" Wall Oven

Features and Benefits

- Speedcook Technology - Cooks up to 4 times faster than a conventional oven
- 4 Ovens in 1 to Meet Your Cooking Needs - Speedcook, True European Convection, Warming/Proofing, Sensor Microwave
- Sensor Microwave Oven - 975-watt sensor microwave oven mode automatically delivers exceptional cooking results
- Warming Oven - Keeps prepared foods warm and fresh, and retains superb moistness and crispness
- Proof Feature - Specialized mode allows dough to rise quickly
- 16" Turntable - Allows complete rotation of a 9" x 13" casserole dish
- Glass Touch Controls - Features a smooth glass design that is easy to operate and easy to clean
- Preprogrammed Recipes - Provide quick and easy programming of over 175 speedcook food selections
- Multi-Level Cooking - Removable pedestal rack allows cooking of multiple dishes at once
- Model PSB1001NSS - Stainless Steel



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PDW1800/60N

GE Profile™ 18" Built-In Dishwasher

Dimensions and Installation Information (in inches)

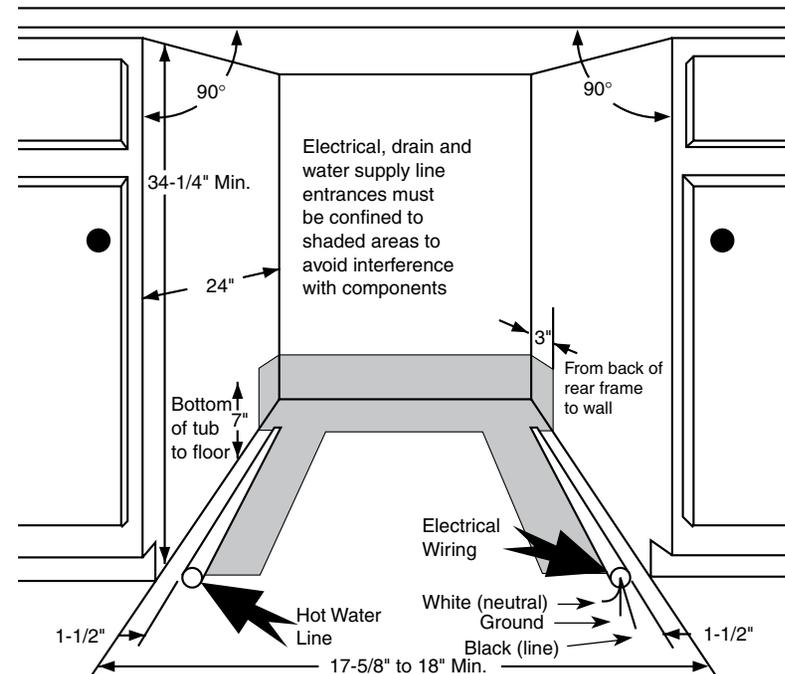
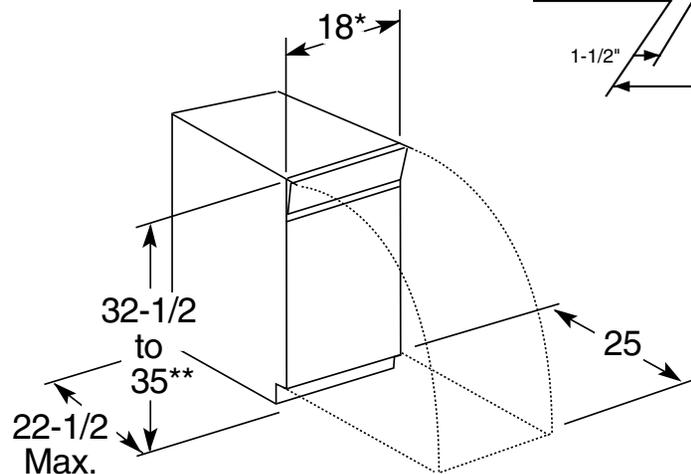
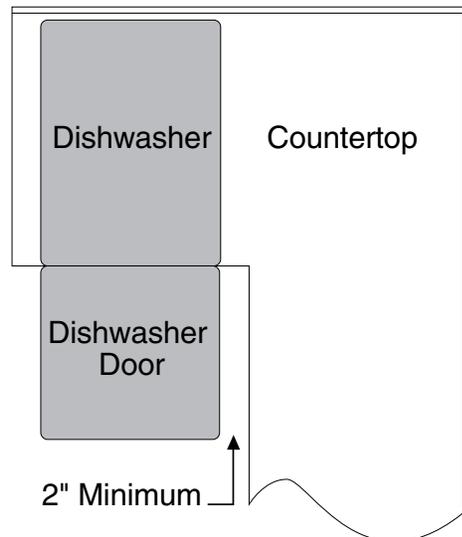
Electrical Rating

Voltage AC.....	120
Hertz.....	60
Total connected load amperage.....	9.0
Calrod® heater watts max.....	550

For use on adequately wired 120-volt, 15-amp circuit having 2-wire service with a separate ground wire. This appliance must be grounded for safe operation.

Note: Dishwasher must not be installed more than 10 feet from sink for proper drainage. All plumbing and electrical work must be in accordance with local codes.

Installation Information: Before installing, consult installation instructions packed with product for current dimensional data.



*Width adjustable from 17-5/8" to 18".
 **Meets ADA countertop height requirement of 34".

For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at ge.com or call GE Answer Center® service, 800.626.2000.



As an ENERGY STAR® partner, GE has determined that this product meets the ENERGY STAR guidelines for energy efficiency.

PDW1800/60N GE Profile™ 18" Built-In Dishwasher

Custom Dishwasher Door Panel Template

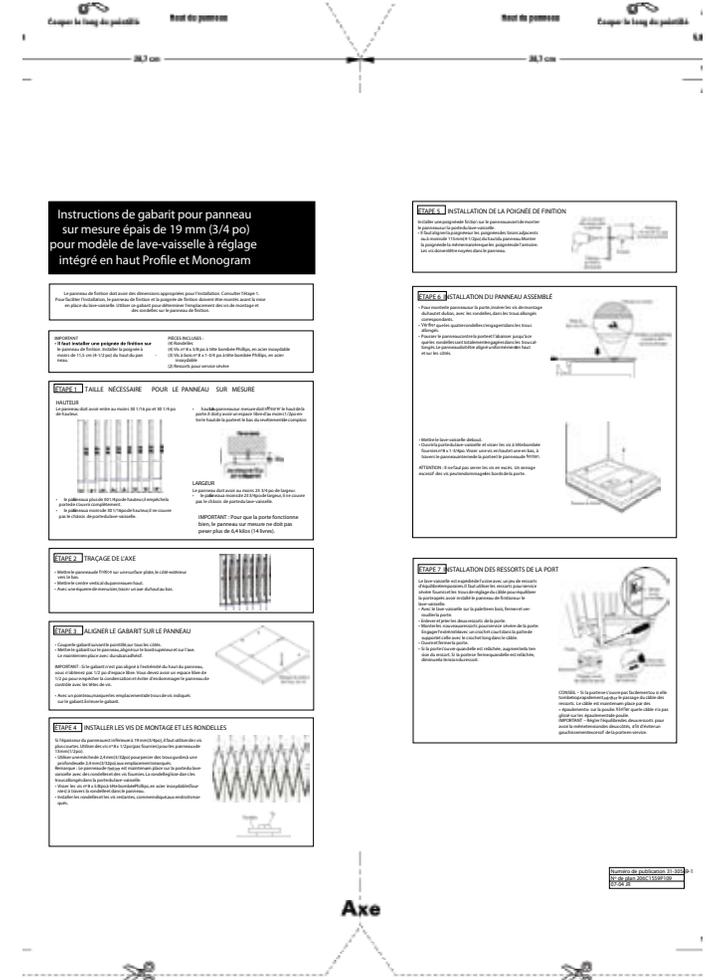
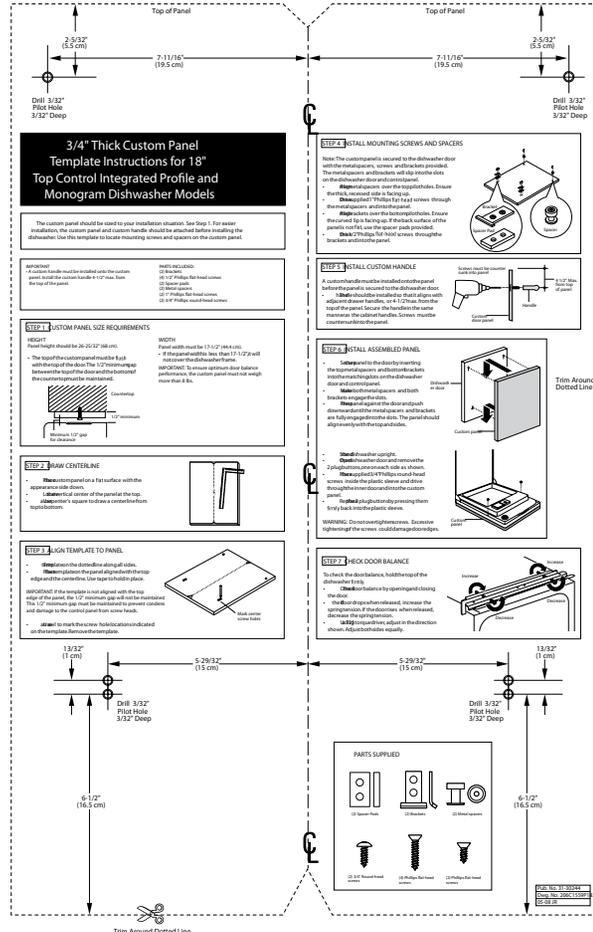
GE Pub. No. 031-30244

**For Reference Only
Not to Scale**

Order GE Pub. No. 031-30244
Call 1-800-626-2000

For a full-size panel template with complete panel installation instructions.

For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at ge.com or call GE Answer Center® service, 800.626.2000.



Listed by Underwriters Laboratories



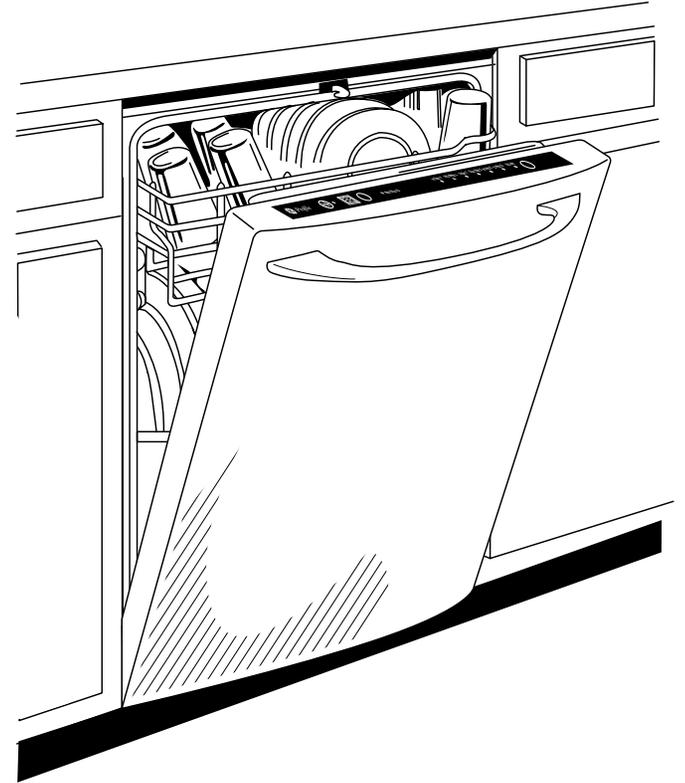
As an ENERGY STAR® partner, GE has determined that this product meets the ENERGY STAR guidelines for energy efficiency.

PDW1800/60N

GE Profile™ 18" Built-In Dishwasher

Features and Benefits

- Bright Annealed Stainless Steel Interior - A lustrous finish and lasting beauty that resists stains and corrosion
- Hidden Electronic Controls - Tucks easy-to-use controls out of sight inside the door's top edge
- SpeedWash Cycle - Saves time by washing dishes faster
- Glasses Cycle - Gently washes glassware; great for entertaining
- Air-Dry Cycle - Washes lightly soiled dishes without a heated dry
- Nylon Racks - Heavy-duty design secures and protects dishes during each cycle
- ADA-compliant - Dishwasher design allows for simple operation and easy access
- 1-24-Hour Delay Start - Offers the ability to start the dishwasher when no one's home
- Model PDW1800NSS -Stainless steel
- Model PDW1800NWW -White
- Model PDW1800NBB -Black
- Model PDW1800NII -Custom panel



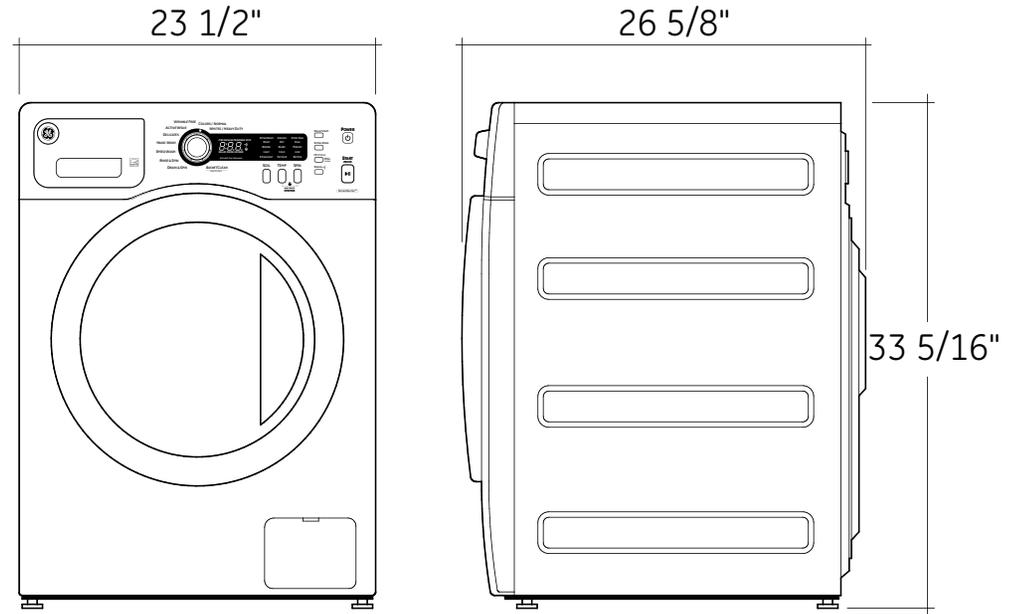
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WCVH4800K/4815K

GE® 2.2 DOE Cu. Ft. Capacity Frontload Washer with Stainless Steel Basket

Dimensions and Installation Information (in inches)

Installation Information: For complete information, see installation instructions packed with your washer.



For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at geappliances.com or call GE Answer Center® service, 800.626.2000.



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Listed by
Underwriters
Laboratories

WCVH4800K/4815K

GE® 2.2 DOE Cu. Ft. Capacity Frontload Washer with Stainless Steel Basket

Special Installation Requirements:

Stacked Installation:

- Kit for stacking dryer over washer are is not included with the washer. Order part no. GEFLSTACK.

Alcove or Closet Installation:

- If your dryer is approved for installation in an alcove or closet, it will be stated on a label on the dryer back.
- The dryer MUST be exhausted to the outside with the exception of the condensing dryer.
- Minimum clearances between dryer cabinet and adjacent walls or other surfaces are: 0" either side, 3" front and rear
- Minimum vertical space from floor to overhead cabinets, ceilings, etc. is 52".
- Closet doors must be louvered or otherwise ventilated and must contain a minimum of 60 sq. in. of open area equally distributed. If this closet contains both a washer and a dryer, doors must contain a minimum of 120 sq. in. of open area equally distributed.
- No other fuel-burning appliance shall be installed in the same closet with a gas dryer.

Bathroom or Bedroom Installation:

- The dryer MUST be exhausted to the outdoors with the exception of the condensing dryer.
- The installation must conform with the local codes, or in the absence of local codes, with the National Electric Code and National Fuel Gas Code, ANSI Z223 for gas dryers.

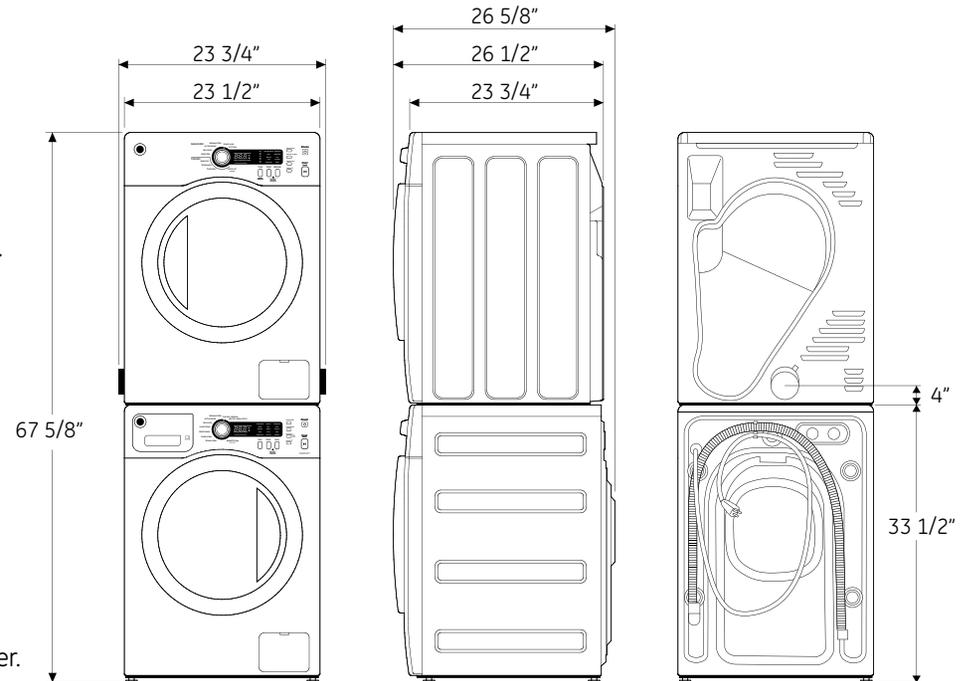
Minimum Clearance other than Alcove or Closet Installations:

- Minimum clearances to combustible surfaces 0" both sides, 3" rear.

For more information on venting kits and accessories, please call 1-800-GE-CARES.

For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at geappliances.com or call GE Answer Center® service, 800.626.2000.

Stacked Dimensions (in inches)

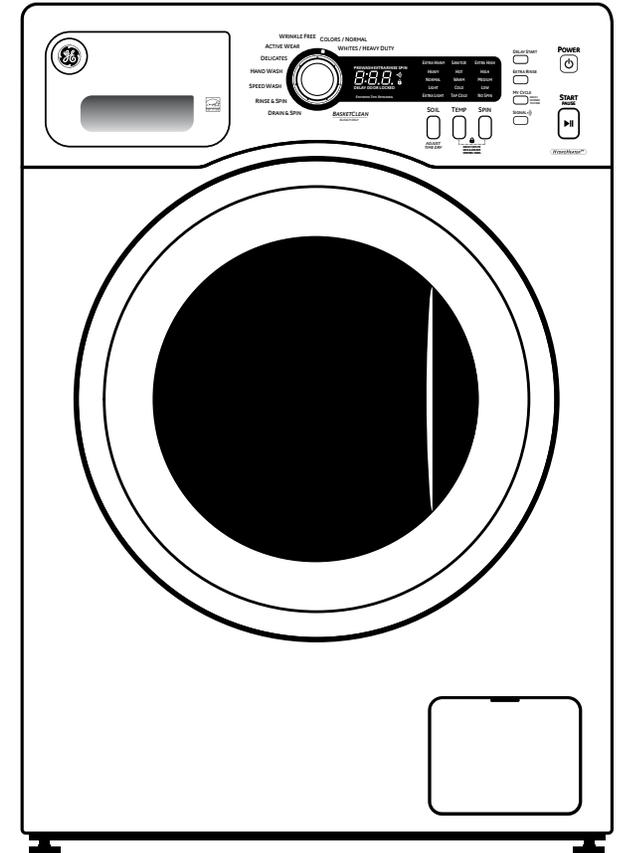


WCVH4800K/4815K

GE® 2.2 DOE Cu. Ft. Capacity Frontload Washer with Stainless Steel Basket

Features and Benefits

- ENERGY STAR® Qualified - Meets or exceeds federal guidelines for energy efficiency for year-round energy and money savings
- HydroMotion™ Wash Action - Reversing wash action offers great cleaning performance with gentle wash motion
- HydroHeater™ - Increases wash temperature to reduce bacteria and provide better cleaning for the really tough stains
- 5 Wash/Spin Speed Combinations - Washer alternates speeds for great clothes care
- Multiple Wash Cycles - Choose from various wash actions for optimal cleaning and clothes care
- 5 Wash/Rinse Temperatures with Sanitize - Multiple settings and a Sanitize wash offer a greater degree of control over fabric cleaning and care
- Automatic Water Levels - Reduce water waste per cycle by filling only enough water to match the load size
- Delay Start Up To 18 Hours - Set the washer or dryer to begin cycles anytime in the next 18 hours
- ADA Compliant
- Model WCVH4800KWW - White on white
- Model WCVH4815KMS - Metallic Silver



Modified Energy Factor (MEF)	2.30
Water Factor (WF)	4.33



DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Dimensions and Installation Information (in inches)

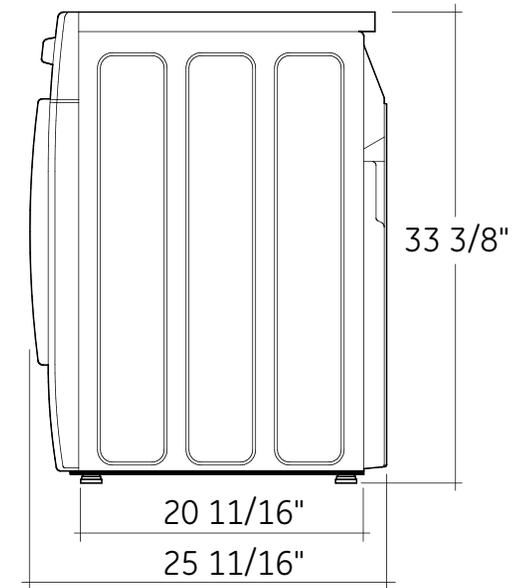
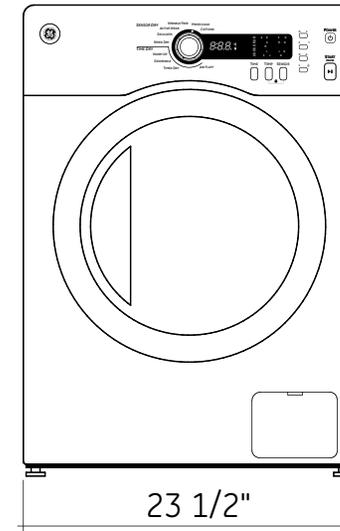
Electric Dryer Rating	
240V	3000W, 12.5A, 60Hz

Exhaust Options: 4-way via rear, right, left and bottom.

Circuit Requirements: An individual, properly grounded branch circuit, protected by a 30-amp circuit breaker or a time-delay fuse, is required.

Note: Dryer wall outlet must be located within 36" of service cord entry and accessible when dryer is mounted in position.

Installation Information: For complete information, see installation instructions packed with your dryer.



For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at ge.com or call GE Answer Center® service, 800.626.2000.



DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Special Installation Requirements:

Alcove or Closet Installation:

- Stacking Kit - GE24STACK (not included)
- If your dryer is approved for installation in an alcove or closet, it will be stated on a label on the dryer back.
- The dryer MUST be exhausted to the outside.
- Minimum clearances between dryer cabinet and adjacent walls or other surfaces are: 0" either side, 3" front and rear
- Minimum vertical space from floor to overhead cabinets, ceilings, etc. is 52".
- Closet doors must be louvered or otherwise ventilated and must contain a minimum of 60 sq. in. of open area equally distributed. If this closet contains both a washer and a dryer, doors must contain a minimum of 120 sq. in. of open area equally distributed.
- No other fuel-burning appliance shall be installed in the same closet with a gas dryer.

Bathroom or Bedroom Installation:

- The dryer MUST be exhausted to the outdoors.
- The installation must conform with the local codes, or in the absence of local codes, with the National Electric Code and National Fuel Gas Code, ANSI Z223 for gas dryers.

Minimum Clearance other than Alcove or Closet Installations:

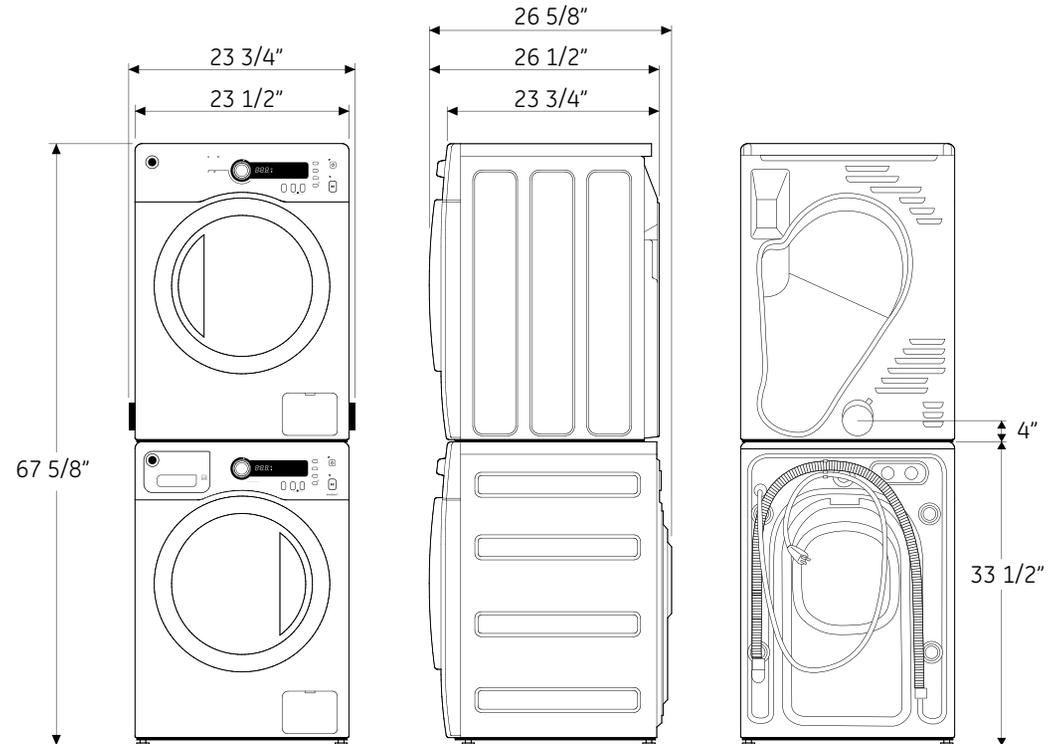
- Minimum clearances to combustible surfaces 0" both sides, 3" rear.

For more information on venting kits and accessories, please call 1-800-GE-CARES.

For answers to your Monogram®, GE Profile™ or GE® appliance questions, visit our website at ge.com or call GE Answer Center® service, 800.626.2000.



Stacked Dimensions (in inches)



DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Dryer Exhausting Information – Metal Duct Only

For complete information, see installation instructions packed with your dryer.

Ducting Materials: For best performance, this dryer should be vented with 4" diameter all rigid metal exhaust duct. If rigid metal duct cannot be used, then UL-listed flexible metal (semi-rigid) ducting can be used (Kit WX08X10077). In special installations, it may be necessary to connect the dryer to the house vent using a flexible metal (foil-type) duct. A UL-listed flexible metal (foil-type) duct may be used **ONLY** in installations where rigid metal or flexible metal (semi-rigid) ducting cannot be used **AND** where a 4" diameter can be maintained throughout the entire length of the transition duct. Please see installation instruction packed with your dryer for complete instructions when using flexible metal (foil type) ducting.

Exhaust Length Calculation:

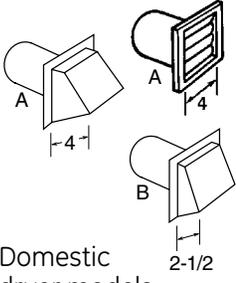
1. Determine the number of 90° turns needed for your installation. If you exhaust to the side or bottom of dryer, add one turn.
2. The maximum length of 4' rigid (aluminum or galvanized) duct which can be tolerated is shown in the table.
 - A turn of 45° or less may be ignored. Two 45° turns within the duct length should be treated as a 90° elbow.
 - A turn over 45° should be treated as a 90° elbow.

Dryers **must** be exhausted to the outside.

Caution: For personal safety do not terminate exhaust into a chimney, under any enclosed house floor (crawl space), or into an attic, since the accumulated lint could create a fire hazard or moisture could cause damage. Never terminate the exhaust into a common duct or plenum with a kitchen exhaust, since the combination of lint and grease could create a fire hazard.

Exhaust ducts should be terminated in a dampered wall cap to prevent back drafts, bird nesting, etc. The wall cap must also be located at least 12" above the ground or any other obstruction with the opening pointed down.

For more information on venting kits and accessories, please call 1-800-GE-CARES.



		Best performance	
		Maximum length of 4" dia. rigid metal duct	
		Exhaust hood type	
Domestic dryer models	Number of 90° turns	A 4" opening	B 2-1/2" opening
	0	90 ft.	60 ft.
40 cu. ft. capacity models	1	60 ft.	45 ft.
all electric dryers	2	45 ft.	35 ft.
	3	35 ft.	25 ft.

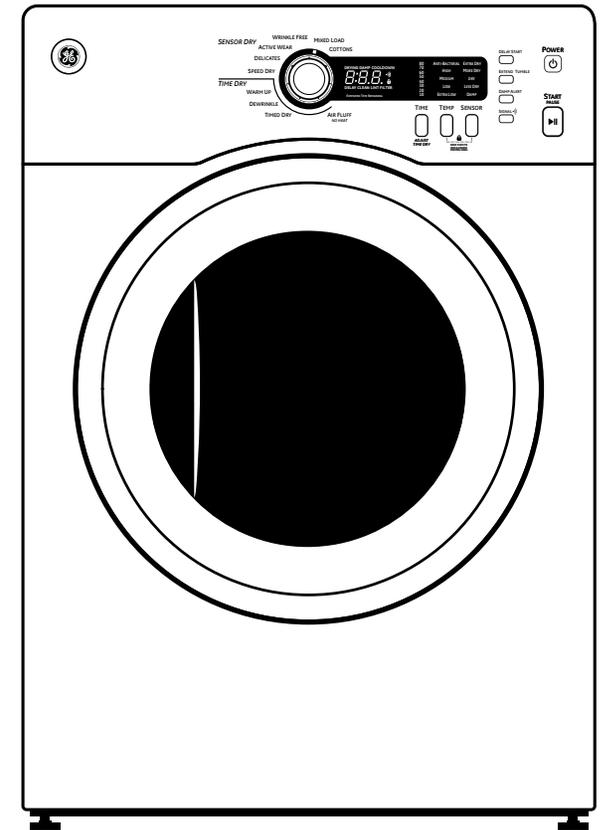


DCVH480/485EK

GE® 4.0 Cu. Ft. Capacity Frontload Electric Dryer

Features and Benefits

- 4.0 Cu. Ft. Large Stainless Steel Basket - Handles a king-size comforter or 24 full-size bath towels with ease
- 5 Heat Selections - Offer enhanced drying performance and fabric care
- Sensor Dry™ - Continually monitors moisture content to help prevent clothing wear and tear
- Stainless Steel Drum Interior - Smooth stainless interior helps prevent rust and protect clothes
- Multiple Dry Cycles - Deliver optimal drying results
- Delay Start - Lets you do the laundry on your terms
- Antibacterial Option - Certified by the NSF® to reduce up to 99.9% of certain types of bacteria
- Extended Tumble Plus - Tumble clothes without heat to help prevent creasing and wrinkling
- Speed Dry - Delivers ready-to-go results in minutes
- ADA Compliant
- Model DCVH480EKWW – White on white
- Model DCVH485EKMS – Metallic silver



SECTION 12 58 29.33

MURPHY BED

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. The custom-designed and fabricated bed. The bed will be a vertical Murphy bed that will lift up to provide more floor and storage space in the bedroom. It will have built-in features such as cabinets for storage spaces.

1.3 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site.
- B. Shop Drawings: Submit shop drawings for work specified herein for approval and obtain approval prior to fabrication and shipment of materials to the job site.
- C. Samples: Samples of materials specified herein and shall be submitted for approval, and approval obtained before materials are delivered to the site. Samples shall include the following:

PART 2 - PRODUCTS

2.1 BED HARDWARE

- A. Manufacturer: Hafele America Co. 3901 Cheyenne Drive Archdale, NC 27263 Tel : 1.336.434.2322 Fax: 1.800.325.6197
- B. Foldaway Bed Fitting from Hafele 877
- C. Door Knobs two

2.2 BED

- A. Manufacturer: IKEA
- B. MDF(BOX AND PANEL) 3/8"x4"x8"
- C. Full Size Mattress 53"x75"
- D. Slatted bed base Sulttan Lade from Ikea



2.3 FABRICATION

- A. The bed frame will be custom built with MDF material with the dimensions of 3/8"x4"x8". The bed frame will be built to fit a mattress with the dimensions 53"x75".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Examine the Contract Documents in order to insure the completeness of the work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, with particular attention given to the installation of items embedded in concrete and masonry so as not to delay job progress.

3.3 INSTALLATION

- A. Bed shall be installed with house construction on site.

END OF SECTION



SECTION 13 32 00

SPACE FRAMES

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. Work includes
 - 1. Steel space frame including design , detail engineering, factory fabrication, and installation
- B. Related Work Specified Elsewhere
 - 1. Division 05 Section "Structural Steel".
 - 2. Structural Insulated Panels
 - 3. Division 08 Section "Skylights"

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated
- B. Withstand design loads as shown on Structural Drawings:

1.4 SUBMITTALS

- A. Product Data: For space frame. Include details of construction relative to materials, dimensions of individual components, profiles, and finishes. Provide installation instructions,. Include the following:
 - 1. Setting drawings, templates, and installation instructions for mounting and anchor devices.
 - 2. Summary of forces and loads on space frame.
- B. Shop Drawings: Showing elevations, sections and large scale details of complete space frame system, including,
 - 1. Layout, profiles and dimensions, product components, edge conditions, and special shapes. ,
 - 2. Installation details: Attachment methods, fasteners, joints, corners, openings, intersections with adjacent materials, flashings, closures, trim, and other critical conditions.
- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Provide test reports on structural connections, tube materials and high strength threaded hardware
- E. Affidavit certifying material meets requirements specified.



1.5 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of 10 years experience in the manufacturing of this product.
- B. Installer shall be trained by the space frame manufacturer.
- C. Field measurements should be taken prior to the completion of shop fabrication whenever possible. However, coordinate fabrication schedule with construction progress as directed by the Contractor to avoid delay of work. Field fabrication may be allowed to ensure proper fit. However, field fabrication shall be kept to an absolute minimum with the majority of the fabrication being done under controlled shop conditions.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Protect finish in accordance with manufacturer's recommendations.
- B. Store material in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Triodetic Space Frames, Inc, New York

2.2 STRUCTURAL STEEL

- A. Triodetic Axial Members: Welded tubes with .148 inch wall thickness in accordance with ASTM A500-Grade B Structural members are to conform to CSA G40.21

2.3 ACCESSORIES

- A. Triodetic Connectors are to be aluminum alloy 6351-T6
- B. Miscellaneous Steel Brackets and Weldments are to conform to ASTM-A36 (FY=36 ksi)
- C. Bolts, Nuts and Threaded Rods are to conform to ASTM-A307 and ASTM A325, ASTM A490 or ASTM A193-B7 where required by design.
- D. Steel Washers are to conform to specification ASTM-A529 (FY=42)

2.4 FABRICATION

- A. Factory prefabricated round tubular section with cold-formed tooth ends to suit mechanical connector
- B. Mechanical connector nodes shall be cylindrical aluminum extrusions

2.5 FINISHES

- A. Steel tube members are to be factory pre-galvanized coating in accordance with ASTM A446-65T
- B. Beams and all miscellaneous structural steel elements, purlins, girts and all miscellaneous steel brackets and Weldments are to be hot-dip galvanized in accordance with ASTM A123-97
- C. Triodetic connectors, connector plugs and batten caps are to be mill finished



- D. Bolts, Nuts and Threaded Rods will have an electroplated finish ASTM B633-98 with a zinc coating weight range from .00015 to .001 inches

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that support conditions will accept the work of this Section.
- B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 ERECTION

- A. Perform work by authorized erector trained by manufacturer..
- B. Space frame shall be erected in accordance with an approved Shop Drawings.
- C. Install plumb and true..

3.3 ADJUSTING AND CLEANING

- A. Repair damage.
- B. Provided additional protection, after installation,

END OF SECTION



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SECTION 21 13 00

Fire Suppression Sprinkler Head

PART 1 -GENERAL

A DESCRIPTION OF WORK:

1. Provide sprinkler heads for fire suppression.

B SECTION INCLUDES:

1. Tyco Residential Sprinkler Head

PART 2- PRODUCTS

- A. See attached cut sheet

END OF SECTION



Series LFII Residential, NFPA 13 Optimized Pendent, Recessed, and Concealed Sprinklers 6.9 K-factor, 3/4" NPT

General Description

The Tyco[®] Rapid Response[™] Series LFII (TY4234) Residential Pendent, Recessed Pendent, and Concealed Pendent Sprinklers are decorative, fast response, frangible bulb sprinklers designed for use in residential occupancies such as homes, apartments, dormitories, and hotels. When enhanced flow characteristics for residential portions of any occupancy per NFPA 13 is the major consideration, the Series LFII (TY4234) should be the first choice.

When higher flow demands are required for residential sprinklers used in an NFPA 13 design, the large 6.9 K-factor of the Series LFII (TY4234) is an attractive choice. Although primarily intended where residential sprinklers are to be used in an NFPA 13 design, the Series LFII (TY4234) can also be used in wet pipe residential sprinkler systems for one- and two-family dwellings and mobile homes per NFPA 13D, and wet pipe residential sprinkler systems for residential occupancies up to and including four stories in height per NFPA 13R.

The recessed version of the Series LFII (TY4234) is intended for use in areas with finished ceilings. It employs a two-piece Style 30 Recessed Escutcheon. The Recessed Escutcheon provides 1/4 inch (6,4 mm) of recessed adjustment or up to 1/2 inch (12,7 mm) of to-

tal adjustment from the flush mounting surface position. The adjustment provided by the Recessed Escutcheon or Concealed Cover Plate provides a measure of flexibility with regard to which the length of fixed pipe drops to the sprinklers must be cut.

The concealed version utilizes a cover plate assembly that conceals the sprinkler operating components above the ceiling. The separable two-piece design of the Cover Plate and Support Cup Assemblies allows installation of the sprinklers and pressure testing of the fire protection system prior to the installation of the ceiling or application of a finish coating.

Also, the separable "push-on and thread-off" two-piece design of the concealed version provides for 1/2 inch (12,7 mm) of vertical adjustment.

The Series LFII (TY4234) Residential Concealed Pendent Sprinklers are shipped with a Disposable Protective Cap. The Protective Cap is temporarily removed for installation, and it must be replaced to protect the sprinkler while the ceiling is being installed or finished. The tip of the Protective Cap can also be used to mark the center of the ceiling hole into plaster board, ceiling tiles, etc. by gently pushing the ceiling product against the Protective Cap. When ceiling installation is complete, the Protective Cap must be removed and the Cover Plate Assembly installed. The Protective Cap must be removed to ensure proper performance of the sprinklers.

The Series LFII (TY4234) has been designed with heat sensitivity and water distribution characteristics proven to help in the control of residential fires and to improve the chance for occupants to escape or be evacuated.

NOTICE

The Series LFII (TY4234) Residential Pendent, Recessed Pendent, and Concealed Pendent Sprinklers described herein must be installed and maintained in compliance with this document and with the applicable



IMPORTANT

Always refer to Technical Data Sheet TFP700 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

Maximum Coverage Area (a) Ft. x Ft. (m x m)	Maximum Spacing Ft. (m)	Minimum Flow ^(b) and Residual Pressure For Horizontal Ceiling (Max. 2 Inch Rise for 12 Inch Run)		Minimum Flow ^(b) and Residual Pressure For Sloped Ceiling (Greater Than 2 Inch Rise for 12 Inch Run Up To Max. 8 Inch Rise for 12 Inch Run)	
		Pendent and Recessed Pendent	Concealed Pendent	Pendent and Recessed Pendent	Concealed Pendent
		155°F/68°C or 175°F/79°C	155°F/68°C or 175°F/79°C	155°F/68°C or 175°F/79°C	155°F/68°C or 175°F/79°C
12 x 12 (3,7 x 3,7)	12 (3,7)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)
14 x 14 (4,3 x 4,3)	14 (4,3)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)
16 x 16 (4,9 x 4,9)	16 (4,9)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)
18 x 18 (5,5 x 5,5)	18 (5,5)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	21 GPM (79,5 LPM) 9.3 psi (0,64 bar)	19 GPM (71,9 LPM) 7.6 psi (0,52 bar)	24 GPM (91,8 LPM) 12.1 psi (0,83 bar)
20 x 20 (6,1 x 6,1)	20 (6,1)	22 GPM (83,3 LPM) 10.2 psi (0,70 bar)	24 GPM (90,8 LPM) 12.1 psi (0,83 bar)	24 GPM (91,8 LPM) 12.1 psi (0,83 bar)	24 GPM (91,8 LPM) 12.1 psi (0,83 bar)

(a) For coverage area dimensions less than or between those indicated, it is necessary to use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.

(b) Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design Criteria Section for details.

**TABLE A
UL AND C-UL LISTED
NFPA 13D AND NFPA 13R WET PIPE HYDRAULIC DESIGN CRITERIA
FOR THE SERIES LFII (TY4234) RESIDENTIAL PENDENT, RECESSED PENDENT,
AND CONCEALED PENDENT SPRINKLERS**

standards of the National Fire Protection Association, in addition to the standards of any authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

Sprinkler/Model Identification Number

SIN TY4234

Technical Data

Approvals:

UL and C-UL Listed (Refer to Table A and the Design Criteria section — Pendent Recessed Pendent, and Concealed Pendent).

FM Approved (Refer to Table B and the Design Criteria section — Pendent and Recessed Pendent).

NYC Approved under MEA 44-03-E-2. The Series LFII Concealed Pendent Sprinklers are only listed and approved with the Series LFII Concealed Cover Plates having a factory applied finish.

Maximum Working Pressure:

175 psi (12,1 bar)

Discharge Coefficient:

K=6.9 GPM/psi^{1/2} (99,4 LPM/bar^{1/2})

Pipe Thread Connection:

3/4 NPT

Sprinkler Temperature Rating:

- Pendent and Recessed Pendent: 155°F/68°C or 175°F/79°C

- Concealed Pendent: 155°F/68°C w/139°F/59°C Cover Plate*

175°F/79°C
w/139°F/59°C Cover Plate*

*Suitable for use with maximum 100°F/38°C ceiling temperature.

Finishes:

- Sprinkler: White Polyester Coated, Chrome Plated, or Natural Brass
- Recessed Escutcheon: White, Chrome, or Brass
- Concealed Cover Plate: Refer to Ordering Procedure section.

Physical Characteristics:

Frame Brass
 Button Bronze
 Sealing Assembly
 Beryllium Nickel w/Teflon†
 Bulb 3 mm dia. Glass
 Compression Screw Bronze
 Deflector Bronze
 Ejection Spring Stainless Steel
 Support Cup Steel
 Cover Plate Brass
 Retainer Brass
 Cover Plate Ejection Spring
 Stainless Steel

†DuPont Registered Trademark

Patents:

U.S.A. 7,201,234

Maximum Coverage Area ^(a) Ft. x Ft. (m x m)	Maximum Spacing Ft. (m)	Minimum Flow ^(b) and Residual Pressure For Horizontal Ceiling (Max. 2 Inch Rise for 12 Inch Run)	
		Pendent and Recessed Pendent	
		155°F/68°C or 175°F/79°C	
12 x 12 (3,7 x 3,7)	12 (3,7)	20 GPM (75,7 LPM) 8.4 psi (0,58 bar)	
14 x 14 (4,3 x 4,3)	14 (4,3)	20 GPM (75,7 LPM) 8.4 psi (0,58 bar)	
16 x 16 (4,9 x 4,9)	16 (4,9)	20 GPM (75,7 LPM) 8.4 psi (0,58 bar)	
18 x 18 (5,5 x 5,5)	18 (5,5)	20 GPM (75,7 LPM) 8.4 psi (0,58 bar)	
20 x 20 (6,1 x 6,1)	20 (6,1)	23 GPM (87,1 LPM) 11.1 psi (0,76 bar)	

(a) For coverage area dimensions less than or between those indicated, it is necessary to use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.

(b) Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design Criteria Section for details.

TABLE B
FM APPROVED
WET PIPE HYDRAULIC DESIGN CRITERIA
FOR THE SERIES LFII (TY4234)
RESIDENTIAL PENDENT, RECESSED PENDENT SPRINKLERS

Design Criteria

UL AND C-UL LISTING CRITERIA

The Series LFII (TY4234) Residential Pendent Sprinklers are UL and C-UL Listed for installation in accordance with the following criteria.

Note: When conditions exist that are outside the scope of the provided criteria, refer to the Residential Sprinkler Design Guide TFP490 for the manufacturer's recommendations that may be acceptable to the local Authority having Jurisdiction.

System Type. Only wet pipe systems may be utilized.

Hydraulic Design. The minimum required sprinkler flow rate for systems designed to NFPA 13D or NFPA 13R are given in Table A as a function of temperature rating and the maximum allowable coverage areas. The sprinkler flow rate is the minimum required discharge from each of the total number of "design sprinklers" as specified in NFPA 13D or NFPA 13R.

For systems designed to NFPA 13, the number of design sprinklers is to be the four most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in Table A for NFPA 13D and 13R as a function of temperature rating and the maximum allowable coverage area.
- A minimum discharge of 0.1 gpm/sq. ft. over the "design area" comprised of the four most hydraulically demanding sprinklers for the actual coverage areas being protected by the four sprinklers.

Example No. 1: A corridor being protected is 8 ft. wide; consequently, an actual coverage area of 8 ft. x 20 ft. is being contemplated. Based on using the LFII (TY4234) Residential Pendent Sprinkler, the flow rate provided in Table A for a 20 ft x 20 ft. coverage area is 22 GPM. However based on minimum discharge of 0.1 gpm/sq. ft. the flow rate would be 16 GPM. In this case a minimum flow rate of 22 GPM for this design sprinkler must be utilized.

Example No. 2: A long narrow room being protected is 12 ft. wide; consequently, an actual coverage area of 12 ft. x 20 ft. is being contemplated. Based on using the LFII (TY4234) Residential Pendent Sprinkler, the flow rate provided in Table A for a 20 ft x 20 ft. coverage area is 22 GPM. However based on minimum discharge of 0.1 gpm/sq. ft. the flow rate would be 24 GPM. In this case a minimum flow rate of 24 GPM for this design sprinkler must be utilized.

Obstruction To Water Distribution.

Locations of sprinklers are to be in accordance with the obstruction rules of NFPA 13 for residential sprinklers.

Operational Sensitivity (Horizontal and Sloped Ceilings).

- For pendent sprinkler installations, the sprinklers are to be installed with a deflector to ceiling distance of 1-1/2 to 4 inches (38 to 100 mm).

Note: So as to help avoid obstructions to water distribution, a maximum 12 inch deflector-to-ceiling distance is permitted for NFPA 13D and NFPA 13R applications where the sprinklers are located in closets.

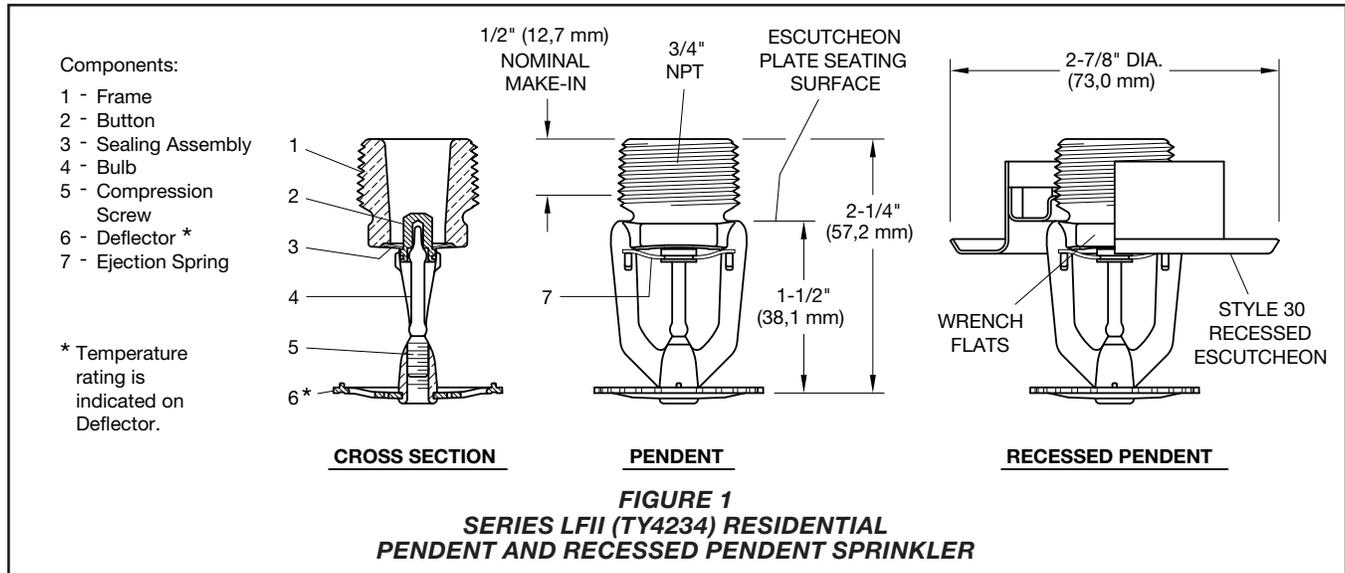
- For recessed pendent sprinkler installations, the sprinklers relative to the ceiling mounting surface are to be installed per Figure 2.
- For concealed pendent sprinkler installations, the sprinklers relative to the ceiling mounting surface are to be installed per Figure 6.

Sprinkler Spacing. The minimum spacing between sprinklers is 8 feet (2,4 m). The maximum spacing between sprinklers cannot exceed the length of the coverage area (Ref. Table A) being hydraulically calculated (e.g., maximum 12 feet for a 12 ft. x 12 ft. coverage area, or 20 feet for a 20 ft. x 20 ft. coverage area).

The Series LFII must not be used in applications where the air pressure above the ceiling is greater than that below. Down drafts through the Support Cup could delay sprinkler operation in a fire situation.

FM APPROVAL CRITERIA

The Series LFII (TY4234) Residential Pendent Sprinklers are FM Approved for installation in accordance with the applicable Factory Mutual Loss Prevention Data Sheet. Criteria provided by FM may differ from UL and/or NFPA, therefore the designer should review and become familiar with Factory Mutual requirements before proceeding with design.



Note: When conditions exist that are outside the scope of the provided criteria, refer to the Residential Sprinkler Design Guide TFP490 for the manufacturer's recommendations that may be acceptable to the local Authority having Jurisdiction.

Note: The following information pertaining to System Type, Hydraulic Design, and Sprinkler spacing are provided for reference and are not intended to provide complete installation criteria as provide in the applicable Factory Mutual Loss Prevention Data Sheet

System Type. Only wet pipe systems may be utilized.

Hydraulic Design. The number of design sprinklers is to be the four most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in Table B as a function of the maximum allowable coverage area.
- A minimum discharge of 0.1 gpm/sq. ft. over the "design area" comprised of the four most hydraulically demanding sprinklers for the actual coverage areas being protected by the four sprinklers.

Example No. 1: A corridor being protected is 8 ft. wide; consequently, an actual coverage area of 8 ft. x 20 ft. is being contemplated. Based on using the LFII (TY4234) Residential Pendent Sprinkler, the flow rate provided in Table B for a 20 ft x 20 ft. coverage area is 23 GPM. However based on minimum discharge of 0.1 gpm/sq. ft. the flow rate would be 16 GPM. In this case a minimum flow rate of 23 GPM for this design sprinkler must be utilized.

Example No. 2: A long narrow room being protected is 12 ft. wide; consequently, an actual coverage area of 12 ft. x 20 ft. is being contemplated. Based on using the LFII (TY4234) Residential Pendent Sprinkler, the flow rate provided in Table B for a 20 ft x 20 ft. coverage area is 23 GPM. However based on minimum discharge of 0.1 gpm/sq. ft. the flow rate would be 24 GPM. In this case a minimum flow rate of 24 GPM for this design sprinkler must be utilized.

Sprinkler Spacing. The minimum spacing between sprinklers is 8 feet (2,4 m). The maximum spacing between sprinklers cannot exceed the length of the coverage area (Ref. Table B) being hydraulically calculated (e.g., maximum 12 feet for a 12 ft. x 12 ft. coverage area, or 20 feet for a 20 ft. x 20 ft. coverage area).

The Series RFI must not be used in applications where the air pressure above the ceiling is greater than that below. Down drafts through the Support Cup could delay sprinkler operation in a fire situation.

Operation

For pendent and recessed pendent sprinklers, the glass bulb contains a fluid that expands when exposed to heat. When the rated temperature is reached, the fluid expands sufficiently to shatter the glass bulb allowing the sprinkler to activate and flow water.

For the concealed pendent sprinkler, the cover plate which is soldered to the support cup at three places, first falls away when exposed to heat from a fire. The sprinkler then operates similar to pendent and recessed pendent sprinklers described above.

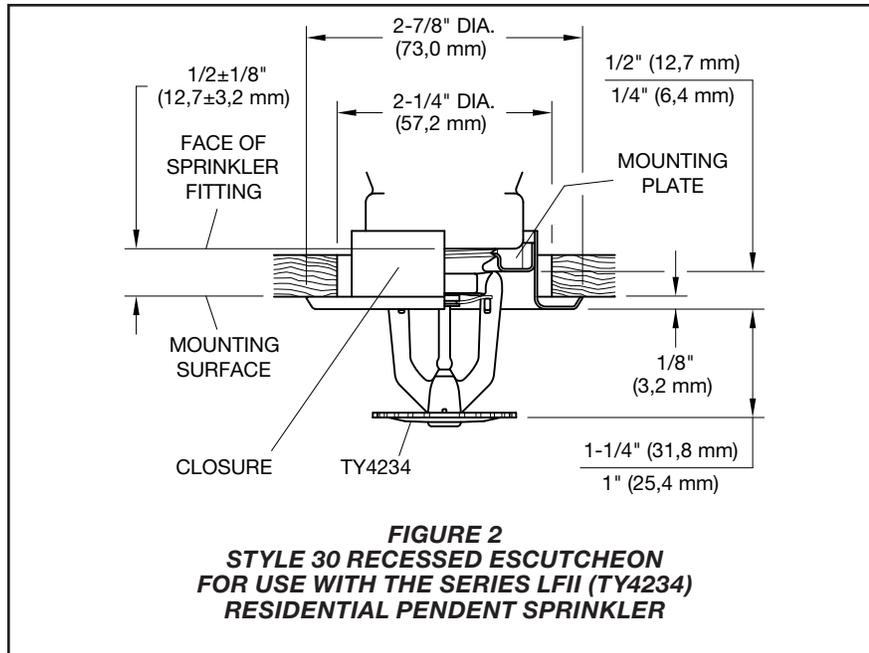


FIGURE 2
STYLE 30 RECESSED ESCUTCHEON
FOR USE WITH THE SERIES LFII (TY4234)
RESIDENTIAL PENDENT SPRINKLER

Installation

The Tyco® Rapid Response™ Series LFII (TY4234) must be installed in accordance with the following instructions:

NOTICE

Do not install any bulb type sprinkler if the bulb is cracked or there is a loss of liquid from the bulb. With the sprinkler held horizontally, a small air bubble should be present. The diameter of the air bubble is approximately 1/16 inch (1,6 mm).

A 3/4 inch NPT sprinkler joint should be obtained with a minimum to maximum torque of 10 to 20 ft.lbs. (13,4 to 26,8 Nm). Higher levels of torque may distort the sprinkler inlet with consequent leakage or impairment of the sprinkler.

Do not attempt to compensate for insufficient adjustment in an Escutcheon Plate by under- or over-tightening the Sprinkler. Readjust the position of the sprinkler fitting to suit.

The **Series LFII Pendent Sprinklers** must be installed in accordance with the Steps 1P through 3P.

Step 1P. Pendent sprinklers are to be installed in the pendent position with the deflector parallel to the ceiling.

Step 2P. With pipe thread sealant applied to the pipe threads, hand tighten the sprinkler into the sprinkler fitting.

NOTICE

The sprinkler has been provided with a Sprinkler Strap similar that shown in Figure 5 for the concealed sprinkler assembly. Do not remove the Sprinkler Strap until the sprinkler system is to be placed in service. As long as the Sprinkler Strap remains in place, the system is considered to be "Out Of Service".

Step 3P. Tighten the sprinkler into the sprinkler fitting using only the W-Type 6 Sprinkler Wrench (Ref. Figure 3). With reference to Figure 1, the W-Type 6 Sprinkler Wrench is to be applied to the wrench flats.

Note: Refer to Technical Data Sheet TFP700 regarding instructions for the removal of the Sprinkler Strap.

The **Series LFII Recessed Pendent Sprinklers** must be installed in accordance with Steps 1R through 4R.

Step 1R. Recessed pendent sprinklers are to be installed in the pendent position with the deflector parallel to the ceiling.

Step 2R. After installing the Style 30 Mounting Plate over the sprinkler threads and with pipe thread sealant applied to the pipe threads, hand tighten the sprinkler into the sprinkler fitting.

NOTICE

The sprinkler has been provided with a Sprinkler Strap similar that shown in Figure 5 for the concealed sprinkler assembly. Do not remove the Sprinkler Strap until the sprinkler system is to be placed in service. As long as the Sprin-

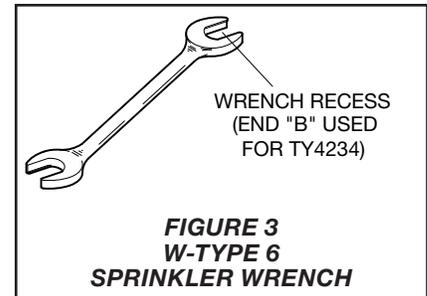


FIGURE 3
W-TYPE 6
SPRINKLER WRENCH

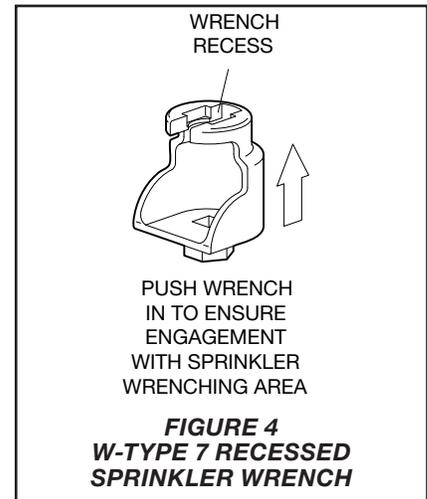


FIGURE 4
W-TYPE 7 RECESSED
SPRINKLER WRENCH

kler Strap remains in place, the system is considered to be "Out Of Service".

Step 3R. Tighten the sprinkler into the sprinkler fitting using only the W-Type 7 Recessed Sprinkler Wrench (Ref. Figure 4). With reference to Figure 1, the W-Type 7 Recessed Sprinkler Wrench is to be applied to the sprinkler wrench flats.

Step 4R. After the ceiling has been installed or the finish coat has been applied, slide on the Style 30 Closure over the Series LFII Sprinkler and push the Closure over the Mounting Plate until its flange comes in contact with the ceiling.

Note: Refer to Technical Data Sheet TFP700 regarding instructions for the removal of the Sprinkler Strap.

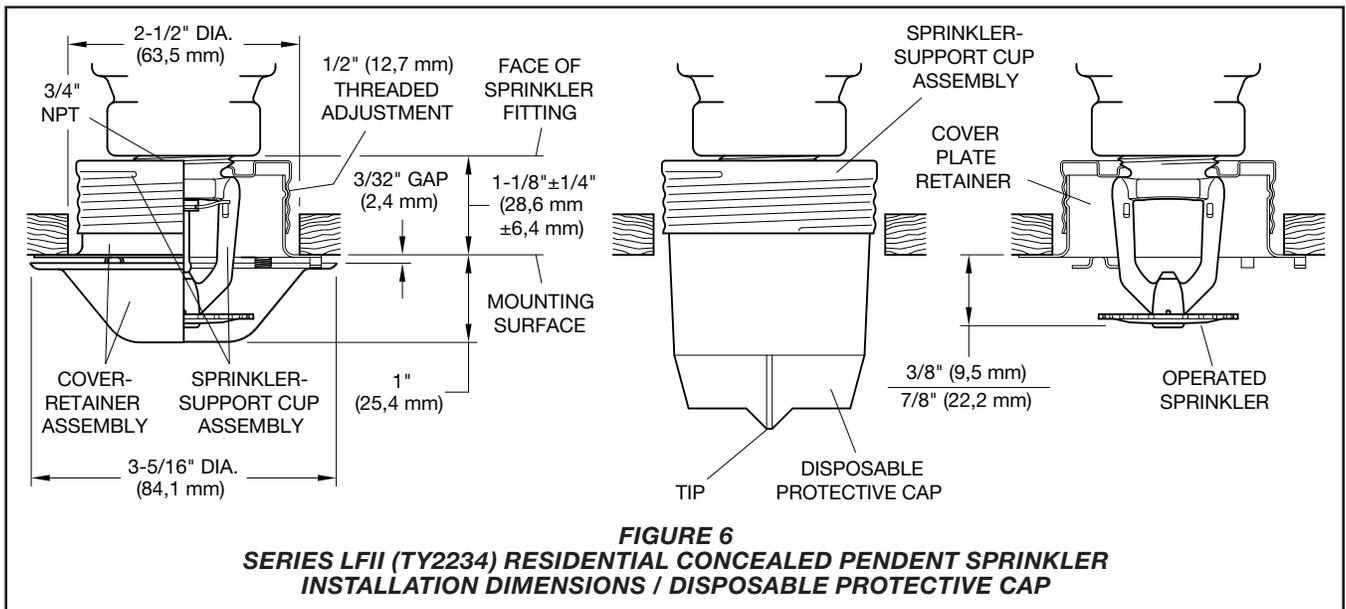
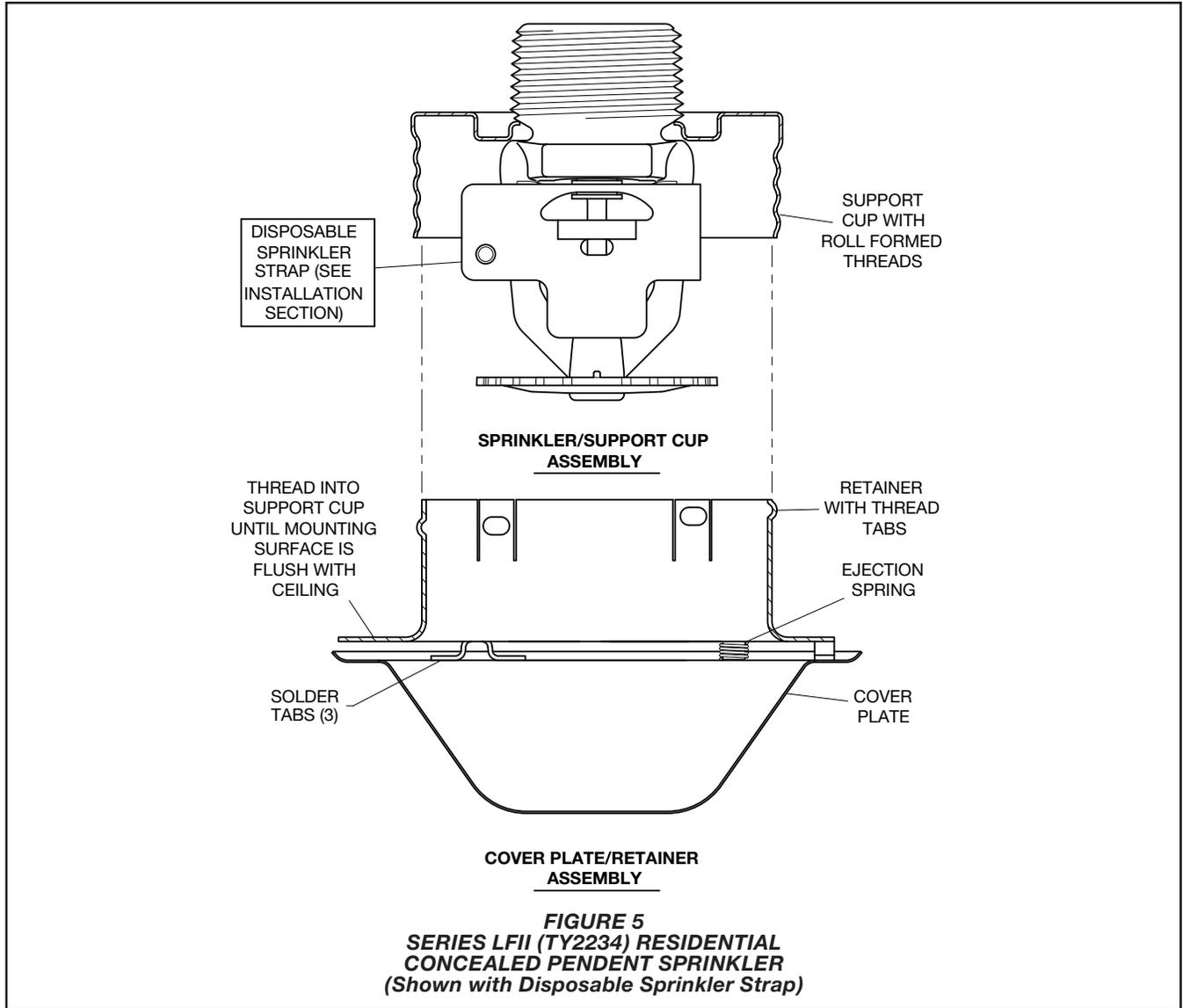
The **Series LFII Concealed Pendent Sprinklers** must be installed in accordance with Steps 1C through 6C.

Step 1C. The sprinkler must only be installed in the pendent position and with the centerline of the sprinkler perpendicular to the mounting surface.

Step 2C. Remove the Protective Cap.

NOTICE

Do not remove the Sprinkler Strap (Fig. 5) until the sprinkler system is to be placed in service.



Step 3C. With pipe thread sealant applied to the pipe threads, and using the W-Type 7 Wrench shown in Figure 4, install and tighten the Sprinkler/Support Cup Assembly into the fitting. The W-Type 7 Wrench will accept a 1/2 inch ratchet drive.

Step 4C. Replace the Protective Cap by pushing it upwards until it bottoms out against the Support Cup. The Protective Cap helps prevent damage to the Deflector and Arms during ceiling installation and/or during application of the finish coating of the ceiling. It may also be used to locate the center of the clearance hole by gently pushing the ceiling material against the center point of the Cap.

NOTICE

As long as the Sprinkler Strap (Fig. 5) or the Protective Cap (Fig. 6) remains in place, the system is considered to be "Out Of Service".

Step 5C. After the ceiling has been completed with the 2-1/2 inch (63 mm) diameter clearance hole and in preparation for installing the Cover Plate/Retainer Assembly, remove and discard the Protective Cap and the Sprinkler Strap.

Note: Refer to Technical Data Sheet TFP700 regarding instructions for the removal of the Sprinkler Strap.

Step 6C. Push the Cover Plate/Retainer Assembly into the Support Cup, and as necessary, make the final adjustment of the Cover Plate with respect to the ceiling by turning the Cover Plate/Retainer Assembly clockwise until its flange just comes in contact with the ceiling.

If it becomes necessary to remove the Cover Plate, it can be removed by unscrewing in a counter-clockwise direction.

If the Cover Plate/Retainer Assembly cannot be engaged with the Support Cup or the Cover Plate/Retainer Assembly cannot be engaged sufficiently to contact the ceiling, the Sprinkler Fitting must be repositioned.

Care and Maintenance

The Tyco® Rapid Response™ Series LFII (TY4234) must be maintained and serviced in accordance with the following instructions:

NOTICE

Absence of an Escutcheon Plate may delay the sprinkler operation in a fire situation.

When properly installed, there is a nominal 3/32 inch (2,4 mm) air gap between the lip of the Cover Plate and the ceiling, as shown in Figure 6. This air gap is necessary for proper operation of the sprinkler by allowing heat flow from a fire to pass below and above the Cover Plate to help assure appropriate release of the Cover Plate in a fire situation. If the ceiling is to be repainted after the installation of the Sprinkler, care must be exercised to ensure that the new paint does NOT seal off any of the air gap.

Factory painted Cover Plates MUST NOT be repainted. They should be replaced, if necessary, by factory painted units. Non-factory applied paint may adversely delay or prevent sprinkler operation in the event of a fire.

Do not pull the Cover Plate relative to the Enclosure. Separation may result.

Before closing a fire protection system main control valve for maintenance work on the fire protection system which it controls, permission to shut down the affected fire protection system must be obtained from the proper authorities and all personnel who may be affected by this action must be notified.

Sprinklers which are found to be leaking or exhibiting visible signs of corrosion must be replaced.

Automatic sprinklers must never be painted, plated, coated, or otherwise altered after leaving the factory. Modified or over heated sprinklers must be replaced.

Care must be exercised to avoid damage to the sprinklers -before, during, and after installation. Sprinklers damaged by dropping, striking, wrench twist/slippage, or the like, must be replaced. Also, replace any sprinkler that has a cracked bulb or that has lost liquid from its bulb. (Ref. Installation Section).

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable stan-

dards of the National Fire Protection Association (e.g., NFPA 25), in addition to the standards of any other authorities having jurisdiction. The installing contractor or sprinkler manufacturer should be contacted relative to any questions.

NOTICE

The owner must assure that the sprinklers are not used for hanging of any objects and that the sprinklers are only cleaned by means of gently dusting with a feather duster; otherwise, non-operation in the event of a fire or inadvertent operation may result.

Automatic sprinkler systems should be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and/or national codes.

Limited Warranty

Products manufactured by Tyco Fire & Building Products (TFBP) are warranted solely to the original Buyer for ten (10) years against defects in material and workmanship when paid for and properly installed and maintained under normal use and service. This warranty will expire ten (10) years from date of shipment by TFBP. No warranty is given for products or components manufactured by companies not affiliated by ownership with TFBP or for products and components which have been subject to misuse, improper installation, corrosion, or which have not been installed, maintained, modified or repaired in accordance with applicable Standards of the National Fire Protection Association, and/or the standards of any other Authorities Having Jurisdiction. Materials found by TFBP to be defective shall be either repaired or replaced, at TFBP's sole option. TFBP neither assumes, nor authorizes any person to assume for it, any other obligation in connection with the sale of products or parts of products. TFBP shall not be responsible for sprinkler system design errors or inaccurate or incomplete information supplied by Buyer or Buyer's representatives.

In no event shall TFBP be liable, in contract, tort, strict liability or under any other legal theory, for incidental, indirect, special or consequential damages, including but not limited to labor charges, regardless of whether TFBP was informed about the possibility of such damages, and in no event shall TFBP's liability exceed an amount equal to the sales price.

The foregoing warranty is made in lieu of any and all other warranties, express or implied, including warranties of merchantability and fitness for a particular purpose.

This limited warranty sets forth the exclusive remedy for claims based on failure of or defect in products, materials or components, whether the claim is made in contract, tort, strict liability or any other legal theory.

This warranty will apply to the full extent permitted by law. The invalidity, in whole or part, of any portion of this warranty will not affect the remainder.

Ordering Procedure

When placing an order, indicate the full product name. Contact your local distributor for availability.

- For pendent sprinkler, order pendent sprinkler assembly plus sprinkler wrench.
- For recessed pendent sprinkler, order pendent sprinkler assembly plus separately ordered recessed escutcheon plus sprinkler wrench.
- For concealed pendent sprinkler, order concealed pendent sprinkler assembly plus separately ordered cover plate assembly plus sprinkler wrench.

Pendent Sprinkler Assembly:

Series LFII (TY4234), K=6.9, Residential Pendent Sprinkler with (specify) temperature rating and (specify) finish, P/N (specify).

155°F/68°C	
Chrome Plated	.....P/N 51-069-9-155
155°F/68°C	
Signal White (a)	
(RAL9003)	.....P/N 51-069-4-155
155°F/68°C	
Pure White (b)	
(RAL9010)	.....P/N 51-069-3-155
155°F/68°C	
Natural Brass	.....P/N 51-069-1-155
175°F/79°C or	
Chrome Plated	.....P/N 51-069-9-175
175°F/79°C	
Signal White (a)	
(RAL9003)	.....P/N 51-069-4-175
175°F/79°C	
Pure White (b)	
(RAL9010)*	.....P/N 51-069-3-175
175°F/79°C	
Natural Brass	.....P/N 51-069-1-175

- (a) Previously known as Bright White.
- (b) Eastern Hemisphere sales only.

Separately Ordered Recessed Escutcheon:

Specify: Style 30 Recessed Escutcheon with (specify*) finish, P/N (specify*).

*Refer to Technical Data Sheet TFP770.

Concealed Pendent Sprinkler Assembly:

Series LFII (TY4234), K=6.9, Residential Concealed Pendent Sprinkler with (specify) temperature rating and without Cover Plate Assembly, P/N (specify).

155°F/68°C	.....P/N 51-068-1-155
175°F/79°C	.....P/N 51-068-1-175

Separately Ordered Cover Plate Assembly:

139°F/58°C, Cover Plate Assembly having a (specify) finish for the Series LFII (TY4234), K=6.9, Residential Concealed Pendent Sprinkler, P/N (specify).

Chrome	.....P/N 56-873-9-135
Signal White (a)	
(RAL 9003)	.....P/N 56-873-4-135
Pure White (b)	
(RAL 9010)	.....P/N 56-873-3-135
Custom	.....P/N 56-873-X-135

- (a) Previously known as Bright White.
- (b) Eastern Hemisphere sales only.

Separately Ordered Sprinkler Wrench:

Specify: W-Type 6 Sprinkler Wrench, P/N 56-000-6-387. (For pendent sprinklers.)

Specify: W-Type 7 Sprinkler Wrench, P/N 56-850-4-001. (For recessed pendent sprinklers and concealed pendent sprinklers.)

SECTION 21 32 00

Fire Sprinkler Pump

PART 1 -GENERAL

1.01 DESCRIPTION OF WORK:

- A. Provide pumps for fire suppression.

1.02 SECTION INCLUDES:

- A. Single Stage, Close Coupled, 1580 Series Vertical In-Line Pump

RELATED DOCUMENTS:

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

1.03 QUALITY ASSURANCE:

- A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.
- B. The fire pump shall be assembled by the pump manufacturer. An assembler of fire pumps not engaged in the design and construction of fire pumps shall not be considered as a fire pump manufacturer. The manufacturer shall assume "Unit Responsibility" for the complete fire pump. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.
- C. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed, but not less than specified.
- D. The manufacturer shall have a minimum of 20 years experience in the design and construction of fire pump systems.
- E. The manufacturer shall carry a minimum product liability insurance of \$2,000,000 per occurrence, with an aggregate product liability of \$6,000,000.
- F. Equipment provider shall be responsible for providing certified equipment start-up and, when noted, an in the field certified training session. This pump start-up shall be by the pump manufacturer or a certified factory-trained representative per NFPA 20, Section 11-2. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner's designated representative. This job site visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed off on the manufacturer's start-up request form.

1.04 PRODUCT HANDLING:

- A. Protection: Use all means necessary to protect equipment before, during, and after installation in accordance with



manufacturer's storage, installation and maintenance instructions.

1.05 REGULATORY REQUIREMENTS:

- A. National Fire Protection Association (NFPA 20)
- B. Factory Mutual (FM)
- C. Institute of Electrical and Electronic Engineers (IEEE)
- D. National Electrical Manufacturers Association (NEMA)
- E. American Society for Testing and Materials (ASTM)
- F. National Electric Code (NEC)
- G. Occupational Safety and Health Administration (OSHA)
- H. ANSI/Hi standards
- I. Underwriters Laboratories, Inc.

1.06 SUBMITTAL:

- A. Submit each item in this article according to the Conditions of the Contract and Specifications Sections.
- B. Submit manufacturer's installation instructions under provisions of General Conditions.
- C. Product Data including certified performance curves and rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate pump's operating point on curves.
- D. Hanging and support requirements should follow the recommendations in the manufacturer's installation instructions.

1.07 OPERATION AND MAINTENANCE DATA:

- A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

1.08 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver materials to the site in such a manner as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids. Materials damaged by the elements should be packaged in such a manner that they could withstand short-term exposure to the elements during transportation.
- B. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.

1.09 WARRANTY:

- A. Provide a minimum one (1) year warranty from the date of operation or eighteen (18) months from the date of shipment on the product, whichever comes first.

2.00 PART 2- PRODUCTS



- A. The specifying engineer reserves the right to specify a primary supplier / lead spec manufacturer on all supplied schedule and specification documents. These primary suppliers have lead their respective industry in research and development and their products have had proven track records in the field. These primary suppliers, in the opinion of this engineering firm, produce a superior product to the alternately listed manufacturers. The contractor may choose to supply equivalent equipment as manufactured by the alternately specified manufacturer. This alternately specified equipment will be supplied on a deduct alternate basis and based on the approval of the supplied alternate manufacturer's submittals.

The use of a primary supplier and deduct alternates protects the specifying engineer's design concept, but allows for a check-and-balance system to protect the post-commissioning owner.

2.01 Single Stage, Close Coupled, 1580 Series Vertical In-Line Fire Pump

A. Manufacturer

Contractor shall furnish and install an A-C Fire Pump System or approved equal - UL Listed single stage, close coupled 1580 Series vertical in-line pump for fire suppression. The pump(s) shall conform to the standards of NFPA 20 latest edition for the installation of centrifugal fire pumps.

B. Single Stage, Close Coupled, Vertical In-Line Pump

1. The pump will provide a rated capacity of _____ GPM and a differential pressure of _____ PSI. At 150% of rated capacity, the pump shall develop at least 65% of its rated head and shall not exceed 140% of the rated head at zero capacity. The pump shall be tested at the factory and a test curve shall be submitted showing the performance and horsepower requirements based on this test before final acceptance.
2. The pump shall be a single stage, close coupled, vertical in-line design, in cast iron bronze fitted construction with packing bearing directly on a stainless steel or a bronze shaft sleeve. The pump internals shall be capable of being serviced without disturbing piping connections.
3. The 1580 Series is a compact and self-contained design and is a popular choice where space restrictions play a big factor. No foundation or pad is required. The support ring on the underside of the pump volute is designed to provide ground support when necessary. These pumps can be easily installed in the pipelines. Pump supports may be required in larger sizes.
4. The **pump casing** shall be made of cast iron ASTM #A278, Class 30 or 35, or ductile iron ASTM #A536, Grade 65, with the suction and discharge flanges located on a common centerline, 180° apart, for mounting in the pipeline. The standard pipe flanges shall be drilled for 125# per ANSI B16.1 standard.
5. The pump shall be rated for a minimum of 175 psi working pressure and a maximum of 370 psi (H6x6x11) with 250# discharge flanges and ductile iron casing.
6. The **impeller** will be of a cast bronze ASTM #B584 – Alloy 875, enclosed type, balanced, keyed to the shaft and secured by a cap screw and lockwasher.
7. The **casing wear rings** shall be made of bronze and can be easily replaced.
8. The pump shall be direct coupled to the motor shaft for easy maintenance, to minimize impeller run out and to reduce noise.
9. The pump shall have a vertical back pullout design that makes servicing simple and fast. The rotating element is easily removed without disturbing the piping.



10. The pump shall have split bronze packing glands for easy packing replacement.
11. The **stuffing box** shall be furnished with impregnated yarn packing, lantern ring and a catch basin for piping leakage to drain.
12. The pump shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
13. A **rubber slinger** will be installed on the shaft before the motor to prevent the passage of liquid to the motor.
14. The motor will be the JP frame type.
15. Nameplates and other data plates shall be all corrosion resistant and suitably secured to the pump.
16. Pump manufacturer shall be ISO9001 certified.

2.02 Accessories

A. The 1580 Series In-Line Fire Pump shall be furnished with the following fittings as standard:

- 1) 3 ½" dial suction and discharge gauges
- 2) ¾" casing relief valve

B. Other fittings and accessories may include the following based on the specification:

- 1) eccentric suction reducer (if required)
- 2) concentric discharge increaser (if required)
- 3) hose valve test header
(___) hose valve with 2 ½" NST
(___) caps and chains for the above hose valves
- 4) main relief valve
- 5) closed waste cone
- 6) flowmeter
- 7) suction control valve

END OF SECTION



SECTION 22 05 23.10

Check Valve

PART 1 - GENERAL

1.2 SUMMARY

- A. Submittals: Construction documents and product data

1.3 DEFINITIONS

- A. Definition: The Spring Check Valve will be used to prevent backflow in the water supply pipes.
- B. Sizing : ¾"

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Campbell
www.drillspot.com

2.2 PRODUCTS

- A. Campbell – Spring Check Valve
- B. Product Number: cv-3T

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturers instruction www.drillspot.com
- B. Follow NYC Plumbing Codes

END OF SECTION



SECTION 26 33 30.13

RESIDENTIAL, SMALL CAPACITY DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Rheem. Electric Water Heaters, Point-of-Use Series, 82VP30-1.
- B. Dimensions:
1. Height: 30 inches
2. Diameter: 23 inches
- C. Connection:
1. $\frac{3}{4}$ " NPT outlet, inlet, anode rod
2. T&P valve connections
- D. Controls: Standard On/Off Control.
- E. Characteristics and Capacities:
1. Capacity: 30 Gallons
2. Maximum Operating Pressure: 150 Psi
3. Power: 120 volt AC, 2000 Watt single element
- F. Product Data Sheet
1. <http://globalimageserver.com/fetchDocument.aspx?id=b29ecc82-fc7c-4274-b9d4-622fcbc3729f>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's installation instructions.
1. <http://globalimageserver.com/fetchDocument.aspx?id=f43430fe-a847-4371-b6c7-cab5eb0e34a6>

END OF SECTION



SECTION 23 12 23.13

HYDRONIC PUMP

PART 1 – GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data; P-601 Plumbing Schematic; M-603 Solar Thermal Schematic;

1.2 SYSTEM DESCRIPTION

- A. Definition:
1. Bell and Gossett NRF Series Pumps of cast iron construction are designed to deliver the specified flow rate needed for heating and cooling with minimal noise during operation.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. In-Line Centrifugal Hydronic Pump: Bell & Gossett/Domestic Pump 8200 N. Austin Ave. Morton Grove, IL 60053 Tel. (847) 966-3700 Fax. (847) 966-9052

2.2 SPECIFICATIONS

A. Cooling tower pump (NRF-36)

1. Pump setting: Speed 3
2. Maximum working pressure: 150 psig (10.3 Bar)
3. Maximum operating temperature: 225°F (107°C)
4. Electrical Data: 115V / 60 Hz / 1 ph
5. Capacity of 17 GPM at 19-21 ft of head

B. Fan coil pump (NRF-36)

1. Pump setting: Speed 2
2. Maximum working pressure: 150 psig (10.3 Bar)
3. Maximum operating temperature: 225°F (107°C)
4. Electrical Data: 115V / 60 Hz / 1 ph
5. Capacity of 9 GPM at 20-22 ft of head

C. Chiller driving heat pump (NRF-33)



1. Maximum working pressure: 150 psig (10.3 Bar)
2. Maximum operating temperature: 225°F (107°C)
3. Electrical Data: 115V / 60 Hz / 1 ph
4. Capacity of 7 GPM at 8-10 ft of head

D. Solar thermal pump (NRF-36)

1. Pump setting: Speed 2
2. Maximum working pressure: 150 psig (10.3 Bar)
3. Maximum operating temperature: 225°F (107°C)
4. Electrical Data: 115V / 60 Hz / 1 ph
5. Capacity of 9 GPM at 20-22 ft of head

E. Domestic hot water pump (NRF-22)

1. Maximum working pressure: 150 psig (10.3 Bar)
2. Maximum operating temperature: 240°F (115°C)
3. Electrical Data: 115V / 60 Hz / 1 ph
4. Capacity of 10 GPM at 6-8 ft of head

F. Radiant heating pump (NRF-22)

1. Maximum working pressure: 150 psig (10.3 Bar)
2. Maximum operating temperature: 240°F (115°C)
3. Electrical Data: 115V / 60 Hz / 1 ph
4. Capacity of 5 GPM at 10-12 ft of head

2.3 MATERIALS

- A. Pump body: Cast iron
- B. Impeller: Noryl
- C. Shaft: Ceramic
- D. Bearings: Double-sintered Carbon

2.4 PRODUCT DATA

- A. Manufacturer: <http://www.bellgossett.com/literature/files/4.pdf>

PART 3 – EXECUTION

3.1 INSTALLATION

- A. For NRF 22, 33: Follow manufacturer's instructions: <http://www.bellgossett.com/literature/files/28.pdf>
- B. For NRF 36: Follow manufacturer's instructions: <http://www.bellgossett.com/literature/files/6825.pdf>

END OF SECTION



SECTION 23 56 13

SOLAR THERMAL COLLECTORS

PART 1 – GENERAL

1.1 SUMMARY

- A. Product Data
- B. Testing of a solar collector in accordance with (SRCC) Standard 100-08

PART 2 – PRODUCT

2.1 Evacuated twin glass solar thermal collectors

- A. Description: Manufacture fabricated and tested twin glass evacuated tube technology solar thermal collectors.
 - 1. Solar US SL-30 collectors manufactured by SolarUS, INC
- B. Characteristics and capacities:
 - 1. Heat transfer medium: water or Water/Glycol
 - 2. Maximum Pressure Rating: 0.7 MPa or 102 psi
 - 3. Maximum Working Temperature Rating: 260degC or 500degF
 - 4. Maximum Flow Rates: 8L/tube/min or 2.11 gal./tube/min
 - 5. Recommended Flow rates: 0.03L/tube/min or 0.008 gal./tube/min
 - 6. Maximum Efficiency : 0.74 (considering the apparatus area)

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's insulation instructions

END OF SECTION



SECTION 23 64 16.16**WATER-COOLED CENTRIFUGAL WATER CHILLERS****PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. SorTech AG. Adsorption Chiller, ACS 08 (8 kW)

2.2 ABSORPTION CHILLER

- A. Description: Factory-assembled and run-tested adsorption chiller
- B. Refrigeration:
1. Refrigerant: Water
 2. Adsorbent: Silica Gel
 3. Refrigeration Process: Uses two absorber chambers working simultaneously, where one works as an absorber and the other works as a desorber.
- C. Controls: Standard On/Off control. Variation of the chilled water can be controlled by flow rate of hot water into the chiller and the hot water temperature input.
- D. Characteristics and Capacities:
1. Cooling Capacity: 8 kW
 2. COP: 0.60
 3. Chilled Water Temperature: 18/15°C
 4. Recooled Water Temperature: 27/32°C
 5. Hot Water Temperature: 72/65°C
 6. Max. Operating Pressure: 4 bar
 7. Power Input: 7 W
 8. Voltage and Frequency: 230~V ; 50 Hz
- E. Product Data Sheet
http://www.sortech.de/content/documents/1%20Product%20data%20sheet_SorTech%20AG_ACS%20RCS_01072010.PDF

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Follow manufacturer's installation instructions.

END OF SECTION





Adsorption Chiller ACS 08/ACS 15

Cold from Heat – Cooling and Heating
Environmentally-friendly • Compact • Silent



ACS 08



ACS 15

The compact adsorption chillers ACS are available in two sizes: ACS 08 and ACS 15 with 8 kW and 15 kW nominal cooling capacity respectively. Key application is cooling and air-conditioning of small to medium sized domestic and commercial buildings and processes. Solar, district and waste heat as well as cogeneration units are equally suitable for driving the process. By combining several modules larger cooling capacities can be achieved.

Driving temperatures as low as 55°C are sufficient to generate cold. With silica gel and water (refrigerant) the chillers use particularly environmentally-friendly materials.

The ACS is offered in combination with the tailored re-cooler RCS. The optimized subsystem achieves high overall energy efficiency of 10 and beyond. The ACS can alternatively be combined with other re-cooling solutions (wet cooling tower, bore holes, etc.).

In the heat pump mode the ACS can also be used for heating applications, enhancing the efficiency of traditional heating systems by up to 50%. Ambient air (in connection with the RCS), solar heat or geothermal energy can serve as low temperature energy sources. Driving energy is hot water, similar to cooling mode.

Basic performance data	ACS 08	ACS 15
Cooling capacity, max.	11 kW	23 kW
COP _{therm} , max.	0.65	0.65
Cooling capacity, nominal	8 kW	15 kW
COP _{therm} , nominal	0.60	0.60
Power consumption Ø	7 W	14 W
Operating range		
Chilled water circuit	6-20 °C	6-20 °C
Heat rejection circuit	22-37 °C	22-37 °C
Driving heat circuit	55-95 °C	55-95 °C
Cooling capacity	5-11 kW	10-23 kW

Technical data at nominal working point

			ACS 08	ACS 15
	Cooling capacity, nominal	kW	8	15
	COP _{therm} , nominal		0,60	0,60
Chilled water circuit	Temperature in/out	°C	18/15	18/15
	Volume flow	m³/h	2.0	4.0
	Pressure loss	mbar	300	500
	Operating pressure max.	bar	4	4
	Connection external thread		1"	5/4"
Heat rejection circuit	Temperature in/out	°C	27/32	27/32
	Volume flow	m³/h	3.7	7.0
	Pressure loss	mbar	350	440
	Operating pressure max.	bar	4	4
	Connection external thread		1"	5/4"
Driving heat circuit	Temperature in/out	°C	72/65	72/65
	Volume flow	m³/h	1.6	3.2
	Pressure loss	mbar	230	260
	Operating pressure max.	bar	4	4
	Connection external thread		3/4"	5/4"
Electricity supply	Voltage	V	230 ~	230 ~
	Frequency	Hz	50	50
	Power consumption Ø	W	7	14
Dimensions	Length	mm	790	790
	Width	mm	1060	1340
	Height	mm	940	1390
	Weight (empty)	kg	265	530
	Operating weight	kg	295	590

ACS with heat pump feature

Heating capacity: 10 - 25 kW (ACS 08)
20 - 50 kW (ACS 15)

COP_{therm}: 1.3 -1.5 *Details on request.*

SECTION 23 65 13.13

OPEN- CIRCUIT FORCED DRAFT COOLING TOWER

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. RSD Fiberglass Cooling Towers. Cooling Tower, RSD 005.

2.2 OPEN- CIRCUIT FORCED DRAFT COOLING TOWER

- A. Description: Factory-assembled and run-tested cooling tower
- B. Heat Removal:
 - 1.Refrigerant: Water
 - 2.Cooling Process: Forced air flow through use of a fan with a counter flow tower type.
- C. Controls: Standard On/Off control for fan motor. Other controls, such as for flow rates, are determined by the control of the adsorption chiller (See Section 23 64 16.16)
- D. Characteristics and Capacities:
 - 1.Capacity: 5 Refrigeration Ton
 - 2.Water Flow Rate: 15 GPM
 - 3.Total Pump Head: 4 ft.
 - 4.Fan Motor HP: 1/6 H.P.
 - 5.Fan Voltage/Phase: 115/230-1
- E. Product Data Sheet
<http://www.amchiller.com/Literature/ACTS-5%20Specs.pdf>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's installation instructions.

END OF SECTION



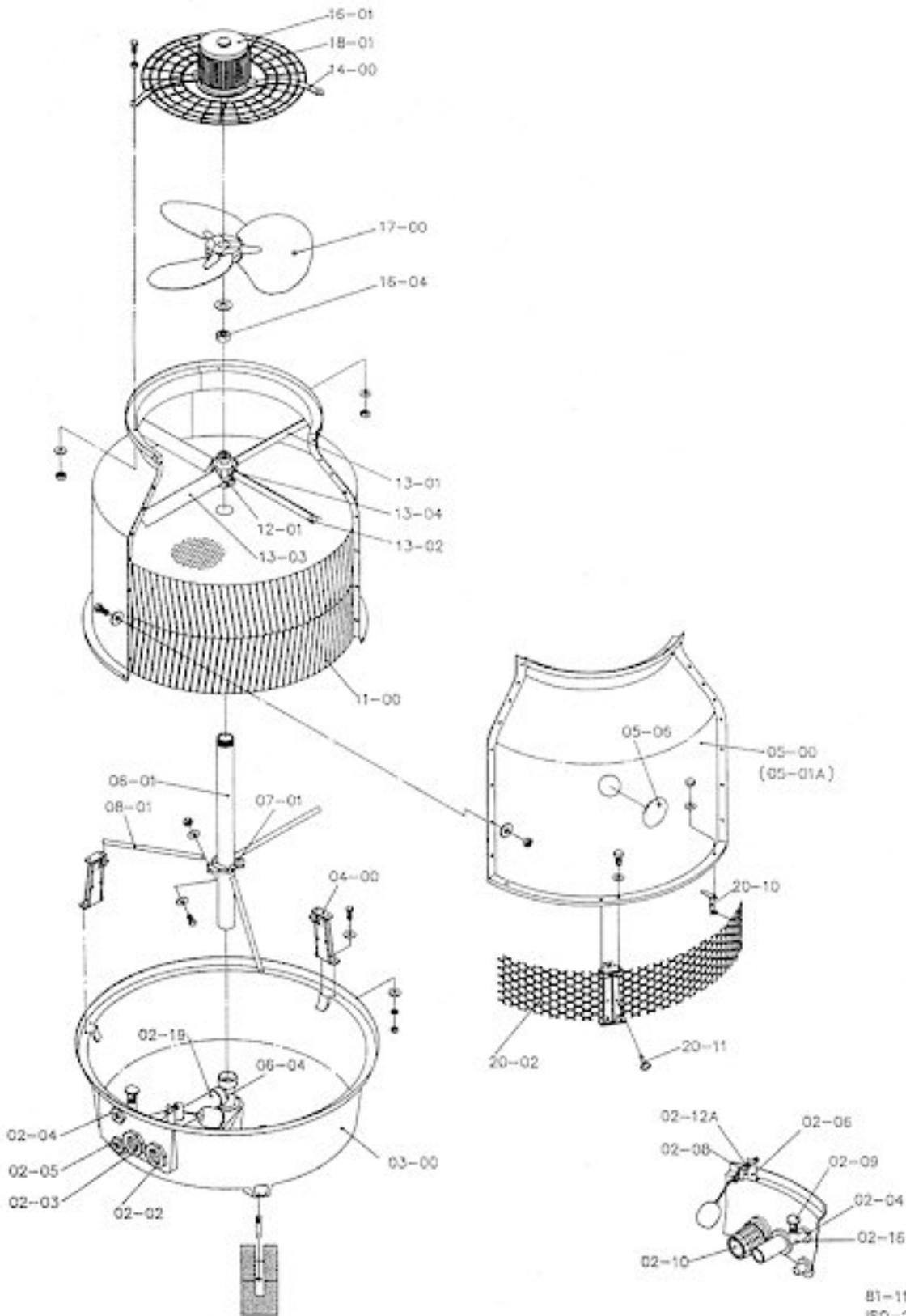
ACTS-5 Specifications

Basic Tower Construction Materials	
Tower support frame assembly:	-
Casing:	FRP
Casing supporter:	Nylon
Cold water basin:	FRP
Filling:	PVC
Filling support:	PVC
Fan guard:	PP
Mechanical equipment support	HDGS
Air inlet louver:	PVC
Structural Details	
Overall diameter:	33.5 in
Overall height:	52 in
Dry weight:	86 lbs
Operating weight:	251 lbs
Total pump head:	5 ft
Design wind load:	30.7 lb/sq ft
Fan Motor	
Number of motors:	one unit per tower
Type:	Induction
Insulation:	E class
Rated HP:	1/6 h. p.
Voltage and phase:	110/220-1

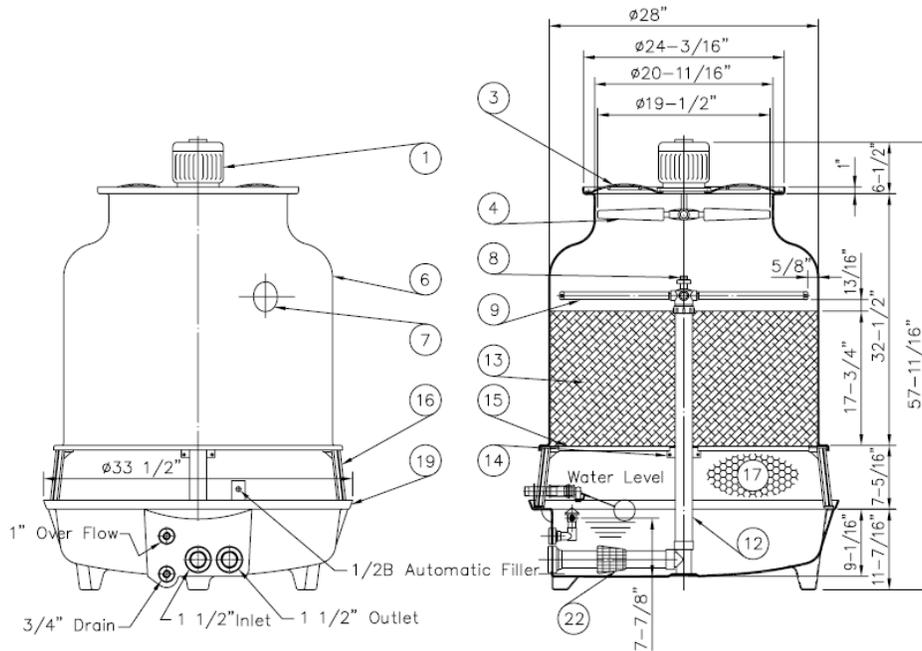
Piping Connections	
Primary water inlet diameter:	1.5 in
Primary water outlet diameter:	1.5 in
Auto fill inlet diameter:	0.5 in
Quick fill inlet diameter:	- in
Overflow outlet diameter:	1 in
Drain diameter:	0.75 in
Design and Operating Conditions	
Nominal Tons:	5
Tower type:	Counter Flow
Water flow rates:	10 gpm
Hot water temperature:	95° f
Cold water temperature:	85° f
Ambient wet bulb	75° f
Total fan BHP:	1/6 h. p.
Drift loss of water flow rates:	0.002%
Evaporation loss of water	0.93%
Mechanical Equipment	
Fan unit:	one unit per
Type:	Axial Flow
Diameter:	19.5 in
Blade material:	Nylon
Hub material:	Nylon
Nominal air volume:	2,100 cfm

American Chillers & Cooling Tower Systems

Assembly Diagram

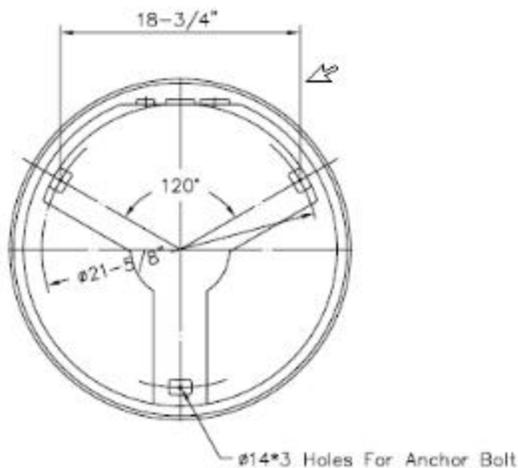


American Chillers & Cooling Tower Systems



Item No.	Description	Qty
1	Fan Motor	1 pcs
2	V-Belt Reducer	-
3	Motor Frame Assembly	1 set
4	Fan	1 set
5	Fan Guard	-
6	Casing	3 pcs
7	Hand Hole	1 pcs
8	Sprinkler Head	1 set
9	Sprinkler Pipe	4 pcs
10	Eliminator	-
11	Tension Device	-
12	Stand Pipe	1 set

Item No.	Description	Qty
13	Filling	1 set
14	Stopper or Column	1 set
15	Filling Supporter	1 set
16	Casing Supporter	3 pcs
17	Inlet Louver	1 set
18	Frame Assembly	-
19	Water Basin	1 pcs
20	Water Sump	-
21	Ladder	-
22	Strainer	1 pcs
23	Flange	-
24	Basin Supporter	-



Measurement	Distance (Inches)
D1	21.625
W	18.75
B	8
A	-
h	6
h1	-
C	-
D2	-
Anchor Bolt	
Size (In.)	Length (In.)
0.50	4.75

SECTION 23 83 16

RADIANT- HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Radiant Floor Panels: Warmboard Radiant Heat Subfloor
- B. Manifold: Zurn, AccuFlow Manifold
- C. Tubing: Allied Pipe Systems, Pex Aluminum Pex

2.2 RADIANT HEAT SUBFLOOR

- A. Description: 4 types of factory-assembled panels. Panel types consist of Straight, Right, Left, and Double.
- B. Specifications:
 - 1. Subfloor: 1-1/8" ICC approved plywood
 - 2. Aluminum: 0.025" Aluminum Sheet permanently bonded to plywood
 - 3. Tubing: 5/8" Tracks for tubing

2.2 MANIFOLD

- A. Description: Factory-assembled manifold included with Warmboard.
- B. Controls: Actuator contains End switch and On/Off indicator.
- C. Specifications:
 - 1. Actuator Power: 24 V
- D. Product Data: http://www.warmboard.com/wp-content/uploads/2008/11/manifold_brochure_final_web.pdf

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's installation instructions.
http://www.warmboard.com/wp-content/uploads/2008/08/install_guide_0801102.pdf

END OF SECTION



SECTION 25 13 00

INTEGRATION AUTOMATION CONTROL AND MONITORING NETWORK

PART 1 - GENERAL

1.1 SUMMARY

A. The supervisory controller provides network connectivity and network supervisory.

1.2 DEFINITIONS

A. Controller Configuration Tool (CCT): Programming using logic blocks.

B. System Configuration Tool (SCT): Allows commissioning of devices using CCT.

1.3 QUALITY ASSURANCE

A. UL Listed, File E107041, CCN PAZX7, UL 916, Energy Management Equipment FCC Compliant to CFR47.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Johnson Controls INC

2.2 PRODUCTS

A. Metasys Network Control Engine (NCE), MS-NCE25

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow Manufacture's Instruction http://cgproducts.johnsoncontrols.com/MET_PDF/241014363.PDF

END OF SECTION



SECTION 25 14 00

INTEGRATED AUTOMATION LOCAL CONTROL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Controller that runs under user-programmed application and provides input and output required to monitor and control equipments.

1.2 DEFINITIONS

- A. Controller Configuration Tool (CCT): Programming using logic blocks.

1.3 QUALITY ASSURANCE

- A. UL Listed, File E107041, CCN PAZX7, UL 916, Energy Management Equipment FCC Compliant to CFR47.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Johnson Controls INC

2.2 PRODUCTS

- A. Metasys Field Control Engine (FEC) MS-FEC

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow Manufacture's Instruction http://cgproducts.johnsoncontrols.com/MET_PDF/2410143136.pdf

END OF SECTION



SECTION 25 35 00

INTEGRATED AUTOMATION INSTRUMENTATION AND TERMINAL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. This section includes instrumentation and control associated with electrical systems.

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Comply with plenum rated UL 945va.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Schneider-Electric

2.2 PRODUCTS

- A. Temperature and Humidity Sensor
1. Input Current: Two-wire 12 to 24 Vdc 30 mA
 2. Input Voltage: 12 to 24 Vdc or 24 Vac
 3. Operating Temperature Conditions: -58 to 122°F (-50 to 50°C)
 4. Humidity: 0 to 100% non-condensing.
 5. Mounting inside wall

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with product installation manual
[http://www.global-download.schneider-electric.com/852577A4005D7372/all/751C2EA5D354D3EB852578100067AB3C/\\$File/electric-electronic%20products%20catalog.pdf](http://www.global-download.schneider-electric.com/852577A4005D7372/all/751C2EA5D354D3EB852578100067AB3C/$File/electric-electronic%20products%20catalog.pdf)

END OF SECTION



SECTION 25 36 00**INTEGRATED AUTOMATION INSTRUMENTATION AND TERMINAL DEVICES FOR ELECTRICAL SYSTEM****PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes the sub power meter to display power production and generation information.

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Electro Industries/ GaugeTech.

2.2 PRODUCTS

- A. Wireless Sub-meter
1. The sub-meter shall accept universal voltage input suitable for 120, 220, and 277 power systems.
 2. Sub-meter shall be a traceable revenue sub-meter, which shall contain a utility grade test pulse, allowing power providers to verify and confirm that the sub-meter is performing to its rated accuracy.
 3. The sub-meter shall include two independent communication ports with advanced features. Port 1 shall provide an optical IrDA port and Port 2 shall be selectable for RS 485 communication.
 4. Ethernet Capabilities: 802.11b Wireless, 10 Base T Ethernet (RJ45), Wireless Security 128 Bit, Modbus TCP Protocol
 5. Compliance: IEC 687 (0.2% Accuracy), ANSI C12.20 (0.2% Accuracy), ANSI (IEEE) C37.90.1 Surge Withstand, ANSI C62.41 – Burst, IEC1000-4-2 – ESD, IEC1000-4-3 – Radiated Immunity, IEC 1000-4-4 – Fast Transient, IEC 1000-4-5 – Surge Immunity

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with product installation manual
http://www.electroind.com/pdf/Shark_New/E145721_Shark100-S_UserMan_v1.13.pdf

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Submittals: Product data, construction drawings
- B. Related 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. Regulatory requirements: compliance with UL 83

1.2 SYSTEM DESCRIPTION

- A. Related 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 MANUFACTURERS

- A. Schneider Electric, 520 Eighth Ave, 21st Floor New York, NY 10018; tel: (203) 373-2211
- B. Yingli Solar, 245 5th Ave., Suite 2301, New York, NY 10016; tel: (888) 686-8820
- C. Enphase Energy, 201 1st Street Suite 111, Petaluma, CA 94952; (877)797-4743
- D. Home Depot; tel (800) 466-3337
- F. ERICO, tel: 1-800-853-0878

2.2 MATERIALS

- A. Enphase Micro inverters
 1. Model# M190-72-240-S12/3
 2. http://www.enphaseenergy.com/downloads/Enphase_M190_Datasheet.pdf



B. Grounding Materials

1. Conductors: No. 6 AWG Solid Copper between photovoltaics, and No. 1 AWG service ground.
2. Ground Rods: Galvanized; 5/8" in diameter.

C. Steel City Outdoor Enclosure Box

1. Model# AB-664RBGK001
2. 6"x6"x4" Junction boxes used at module connections.
3. http://www.homedepot.com/h_d1/N-5yc1v/R-202590858/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

PART 3 -EXECUTION

3.1 GENERAL ELECTRICAL EQUIPMENT INSTALLATION REQUIREMENTS

- A. Install electrical equipment in accordance with NEC 110, NEC 690, and all other relevant sections. Install electrical equipment in accordance with required clearances.
- B. Install electrical equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
- C. Install electrical equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.
- D. Install electrical equipment to allow right of way for piping and conduit installed at required slope.
- E. Comply with NECA 1.

3.2 RACEWAY AND CABLE INSTALLATION

- A. Outdoor Raceways Applications:
 1. Exposed or Concealed: LFMC, RMC.
 2. Boxes and Enclosures: Metallic, 4" square when possible, NEMA 250, Type 3R or Type 4.
- B. Conceal raceways and cables, unless otherwise indicated (instrumentation sensor wiring), within finished walls, ceilings, and floors.
- C. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.
- D. Connect motors and equipment subject to vibration, noise transmission, or movement with a 72inch maximum length of flexible conduit.
- E. Install raceways and cables conceal within finished walls, ceilings, and floors unless otherwise indicated.



3.3 GROUNDING

- A. Underground Grounding Conductors: Install bare copper conductor, [No. 2/0] AWG minimum. Bury at least 24 inches below grade.
- B. Pipe and Equipment Grounding Conductor Terminations: Bolted.
- C. Connections to Structural Steel: Ground lugs.
- D. Install grounding conductors routed along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- E. Install ground rod driven into ground until tops are 2 inches below finished floor or final grade unless otherwise indicated. Install ground rod according to organizers' determination of location, Rule 4-3.
- F. Make connections without exposing steel or damaging coating if any.
- G. Install bonding straps and jumpers in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

3.4 IDENTIFICATION

- A. Comply with NEC 690.64 for the labeling of load-side inverter breakers in load panel.
- B. Warning Labels for Enclosures for Power and Lighting: Comply with 29 CFR 1910.145; identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- C. Equipment Identification Labels:
 - 1. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Transformers.
 - c. Motor-control centers.
 - d. Enclosed circuit breakers.
 - e. Motor starters.
 - f. Power transfer equipment.
 - g. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
- D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- E. Label location of boxes in walls based on circumferential distance from nearest structural steel member in the wall. Label boxes in dropped ceiling based on a Cartesian coordinate system from the center of a module.



3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Fasten hangers and supports securely in place, with provisions for thermal and structural movement. Install with concealed fasteners unless otherwise indicated.

- B. Multiple Raceways or Cables: Install on trapeze-type supports fabricated with steel slotted channel.

- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods, unless otherwise indicated or required by Code:
 - 1. To Wood: Cable staples.
 - 2. To Steel: Beam clamps.
 - 3. To Light Steel: Sheet metal screws.

END OF SECTION



SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Submittals: Product data, construction drawings

1.2 SYSTEM DESCRIPTION

- A. A grounding kit is used as a safety device and acts as an electrical reference. To be driven into the ground construction process for tower, substation, pole, and necessary grounding of the all major products. It provides a low impedance path for excess current to flow back to the source and the current is safely shunted to ground before voltage can rise to lethal levels on any electrical component.

PART 2 -PRODUCTS

2.1 MANUFACTURER

- A. Nehring Electrical Works Company; toll-free: 800-435-4481
- B. 1005 E. Locust Street, DeKalb, IL 60115

2.2. MATERIALS

1. Grounding Rod
2. Nehring part No.941200000
3. <http://www.nehringwire.com/grounding-rods/copper-clad-rods>

PART 3 -EXECUTION

3.1 INSTALLATION

- A. Grounding rod shall be mounted in the ground at 45-degree angle

END OF SECTION



Copper-Clad Rods



Product Description

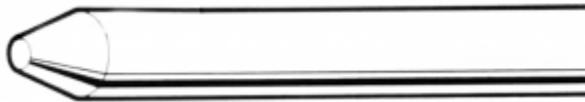
High carbon steel with an electrolytically applied copper finish in 1/2", 5/8", 3/4", and 1" diameters in varying lengths. Available in single type and sectional ground rod styles.

Application

Driven into the ground in the construction process for tower, substation, pole, and necessary grounding of all major projects.

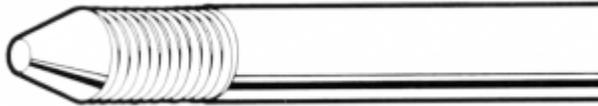
Product Data

Copper-Clad Rods



Rod Diameter x Length	U.L. Listed*	Weight (lbs.) per 100 Pcs.	Nehring Part No.
1/2 x 6	-	415	945000000
1/2 x 8 Non-UL	-	549	941050000
1/2 x 8 Full Sized UL	UL	549	941080000
1/2 x 10	UL	684	941100000
5/8 x 6	-	530	941150000
5/8 x 8	UL	704	941200000
5/8 x 10	UL	879	941250000
3/4 x 6	-	775	941300000
3/4 x 8	UL	1,035	941350000
3/4 x 10	UL	1,284	941400000
1 x 10	-	2,325	946150000

Copper-Clad Sectional Rods



Rod Diameter x Length	U.L. Listed *	Weight (lbs.) per 100 Pcs.	Nehring Part No.
5/8 x 8	UL	704	942100000
5/8 x 10	UL	879	942150000
3/4 x 8	UL	1035	942200000
3/4 x 10	UL	1284	942500000
1 x 10	UL	2325	942300000

*UL only lists rods 1/2" diameter or larger and 8" lengths or longer.

Specification Data

UL listed product with a .010" copper electroplated finish on high quality high carbon steel.

Source URL: <http://www.nehringwire.com/grounding-rods/copper-clad-rods>

Published on **Nehring Electrical Work Company** (<http://www.nehringwire.com>)

SECTION 26 05 33.05

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Product data, construction drawings

B. Related Sections

1. Section 26 05 00 Common Work Results for Electrical

1.2 SYSTEM DESCRIPTION

A. Items protect wires and make the electrical system less prone to electrocution.

B. EMT will be used for the interior of the house and will protect insulated electrical conductors and cables from magnetic fields, impact damage and crushing. Rigid metal conduit will be used for outdoor applications and will protect insulated electrical conductors and cables.

PART 2 -PRODUCTS

2.1 MANUFACTURER

A. The Home Depot; Tel: 1-800-466-3337

B. MATERIALS

1. EMT (Electrical Metallic Tubing) ½", ¾", 1 ¼"

2. Model # 101550

3. Link to website:

http://www.homedepot.com/h_d1/N-5yc1v/R-100400406/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

4. Rigid metal conduit 1 ½"

5. Model # 103093

6. Link to website:

http://www.homedepot.com/h_d1/N-5yc1v/R-100119816/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

2.2 QUALITY ASSURANCE



A. Installer Qualifications: Installer should be experienced in performing work of this section and should have specialized in installation of work similar to that required for this project.

2.3 REGULATORY REQUIREMENTS

A. Conduit must be bent appropriately and used in respectively correct environments.

PART 3 -EXECUTION INSTALLATION

A. Installed in accordance with NEC article 314

END OF SECTION



SECTION 26 09 00

INSTRUCTION AND CONTROL FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. This section includes instrumentation and control associated with electrical systems.

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. FCC approved pursuant to Part15 of the FCC rules.
- B. IC (RSS-210)
- C. RoHS compliant.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. LUTRON Inc.

2.2 PRODUCTS

- A. LRF2-DCRB-WH Wireless Daylight Sensor
 - 1. Requires one CR 2450 lithium battery
 - 2. Temperature Conditions: 32 to 104 °F (0 to 40 °C)
 - 3. For Indoor use only
 - 4. Load controls must be located within 60ft line of sight or 30ft through walls
- B. LRF2-OCRB-P Wireless Occupancy and Vacancy Sensors
 - 1. Requires one CR 123 lithium battery
 - 2. Temperature Conditions: 32 to 104 °F (0 to 40 °C)
 - 3. For Indoor use only
 - 4. Lens illuminates orange in response to motion during test mode and is visible from 60 ft

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with product installation manual
<http://www.lutron.com/TechnicalDocumentLibrary/041277A.pdf>
- B. Comply with product installation manual
<http://www.lutron.com/TechnicalDocumentLibrary/041272a%2016th%20Apr.pdf>

END OF SECTION



SECTION 26 24 16

PANELBOARDS

PART 1- GENERAL

1.1 SUMMARY

Section Includes:

- Distribution panel boards.
- Lighting and appliance branch-circuit panel boards.
- Load centers.

System Description.

1. Contains grid electricity. Distributes power to loads in the house and general area of the house. Provides protection via circuit breakers. Depending on the amount of load, the circuit breakers are sized accordingly.

PRODUCTS

2.1 MANUFACTURER

Schneider Electric

Schneider Electric

2.2 MATERIALS

A. QO130M200 Load Center

1. Product specifications
 - a. Main Type: Convertible - Factory installed main breaker
 - b. Maximum Single Pole Circuits: 30
 - c. Maximum Tandem Circuit Breakers - 0
 - d. Phase - 1-Phase
 - e. Spaces - 30
 - f. Ampere Rating - 200A



- g. Voltage Rating - 120/240VAC
- h. Application - Designed to meet residential, commercial and industrial requirements to protect electrical systems, equipment and people.
- i. Wire Size - #4 to 250 AWG/kcmil (Al/Cu)
- j. Wiring Configuration - 3-Wire
- k. Depth - 3.75 Inches
- l. Approvals - UL Listed
- m. Height - 29.86 Inches
- n. Width - 14.25 Inches
- o. Cover Type - Order separately
- p. Bus Material - Tin Plated Copper
- q. Enclosure Type - Indoor
- r. Box Number - 9
- s. Enclosure Rating - NEMA 1
- t. Grounding Bar - Order separately
- u. Short Circuit Current Rating - 22kA

B. QO816L100S Load Center

- 1. Product specifications
 - a. Short Circuit Current Rating - 10kA
 - b. Main Type - Fixed Mains- Lugs
 - c. Maximum Single Pole Circuits - 16
 - d. Maximum Tandem Circuit Breakers - 8
 - e. Phase - 1-Phase
 - f. Spaces - 6
 - g. Ampere Rating - 100A
 - h. Voltage Rating - 120/240VAC
 - i. Wire Size - #8 to 1 AWG (Al/Cu)
 - j. Application - Designed to meet residential, commercial and industrial requirements to protect electrical systems, equipment and people.
 - k. Wiring Configuration - 3-Wire
 - l. Depth - 3.80 Inches
 - m. Approvals - UL Listed



- n. Height - 12.57 Inches
- o. Cover Type - Surface (without door)
- p. Width: 8.88 Inches
- q. Bus Material - Tin Plated Aluminum
- r. Enclosure Type - Indoor
- s. Box Number - 4
- t. Enclosure Rating - NEMA 1
- u. Grounding Bar - Order separately

EXECUTION

INSTALLATION

1. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.
2. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
3. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
4. Provide filler plates for unused spaces in panelboards.
5. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

3.2 SAFETY

1. NEC Article 110 – 26 requires that sufficient access and working space shall be provided and maintained about electrical equipment to permit ready and safe operation and maintenance of such equipment. The minimum working space required by the NEC for power panels 150V to ground is 3 feet. For voltage over 3 feet, 3 feet is required from the enclosure to insulated surfaces, 3.5 feet is required to grounded surfaces, including concrete, and 4 feet is required to exposed live parts. Working space is required for all accessible surfaces.
2. NEC 240.24(A) states that when considering the location for a power panel the center grip of the operating handle of a circuit breaker or switch, when it is in its highest position, to be turned no more than 6 feet and 6 inches above the floor or operating platform.
3. The sizing allows only the following device options: a bolt on group mounted Spectra molded case circuit breakers that hold a load of 150 Amps maximum. Double mounted feeder breakers whenever possible. The provisions for future devices are not allowed.
4. Although UL listed series ratings are available, this sizing program supports only fully rated protective devices and bus.



5. This sizing program supports only NEMA 1 enclosures, however others are available.
6. All dimensions are in inches or mm.

END OF SECTION



SECTION 26 27 13

ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

Section includes equipment for electricity metering by utility company.

B. ACTION SUBMITTALS

1. Product Data

- a. Provide data for each component

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. General Electric (GE)

2.1 MATERIALS

- A. I-210+c Smart Meter

1. Product Specifications:

- a. Voltage range – 120V – 480V
- b. Low voltage range – 69V – 120V
- c. Extended operating range - -20% to + 10% of rating
- d. Supply operation – 50Hz or 60H of line frequency

2. WARNINGS

- a. Not to exceed 575V on the power supply voltage input terminals for the 57V – 120V, or 575V for the 120V – 480V supply range.

PART 3 –EXECUTION

3.1 INSTALLATION

Comply with equipment installation requirements in NECA 1.



Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

Install modular meter center according to NECA 400 switchboard installation requirements.

IDENTIFICATION

Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.

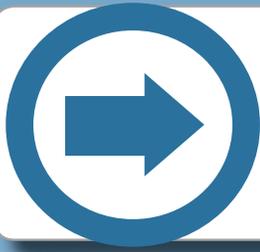
Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, with occupant's name.

3.3 FIELD QUALITY CONTROL

- A. Test and inspect the component accordance with local and universal codes.
- B. Inspections are required accordance to local and universal codes.

END OF SECTION





I-210+c[®] SmartMeter

SmartSynch's residential smart metering solution features a communications module that is integrated into the GE I-210+c electricity meter. The I-210+c SmartMeter communicates over an existing cellular network with the SmartSynch Transaction Management System™ (TMS) or other C12.21 head-end system (such as MV-90) and complies with ANSI C12.19 protocols for data storage and transmission.

The I-210+c SmartMeter is a single-phase electronic watt-hour meter for use in residential and light commercial service locations. The I-210+c's key features include Time of Use, Demand and Load Profile, Remote Connect/Disconnect, and C12.22/C12.21 compatibility. The I-210+c SmartMeter also includes an optional ZigBee[®] wireless component for in-premise communications and an optional Badger ORION[®] wireless component for gas and water reads.

Functions & Features

Wireless Communications

- GPRS
- ZigBee[®]
- Badger ORION[®]

Advanced Metering Functionality

- Remote Disconnect/Reconnect
- Flexible Two-Way Data Retrieval
- Scheduled & On-Demand Reads
- Interval Reads (5, 15, 30, 60 minutes)
- Real-Time Interval Reads
- Automated Register, Self-Read & TOU
- Demand Resets
- Real-Time Meter Event & Alarm Retrieval
- Real-Time Power Outage & Restoration
- Service Diagnostics & Tamper Detection
- Tilt Detection
- Meter Clock Synchronization
- SmartMeter Status Display
- Automated Meter Registration
- Secure & Encrypted Data Transmissions
- Bi-Directional Metering
- Over-The-Air SmartMeter Module Firmware Upgrade

Supported Meter Forms

- Class 20: 3S, 4S
- Class 100: 1S
- Class 200: 2S, 12S, 25S
- Class 320: 2S
- See back page for Supported Forms with Remote Disconnect

Hardware Components

- Remote Disconnect/Reconnect
- Radio Control Module Board (RCM)
- Capacitor Storage Bank (CSB)
- GSM/GPRS Modem
- ZigBee Transceiver
- Badger ORION Receiver
- Internal Antenna

Operating Ranges

Temperature

- Operating: [-40°C, +85°C]
- Transmission (GPRS): [-40°C, +85°C]

Humidity

- 0% to 95% non-condensing

Accuracy

- Meets ANSI 12.20 for accuracy class 0.5%

Regulatory & Industry Specifications

- FCC Part 15 Class B
- ANSI C37.90.1 – 1989: (SWC)
- ANSI C12.20 (Class 0.5) – 1998
- PTCRB Certified
- Network Carrier Certified
- Measurement Canada Certified

SmartSynch, Inc.
4400 Old Canton Road
Jackson, Mississippi 39211
1-888-362-1780

www.smartsynch.com

Remote Disconnect/Reconnect

Remote connect and disconnect functionality is supported by the I-210+c single-phase SmartMeter, which has a load-limiting switch that can be used to shed overall load at the premise without regards to specific appliance. This 200-Amp switch may be used to throttle load at the premise to a specific maximum threshold or to perform remote disconnects and reconnects.

Flexible Two-Way Data Retrieval and Scheduled Data Collection

Users can execute all appropriate TMS functionality using user-configurable, SmartMeter-controlled schedules and TMS-controlled schedules and as well as on an on-demand basis.

Automated Interval Data/Energy Usage Retrieval

The I-210+c SmartMeter module retrieves and transmits interval data for 1 unique energy value for intervals as small as 5 minutes. Recorded events and exceptions with each interval are also transmitted to TMS, which interprets them and logs appropriate messages (e.g. time adjustments).

Real-Time Interval Reads

Real-time interval data acquisition enables utilities to implement Load Curtailment and Real Time Pricing (RTP) programs. With this functionality, the user can configure the SmartMeter module to transmit load profile data as often as every 15 minutes at interval completion.

Automated Register, Self-Read and TOU Retrieval

The I-210+c SmartMeter module is configured by TMS to read and transmit all or a subset of enabled registers, including totals, self-reads, maximum demand and time-of-use values.

Demand Resets

The I-210+c SmartMeter module executes Demand Resets using one of three methods: SmartModule-initiated schedules, TMS-initiated schedules or TMS on-demand requests.

Real-Time Meter Event and Alarm Retrieval

The I-210+c SmartMeter provides automatic real-time alarm reporting of all events defined in the ANSI C12.19 standard, including history and event codes, ANSI Standard status and manufacturer status alarms. Additionally, alarms received by TMS can be automatically routed via e-mail to a specific user or group of users using the TMS Message Routing Interface.

Real-Time Power Outage and Restoration Alarms

With built-in ultracapacitor energy storage, the I-210+c SmartMeter module will transmit a real-time "last gasp" notification when detecting an AC power outage without requiring the use of less reliable batteries. The I-210+c SmartMeter also notifies TMS when the AC power is restored and provides full configuration of these alarms based on user-defined durations.

Service Diagnostic and Tamper Detection Alerts

The I-210+c SmartMeter can report power service and wiring errors detected by the meter, including reverse polarity, cross-phase and energy flow, phase voltage deviation, inactive phase current, phase angle displacement and current waveform distortion. In addition, the SmartMeter can detect and report exceptions for the following tamper events: number of Demand Resets, Loss of AC power and reported power outages.

TMS configures a specific filter in the SmartMeter for each of these events, enabling the transmission of a corresponding alert only after the event is repeated a minimum number of times within a specific duration. TMS can also configure the SmartMeter to reset the event counter when the alert message is transmitted.



Functions & Features



Tilt Detection

The I-210+c SmartMeter can detect and report tilt events that occur when the SmartMeter is moved from its installation position.

Meter Clock Synchronization

If enabled, the SmartModule automatically adjusts the meter clock when the time deviation falls within user-defined lower and upper deviation boundaries based on a reference clock provided by TMS. If the deviation exceeds the upper boundary, the module reports the deviation via an alarm but does not correct the meter clock. If the deviation is less than the lower boundary, the module ignores the deviation.

SmartMeter Status Display

The I-210+c SmartMeter supports an optional LCD status sequence to display important SmartMeter indicators periodically. This status sequence includes the meter site coverage status, SmartModule firmware state and any SmartModule firmware warnings/errors enabling technicians to ensure proper installation of the I-210+c SmartMeters and allow field troubleshooting without any other tools.

Automated Meter Registration

The SmartMeter module automatically transmits a registration message to TMS when the meter is installed without requiring user intervention. This message permits TMS to create or update the meter record with validated information, ensuring accurate and automated record entries without user intervention.

Secure and Encrypted Data Transmissions

256-bit encryption is applied to all messages exchanged between TMS and the SmartMeter module, utilizing a unique meter-specific encryption key.

Bi-Directional Metering

The I-210+c SmartMeter is a bi-directional meter that supports Net Metering. Both received and delivered data metrics are stored in the meter and can be delivered to the utility as needed to support "green-credit" electricity programs for consumers who own renewable energy facilities or participate in vehicle-to-grid systems.

Over-The-Air SmartMeter Module Firmware Upgrade

TMS users with administrator privileges can remotely upgrade the I-210+c SmartMeter module firmware for one or multiple communication modules.

Transmission Efficiency

In addition to support for allowing users to filter the number of meter channels and types of diagnostics that are returned, all wireless messages are converted to binary and optimally compressed before transmission to ensure the most economical data processing rates. The compression ratio can be as high as 50% and overall data usage can be as little as 5% of the total usage of other wireless systems.

Automated ID Tracking

Barcode labels and important identifiers (e.g. ICC-ID / MS-ISDN) are attached to the integrated SmartMeter for tracking and troubleshooting purposes. The SmartMeter module manufacturer and meter integrator scan and track all device IDs accurately.

On-Demand Data Reads For Virtual Disconnect

Customers can perform virtual disconnects through TMS by retrieving a final read for one end-user and an initial read for a subsequent end-user. This function may also be used to perform meter "switch-outs."



Hardware Specifications



Hardware Component	Description
Radio Control Module Board (RCM)	32-bit ARM processor, 256K RAM, 512K flash
Capacitor Storage Bank (CSB)	Supplies peak power for data transmissions and all functions during power outages – no batteries required
GSM/GPRS Modem	GSM modem communicates with head-end using GPRS and SMS services
ZigBee Transceiver	Wireless component for in-premise two-way communications
Badger ORION Receiver	Wireless component for receiving gas and water reads
Internal Antenna	Flexible dual frequency GSM antenna for the modem

Temperature Ranges

Operating: [-40°C, +85°C]

Transmission (wireless): [-40°C, +85°C]

Supported Meter Forms

Class 20: 3S, 4S

Class 100: 1S

Class 200: 2S, 12S, 25S

Class 320: 2S

With Disconnect

Class 100: 1S

Class 200: 2S, 12S, 25S

Class 320: 2S

Humidity Range

0% to 95% non-condensing

Accuracy

Meets ANSI 12.20 for accuracy class 0.5%

Regulatory & Industry Certifications

FCC Part 15 Class B

ANSI C37.90.1 – 1989: Surge Withstand Capability (SWC)

ANSI C12.20 (Class 0.5) – 1998

PTCRB Certified

Measurement Canada Certified

Network Carrier Certified

Input/Output Signal or Interface Definition/Values

Module Power Input Voltage	120 - 240 VAC
Meter Serial Interface	3.3V / TTL compatible asynchronous

Integration

The SmartMeter module is a fully integrated, under-the-cover option inside the I-210+c meter. The I-210+c SmartMeter is shipped as one complete unit, ready for field deployment.

Version and Compatibility Information

I-210+c Meter Hardware:	Supported meter forms, classes, and types, equipped with battery
I-210+c Meter Firmware:	Latest fully supported
SmartModule:	I-210+c GPRS SmartMeter Module
SmartSynch TMS:	Version 6.0 or higher

About SmartSynch: Headquartered in Jackson, Miss., SmartSynch has been developing successful Smart Grid *Intelligence* solutions for the utility industry since 2000. The company's clean-tech innovations in the two-way delivery of real-time energy usage data over cellular networks (AT&T, Rogers, etc.), in lieu of private network build-outs, have to date simplified SmartMeter deployments for 150 major North American utilities, while enabling green-energy initiatives and delivering significantly higher Returns on Resources.

Unlike proprietary, closed-architecture solutions, SmartSynch's SmartMeters represent *future-proof* investments in technology. The standards-based IP connectivity enabled in every SmartMeter deployed makes them adaptable and remotely upgradable to support today's sensor and communications needs, as well as tomorrow's opportunities, better than any alternative.

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

Section Includes:

- Receptacles, receptacles with integral GFCI, and associated device plates.
- Twist-locking receptacles.
- Receptacles with integral surge-suppression units.
- Isolated-ground receptacles.
- Hospital-grade receptacles.
- Tamper-resistant receptacles.
- Weather-resistant receptacles.
- Snap switches and wall-box dimmers.
- Solid-state fan speed controls.
- Wall-switch and exterior occupancy sensors.
- Communications outlets.
- Pendant cord-connector devices.
- Cord and plug sets.
- Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

EMI: Electromagnetic interference.

GFCI: Ground-fault circuit interrupter.

Pigtail: Short lead used to connect a device to a branch-circuit conductor.

RFI: Radio-frequency interference.

TVSS: Transient voltage surge suppressor.

UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

Coordination:

Receptacles for Owner-Furnished Equipment: Match plug configurations.

Cord and Plug Sets: Match equipment requirements.



PART 2 - PRODUCTS

2.1 MANUFACTURERS

Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
Leviton Mfg. Company Inc. (Leviton).
Pass & Seymour/Legrand (Pass & Seymour).

Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Comply with NFPA 70.

Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

Connectors shall comply with UL 2459 and shall be made with stranding building wire.
Devices shall comply with the requirements in this Section.

2.3 GFCI RECEPTACLES

General Description:

Straight blade, feedthrough type.
Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
Pass & Seymour; 2095.
Leviton; 7590.

Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:

Products: Subject to compliance with requirements

Hubbell; GFTR20.
Pass & Seymour; 2095TR.



Description:

Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

Manufacturers: Subject to compliance with requirements.

Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

Cooper Crouse-Hinds.
EGS/Appleton Electric.
Killark; Division of Hubbell Inc.

2.5 RESIDENTIAL DEVICES

Residential-Grade, Tamper-Resistant Convenience Receptacles, 125 V, 15 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

Products: Subject to compliance with requirements,

Cooper; TR270.
Hubbell; RR155TR.
Leviton; T5320.
Pass & Seymour; TR62.

Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

Weather-Resistant and Tamper-Resistant Convenience Receptacles, 125 V, 15 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**

Cooper; TWR270.
Hubbell; RR155WRTR.
Leviton; TWR15.
Pass & Seymour; 3232TRWR.



Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.

Fan Speed Controls:

Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.

Comply with UL 1917.

Continuously adjustable [slider] [toggle switch] [rotary knob], [5 A] [1.5 A].

Three-speed adjustable [slider] [rotary knob], 1.5 A.

Telephone Outlet:

Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

Cooper; 3560-6.

Leviton; 40649.

<Insert manufacturer's name; catalog number(s)>.

Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with [Category 5e] <Insert category>. Comply with UL 1863.

Combination TV and Telephone Outlet:

Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

Cooper; 3562.

Leviton; 40159.

<Insert manufacturer's name; catalog number(s)>.

Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with [Category 5e] <Insert category>. Comply with UL 1863.



PART 3 - EXECUTION

3.1 INSTALLATION

Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

Coordination with Other Trades:

Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

Install wiring devices after all wall preparation, including painting, is complete.

Conductors:

Do not strip insulation from conductors until right before they are spliced or terminated on devices.

Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

Existing Conductors:

Cut back and pigtail, or replace all damaged conductors.

Straighten conductors that remain and remove corrosion and foreign matter.

Pigtailing existing conductors is permitted, provided the outlet box is large enough.

Device Installation:

Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

Connect devices to branch circuits using pigtails that are not less than **6 inches (152 mm)** in length.

When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

Use a torque screwdriver when a torque is recommended or required by manufacturer.

When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

Tighten unused terminal screws on the device.

When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

Receptacle Orientation:



Install ground pin of vertically mounted receptacles **[up]** **[down]**, and on horizontally mounted receptacles to the **[right]** **[left]**.

Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

Dimmers:

Install dimmers within terms of their listing.

Verify that dimmers used for fan speed control are listed for that application.

Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

Comply with Division 26 Section "Identification for Electrical Systems."

Identify each receptacle with panelboard identification and circuit number. Use hot, stamped or engraved machine printing with **[black]** **[white]** **[red]**-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

Perform the following tests and inspections:

In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.

Test Instruments: Use instruments that comply with UL 1436.

Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

Tests for Convenience Receptacles:

Line Voltage: Acceptable range is 105 to 132 V.

Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

Ground Impedance: Values of up to 2 ohms are acceptable.



GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

Using the test plug, verify that the device and its outlet box are securely mounted.

Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

Wiring device will be considered defective if it does not pass tests and inspections.

Prepare test and inspection reports.

END OF SECTION





Weather-Resistant Receptacles

December 2007

Section 406.8 of the 2008 *National Electrical Code*® (NEC®) requires that all 15- and 20-Ampere, 125- and 250-Volt non-locking receptacles installed in wet or damp locations shall be Weather-Resistant Receptacles.

Porches, decks and other outdoor locations are all examples of wet or damp locations and are challenging environments where cracked covers or corrosion can cause premature failure. New Pass & Seymour Weather-Resistant Receptacles were designed to comply with this code.

Features & Benefits

- Listed to the Weather-Resistant supplement of UL498, meeting demanding UL® requirements including:
 - Ultraviolet light exposure test
 - Cold impact test
 - Accelerated aging test
 - Stringent material requirements for current-carrying parts, wire binding screws and mounting straps to ensure superior corrosion resistance
- Residential Weather-Resistant Receptacles are Tamper-Resistant as required by 2008 NEC.
- All receptacles are cULus listed.
- Receptacles still require a weatherproof cover in wet or damp locations.
- WR marking on face as required by UL Standard.

Applications

- Required for wet and damp locations such as outdoor, roofed or open porches, canopies, basements, barns, and wash-down areas.

Weather-Resistant Receptacle Ordering Information

Catalog Number	Description	Listed to FSUL WC596	Rating		Color
			A.	V.	
3232TRWR**	TradeMaster® Duplex Receptacle		15	125	Brown, I, LA, W
885TRWR**	TradeMaster Decorator Receptacle		15	125	Brown, I, LA, W
1595TRWR**	TradeMaster Specification Grade GFCI Receptacle	•	15	125	Brown, I, LA, W
WR5262*	Specification Grade Straight Blade Duplex Receptacle	•	15	125	GRY, I, W
WR5362*	Specification Grade Straight Blade Duplex Receptacle	•	20	125	GRY, I, W
WR20TR**	Commercial Grade Duplex Receptacle		20	125	Brown, GRY, I, LA, W
2095TRWR**	Commercial Grade GFCI Receptacle	•	20	125	Brown, GRY, I, LA, W

* Indicates Tamper-Resistant product

*Color Designation	
—	Brown
GRY	Gray
I	Ivory
LA	Light Almond
W	White

Available Now!



3232TRWR*



1595TRWR*



WR20TR*



WR5362*

For additional or application-specific information — call 800-223-4185 or visit our website at www.passandseymour.com. We are eager to put our expertise to work for you.

Residential and
Commercial
Grade

Tamper Resistant Receptacles

NEMA 5-15

**Single and Duplex Receptacles
2-Pole, 3-Wire Grounding
15A 125V/AC**



Product:

Application:

Cooper Wiring Devices' UL Listed safety shutter system for tamper resistant receptacles prevents insertion of foreign objects into the receptacle and provides significantly improved protection when compared to traditional receptacles with removable plastic safety caps. Applications include residential homes, extended stay hotels, assisted living facilities, retirement communities and apartment buildings.

**Design
Features &
Benefits:**

Receptacles:

- Provides compliance with 2008 NEC section 406.11 specification that states that all receptacles installed in dwelling units must be tamper resistant.
- Manufactured with the highest grade materials; durable impact-resistant thermoplastic face and back body is virtually unbreakable.
- "TR" designation makes it easy to identify at a glance.
- Terminal screws are backed out and ready to wire.
- Extra-long and extra-wide mounting straps.
- Patented built-in wire stripper for #14 and #12 wire to speed installation.
- Tri-combo screws accept slotted-, Phillips and Robertson-head tools for installation flexibility.
- Side-wire terminals accept up to #10 solid or stranded wire.
- Push-in terminals accept #14 solid wire (duplex devices only).
- Patented Screw-Catch™ feature on duplex devices speeds wallplate installation.

**Technical
Specifications**

TESTING AND CODE COMPLIANCE

cULus to UL498 & CSA C22.2. No. 42, NOM/ANSI

SPECIFICATIONS

Environmental:

Flammability:

For TR270, TR270-9, TR1107, TR1107-9, 9505TR, 9507TR:
V2 per UL94

For TR817, TR6250, TRVGF15, 9566TR: V0 per UL94

Operating Temperature:

For TR270, TR270-9, TR817, TR1107, TR1107-9, TR6250, 9505TR:
-20°C to 60°C

For TRVGF15, 9566TR: -35°C to 66°C

Electrical:

Dielectric Voltage: Withstands 2000V per UL 498

Current Interrupting: Yes, at full-rated current

Temperature Rise: Max. 30°C

Mechanical:

Terminal Accommodation: #14 - #10 AWG

Product Identification: Voltage ratings and TR logo permanently marked on device

MATERIALS

Body: Thermoplastic

Ground Strap:

For TR270, TR270-9, TR1107, TR1107-9, TR817, 9505TR, 9507TR: Zinc-plated steel

For TR6250: Gold-toned zinc

For TRVGF15, 9566TR: Nickel-plated steel

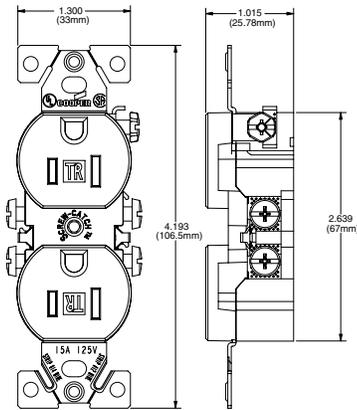
Contacts: Brass alloy

Terminal Screws: Brass/nickel-plated steel

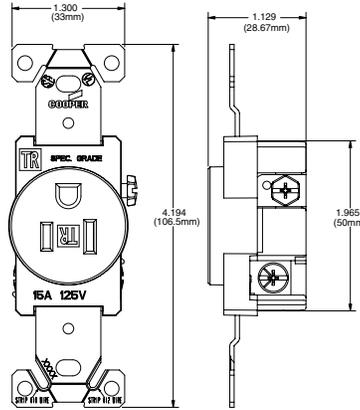
Terminal Clamps: Brass-plated steel

Dimensions:

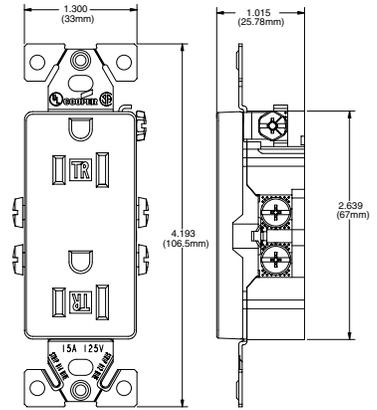
TR270 Receptacles



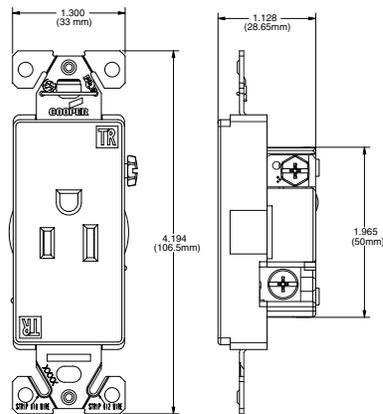
TR817 Receptacles



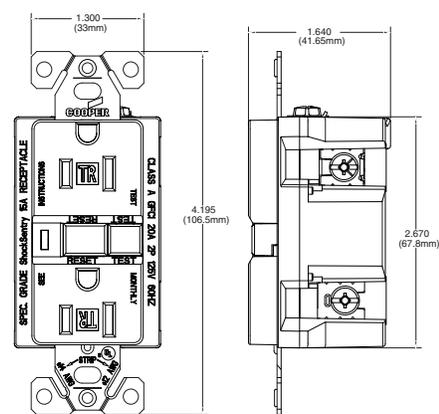
TR1107, 9505TR Receptacles



TR6250, 9507TR Receptacles



TRVGF15, 9566TR Receptacles



Ordering Information:

NEMA 5-15 Tamper Resistant Receptacles: 2-Pole, 3-Wire 15A 125V/AC

Catalog No.	Description	Color
<input type="checkbox"/> TR270	Standard Duplex Receptacle	B, LA, V, W
<input type="checkbox"/> TR270-9*	Standard Duplex Receptacle with Automatic Grounding	B, LA, V, W
<input type="checkbox"/> TR817	Commercial Single Receptacle	A, B, BK, GY, LA, V, W
<input type="checkbox"/> TR1107	Decorator Duplex Receptacle	A, B, BK, GY, LA, V, W
<input type="checkbox"/> TR1107-9*	Decorator Duplex Receptacle with Automatic Grounding	A, B, BK, GY, LA, V, W
<input type="checkbox"/> TR6250	Commercial Decorator Single Receptacle	A, B, BK, GY, LA, V, W
<input type="checkbox"/> TRVGF15	Specification Grade Duplex GFCI	A, B, BK, GY, LA, V, W
<input type="checkbox"/> 9505TR	ASPIRE™ Design System Duplex Receptacle	WS, DS, SG
<input type="checkbox"/> 9507TR	ASPIRE™ Design System Duplex Receptacle	WS, DS, SG
<input type="checkbox"/> 9566TR	ASPIRE™ Design System Duplex GFCI	WS, DS, SG

For ordering, include Cat. No. followed by the color code: A- Almond, B – Brown, BK – Black, GY – Gray, LA – Light Almond, V – Ivory, W – White, WS – White Satin, DS – Desert Sand, SG – Silver Granite

**Cooper Wiring Devices
United States**
203 Cooper Circle
Peachtree City, GA 30269
P: 866-853-4293 F: 800-329-3055
www.cooperwiringdevices.com

Canada
5925 McLaughlin Road
Mississauga, Ontario, L5R 1B8
P: 800-267-1042 F: 800-761-5748

Project Name:	
Project Number:	Date:
Prepared By:	

SECTION 26 28 13

FUSES

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. This Section includes the following:
 - 1. Cartridge fuses rated 600-V ac and less for use in control circuits enclosed switches panelboards switchboards enclosed controllers and motor-control centers.
 - 2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches fuse holders and panel boards.
 - 3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
 - 4. Spare-fuse cabinets.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
 - 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.



3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuse holders and sockets. Ensure that adapters are irremovable once installed.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION



SECTION 26 31 00

PHOTOVOLTAIC COMPONENTS

PART 1 – GENERAL

1.1 SUMMARY

- A. Functionality and specifications for Photovoltaic.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. SunPower
- B. Enphase Energy

2.2 MATERIALS

A. SunPower

1. Product Specifications:

- a. Module type – E19/238
- b. Power output – 238 Watts
- c. Module efficiency – 19.1%
- d. Voltage at output – 40.5 Volts
- e. current at output – 5.88 Amps
- f. Short circuit current – 6.25 Amps
- g. Operating temperatures– -40 to +85
- h. Maximum wind load – 245 kg / m²
- i. Maximum snow load – 550 kg / m²
- j. Nominal operating cell temperature – 45+/- 2 Celsius
- k. Temperature coefficient of the short circuit current – 3.5mA / k
- l. Temperature coefficient of the open circuit voltage – -132.5mV / k

B. Enphase Micro inverter M210-84-240-S12

Product Specifications:



- a. Recommended input power – 240 Watts
- b. Maximum input DC voltage – 62 Volts
- c. Peak power tracking voltage – 31Volts – 50 Volts
- d. Min/max start voltage – 38V/62V
- e. Maximum DC short circuit current – 12 Amps
- f. Maximum input current – 10 Amps
- g. Maximum output power – 210 Watts
- h. Nominal output current – 0.88A
- i. Power factor - > 0.95
- j. Peak inverter efficiency – 96 %
- k. CEC weighted efficiency – 95.5%
- l. Nominal MPP tracking – 99.6%
- m. Operating temperature - -40 Celsius to 65 Celsius
- n. Night time power consumption – 30 mW
- o. Weight – 4.4 lbs.
- p. Communication - Powerline

PART 3 – EXECUTION

3.1 – INSTALLATION

1. SunPower

A. SAFTEY FACTORS

1. Work according to the applicable safety standards when working with PV's.
2. Do not handle or install modules in adverse conditions like periods of strong winds or wet or frosted roofs
3. Do not touch electrical terminal or the ends of any wire while the PV module is exposed to light.
4. To avoid arching, do not disconnect electrical connections under load. Keep connectors dry and clean.
5. Do not wear metallic jewelry during installation.

B. MECHANICAL INSTALLATION



1. PV modules shall be mounted in a way that maximizes direct exposure of sunlight to the solar cells
2. PV modules must be secured in a safe position using a mounting structure or racking system intended for PV applications.
3. Mounting structures and mechanical parts must be designed and approved for the maximum applicable loads determined by local requirements and ASCE.
4. Sunpower modules have been approved by UL 1703 to withstand positive and negative design loads of 50 pounds per square foot when mounted according to installation instructions.
5. Sunpower modules can be mounted in either landscape or portrait position with a minimum tilt of 10 degrees to allow proper self-cleaning by the rain.
6. Allow a minimum of 4 inches gap between the module and the roof surface to allow for proper cooling.
7. Allow a 0.25 inch gap between module frames to avoid tension from thermal expansion.
8. Yingli modules shall not be subjected to forces from substructure. Keeping in mind thermal expansion.

C. ELECTRICAL INSTALLATION

1. Do not use PV modules of different characteristics and electrical properties in the same system.
2. Cover PV module with opaque material before making or breaking electrical connections.
3. Panels are equipped with installation ready wires and quick connectors for module to be interconnected in series. Each module has a positive and negative stranded sunlight resistant output cable.
4. The positive terminal has a female connector while the negative terminal has a male connector. The module wiring is for series connections only.
5. Module voltage will be summed when connected together. The maximum number of modules connected in series must follow regulations in such a way that the specified maximum system voltage of the PV module and all other electrical DC components will not be exceeded in open-circuit operation at the lowest temperature reported for the area.
6. Rated electrical characteristics are within 10 percent of measured values at standard test conditions.
7. Use cable qualified for DC wiring in PV systems per UL 1703 standard. The minimum lead cross-section shall be 12 AWG. Wiring details shall be accordance with the NEC.



8. Attach loose electrical cables to the mechanical sub structure without applying any stress to the cables.

D. GROUNDING

1. All equipment shall be grounded in accordance with local regulations and the NEC, article 250.
2. Proper grounding of the PV is achieved by connecting the module frame and structural members continuously to one another using suitable copper equipment grounding conductors. The grounding conductor must make a connection to earth using a suitable earth ground electrode.
3. Recommended grounding method: A 10 or 12 gauge AWG equipment grounding conductor shall be attached to the module frame at the designated grounding locations. Do not drill additional holes into the frame.
4. A stainless steel cup washer is required between the copper EGC and aluminum module frame.
5. A stainless steel backing nut is required to secure the grounding hardware to the frame.
6. A stainless steel tooth lock washer is required to engage the frame and penetrate the nonconductive anodized layer of the aluminum frame. The tooth lock washer can either be integrated with or independent of the backing nuts.
7. Modules can also be grounded using third party grounding washers or clip devices as long as the products are approved for grounding metallic frames of PV modules.

OPERATION AND MAINTENANCE

1. Yearly inspections of all PV systems performed by the installer. Special attention shall be paid to loose or corroded electrical or mechanical connections and correct grounding.
1. In the unusual event that a module must be replaced, proceed with the same care as during the initial installation.
2. Do not clean hot modules with cold water. This can cause the glass to break from the thermal shock.
3. If the modules must be cleaned, it is recommended that you use water with a soft sponge or brush. Remaining deposits can be treated with mild and non-alkaline detergent.

END OF SECTION



BENEFITS

Highest Efficiency

SunPower™ Solar Panels are the most efficient photovoltaic panels on the market today.

More Power

Our panels produce more power in the same amount of space—up to 50% more than conventional designs and 100% more than thin film solar panels.

Reduced Installation Cost

More power per panel means fewer panels per install. This saves both time and money.

Reliable and Robust Design

Proven materials, tempered front glass, and a sturdy anodised frame allow panel to operate reliably in multiple mounting configurations.

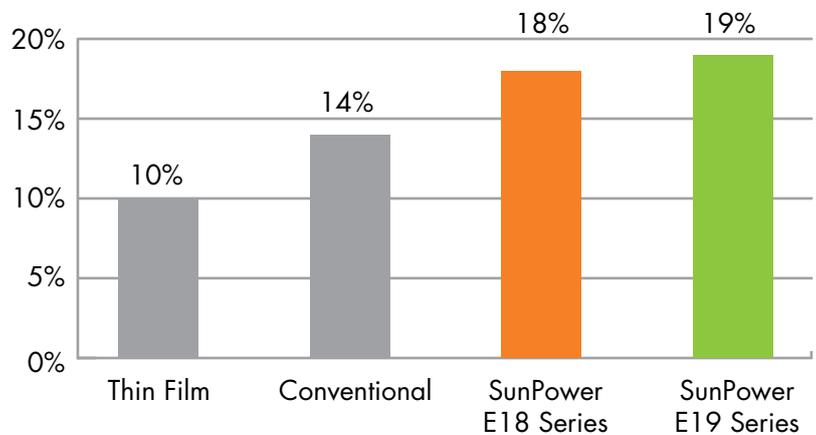


SPR-238E-WHT-D



The SunPower™ 238 Solar Panel provides today's highest efficiency and performance. Utilising 72 SunPower back-contact solar cells, the SunPower 238 delivers a total panel conversion efficiency of 19.1%. The panel's reduced voltage-temperature coefficient, anti-reflective glass and exceptional low-light performance attributes provide outstanding energy delivery per peak power watt.

SunPower's High Efficiency Advantage



Electrical Data

Measured at Standard Test Conditions (STC): Irradiance 1000W/m², AM 1.5, and cell temperature 25° C

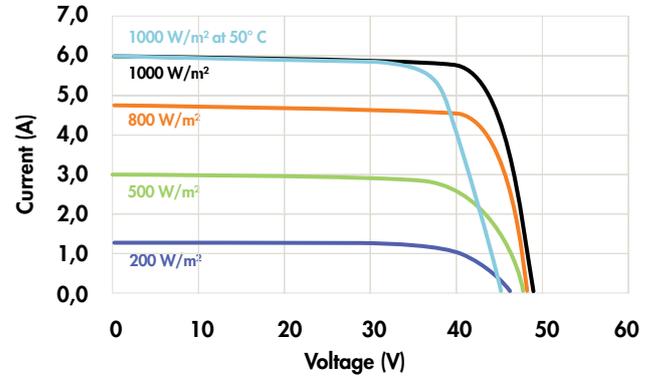
Nominal Power (+5/-3%)	P _{nom}	238 W
Efficiency	η	19.1 %
Rated Voltage	V _{mpp}	40.5 V
Rated Current	I _{mpp}	5.88 A
Open Circuit Voltage	V _{oc}	48.5 V
Short Circuit Current	I _{sc}	6.25 A
Maximum System Voltage	IEC	1000 V
Temperature Coefficients	Power (P)	-0.38% / K
	Voltage (V _{oc})	-132.5mV / K
	Current (I _{sc})	3.5mA / K
NOCT		45° C +/-2° C
Series Fuse Rating		20 A
Limiting Reverse Current (3-strings)	I _r	15.6 A

Electrical Data

Measured at Nominal Operating Cell Temperature (NOCT): Irradiance 800W/m², 20° C, wind 1 m/s

Nominal Power	P _{nom}	177 W
Rated Voltage	V _{mpp}	37.3 V
Rated Current	I _{mpp}	4.73 A
Open Circuit Voltage	V _{oc}	45.4 V
Short Circuit Current	I _{sc}	5.06 A

I-V Curve



Current/voltage characteristics with dependence on irradiance and module temperature.

Tested Operating Conditions

Temperature	-40° C to +85° C
Max load	550 kg / m ² (5400 Pa) front - e.g. snow 245 kg / m ² (2400 Pa) front and back - e.g. wind
Impact Resistance	Hail – 25 mm at 23 m/s

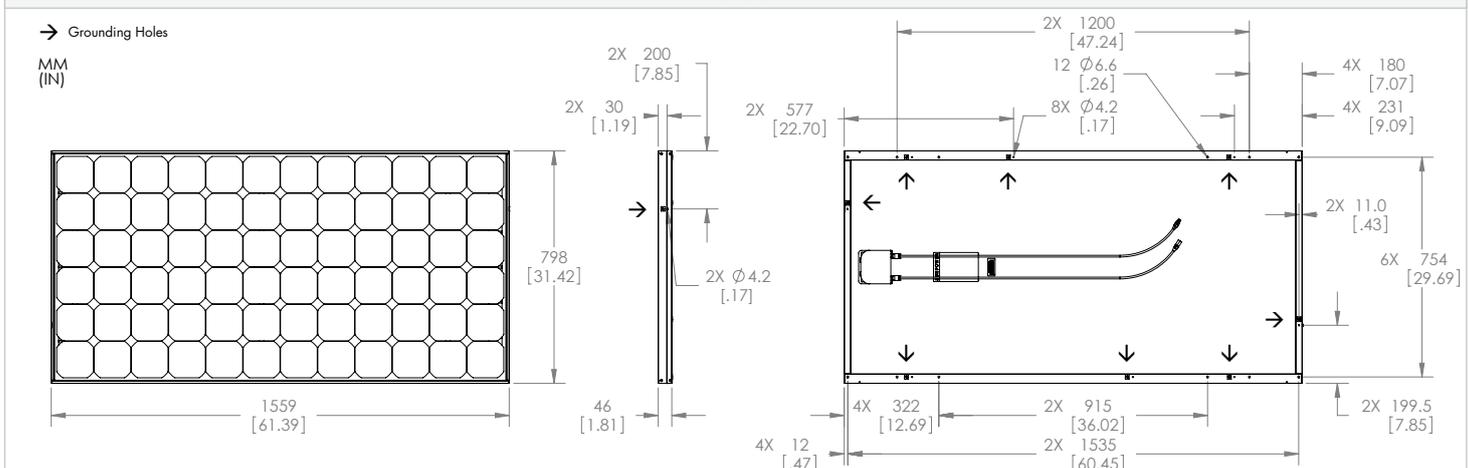
Warranties and Certifications

Warranties	25 year limited power warranty 10 year limited product warranty
Certifications	IEC 61215 Ed. 2, IEC 61739 (SCII)

Mechanical Data

Solar Cells	72 SunPower all-back contact monocrystalline	Output Cables	1000mm length solar cables / MultiContact (MC4) connectors
Front Glass	High transmission tempered glass with anti-reflective (AR) coating	Frame	Anodised aluminium alloy 6063 (black)
Junction Box	IP-65 rated with 3 bypass diodes 32 x 155 x 128 (mm)	Weight	15.0 kg

Dimensions



CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

Visit sunpowercorp.com for details

SECTION 26 50 00

LIGHTING

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. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This Section includes the following:
 - 1. Interior and exterior lighting fixtures with lamps and ballasts.
 - 2. Lighting fixtures mounted on exterior building surfaces.

1.3 DEFINITIONS

- A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
- B. CRI: Color rendering index.
- C. CU: Coefficient of utilization.
- D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:
 - 1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.
- E. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of fixture, including dimensions and verification of indicated parameters.
 - 2. Emergency lighting unit battery and charger.
 - 3. Fluorescent and high-intensity-discharge ballasts.
 - 4. Low voltage halogen transformers.
 - 5. Lamps.
- B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.



- C. Wiring Diagrams: Power, signal, and control wiring.
- D. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which lighting-fixture suspension systems will be attached.
 - 3. Other items in finished ceiling, including the following:
 - a. Air outlets and inlets.
 - b. Sprinklers.
- E. Samples for Verification: For interior lighting fixtures designated for sample submission in the Interior Lighting Fixture Schedule.
 - 1. Lamps: Specified units installed.
 - 2. Ballast: 120-V models of specified ballast types.
 - 3. Accessories: Cords and plugs.
- F. Product Certificates: For each type of ballast for dimmer-controlled fixtures, signed by product manufacturer.
- G. Source quality-control test reports.
- H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
 - 1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.
- I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- E. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.
- F. New York City Building Code Compliance: Comply with housing construction, exit sign lettering, and any other lighting fixture requirements particular to NYC jurisdiction.
- G. Mockups: Provide lighting fixtures for room or module mockups. Install fixtures for mockups with power and control connections.
 - 1. Obtain Architect's approval of fixtures for mockups before starting installations.



2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
- B. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
 2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In the Lighting Fixture Schedule attached to the end of this Section or other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products (Or Approved Equal by Others): Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products (Or Approved Equal by Specific Manufacturer(s)): Subject to compliance with requirements, provide one of the products specified.
 3. Proprietary Products (No Equal Listed): Provide the product specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.



- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is scheduled.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 LIGHTING FIXTURES

- A. Luminaires as scheduled at end of this Section and as meet all applicable requirements of this Section. (Fixture cuts are provided at the end of this Section for general reference only, unless otherwise noted in the schedule.)

2.4 FLUORESCENT LAMP BALLASTS

- A. Description: Include the following features, unless otherwise indicated:
 - 1. Designed for type and quantity of lamps indicated at full light output, except for emergency lamps powered by in-fixture battery-packs.
- B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:
 - 1. Comply with NEMA C82.11.
 - 2. Ballast Type: Instant start, unless otherwise indicated.
 - 3. Programmed Start: Ballasts with two-step lamp starting to extend life of frequently started lamps.
 - 4. Sound Rating: A
 - 5. Total harmonic distortion rating of less than 10 percent according to NEMA C82.11.
 - 6. Transient Voltage Protection: IEEE C62.41, Category A.
 - 7. Operating Frequency: 20 kHz or higher.
 - 8. Lamp Current Crest Factor: Less than 1.7.
 - 9. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
- C. Electromagnetic ballasts for linear lamps shall have the following features, unless otherwise indicated:
 - 1. Comply with NEMA C82.1.
 - 2. Type: Energy-saving, high power factor, Class P, automatic-reset thermal protection.
 - 3. Ballast Manufacturer Certification: Indicated by label.
 - 4. Provide lamp end-of-life detection and shutdown circuit for T5 diameter lamps.



- D. Ballasts for compact lamps in recessed fixtures shall have the following features, unless otherwise indicated:
1. Type: Electronic.
 2. Power Factor: 90 percent, minimum.
 3. Flicker: Less than 5 percent.
 4. Lamp Current Crest Factor: Less than 1.7.
 5. Electronic Ballast Operating Frequency: 20 kHz or higher.
 6. Lamp end-of-life detection and shutdown circuit.
 7. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
 8. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
- E. Ballasts for compact lamps in nonrecessed fixtures shall include the following features, unless otherwise indicated:
1. Power Factor: 90 percent, minimum.
 2. Ballast Coil Temperature: 65 deg C, maximum.
 3. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
 4. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
- F. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:
1. Dimming Range: 100 to 1 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming system indicated.
- G. Ballasts for Low-Temperature Environments:
1. Temperatures 0 deg F (Minus 17 deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F minus 17 deg C starting temperature.
 2. Temperatures Minus 20 deg F minus 29 deg C and Higher: Electromagnetic type designed for use with high-output lamps.
- H. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

2.5 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

- A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated.
1. Type: Constant-wattage autotransformer or regulating high-power-factor type.
 2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
 3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
 4. Open-circuit operation that will not reduce average life.
- B. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.



2.6 EXIT SIGNS

- A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - 1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

2.7 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.
- B. T5 programmed-start low-mercury lamps, rated 14-80 watts, CRI of 85, color temperature of 3500 K, and average rated life of 20,000 hours minimum.
- C. T8 low-mercury lamps, rated 32 W maximum, 2800 initial lumens (minimum), CRI of 80 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- D. Compact Fluorescent Lamps: CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated. Low-mercury for lamp types as available.

2.8 HIGH-INTENSITY-DISCHARGE LAMPS

- A. Metal-Halide Lamps: ceramic color-stabilized type, universal burning position, wattage and lamp type as scheduled, CRI 80 minimum, color temperature 4000 K.

2.9 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage (2.68 mm).
- E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- F. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.



- H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.10 FINISHES

- A. Fixtures: Manufacturers' standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 - 2. Metallic Finish: Corrosion resistant.

2.11 SOURCE QUALITY CONTROL

- A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) 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.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Adjust aimable fixtures to provide required light intensities.

3.2 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Verify normal operation of each fixture after installation.
- C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- E. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.



3.4 LIGHTING FIXTURE CUTS: Attached

END OF SECTION



Aero Head



DESCRIPTION

Dozens of design possibilities. Accessories in myriad styles and colors allow you to create the ideal custom element (accessory required; sold separately). Aero's head rotates 360°, pivots 260° to direct the beam. Removable glass handle. Low-voltage, MR16 lamp of up to 50 watts (not included). See accessory for maximum wattage usage.

SYSTEM

Available for FreeJack, MonoRail, Two-Circuit MonoRail, and Wall MonoRail. For use on T-trak, order FreeJack version and T-trak FreeJack Connector (sold separately).

INSTALLATION

Socket terminates with FreeJack male connector, which may be installed into a system connector. Elements ordered with a system prefix include a connector for that system.

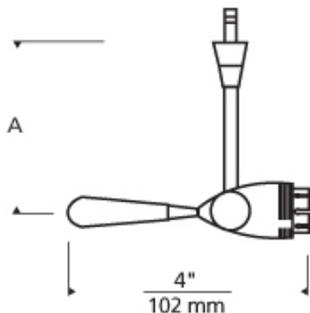
ACCESSORIES & OPTICAL CONTROLS

Bell Shade, Belladonna Shade, Cone Glass Shield, Cone Onyx Shield, Dichroic Glass Shield, Firebird Glass Shield, Lil Egypt Shade, Martini Glass Shield, Meteorite Shield, Prism Glass Shield, Round Glass Shield, Scavo Glass Shade, Soda Glass Shade, Sugar Accessory, Taza Accessory, Tinkerbell Shade, Wood Handle Accessory

WEIGHT

0.55-1lb / 0.25-0.45kg

ORDERING INFORMATION



700	SYSTEM	AE	LENGTH	FINISH
FJ	FREEJACK (MONO POINT)		3 3"	Z ANTIQUE BRONZE
MO	MONORAIL		6 6"	C CHROME
MO2	TWO-CIRCUIT MONORAIL		12 12"	S SATIN NICKEL
WMO	WALL MONORAIL		18 18"	
			24 24"	



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700 _____ AE _____

FIXTURE TYPE: _____

JOB NAME: _____

NOTES: _____



T W O - C I R C U I T M O N O R A I L

Two-Circuit MonoRail Conductive Connectors



DESCRIPTION

Conductive connectors join sections of rail end to end and are included with all Two-Circuit MonoRail pieces. Order separately if cutting and rejoining rails. Set of three.

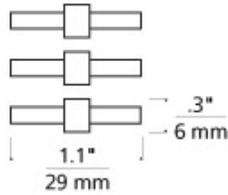
WEIGHT

0.01lb / 0kg

ORDERING INFORMATION

700MO2CCN FINISH

- Z ANTIQUE BRONZE
- C CHROME
- S SATIN NICKEL



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FIXTURE TYPE: _____

JOB NAME: _____

NOTES: _____



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Two-Circuit MonoRail 4" Round Power Feed Canopy Single-Feed



DESCRIPTION

A single-feed canopy is mounted to the ceiling above the Two-Circuit MonoRail run. It brings power to the Two-Circuit MonoRail run from a remote two-circuit transformer (sold separately). The low-voltage leads from the remote transformer are connected to the canopy leads inside the junction box. This canopy provides two independent circuits.

INSTALLATION

This product can mount to either a 4" square electrical box with round plaster ring or an octagon electrical box (not included).

OTHER INFORMATION

Black and white finish have satin nickel feeds. For use with a two-circuit single-feed remote transformer (sold separately). The shortest rigid standoff that can be used with a Two-Circuit MonoRail single-feed canopy is the 2" rigid standoff (sold separately). If dropping the rail more than 2" below the ceiling, order the desired rigid standoff length and one compatible power extender (sold separately).

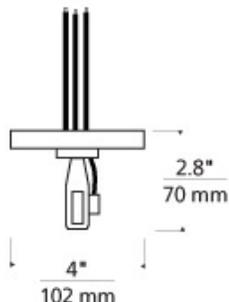
WEIGHT

0.95lb / 0.43kg

ORDERING INFORMATION

700MO2P4C02 FINISH

- Z ANTIQUE BRONZE
- B BLACK
- C CHROME
- S SATIN NICKEL
- W WHITE



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700MO2P4C02 _____

FIXTURE TYPE: _____

JOB NAME: _____

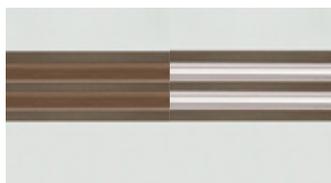
NOTES: _____



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T W O - C I R C U I T M O N O R A I L

Two-Circuit MonoRail



BROWN CLEAR

DESCRIPTION

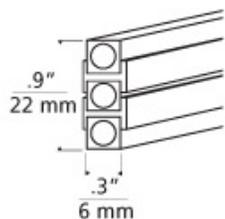
Low-voltage conductor of three individual conductive metal pieces fused together with plastic separators. Hand-bendable, field-cutable Two-Circuit MonoRail is rated for 300 watts per circuit at 12 volts. Each piece of rail is shipped with conductive connectors to join rail pieces end to end. Order additional connectors if cutting and rejoining rails. Two-Circuit MonoRail bends horizontally to a radius as small as 12", and custom factory bends are available. It cannot be bent vertically in the field.

WEIGHT

0.42-1.65lb / 0.19-0.75kg

ORDERING INFORMATION

700MO2A	LENGTH	COLOR	FINISH
	24 24"	BR BROWN	Z ANTIQUE BRONZE
	48 48"	CLEAR	C CHROME
	96 96"		S SATIN NICKEL



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FIXTURE TYPE: _____

JOB NAME: _____

NOTES: _____



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Remote Transformer-2x300W Mag 12v



DESCRIPTION

This remote magnetic transformer converts standard 120 or 277 volt line-voltage to 12 volts, providing the necessary voltage for powering a Two-Circuit MonoRail low-voltage lighting system. Each transformer includes fast-acting secondary circuit breakers that will safely turn the system off should a short occur. Once the short has been removed the breakers can be reset. Transformer powers lamp totaling up to 600 watts.

INSTALLATION

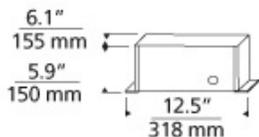
This transformer must be installed in a remote but accessible location (such as above the ceiling or in a closet). To simplify installation the transformer should be located no more than 20' from the run or power feed. The electrician will need to supply the proper gauge conductor from the transformer to the power feed location based on distance (see Low-Voltage Wire Size Table, below).

DIMMING

Transformer is equipped with two 120 or 277 volt input lines, and is dimmable with two 600 watt low-voltage magnetic dimmers. Each dimmer can control up to 300 watts. Dimmers are placed on the line side of the transformer (consult dimmer manufacturer for specifics). Dimming a transformer may create a buzzing sound, which may be objectionable in some applications. Debuzzing dimming coils can be purchased to reduce the audible noise (sold separately).

OTHER INFORMATION

12 volt output transformers require the use of 12 volt lamps. Use with a single-feed Two-Circuit canopy or other power feed option (sold separately).



LOW-VOLTAGE WIRE SIZE TABLE

Use to determine the correct THHN wire size for a recommended 3 percent drop in voltage at the specified wattage. The length shown is the length of wire from the transformer to the power feed.

	5 ft.	6-15 ft.	16-20 ft.	21-40 ft.	41-60 ft.	61-90 ft.
12 Volt						
300 Watt	#10 GA	#6 GA	#4 GA	#1 GA	1/0	3/0

WEIGHT

24.2lb / 10.98kg

ORDERING INFORMATION

700AT2X300T VOLTAGE

120V IN/12V OUT
 277 277V IN/12V OUT



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700AT2X300T _____

FIXTURE TYPE: _____

JOB NAME: _____

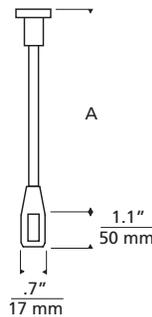
NOTES: _____



Rigid Standoff



Shown approximately 15% actual size.



DESCRIPTION

The field-cuttable rigid standoff is recommended for curvy runs or runs with heavier elements, such as glass pendants. Rigid standoffs are compatible with various power feed options: Use the chart below to determine the appropriate standoff for your run.

Use standoff supports every three feet of Two-Circuit MonoRail run and at corners. Standoffs can be positioned to cover points where rails are joined.

FINISH

Antique bronze, chrome, satin nickel.

WEIGHT

0.25-2.55 lb./0.11-1.16 kg. ±

COMPATIBLE STANDOFF

LENGTH	USED WITH
2" (1.9)*	- Remote transformer with any canopy
3" (3.6)*	- Canopy with 3" power extender
6" (5.8)*	- Surface transformer 300w - Surface transformer 500w - Canopy with 6" power extender
12"*	- Canopy or surface transformer with 12" power extender
24"*	- Canopy or surface transformer with 24" power extender
36"*	- Canopy or surface transformer with 36" power extender
48"*	- Canopy or surface transformer with 48" power extender
96"*	- Canopy or surface transformer with 96" power extender

*Actual length from ceiling to top of rail.

ORDERING INFORMATION

700MO2S	LENGTH (A)	FINISH
02	2" (1.9")	Z ANTIQUE BRONZE
03	3" (3.6")	C CHROME
06	6" (5.8")	S SATIN NICKEL
12	12"	
24	24"	
36	36"	
48	48"	
96	96"	

700MO2S _____

FIXTURE TYPE: _____

JOB NAME: _____



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EnduraLED MR16

EnduraLED MR16 7W 3000K 12V Dimm

Philips EnduraLED MR16 Lamps provide ambient level light to illuminate hard to maintain applications. Increased transformer compatibility allows for operation on a wider range of transformers. Available in flood and spot versions, these lamps are ideal for track and open recessed fixtures in rooms, hallways, lobbies and retail displays.

Product data

• Product Data

Product number	410035
Full product name	EnduraLED MR16 7W 3000K 12V Dimm
Short product name	12V EnduraLED 7W MR16 24D 3000K dimmable
Pieces per Sku	1
Skus/Case	10
Bar code on pack	46677410032
Bar code on case	50046677410037
Logistics code(s)	929000173904
eop_net_weight_pp	0.045 kg

• General Characteristics

Cap-Base	GU5.3
Bulb	MR16 [MR 16inch/50mm]
Average Lifetime	40000 hr

• Electrical Characteristics

Wattage	7 W
Wattage Technical	7.0 W

Voltage	12 V
Power Factor	0.8 -
Lamp Current mA	700 mA
Dimmable	Yes

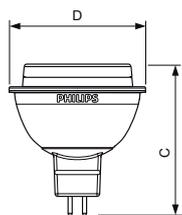
• Light Technical Characteristics

Color Code	WH
Color Designation (text)	White
Beam Angle	24 D
Correlated Color Temperature	3000 K
Luminous Intensity	1460 cd
Color rendering index	80
Color Temperature	3000 K [CCT 3000K]

• Product Dimensions

Diameter D	50 mm
Overall Length C	53.7 mm

Dimensional drawing



Product	C (Norm)	D (Norm)
LED 7W GU5.3 WH 3000K 12V MR16 24D Dimm	53.7	50



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2011, February 8
data subject to change

SPECIFICATION SHEET

4" 2000 SERIES

R2100

REGRESSED ADJUSTABLE SQUARE TRIM



YES

Damp Location



MR16

37-50W MAX



Insulated ceiling housing

ISMR2000E37, ISMR2000M37, ISMR2000M



New construction housing

NW2000E, NW2000CE, NW2000CM, NW2000LM



Remodel housing

IT2000M, IT2000CM, IT2000E, IT2000CE



Reflector

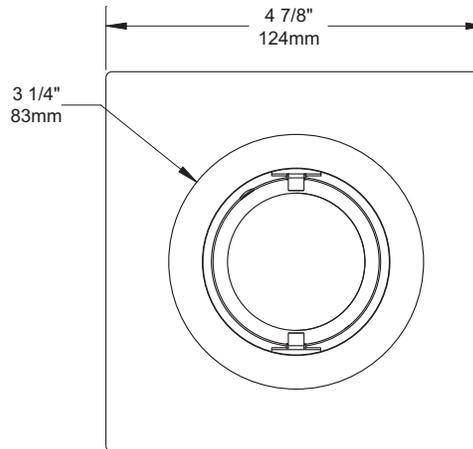
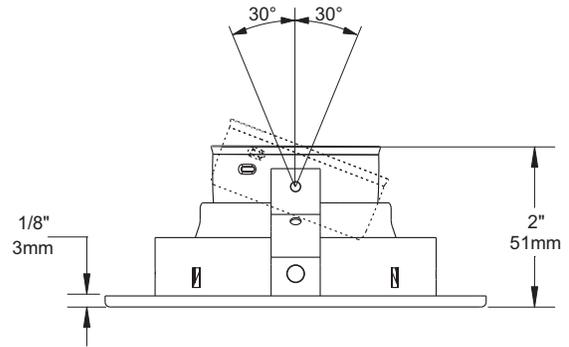
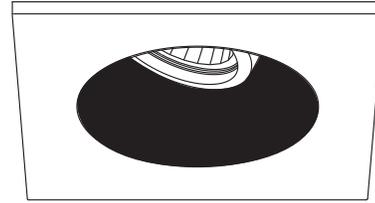
Standard reflector : painted black.

Also available : painted white and clear specular anodized. To order a white trim with a white reflector, add a «W» after the trim color. Ex. : R2100-01W, R2100-11W.

Available only with -01 and -11 finishes.

To order a white trim with a clear specular reflector, add an «S» after the trim color. Ex.: R2100-08S.

Available with all finishes.



COMPATIBLE HOUSINGS

37W MAX	42W MAX	50W MAX
ISMR2000E37	IT2000CE	ISMR2000M
ISMR2000M37	IT2000CM	IT2000E
	NW2000CE	IT2000M
	NW2000CM	NW2000E
		NW2000LM

TRIM FINISHES

-01 WHITE	-04BR BRUSHED CHROME	-08 ANTIQUE SILVER
-02 BLACK	-05 ARCHITECTURAL BRONZE	-11 MATTE WHITE
-03 24K GOLD	-06 ANTIQUE COPPER	-12BR BRUSHED NICKEL
-04 CHROME	-07 ANTIQUE BRASS	-13 SATIN NICKEL
		-14 ALMOND

Unless otherwise indicated, trims are for interior use only. For exterior use and up to wet conditions, MARINE GRADE treatment is recommended. Available for finishes -01, -02, -05, -06, -11 and -14 only.



Project _____

Representative _____

CONTRAST
LIGHTING

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MARCH 2010



2011, January 29
data subject to change

Extra low mercury

T8 Standard

Philips T8 lamps are environmentally responsible.

Benefits

- Sustainable lighting solution - Reduced impact on the environment without sacrificing performance.
- Warranty period: 30 months.

Features

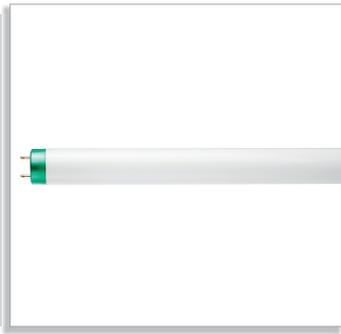
- Reduce maintenance costs by extending the relamping cycle.
- Outstanding lumen performance - 95% lumen maintenance.
- Better for the environment - only 1.7mg of mercury per lamp with ALTO II Technology.
- Available in 17, 25 and 32 watt with 3000, 3500, 4100 & 5000 Color Temperatures.

Application

- Ideal for applications requiring maximum maintained light output.

PHILIPS
sense and simplicity

Related products



Dimensional drawing



Compare table

Product number	Full product name	Bulb	Base	Color Code	Color Designation	Watts	Initial lumen	Color Rendering Index	Color Temperature	Design Mean Lumens	Mercury (Hg) Content
367912	F17T8/TL835 ALTO II	T8	Medium Bi-Pin	TL835	TL835	17	1375	85	3500	1310	1.7
367938	F17T8 TL841 ALTO II	T8	Medium Bi-Pin	TL841	TL841	17	1375	85	4100	1310	1.7
141234	F17T8 TL850 ALTO II	T8	Medium Bi-Pin	TL850	TL850	17	1300	82	5000	1235	1.7
368142	F25T8 TL835 ALTO II	T8	Medium Bi-Pin	TL835	TL835	25	2150	85	3500	2045	1.7
368258	F25T8 TL841 ALTO II	T8	Medium Bi-Pin	TL841	TL841	25	2150	85	4100	2045	1.7
141242	F25T8 TL850 ALTO II	T8	Medium Bi-Pin	TL850	TL850	25	2100	82	5000	1995	1.7
272492	F32T8 TL735 ALTO II	T8	Medium Bi-Pin	TL735	TL735	32	2800	78	3500	2660	1.7
272484	F32T8 TL741 ALTO II	T8	Medium Bi-Pin	TL741	TL741	32	2800	78	4100	2660	1.7
272559	F32T8 TL741 ALTO II U	T8	Medium Bi-Pin	TL741	TL741	32	2800	78	4100	2660	1.7
272682	F32T8 TL750 ALTO II	T8	Medium Bi-Pin	TL750	TL750	32	2700	78	5000	2565	1.7
246678	F32T8 TL830 ALTO II	T8	Medium Bi-Pin	TL830	TL830	32	2950	85	3000	2800	1.7
226829	F32T8 TL830 ALTO II 2SR	T8	Medium Bi-Pin	TL830	TL830	32	2950	85	3000	2800	1.7
246702	F32T8 TL835 ALTO II	T8	Medium Bi-Pin	TL835	TL835	32	2950	85	3500	2800	1.7
246710	F32T8 TL841 ALTO II	T8	Medium Bi-Pin	TL841	TL841	32	2950	85	4100	2800	1.7
272351	F32T8/TL841 ALTO II BLK	T8	Medium Bi-Pin	TL841	TL841	32	2950	85	4100	2800	1.7
272294	F32T8 TL850 ALTO II	T8	Medium Bi-Pin	TL850	TL850	32	2850	82	5000	2710	1.7
272526	F32T8 TL730 ALTO	T8	Medium Bi-Pin	TL730	TL730	32	2800	78	3000	2660	3.5
272591	F32T8 TL735 ALTO BLK	T8	Medium Bi-Pin	TL735	TL735	32	2800	78	3500	2660	3.5
383513	F32T8 TL741 ALTO 10P	T8	Medium Bi-Pin	TL741	TL741	32	2800	78	4100	2660	3.5

Compare table

Product number	Full product name	Energy Saving	Rated Avg Life [12-Hr Prog St]	Rated Avg Life [12-Hr Inst St]	Rated Avg Life [3-Hr Prog St]	Rated Avg Life [3-Hr Inst St]	Picogram per Lumen Hour
367912	F17T8/TL835 ALTO II	Energy Saving	36000	30000	30000	24000	54
367938	F17T8 TL841 ALTO II	Energy Saving	36000	30000	30000	24000	54
141234	F17T8 TL850 ALTO II	Energy Saving	36000	30000	30000	24000	54
368142	F25T8 TL835 ALTO II	Energy Saving	36000	30000	30000	24000	35
368258	F25T8 TL841 ALTO II	Energy Saving	36000	30000	30000	24000	35
141242	F25T8 TL850 ALTO II	Energy Saving	36000	30000	30000	24000	36
272492	F32T8 TL735 ALTO II	Energy Saving	36000	30000	30000	24000	27
272484	F32T8 TL741 ALTO II	Energy Saving	36000	30000	30000	24000	27
272559	F32T8 TL741 ALTO II U	Energy Saving	36000	30000	30000	24000	27
272682	F32T8 TL750 ALTO II	Energy Saving	36000	30000	30000	24000	28
246678	F32T8 TL830 ALTO II	Energy Saving	36000	30000	30000	24000	25
226829	F32T8 TL830 ALTO II 2SR	Energy Saving	36000	30000	30000	24000	25
246702	F32T8 TL835 ALTO II	Energy Saving	36000	30000	30000	24000	25
246710	F32T8 TL841 ALTO II	Energy Saving	36000	30000	30000	24000	25
272351	F32T8/TL841 ALTO II BLK	Energy Saving	36000	30000	30000	24000	25
272294	F32T8 TL850 ALTO II	Energy Saving	36000	30000	30000	24000	26
272526	F32T8 TL730 ALTO	Energy Saving	36000	30000	30000	24000	-
272591	F32T8 TL735 ALTO BLK	Energy Saving	36000	30000	30000	24000	-
383513	F32T8 TL741 ALTO 10P	Energy Saving	36000	30000	30000	24000	-



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www.philips.com/lighting

2011, January 29
data subject to change



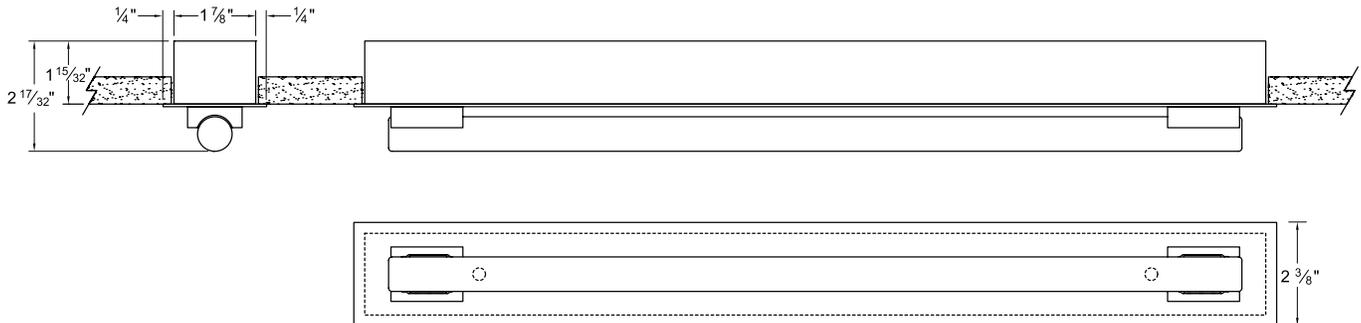
BT6200

type: _____

LINEAR T6 FLUORESCENT

semi-recessed T6 fluorescent fixture

- SPECIFICATIONS**
- Housing is formed and welded, 20ga. steel, chemically treated to resist corrosion and enhance paint adhesion
 - 16ga. trim plate available in #4 stainless steel or Fluoroscape White, black, silver and platinum powdercoat finish
 - Includes machined aluminum socket covers in matching finish
 - Available for nominal 20", 34", 40", 50" and 60" linear fluorescent T6 lamps in single fixture or continuous run configurations
 - Continuous run fixtures include 7 amp power quick connects
 - Electronic 120V or 277V program start ballast is pre-wired to lamp holders
 - 10% Dimming ballast available (requires interface, consult factory for availability and system compatibility)
 - Non-dimming fixtures are UL/ULC listed for insulated ceiling, damp location and through wiring
 - Dimming fixtures are UL/ULC listed for insulated ceiling, dry location and through wiring
 - IBEW manufactured and labeled
 - Made in the U.S.A.

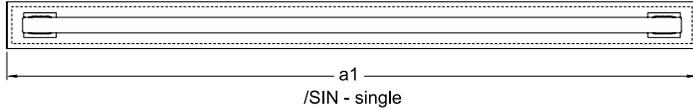
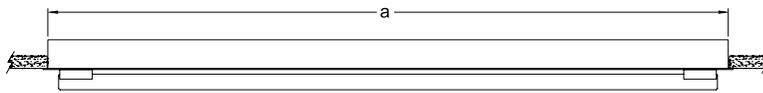


SPECIFICATION / ORDER FORMAT					DIMENSIONAL INFO.	
model no.	voltage	options	configuration	finish	wattage	overall length
BT6200-20**	/120	/DIM - 10% dimming	/SIN - single	/ST - #4 stainless steel	17W	21-23/32"
BT6200-34**	/277	(requires interface, consult factory, not available for 20" lamp)	/STA - starter	/FW - Fluoroscape White	27W	33-1/2"
BT6200-40			/ADD - adder	/BL - black	*30W	39-13/32"
BT6200-50			/TER - terminator	/SL - silver	*38W	49-7/32"
BT6200-60				/PT - platinum	*45W	59-1/16"
BT6200-4040				/CU - custom finish	2x*30W	78-13/16"
BT6200-5050				(consult factory)	2x*38W	98-7/16"

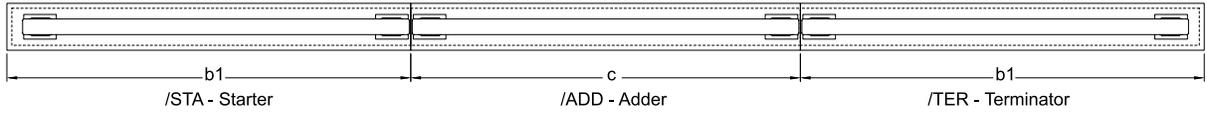
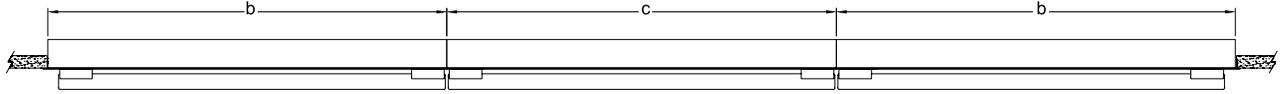
*Wattage rating for non-dimming ballast. When using dimming ballast, add one watt.

**BT6200-20 and BT6200-34 available in single (SIN) configuration only.

Single Fixture Configuration



Continuous Run Configuration

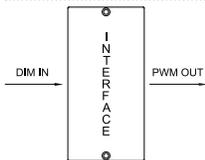


HOUSING LENGTH DIMENSIONS

model no.	/SIN		/STA, /TER		/ADD
	a	a1	b	b1	c
BT6200-20	20-11/16"	21-3/16"	N/A	N/A	N/A
BT6200-34	34-7/16"	34-15/16"	N/A	N/A	N/A
BT6200-40	40-11/32"	40-27/32"	39-7/8"	40-1/8"	39-13/32"
BT6200-50	50-5/32"	50-21/32"	49-11/16"	49-15/16"	49-7/32"
BT6200-60	60"	60-1/2"	59-17/32"	59-25/32"	59-1/16"
BT6200-4040	79-3/4"	80-1/4"	79-9/32"	79-17/32"	78-13/16"
BT6200-5050	99-3/8"	99-7/8"	98-29/32"	99-5/32"	98-7/16"

BT6200 | ACCESSORIES

DIMMING INTERFACE | allows simple integration with common dimming control methods, 120V-277V input, surface mount aluminum enclosure
(see interface cutsheet for complete specifications)



BT-AS-1

Astara PWM interface, single circuit, 25 fixtures max.

BT-AS-3

Astara PWM interface, three circuit, 60 fixtures max. (3x20 fixtures)

C E I L I N G C O L L E C T I O N

Boxie Ceiling



DESCRIPTION

Clean square pressed glass shade with polished surface suspended from a die-cast base. Available in three lamp configurations: incandescent, fluorescent, and LED. Large incandescent includes two 120 volt, 40 watt G9 base halogen lamps; small incandescent includes one 120 volt 40 watt G9 base halogen lamp; large fluorescent includes two 13 watt 2GX7 base twin tube lamps and electronic ballast. Large LED includes two 10 watt, 600 lumen, 2700K LED modules. Incandescent version dimmable with a standard incandescent dimmer. LED version dimmable with low-voltage electronic dimmer. Ceiling mount suitable for wet locations. ADA compliant.

INSTALLATION

This product can mount to either a 4" square electrical box with round plaster ring or an octagonal electrical box (not included).

DIMMING

Incandescent version dimmable with a standard incandescent dimmer (not included).

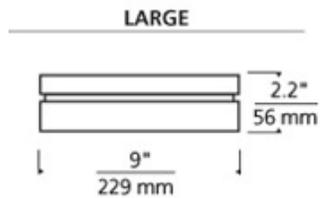
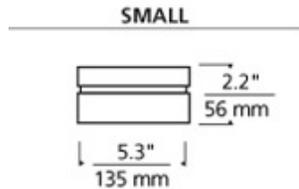
WEIGHT

8.1lb / 3.67kg

ORDERING INFORMATION

700BX	SHAPE OR SIZE	FINISH	LAMP
L	LARGE	C CHROME	INCANDESCENT 120V
S	SMALL	S SATIN NICKEL	-CF COMPACT FLUORESCENT 120V
			-LED LED 2700K

Compact fluorescent and LED lamp options available only with Large Size.



TECH LIGHTING®

7400 Linder Avenue T 847.410.4400
 Skokie, Illinois 60077 F 847.410.4500

www.techlighting.com

700BX _____

FIXTURE TYPE: _____

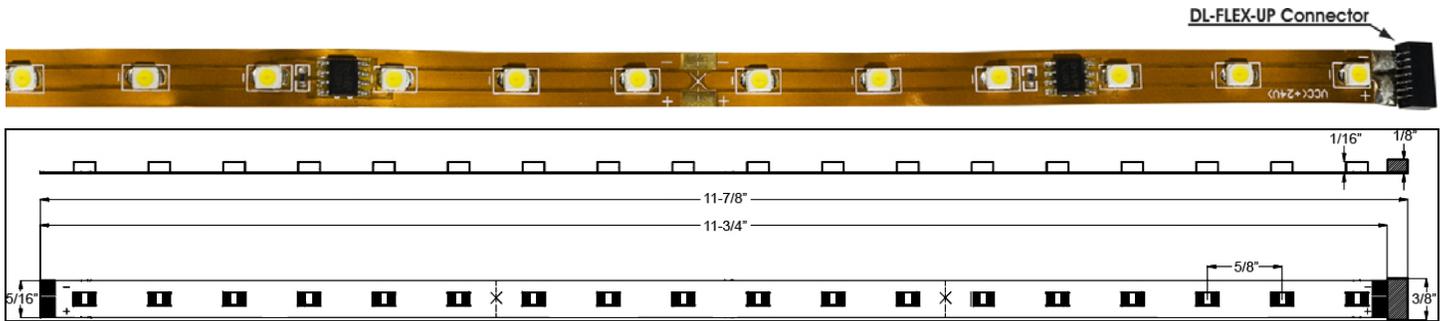
JOB NAME: _____

NOTES: _____



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**LED FLEXIBLE LINEAR • DL-FLEX-UP HIGH-OUTPUT SERIES
DL-FLEX-UPHO**



DESCRIPTION

DL-FLEX-UPHO uses High Output LEDs for maximum brightness. This professional modular lighting system features a wide range of plug-together accessories and a variety of control options. This unique feature eliminates the need for field soldering; providing easy and simple installations. Made of highly flexible material that can be applied to most accessible surfaces using 3M® double-sided tape.

FEATURES

- Low power consumption, low heat.
- Optional aluminum mounting channel with clear and diffused lens covers that snap into the channel without tools.
- No ultra violet (UV/IR) radiation.
- No mercury.
- For a 90° bend or tighter, do so at the cutting mark.
- To make a 90° joint connection use the DL-FLEX-X-CONN connector, which can be trimmed for 2-way L connection or 3-way T connection.

APPLICATIONS

- Cove and soffit lighting
- Path and contour marking
- Display lighting
- Under-shelf and under-cabinet lighting
- Accent and edge lighting
- Backlighting
- Signage

SPECIFICATIONS

Model	DL-FLEX-UPHO-27	DL-FLEX-UPHO-30	DL-FLEX-UPHO-40	DL-FLEX-UPHO-60
Color Temp	2400-2700K	3000-3300K	4000-4300K	6000-6500K
Wattage (per ft)	3 W	3 W	3 W	3 W
Lumens (per ft)	100 lm	100 lm	110 lm	120 lm
Efficacy (lm/W)	38.5	38.5	36.6	40
CRI	80	80	75	70
Beam Angle	120°			
Input Voltage	24V DC			
Lamp Life	50,000 hours			
Dimensions	11-7/8"L x 3/8"W x 1/8"H per section			
LEDs (per ft)	18			
LED Spacing	5/8"			
Operating Temp	-22°F - 185°F			
Max Run*	20'			
Wiring	2-Wire			
Min Run†	6 LEDs, ~4"			
Mounting‡	Clips or Channel			
Environment	Indoor, Dry			
Certifications	 RoHS			
Warranty	5 Years – see published warranty terms for detailed information.			

* Single runs cannot exceed 20'. For longer runs refer to the wiring diagram.

† Cuts can only be made on the cutting mark.

‡ View accessories page for more information.

ORDERING INSTRUCTIONS

Example: **SERIES** – **MODEL** – **COLOR**
 DL – FLEX-UPHO – 30

DL-FLEX-UPHO is packed in 30' roll lengths.

May be ordered in 1' increments. Specify amount of 1' lengths before ordering number for

Example: **20 x DL-FLEX-UPHO-30**

SUBMITTAL

Job Name:	Date:
Specification Type:	Job Location:
Drawing Location of Fixture Type:	Approval:
Specifier Name:	Sales Agency Contact:
Contact Phone/Email:	Contact Phone/Email:



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LED FLEXIBLE LINEAR • DL-FLEX-UP HIGH-OUTPUT SERIES DL-FLEX-UPHO

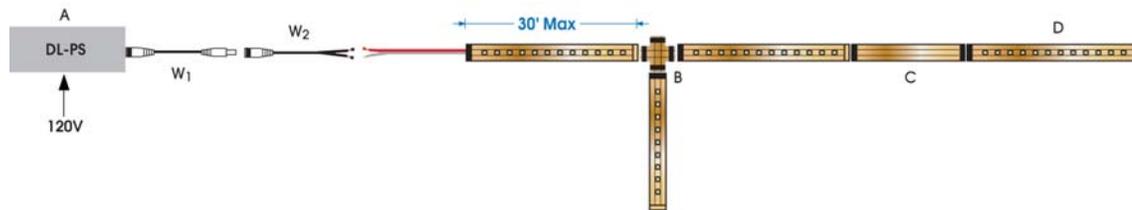
PHOTOMETRIC DATA

DL-FLEX-UPHO-30				DL-FLEX-UPHO-40				DL-FLEX-UPHO-60			
	Height	Light Output	Beam Area		Height	Light Output	Beam Area		Height	Light Output	Beam Area
	12"	44 Fc	17'L x 16"W		12"	53.7 Fc	18'L x 15"W		12"	61.5 Fc	18'L x 16 1/2"W
	18"	19.8 Fc	25'L x 22 1/2"W		18"	24.4 Fc	24'L x 23"W		18"	28.3 Fc	25'L x 23"W
	24"	11.2 Fc	32'L x 31"W		24"	13.8 Fc	32'L x 30 1/2"W		24"	16.2 Fc	32 1/2'L x 29 1/2"W

WIRING DIAGRAMS

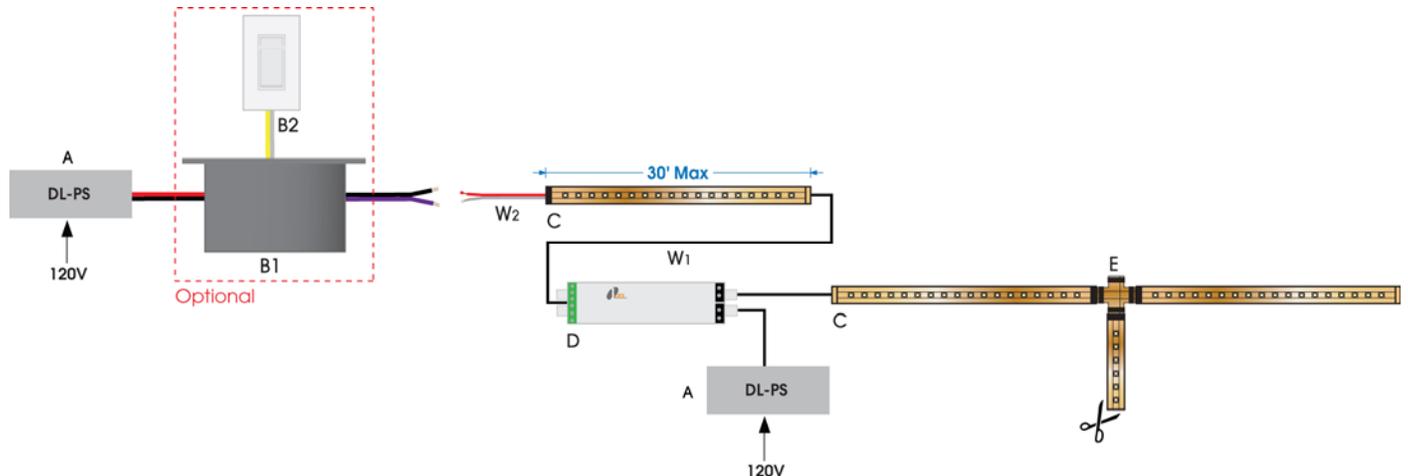
24V • PLUG & PLAY

A.	POWER SUPPLY	DL-PS-XX/24
B.	CONNECTOR	DL-FLEX-X-CONN
C.	CONNECTOR	DL-FLEX-CC6
D.	FIXTURE	DL-FLEX-UP
W1.	CONNECTOR	Included with power supply
W2.	CONNECTOR	DL-FLEX-PC



24V • HARD-WIRE • DIMMING OPTION

A.	POWER SUPPLY	DL-PS-XX/24-JB
B1.	DIMMING	LC-DIM5A-HW (Requires Lutron DS-DV-TV-WH)
B2.	DIMMING	DS-DV-TV (Requires LC-DIM5A-HW)
C.	FIXTURE	DL-FLEX-UP
D.	REPEATER	LC-200-RPT
E.	CONNECTOR	DL-FLEX-X-CONN
W1.	CONNECTOR	DL-FLEX-PT-HW
W2.	CONNECTOR	DL-FLEX-PC-HW



SUBMITTAL

Job Name:	Date:
Specification Type:	Job Location:
Drawing Location of Fixture Type:	Approval:
Specifier Name:	Sales Agency Contact:
Contact Phone/Email:	Contact Phone/Email:



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**LED FLEXIBLE LINEAR • DL-FLEX-UP HIGH-OUTPUT SERIES
DL-FLEX-UPHO**

DL-FLEX Series Power Supply Guide for Max Runs

If the Max Load of a power supply exceeds the fixture's Max Run, then you may install multiple runs per given power supply.

Wattage = Max power capacity of power supply.

Max Load = Fixture quantity a power supply can power.

Max Run = Maximum length of a single fixture.

Hard-Wire Power Supplies (Junction Box Included)		DL-FLEX-UP DL-FLEX-W White, Green, Blue		DL-FLEX-UP DL-FLEX-W Red, Yellow		DL-FLEX-UPHO DL-FLEX-WH		DL-FLEX-UP-RGB DL-FLEX-W-RGB	
		1.4 W/Ft		0.9 W/Ft		3 W/Ft		3.2 W/Ft	
		Model Number	Wattage	Max Run	Max Load	Max Run	Max Load	Max Run	Max Load
DL-PS - 20 / 24 - JB	20	30 ft	14.3 ft	30 ft	22.2 ft	20 ft	6.7 ft	20 ft	6.3 ft
DL-PS - 25 / 24 - DIM-JB	25	30 ft	17.9 ft	30 ft	27.8 ft	20 ft	8.3 ft	20 ft	7.8 ft
DL-PS - 35 / 24 - JB	35	30 ft	25.0 ft	30 ft	38.9 ft	20 ft	11.7 ft	20 ft	10.9 ft
DL-PS - 60 / 24 - JB	60	30 ft	42.9 ft	30 ft	66.7 ft	20 ft	20.0 ft	20 ft	18.8 ft
DL-PS- 60 / 24 - JBS	60	30 ft	42.9 ft	30 ft	66.7 ft	20 ft	20.0 ft	20 ft	18.8 ft
DL-PS - 100 / 24 - JB	96	30 ft	68.6 ft	30 ft	106.7 ft	20 ft	32.0 ft	20 ft	30.0 ft
DL-PS - 150 / 24 - JB	150	30 ft	107.1 ft	30 ft	166.7 ft	20 ft	50.0 ft	20 ft	46.9 ft
DL-PS - 320 / 24 - JB	312	30 ft	222.9 ft	30 ft	346.7 ft	20 ft	104.0 ft	20 ft	97.5 ft
DL-PS - 120 / 24 - JB	2 x 60*	30 ft	2 x 42.9 ft	30 ft	2 x 66.7 ft	20 ft	2 x 20 ft	20 ft	2 x 18.8 ft
DL-PS - 180 / 24 - JB	3 x 60*	30 ft	3 x 42.9 ft	30 ft	3 x 66.7 ft	20 ft	3 x 20 ft	20 ft	3 x 18.8 ft
DL-PS - 200 / 24 - JB	2 x 96*	30 ft	2 x 68.6 ft	30 ft	2 x 106.7 ft	20 ft	2 x 32 ft	20 ft	2 x 30 ft

* Consists of multiple power supplies.

Plug & Play Power Supplies		DL-FLEX-UP DL-FLEX-W White, Green, Blue		DL-FLEX-UP DL-FLEX-W Red, Yellow		DL-FLEX-UPHO DL-FLEX-WH		DL-FLEX-UP-RGB DL-FLEX-W-RGB	
		1.4 W/Ft		0.9 W/Ft		3 W/Ft		3.2 W/Ft	
		Model Number	Wattage	Max Run	Max Load	Max Run	Max Load	Max Run	Max Load
DL-PS - WP 24 / 24	24	30 ft	17.1 ft	30 ft	26.7 ft	20 ft	8.0 ft	20 ft	7.5 ft
DL-PS - 24 / 24	24	30 ft	17.1 ft	30 ft	26.7 ft	20 ft	8.0 ft	20 ft	7.5 ft
DL-PS - 48 / 24	48	30 ft	34.3 ft	30 ft	53.3 ft	20 ft	16.0 ft	20 ft	15.0 ft
DL-PS - 60 / 24	60	30 ft	42.9 ft	30 ft	66.7 ft	20 ft	20.0 ft	20 ft	18.8 ft
DL-PS - 100 / 24	90	30 ft	64.3 ft	30 ft	100.0 ft	20 ft	30.0 ft	20 ft	28.1 ft

Notes :

Wattage must be de-rated if power supply operates at max temperature range.

Refer to specification sheets for more information.

SUBMITTAL

Job Name:	Date:
Specification Type:	Job Location:
Drawing Location of Fixture Type:	Approval:
Specifier Name:	Sales Agency Contact:
Contact Phone/Email:	Contact Phone/Email:



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LED FLEXIBLE LINEAR • DL-FLEX-UP HIGH-OUTPUT SERIES
DL-FLEX-UPHO

DIMMERS

LC-DIM5A	12V/24V Plug & Play Dimmer Built-in 0-10V Dimming Control Smooth Dimming 4-1/4"L x 1-7/8"W x 1-1/8"H
LC-DIM5A-HW	12V/24V Hard-Wire Dimming Interface Requires separate 0-10V Dimmer Switch (See DS-DV-TV-WH). Smooth Dimming. 6-1/4"L x 3"W x 1-1/2"H
DS-DV-TV-HW	Wall-Plate Dimmer Switch (White Switch) 0-10V dimmer. Used with LC-DIM5A-HW Smooth Dimming. Replaces old model: DL-PS-DS-TV. 2-5/8"L x 1-3/4"W
LC-DIM100-RF	12V/24V Plug & Play Remote Dimmer Step Dimming 7"L x 1-7/8"W x 3/4"H
LC-DIM100-RF-HW	12V/24V Hard Wire Remote Dimmer Step Dimming 7"L x 1-7/8"W x 3/4"H

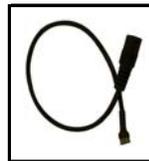
AMPLIFIERS

LC-200-RPT	12V/24V Power Repeater Use for extending runs. Compatible with dimmers. 6-1/2"L x 1-1/2"W x 1"H
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PLUG & PLAY ACCESSORIES



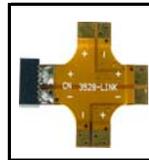
DL-FLEX-PC
19" Input Power Connector
(13-1/4" Cable / 5-7/8" FLEX-UP tape)
Male DC plug connects to equipment with female DC plug (e.g.: DL-PS power supply, DL-PS accessories)
FLEX-UP tape accepts FLEX-UP connector. May be used as a "Live End" connector for DL-FLEX-UP



DL-FLEX-PC2
14" Input Power Connector
(13-1/4" Cable / 3/8" FLEX-UP tape)
Male DC plug connects to equipment with female DC plug (e.g.: DL-PS power supply, DL-PS accessories)
FLEX-UP tape accepts FLEX-UP connector. May be used as a "Live End" connector for DL-FLEX-UP



DL-FLEX-PT
14" Output Power Connector
(13-1/4" Cable / 1/2" FLEX-UP tape with FLEX-UP connector)
Female DC plug connects to equipment with male DC plug (e.g.: LC-200-RPT, DL-PS accessories)
FLEX-UP connector accepts FLEX-UP tape



DL-FLEX-X-CONN
Universal, "L", "X" & "T" connector
Connects four DL-FLEX strips
Cut to make 2-way "L" connection or 3-way "T" connection



DL-FLEX-HO-4-(27/30/40/60)
4" Linear Strip with FLEX-UP connector on one end.
May be connected to cut ends
Readily accepts end of DL-FLEX-UPHO
Output: 2700K, 3000K, 4000K, 6000K
Max Watt: 1W



DL-FLEX-CC6
6" Flexible mid-connector
To reach across or hide behind gaps
DL-FLEX-CC12
12" Flexible mid-connector
To reach across or hide behind gaps

SUBMITTAL

Job Name:	Date:
Specification Type:	Job Location:
Drawing Location of Fixture Type:	Approval:
Specifier Name:	Sales Agency Contact:
Contact Phone/Email:	Contact Phone/Email:



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LED FLEXIBLE LINEAR • DL-FLEX-UP HIGH-OUTPUT SERIES
DL-FLEX-UPHO

HARD-WIRE ACCESSORIES



DL-FLEX-PC-HW
 19" Input Power Connector
 (13-1/2" Bare Wire / 5-7/8" FLEX-UP tape)
 Bare wire is connected to hard-wire equipment
 (e.g.: DL-PS power supply, DL-PS accessories)
 FLEX-UP tape accepts FLEX-UP connector
 May be used as a "Live End" connector for DL-FLEX-UP



DL-FLEX-PC2-HW
 12" Input Power Connector
 (11-1/4" Bare Wire / 3/8" FLEX-UP tape)
 Bare wire is connected to hard-wire equipment
 (e.g.: DL-PS power supply, DL-PS accessories)
 FLEX-UP tape accepts FLEX-UP connector
 May be used as a "Live End" connector for DL-FLEX-UP

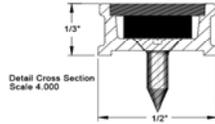


DL-FLEX-PT-HW
 13" Output Power Connector
 (6-7/8" Bare Wire / 6" FLEX-UP tape with FLEX-UP connector)
 Bare wire is connected to hard-wire equipment
 (e.g.: LC-200-RPT, DL-PS accessories)
 FLEX-UP connector accepts FLEX-UP tape

MOUNTING ACCESSORIES



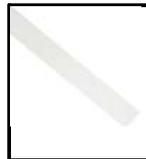
DL-FLEX-CH6
 Aluminum Mounting Channel
 6'L x 1/2"W x 1/3"H



DL-FLEX-CH-CLIP
 Mounting Clip for DL-FLEX-CH6
 Recommended 24" between Clips for most installations.
 (Sold as a pair).



DL-FLEX-DC6
 Clear acrylic lens to protect DL-FLEX
 91.5% light transmittance, 1% haze
 Length: 6"
 For use with DL-FLEX-CH6



DL-FLEX-FL6
 Frosted acrylic lens to protect DL-FLEX
 85% light transmittance, 4% haze
 Length: 6"
 For use with DL-FLEX-CH6



LLMFH-C/C-CH6
 Mounting Channel for carpet to carpet installation
 Includes clear lens
 Field cuttable
 Length: 6"



LLMFH-C/W-CH6
 Mounting Channel for carpet to wood/tile installation
 Includes clear lens
 Field cuttable
 Length: 6"



DL-FLEX-CH-LE
 End cap for DL-FLEX-CH6
 Hole allows cable to pass through
 For use with DL-FLEX-PC2, DL-FLEX-PC2-HW,
 DL-FLEX-PT, or DL-FLEX-PT-HW.



DL-FLEX-CH-EC
 End Cap for DL-FLEX-CH6
 Use for a finished look

SUBMITTAL

Job Name:	Date:
Specification Type:	Job Location:
Drawing Location of Fixture Type:	Approval:
Specifier Name:	Sales Agency Contact:
Contact Phone/Email:	Contact Phone/Email:



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FloodLED™ Floodlights, 12/14VDC

GDL002-200-xxW-014x



Architectural & Landscape

Direct Incandescent Replacement — Consumes Only 12 Watts — Up to 90% Power Savings

FEATURES

- **Warranty:** 3 Years
- Low Power Consumption, High Intensity
- **Long Operating Life:** White LEDs Last Up to 50,000+ Hours
- **Glare-Free Design** Enhances Night Vision
- **Optimally Designed** to Maximize Path Illumination
- **Rugged, Industry-Standard Fixture:** Bronze-Colored Die-Cast Aluminum Housing; Tempered-Glass Lens
- **Solid-State:** High-Shock & High-Vibration Resistant

- **Weather-Proof:** Water-Resistant for Outdoor Applications
- **Adjustable:** Fits any Angle
- **Safety Assurance:** C/UL-Listed



Ideal for Use with Alternate or Renewable Energy Resources – Solar & Wind Power



For Up-Lights, Down-Lights, Wall-Wash, Spot-Lights

Comes with raw wire leads to be spliced onto an AC power supply

APPLICATIONS

- Garden/Landscape Lighting
- Walkways/Pathways
- Amusement Parks/Recreation Areas
- Architectural Wall Washing



- Illuminate Signs
- Emergency Exit Way Lighting

[Left] GDL002 uplights improve landscape ambience, security while reducing energy costs in master-planned community in Ladera Ranch, S. California.

[Above] Solar-powered GDL002-200 floodlights provide accent lighting to Canyon Pines Development entrance in Reno, Nevada.

BENEFITS

- **Major Energy Savings:** Over 90% Compared to Incandescents
- **Reduces Light Pollution/Glare:** "Dark Skies Initiative"-Friendly, No Disability Glare
- **Even Lighting:** High Intensity / No Halation
- **Cool Operation:** Never Gets Hot to the Touch – Less Fire Hazard
- Safe Low-Voltage Operation
- Digitally Controllable / Low Maintenance
- **Eco-Friendly:** No Mercury Content, No Lead
- **No Hazardous Emissions:** No UV or IR Radiation—Does Not Attract Insects; No RF Interference

CUSTOM OPTIONS [For qualified applications & large-quantity OEM orders]

- **Custom LED Colors:** Other White-Color Temperatures and Colors
- **Special Voltages:** 24/28V
- Higher or Lower Intensity
- **Other LED Beam Angles** for Different Effects
- Infrared (IR) LEDs in 730nm, 850nm, 880nm, 940nm

SPECIFICATIONS

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

PART NO.	GDL002-200-xxW-014x
Input Voltage	12- 14 VDC
Housing Material	Bronze-Colored Die-Cast Aluminum
Lens	Tempered Glass
Ambient Operating Temp. Range	~-22°F to ~+122°F [~-30°C to ~+50°C]
Weight	2.769 lb / 44.3 oz / 1.256 kg

PART NUMBER	INPUT CURRENT	ENERGY USED	EFFICACY	TOTAL LUMENS	MAXIMUM CANDELA	COLOR TEMP.	EMITTED COLOR	BEAM ANGLE
WARM WHITE								
GDL002-200-SIW-014V	1013mA	14.1 Watts	41.8 lm/W	589 lm	1,220 cd	3000K	Warm White	55°
TRUE WHITE								
GDL002-200-TPW-014N	900mA	12.6 Watts	55.8 lm/W	703 lm	1,878 cd	4800K~5200K	True White	25°
GDL002-200-TPW-014M	900mA	13.0 Watts	57.2 lm/W	744 lm	1,292 cd	4800K~5200K	True White	40°
GDL002-200-TPW-014W	916mA	12.8 Watts	50.8 lm/W	651 lm	261 cd	4800K~5200K	True White	102°



LEDTRONICS, INC.®
THE FUTURE OF LIGHT



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Fax: (310) 534.1424

E-mail: webmaster@ledtronics.com
Website: http://www.ledtronics.com



GDL002-200-TPW-014N

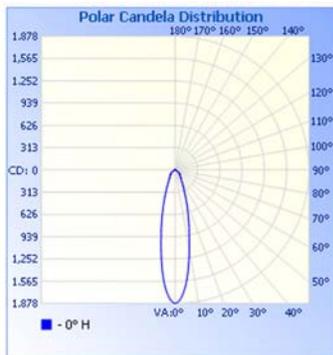
Luminaire Photometric Report

Filename: GDL002-200-TPW-014N
 Manufacturer: LEDTRONICS -
 Luminaire: WITH CLEAR LENS, 14VDC, 12.6W
 Luminaire Cat: GDL002-200-TPW-014N
 Lamp: LUMEN RATING: 703.1Lms.
 Lamp Output: 1 lamp(s), rated lamp lumens: 703.1
 Max Candela: 1,878.0 at Horizontal: 0, Vertical: 0
 Luminous Opening: Point
 Test: 8-23-10

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Luminaire
0-30	473.1	67.3%	67.3%
0-40	560.9	79.8%	79.8%
0-60	678.7	96.5%	96.5%
60-90	24.4	3.5%	3.5%
0-90	703.1	100%	100%
0-180	703.1	100%	100%

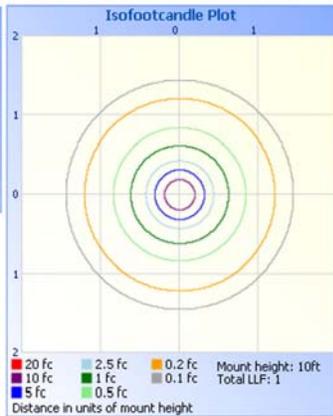
Total Efficiency: 100%



Illuminance at a Distance

Center Beam FC	Beam Width
1.7R	0.7ft
3.3R	1.4ft
5.0R	2.2ft
6.7R	2.9ft
8.3R	3.6ft
10.0R	4.3ft

Beam Spread: 24.5°



GDL002-200-TPW-014W

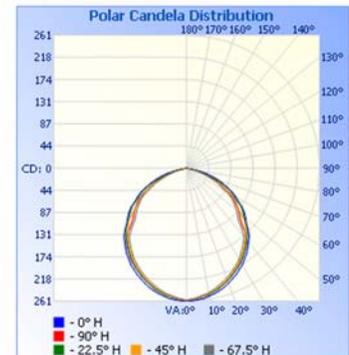
Luminaire Photometric Report

Filename: GDL002-200-TPW-014W
 Manufacturer: LEDTRONICS -
 Luminaire: WITH CLEAR LENS, 14VDC, 12.8W
 Luminaire Cat: GDL002-200-TPW-014W
 Lamp: LUMEN RATING: 650.7Lms.
 Lamp Output: 1 lamp(s), rated lamp lumens: 650.7
 Max Candela: 261.0 at Horizontal: 0, Vertical: 0
 Luminous Opening: Point
 Test: 8-18-10

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Luminaire
0-30	195.2	30%	30%
0-40	318.1	48.9%	48.9%
0-60	548.2	84.2%	84.2%
60-90	102.5	15.8%	15.8%
0-90	650.7	100%	100%
0-180	650.7	100%	100%

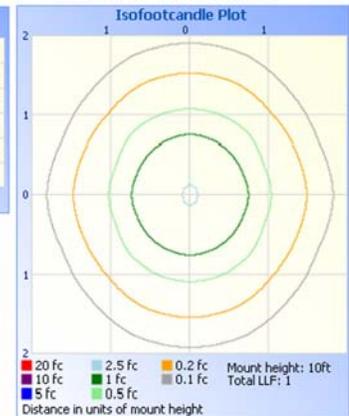
Total Efficiency: 100%



Illuminance at a Distance

Center Beam FC	Beam Width
1.7R	4.9ft
3.3R	9.7ft
5.0R	14.6ft
6.7R	19.4ft
8.3R	24.3ft
10.0R	29.2ft

Vert. Spread: 111.1° Horiz. Spread: 102.2°



GDL002-200-TPW-014M

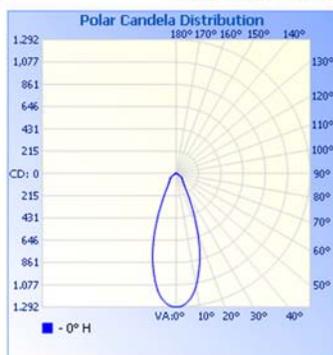
Luminaire Photometric Report

Filename: GDL002-200-TPW-014M
 Manufacturer: LEDTRONICS -
 Luminaire: WITH CLEAR LENS, 14VDC, 13W
 Luminaire Cat: GDL002-200-TPW-014M
 Lamp: LUMEN RATING: 744.0Lms.
 Lamp Output: 1 lamp(s), rated lamp lumens: 744
 Max Candela: 1,292.0 at Horizontal: 0, Vertical: 0
 Luminous Opening: Point
 Test: 8-23-10

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Luminaire
0-30	522.8	70.3%	70.3%
0-40	609.5	81.9%	81.9%
0-60	722.5	97.1%	97.1%
60-90	21.5	2.9%	2.9%
0-90	744.0	100%	100%
0-180	744.0	100%	100%

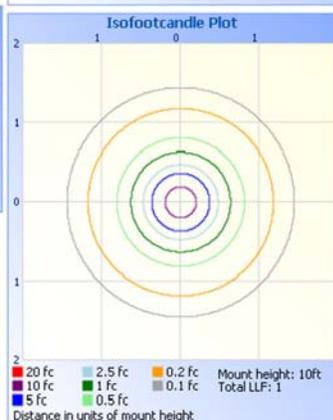
Total Efficiency: 100%



Illuminance at a Distance

Center Beam FC	Beam Width
1.7R	1.2ft
3.3R	2.3ft
5.0R	3.5ft
6.7R	4.7ft
8.3R	5.9ft
10.0R	7.0ft

Beam Spread: 38.7°



GDL002-200-SIW-014V

Luminaire Photometric Report

Filename: GDL002-200-SIW-014V
 Manufacturer: LEDTRONICS -
 Luminaire: WITH CLEAR LENS, 12/14VDC, 14W (±2W)
 Luminaire Cat: GDL002-200-SIW-014V
 Lamp: LUMEN RATING: 589.2Lms.
 Lamp Output: 1 lamp(s), rated lamp lumens: 589.2
 Max Candela: 1,220.0 at Horizontal: 90, Vertical: 0
 Luminous Opening: Point
 Test: 8-26-10 PRELIMINARY

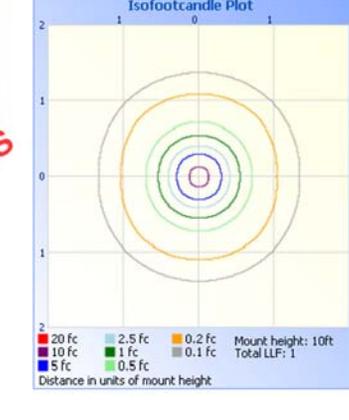
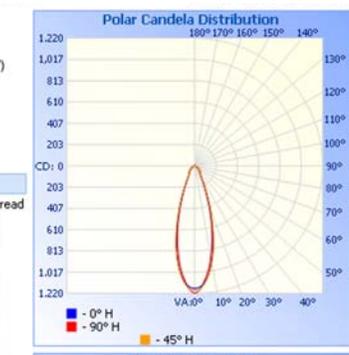
Flood Summary

Efficiency	Lumens	Horizontal Spread	Vertical Spread
Field (10%)	68.1%	401.1	61.5
Beam (50%)	36.7%	216.5	31.2
Total	100%	589.2	

Illuminance at a Distance

Center Beam FC	Beam Width
1.7R	1.0ft
3.3R	1.9ft
5.0R	2.9ft
6.7R	3.9ft
8.3R	4.8ft
10.0R	5.8ft

Vert. Spread: 32.4° Horiz. Spread: 31.2°



PRELIMINARY PHOTOMETRICS



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[Home](#) > [The Millennium Collection](#) > [Outdoor LED Lighting](#) > [LED Recessed Down Lights](#)



Click thumbnails below to enlarge!



DEKOR™ Outdoor LED Recessed Down Light Kit

Sku: RDLKITOUTxx

Price: \$ 176.35

Colors: 01 05 07 10

[bookmark this page](#)

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Add to Cart

This Outdoor Recessed Light kit contains:

- (8) LED Light Elements in your choice of **Down** configuration
 - (8) LED Housings in your choice of 4 different colors
 - (8) LED Diffuser Discs with adhesive back
 - (16) Outdoor UL approved Gel Filled Wire Nuts
 - (1) Custom Ground Forstner Bit
 - (1) EZ Outdoor Waterproof Power Driver (2.5 amp, 30 watt) with the capacity to light (40) LED Light Elements
 - (1) Dusk to Dawn Timer with variable timed off settings
 - (1) Installation Instructions
- Down lights cast light straight down from the lamp.

Wire is not included as each project is unique.

» [Order the correct Wire for this kit](#)

» [Order more Led Recessed Lights for your project](#)

» [Order a Remote Controlled Dimmer to add ambiance](#)

[FEATURES & BENEFITS](#) | [SPECIFICATIONS](#) | [GOT QUESTIONS?](#)

Warm white Recessed LED Down Lights

Outdoor recessed LED down lights from the DEKOR™ Millennium Collection takes accent lighting to a whole new dimension with small yet powerful low voltage LED lights that offer safety, value, and style. Perfect for **landscape lighting, decks, docks, steps, patios, gardens** and any number of places we haven't even thought of, wherever accent or mood lighting is desired. Mount them in **railings** for a unique look while simultaneously lighting your steps or deck.

I have installed almost half of my lights and I am very pleased with the results. The installation has been very simple in my deck rails. I did a lot of research and compared several similar products and I am very glad I chose your lights. You can use me as a sales reference at any time.

-- Lamar S., Georgia, January 16, 2009

Why Outdoor LED Lighting from DEKOR™

Our new **outdoor recessed LED down lights** are 40% brighter than ever and feature an LED technology designed to last for decades. Tiny LED lights are perfect for safely lighting stairs and under rails, and our recessed lights are compact enough



to fit just about anywhere.

- Easy to install, virtually flush with the surface, and hardly visible
- Expandable
- Dimmable
- Waterproof / Weatherproof / Salt Air Resistant (great for **dock lights, marine lights**)
- Green, Energy Efficient (Energy Star Partner)
- Economical
- 100,000 hour lifespan
- Warm white LEDs
- No bulbs to change, ever
- Cool to the touch
- The ambience of incandescent lighting
- Aircraft grade powder coated aluminum housing
- 10 Year Warranty, made in USA

Got Questions?

Customer Service: 1-800-258-0344

Email Us

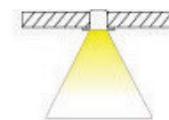
Warranty Policy

Refund and Return Policy

Nobody builds a brighter LED in such a small package. We take great pride in our innovative LED technology and the [quality and craftsmanship](#) of our LED Lighting products. We stand behind our recessed lights and all other LED lighted products with an industry-leading **10 Year Warranty** against failure of workmanship or materials, twice as long as other LED recessed lights on the market.

Mini LED Down Light Specifications

Width of bezel	1-1/4"
Mounting hole diameter	.900"
Mounting hole depth	1"
Length of wire pigtail	6'

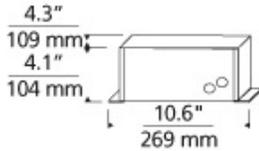


Down Lights cast light straight down from lamp

The **outdoor LED down light kit** is expandable by adding up to 32 lights (max 40) with voltage supplied by the kit transformer.

» Order additional mini LED down lights for your project

Remote Transformer-150W Mag 12v 



DESCRIPTION

This remote magnetic transformer converts standard 120 or 277 volt line-voltage to 12 volts, providing the necessary voltage for powering a MonoRail, Kable Lite, Wall MonoRail or FreeJack low-voltage lighting system. This remote magnetic transformer can be used to power lamps totaling up to 150 watts. This transformer is equipped with fast-acting secondary circuit breaker that will safely turn off the system should a short occur. Once the short has been removed the breaker can be reset.

INSTALLATION

This transformer must be installed in a remote but accessible location (such as above the ceiling or in a closet). To simplify installation the transformer should be located no more than 20 feet from the run or power feed. The electrician will need to supply the proper gauge conductor from the transformer to the power feed location based on distance (see Low-Voltage Wire Size Table, below).

DIMMING

Dimmable with a 600 watt low-voltage magnetic dimmer. The dimmer is placed on the line side of the transformer. (Consult dimmer manufacturer for specifics.) Dimming a transformer may create a buzzing sound, which may be objectionable in some applications. A debuzzing dimming coil can be purchased separately to reduce the audible noise.

OTHER INFORMATION

Input Wiring: Can be ordered to hard wire to a junction box or to plug in with 16' power cord with plug. This transformer provides a single 150 watt output and must be used with a single-feed canopy or other power feed option (sold separately). 12 volt output transformers require the use of 12 volt lamps.

LOW-VOLTAGE WIRE SIZE TABLE						
Use to determine the correct THHN wire size for a recommended 3 percent drop in voltage at the specified wattage. The length shown is the length of wire from the transformer to the power feed.						
12 Volt	5 ft.	6-15 ft.	16-20 ft.	21-40 ft.	41-60 ft.	61-90 ft.
150 Watt	#12 GA	#8 GA	#6 GA	#4 GA	#2 GA	#1 GA

WEIGHT

8.41lb / 3.81kg

ORDERING INFORMATION

700AT150 VOLTAGE

T 120V IN/12V OUT
T277 277V IN/12V OUT



7400 Linder Avenue T 847.410.4400
Skokie, Illinois 60077 F 847.410.4500

www.techlighting.com

700AT150 _____

FIXTURE TYPE: _____

JOB NAME: _____

NOTES: _____



FreeJack Port Alone



DESCRIPTION

Minimal 1-1/2" diameter, 2-1/2" deep. Can be installed in a range of locations. Access to back of ceiling is not needed.

INSTALLATION

Mounts to Tech Lighting's special cylindrical 1-1/2" diameter, 2-1/2" deep junction box (included). Access to back of ceiling is not needed. If wall mounting, head should be no longer than 6".

OTHER INFORMATION

For use with remote transformer and any FreeJack pendant or head (sold separately).

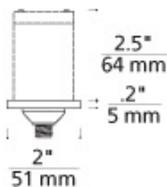
WEIGHT

0.6lb / 0.27kg

ORDERING INFORMATION

700FJFCP FINISH

- Z ANTIQUE BRONZE
- C CHROME
- S SATIN NICKEL



TECH LIGHTING®

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 Skokie, Illinois 60077 F 847.410.4500

www.techlighting.com

700FJFCP _____

FIXTURE TYPE: _____

JOB NAME: _____

NOTES: _____



LOW - VOLTAGE P E N D A N T S

Coronado Pendant 



DESCRIPTION

Rectangular onyx shade with metal frame. Includes low-voltage, 35 watt halogen bi-pin lamp or 6 watt replaceable LED module and six feet of field-cutttable suspension cable.

SYSTEM

Available for FreeJack, MonoRail, and Two-Circuit MonoRail. For use on T-trak, order FreeJack version and T-trak FreeJack Connector (sold separately). Not recommended for Kable Lite due to weight.

INSTALLATION

Socket terminates with FreeJack male connector, which may be installed into a system connector. Elements ordered with a system prefix include a connector for that system.

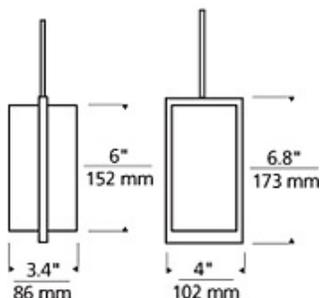
ACCESSORIES & OPTICAL CONTROLS

Swag Hook

WEIGHT

3.06lb / 1.39kg

ORDERING INFORMATION



700	SYSTEM	CORH	COLOR	FINISH	LAMP
FJ	FREEJACK (MONO POINT)		ONYX	Z ANTIQUE BRONZE	12 VOLT HALOGEN
MO	MONORAIL			S SATIN NICKEL	-LED 12 VOLT LED 3000K
MO2	TWO-CIRCUIT MONORAIL				-24 24 VOLT HALOGEN

Note: LED option not available on MO2 at this time.



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www.techlighting.com

700 ____ CORH ____ _ _ _

FIXTURE TYPE: _____

JOB NAME: _____

NOTES: _____



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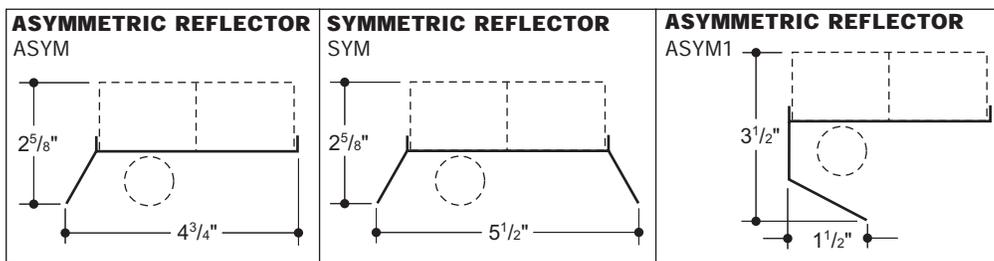
ORDERING DATA

Catalog No.	No. and Type Lamps	Nominal Dimensions	Wt.
1530-117-2 EBO	1-FO17-OCT	4" x 24"	5
1530-125-3 EBO	1-FO25-OCT	4" x 36"	11
1530-132-4 EBO	1-FO32-OCT	4" x 48"	13
1530-140-5 EBO	1-FO40-OCT	4" x 60"	16
1530-125-6T EBO	2-FO25-OCT	4" x 69"	22
1530-132-8T EBO	2-FO32-OCT	4" x 93"	26

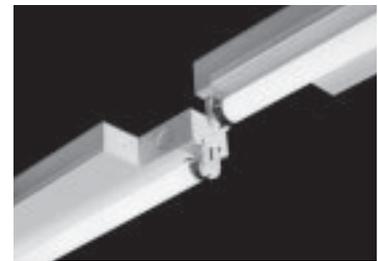
OPTIONS

Suffix "DIM" after catalog no. for dimming ballast.
 Suffix "LT" after catalog no. for cold weather ballast.
 Suffix "DL" after catalog no. for damp location.
 Suffix "EM" after catalog no. for emergency battery packs and see price list for types.
 Suffix "XTA" after catalog no. for XTRALUME® reflector standard with 85% reflectance, for 95% reflectance specify your requirements.
 Suffix "SYM" after catalog no. for post powder coated white SYMMETRIC reflector.
 Suffix "ASYM" after catalog no. for post powder coated white ASYMMETRIC reflector.
 Suffix "ASYM1" after catalog no. for post powder coated white ASYMMETRIC reflector.
 Suffix "GCC" after catalog no. for 3/8" greenfield/conduit connector.

REFLECTOR OPTIONS

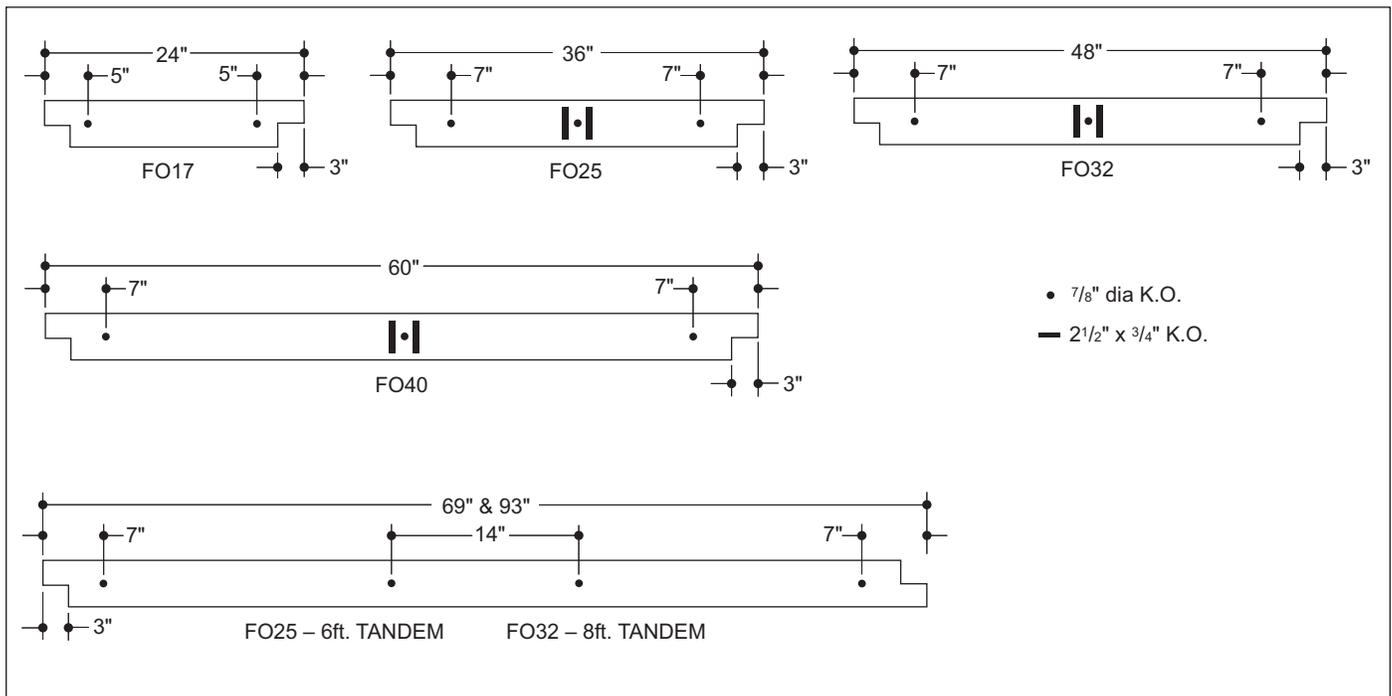


JOINING DETAIL



Reflector configurations shown can be modified to specification. Consult factory for minimum quantity order.

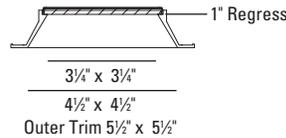
BACK PLANS



FOR PHOTOMETRIC DATA CONSULT FACTORY
 Information supplied primarily for illustrative purposes, subject to change.
 Consult factory for verification and minimum quantity orders.



Downlight



LUMINAIRE INFORMATION

APPLICATION:

Accent luminaire for Residential, Commercial, Retail or Hospitality environments.

MATERIALS:

Trim: Die cast aluminum retained by two mounting clips.

Housing: All-Ways Square™ housing allows alignment of square aperture (up to 20° rotation) after housing installation and prior to finish ceiling installation. Patent pending. Fabricated of 20 ga. galvanized steel with thru wire J-box, 4 in 4 out at min. 90°C, #12 AGW thru branch circuit wiring.

Housing and trim supplied as one complete unit.

Trim Lens: Proprietary low glare blended optical lens system.

Reflector: Interchangeable precision injection molded specular polycarbonate reflector maximized for 30° or 50° beam distribution.

LIGHT ENGINE: Field Replaceable

Available in 10W or 20W ±100K, 80+ CRI. High power white LED's tightly binned for fixture to fixture color consistency.

RATED LIFE: Based on IESNA LM80-2008

20W - 50,000 hours at 70% lumen maintenance (L70).

10W - 50,000 hours at 70% lumen maintenance (L70).

HEATSINK:

Proprietary high performance aluminum die cast heatsink for maximum LED life.

DRIVER: Field Replaceable

Solid state electronic. Constant current.

High power factor. Specify 120V or 277V.

MOUNTING:

Butterfly brackets and adjustable nailer bars with integral nails provided. Nailer bars are extendible from 14" to 24" centers.

CEILING CUT OUT:

5 1/16" x 5 1/16"

LISTINGS:

Dry/Damp.

*Wet under covered ceiling is optionally available (not standard).

Not for use in environmental air handling spaces.

IBEW union made.



NOTES:

- Housing included with trim.
- Maximum ceiling thickness 1 inch. Consult factory for other ceiling conditions.
- Fixture should be installed in applications where ambient temperatures do not exceed 40°C during normal operation.
- 5 year warranty

PHOTOMETRICS:

Consult factory or website for IES files.

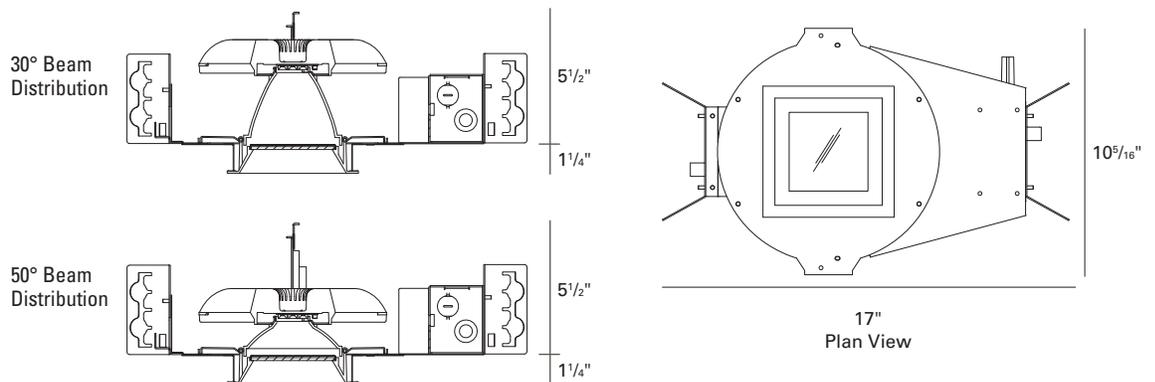
Tested in accordance with IESNA LM79-2008.

HOUSING INFORMATION

New Construction:

LSTD4-9010-C1 (10W)

LSTD4-9020-C1 (20W)



HOW TO SPECIFY

Trim	Finish	Housing	Color Temperature	Reflector	Housing Type	Voltage	Accessories
3010					NC		
3010 BeveLED Trim Downlight	10 - White 21 - Black 28 - Metalized Grey RAL - Special Color	LSTD4-9010-C1 - 10W LED LSTD4-9020-C1 - 20W LED	27 - 2700K 30 - 3000K 35 - 3500K 40 - 4000K	30 - 30° 50 - 50°	NC - New Construction	120V 277V	W - Wet Listed (under covered ceiling) CB27 - 27" C-Channel Bars CB52 - 52" C-Channel Bars DIML2 - 0-10V Low Voltage Dimming Module DIML3 - Lutron Hi-Lume 2 Wire Control ELV Dimming Driver DIML4 - Lutron Hi-Lume / ECO System 3 Wire Control Dimming Driver SLD30 - 30° Reflector SLD50 - 50° Reflector EML - Emergency lighting battery pack w/ remote test switch. Note: Housing size may differ.

BeveLED[®] LED

Downlight

BeveLED Downlight, 50° Beam, 20W

3010-10-LSTD4-9020-C1-30-50-NC-120V

LTL Report No. : 19747

Spacing Criteria: .74

BBCP: 1355

lighting facts^{CM}
A Program of the U.S. DOE

Light Output (Lumens) 1008
Watts 19.8
Lumens per Watt (Efficacy) 50

Color Accuracy
Color Rendering Index (CRI) 81

Light Color
Correlated Color Temperature (CCT) 3059 (Bright White)

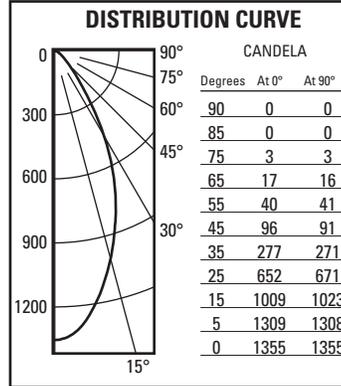
2700K 3000K 3059K 4500K 6500K

All results are according to IESNA LM-79-09/08: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the Label/Reference Guide.

Registration Number: RLTR-35TK04
Model Number: 3010-LSTD4-9020-C1-30-50-NC-120V
Type: Recessed downlight

LIGHTING PERFORMANCE DATA		
Ceiling Height (FT)	Initial Footcandles	Beam Diameter @ 50°
6.0	37.6	4.5
8.0	21.2	6.1
10.0	13.6	7.6
12.0	9.4	9.1
14.0	6.9	10.6



COEFFICIENTS OF UTILIZATION ZONAL CAVITY METHOD						
Effective Floor Cavity Reflectance 0.20						
RC	80		70		50	
	50	30	50	30	50	30
0	1207	1207	1178	1178	1126	1126
1	1119	1094	1098	1074	1056	1038
2	1038	996	1021	982	987	956
3	965	913	951	903	924	884
4	900	842	888	835	866	820
5	842	781	832	775	814	764
6	789	728	781	723	766	715
7	742	681	736	677	722	670
8	700	639	694	636	683	630
9	662	601	656	599	647	594
10	627	567	622	566	614	562

BeveLED Downlight, 30° Beam, 20W

3010-10-LSTD4-9020-C1-30-30-NC-120V

LTL Report No. : 19746

Spacing Criteria: .46

BBCP: 3080

lighting facts^{CM}
A Program of the U.S. DOE

Light Output (Lumens) 842
Watts 19.8
Lumens per Watt (Efficacy) 42

Color Accuracy
Color Rendering Index (CRI) 81

Light Color
Correlated Color Temperature (CCT) 3067 (Bright White)

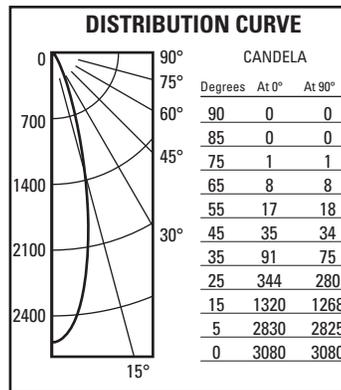
2700K 3000K 3067K 4500K 6500K

All results are according to IESNA LM-79-09/08: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the Label/Reference Guide.

Registration Number: RLTR-500G1B
Model Number: 3010-LSTD4-9020-C1-30-30-NC-120V
Type: Recessed downlight

LIGHTING PERFORMANCE DATA		
Ceiling Height (FT)	Initial Footcandles	Beam Diameter @ 50°
6.0	85.6	2.7
8.0	48.1	3.7
10.0	30.8	4.6
12.0	21.4	5.5
14.0	15.7	6.4



COEFFICIENTS OF UTILIZATION ZONAL CAVITY METHOD						
Effective Floor Cavity Reflectance 0.20						
RC	80		70		50	
	50	30	50	30	50	30
0	1031	1031	1007	1007	962	962
1	971	953	953	936	918	905
2	918	889	903	877	876	855
3	871	836	860	828	838	811
4	830	792	821	785	803	773
5	794	753	786	749	772	739
6	761	720	755	716	743	709
7	732	691	726	688	716	682
8	705	664	700	662	692	657
9	680	640	676	638	669	635
10	657	618	654	617	648	614

BeveLED Downlight, 50° Beam, 10W

3010-10-LSTD4-9010-C1-30-50-NC-120V

LTL Report No. : 19901

Spacing Criteria: .73

CBCP: 750

lighting facts^{CM}
A Program of the U.S. DOE

Light Output (Lumens) **576**
Watts **9.72**
Lumens per Watt (Efficacy) **59**

Color Accuracy
Color Rendering Index (CRI) **81**

Light Color
Correlated Color Temperature (CCT) **3082 (Bright White)**

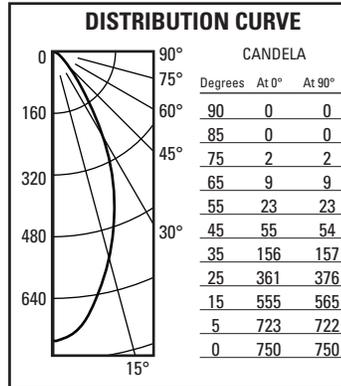
2700K 3000K 4500K 6500K

All results are according to IESNA LM-79-09:09. Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the Label Reference Guide.

Registration Number: B,TR-81589W6
Model Number: 3010-10-LSTD4-9010-C1-30-50-NC-120V
Type: Recessed downlight

LIGHTING PERFORMANCE DATA		
Ceiling Height (FT)	Initial Footcandles	Beam Diameter @ 50°
6.0	20.8	4.5
8.0	11.7	6.0
10.0	7.5	7.6
12.0	5.2	9.1
14.0	3.8	10.6



COEFFICIENTS OF UTILIZATION ZONAL CAVITY METHOD						
Effective Floor Cavity Reflectance 0.20						
RC	80		70		50	
	RW	30	50	30	50	30
0	674	674	658	658	629	629
1	625	610	612	599	589	579
2	579	555	569	548	551	533
3	538	509	530	503	515	493
4	502	469	495	465	483	457
5	469	435	463	432	453	426
6	439	405	435	402	426	397
7	413	378	409	376	402	372
8	389	355	386	353	380	350
9	368	334	365	332	359	330
10	348	315	346	314	341	312

BeveLED Downlight, 30° Beam, 10W

3010-10-LSTD4-9010-C1-30-30-NC-120V

LTL Report No. : 19900

Spacing Criteria: .46

CBCP: 1680

lighting facts^{CM}
A Program of the U.S. DOE

Light Output (Lumens) **490**
Watts **9.72**
Lumens per Watt (Efficacy) **50**

Color Accuracy
Color Rendering Index (CRI) **81**

Light Color
Correlated Color Temperature (CCT) **3089 (Bright White)**

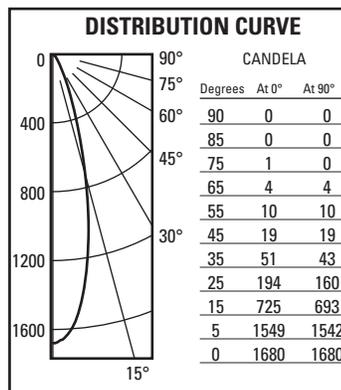
2700K 3000K 4500K 6500K

All results are according to IESNA LM-79-09:09. Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the Label Reference Guide.

Registration Number: B,TR-A-02W19
Model Number: 3010-10-LSTD4-9010-C1-30-30-NC-120V
Type: Recessed downlight

LIGHTING PERFORMANCE DATA		
Ceiling Height (FT)	Initial Footcandles	Beam Diameter @ 50°
6.0	46.7	2.8
8.0	26.2	3.7
10.0	16.8	4.6
12.0	11.7	5.5
14.0	8.6	6.4



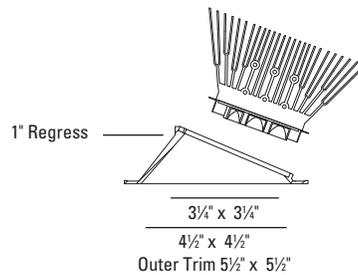
COEFFICIENTS OF UTILIZATION ZONAL CAVITY METHOD						
Effective Floor Cavity Reflectance 0.20						
RC	80		70		50	
	RW	30	50	30	50	30
0	569	569	555	555	531	531
1	535	525	525	516	506	499
2	506	490	498	483	483	471
3	480	461	474	456	462	447
4	457	436	452	432	442	426
5	437	415	433	412	425	407
6	419	396	415	394	409	390
7	402	380	400	378	394	375
8	388	365	385	364	380	361
9	374	352	372	351	368	349
10	361	340	360	339	356	337

BeveLED® LED

Wall Wash



3150



LUMINAIRE INFORMATION

APPLICATION:

Accent luminaire for Residential, Commercial, Retail or Hospitality environments.

MATERIALS:

Trim: Die cast aluminum retained by two mounting clips.
Housing: All-Ways Square™ powder coated black housing allows alignment of square aperture (up to 20° rotation) after housing installation and prior to finish ceiling installation. Patent pending. 16 ga. galvanized steel thru wire J-box, 4 in 4 out at min. 75°C, #12 AGW thru branch circuit wiring.
 Housing and trim supplied as one complete unit.
Trim Lens: Proprietary wall wash lens.

LIGHT ENGINE: Field Replaceable

Available in 10W or 20W ±100K, 80+ CRI. High power white LED's tightly binned for fixture to fixture color consistency.

RATED LIFE: Based on IESNA LM80-2008

20W - 50,000 hours at 70% lumen maintenance (L70).
 10W - 50,000 hours at 70% lumen maintenance (L70).

HEATSINK:

Proprietary high performance extruded aluminum heatsink for maximum LED life.

DRIVER: Field Replaceable

Solid state electronic. Constant current. High power factor. Specify 120V or 277V.

ADJUSTMENT:

90° increments horizontal locking.

MOUNTING:

Butterfly brackets and adjustable nailer bars with integral nails provided. Nailer bars are extendible from 14" to 24" centers.

CEILING CUT OUT:

5 1/16" x 5 1/16"

LISTINGS:

Dry/Damp.

*Wet under covered ceiling is optionally available (not standard).

IBEW union made.



NOTES:

- Housing included with trim.
- Maximum ceiling thickness 1 inch. Consult factory for other ceiling conditions.
- Fixture should be installed in applications where ambient temperatures do not exceed 40°C during normal operation.
- **5 year warranty**

PHOTOMETRICS:

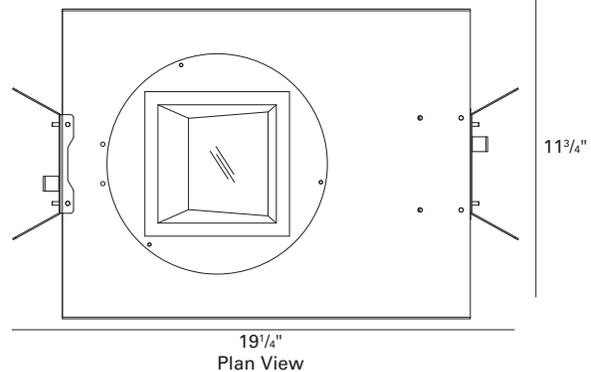
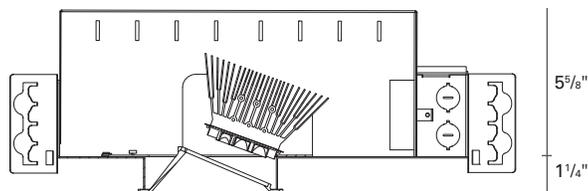
Consult factory or website for IES files. Tested in accordance with IESNA LM79-2008.

HOUSING INFORMATION

New Construction

LSTW4-6010-C1 (10W)

LSTW4-6020-C1 (20W)



HOW TO SPECIFY

Trim	Finish	Housing	Color Temperature	Housing Type	Voltage	Accessories
3150				NC		
3150 BeveLED Trim Wall Wash	10 - White 21 - Black 28 - Metalized Grey RAL - Special Color	LSTW4-6010-C1 - 10W LED LSTW4-6020-C1 - 20W LED	27 - 2700K 30 - 3000K 35 - 3500K 40 - 4000K	NC - New Construction	120V 277V	W - Wet Listed (under covered ceiling) CB27 - 27" C-Channel Bars CB52 - 52" C-Channel Bars DIML2 - 0-10V Low Voltage Dimming Module DIML3 - Lutron Hi-Lume 2 Wire Control ELV Dimming Driver DIML4 - Lutron Hi-Lume / ECO System 3 Wire Control Dimming Driver EML - Emergency lighting battery pack w/ remote test switch. Note: Housing size may differ.

BeveLED[®] LED

Wall Wash

BeveLED Wall Wash, 20W

3150-10-LSTW4-6020-C1-30-NC-120V

LTL Report No. : 19753

Spacing Criteria: 1.17

lighting facts CM
A Program of the U.S. DOE

Light Output (Lumens) **906**
Watts **20.09**
Lumens per Watt (Efficacy) **45**

Color Accuracy
Color Rendering Index (CRI) **82**

Light Color
Correlated Color Temperature (CCT) **3033 (Bright White)**

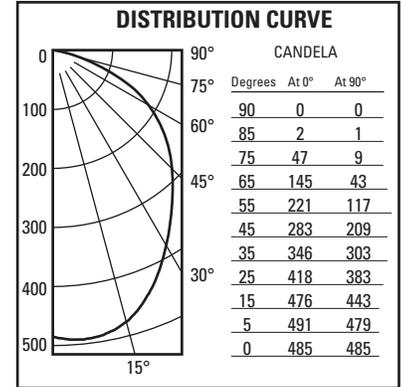
Warm White 2700K 3000K Bright White 4500K Daylight 6500K

All results are according to IESNA LM-79-09: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the Label Reference Guide.

Registration Number: BLTR-1Y5V7Z
Model Number: 3150-LSTW4-6020-C1-30-NC-120V
Type: Recessed downlight

PERFORMANCE SUMMARY



RC	80		70		50	
	50	30	50	30	50	30
0	1034	1034	1009	1009	964	964
1	931	901	912	885	876	854
2	833	784	817	773	788	750
3	748	688	735	679	710	663
4	675	609	664	602	643	590
5	612	543	603	538	585	529
6	558	489	550	485	535	477
7	511	443	505	440	492	434
8	471	404	465	401	454	396
9	436	370	431	368	421	364
10	405	342	400	340	392	336

LIGHTING PERFORMANCE DATA

3' on center
2' from wall

Distance From Ceiling in Feet	Footcandles (FC)			
	1	2	3	4
1	30.4	22.4	22.4	30.4
2	32.5	30.2	30.2	32.5
3	24.4	23.8	23.8	24.4
4	17.6	17.3	17.3	17.6
5	12.7	12.6	12.6	12.7
6	9.4	9.4	9.4	9.4
7	7.1	7.1	7.1	7.1
8	5.4	5.5	5.5	5.4
9	4.2	4.3	4.3	4.2
10	3.4	3.4	3.4	3.4
11	2.7	2.8	2.8	2.7

Average: 13.11 FC
Max / Min: 11.9:1
Avg / Min: 4.8:1

3' on center
3' from wall

Distance From Ceiling in Feet	Footcandles (FC)			
	1	2	3	4
1	8.9	8.6	8.6	8.9
2	20.7	20.1	20.1	20.7
3	20.7	20.5	20.5	20.7
4	17.5	17.4	17.4	17.5
5	14.1	14.1	14.1	14.1
6	11.2	11.2	11.2	11.2
7	8.9	8.9	8.9	8.9
8	7.1	7.2	7.2	7.1
9	5.7	5.8	5.8	5.7
10	4.5	4.7	4.7	4.6
11	3.8	3.8	3.8	3.8

Average: 11.17 FC
Max / Min: 5.5:1
Avg / Min: 2.9:1

4' on center
3' from wall

Distance From Ceiling in Feet	Footcandles (FC)			
	1	2	3	4
1	7.8	6.6	5.1	6.6
2	16.3	15.3	14.1	15.3
3	15.9	15.5	15.0	15.5
4	13.3	13.2	13.0	13.2
5	10.8	10.8	10.7	10.8
6	8.7	8.7	8.6	8.7
7	7.0	7.0	7.0	7.0
8	5.6	5.7	5.6	5.7
9	4.6	4.6	4.6	4.6
10	3.8	3.8	3.8	3.8
11	3.1	3.2	3.2	3.2

Average: 8.60 FC
Max / Min: 5.2:1
Avg / Min: 2.7:1

BeveLED Wall Wash, 10W
3150-10-LSTW4-6010-C1-30-NC-120V
LTL Report No. : 19906
Spacing Criteria: 1.20

BeveLED - Wallwash

lighting facts^{CM}

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Light Output (Lumens)	542
Watts	9.99
Lumens per Watt (Efficacy)	54

Color Accuracy	82
Color Rendering Index (CRI)	

Light Color

Correlated Color Temperature (CCT)

3048 (Bright White)

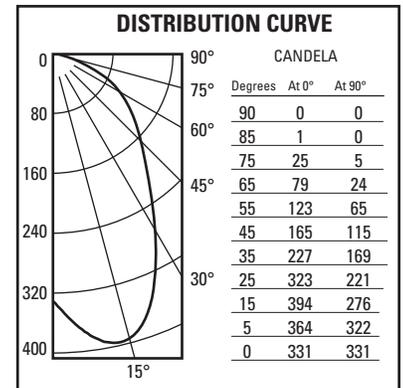
Warm White
Bright White
Daylight

2700K
3000K
4500K
6500K

All results are according to IESNA LM-79-09/02: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the Label Reference Guide.

Registration Number: RLTR 64N71D
 Model Number: 3150-LSTW4-6010-C1-30-NC-120V
 Type: Recessed Downlight



COEFFICIENTS OF UTILIZATION ZONAL CAVITY METHOD

Effective Floor Cavity Reflectance 0.20

RC	80		70		50	
	RW	30	50	30	50	30
0	617	617	602	602	575	575
1	557	540	546	530	524	512
2	501	272	491	465	474	452
3	451	416	443	411	429	401
4	408	370	402	366	390	359
5	372	332	366	329	356	323
6	340	300	335	297	327	293
7	313	273	309	271	301	267
8	289	250	285	248	279	245
9	268	230	265	229	259	226
10	250	213	247	212	242	209

LIGHTING PERFORMANCE DATA

3' on center
2' from wall

Distance From Ceiling in Feet	Footcandles (FC)			
	1	2	3	4
1	16.8	12.3	12.3	16.8
2	18.7	16.9	16.9	18.7
3	15.2	14.0	14.0	15.2
4	11.6	10.8	10.8	11.6
5	8.6	8.2	8.2	8.6
6	6.4	6.2	6.2	6.4
7	4.8	4.8	4.8	4.8
8	3.7	3.7	3.7	3.7
9	2.9	2.9	2.9	2.9
10	2.3	2.3	2.3	2.3
11	1.8	1.9	1.9	1.8

Average: 8.03 FC
Max / Min: 10.1:1
Avg / Min: 4.3:1

3' on center
3' from wall

Distance From Ceiling in Feet	Footcandles (FC)			
	1	2	3	4
1	4.8	4.6	4.6	4.8
2	11.5	11.1	11.1	11.5
3	11.7	11.5	11.5	11.7
4	10.4	10.2	10.2	10.4
5	8.8	8.6	8.6	8.8
6	7.2	7.2	7.2	7.2
7	5.9	5.9	5.9	5.9
8	4.8	4.8	4.8	4.8
9	3.9	3.9	3.9	3.9
10	3.2	3.2	3.2	3.2
11	2.6	2.6	2.6	2.6

Average: 6.74 FC
Max / Min: 4.5:1
Avg / Min: 2.6:1

4' on center
3' from wall

Distance From Ceiling in Feet	Footcandles (FC)				
	1	2	3	4	
1	4.1	3.6	2.7	3.6	4.1
2	9.0	8.4	7.8	8.4	9.0
3	9.1	8.7	8.4	8.7	9.1
4	8.1	7.8	7.5	7.8	8.1
5	6.9	6.6	6.4	6.6	6.9
6	5.7	5.5	5.4	5.5	5.7
7	4.7	4.5	4.5	4.5	4.7
8	3.8	3.7	3.7	3.7	3.8
9	3.1	3.1	3.1	3.1	3.1
10	2.6	2.6	2.6	2.6	2.6
11	2.1	2.1	2.1	2.1	2.1

Average: 5.19 FC
Max / Min: 4.3:1
Avg / Min: 2.4:1



Job Name: _____

Contact: _____

Fixture Type: _____

Part Number: _____

LEDRA® TRIO



Description:

The LEDRA Trio is a recessed fixture, with 10° swivel action. Pressure fit mounting hardware allows for no screws to be visible. The small size, long life, lack of UV, and cool beam through its frosted lens allows for a wide variety of applications. For compatible drivers refer to our [driver section](#).

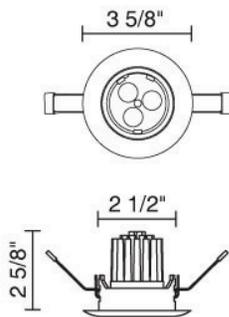
Part Numbers:

135251mc	matte chrome, white
135251-1mc	matte chrome, warm white
135251wht	white, white
135251-1wht	white, warm white

Technical Specs:

700mA DC constant current input
7.5W for 1 (3 x 3 Watt LED)
3000K : 3 x 120 source lumens
4000K : 3 x 140 source lumens

[see technical sheet](#)



Class II rated
Suitable for dry locations only
2 7/8" hole cutout required
1/8" - 1 1/4" material thickness only
Dimmable (with dimming driver)

Note:

Max of 3 fixtures can be wired when using a 40W Driver.

Warranty:

All 3 Watt LED fixtures are warranted to be free from defects in material and workmanship for three (3) years from date of delivery.

For full warranty details, please see our terms and conditions [here](#)

RAB LIGHTING

QB1B



JOB NAME: _____
 DATE: _____
 TYPE: _____

DESCRIPTION

Quartz Bullet Flood with silicone O-ring gasket, thick tempered glass lens, internal and external cooling fins. Gold plated socket contacts and 240 C Teflon coated wires for extended lamp life. Lamp supplied.

SPECIFICATIONS

Finish:

Chip and fade resistant polyester powder coating

Housing:

Precision die cast aluminum, 1/2" NPS threaded arm with locking swivel and EZ Grip lock nut fits all standard mounting covers

Lens Gasket:

High temperature silicone gasket stays in place during relamping

Lens:

Thick, tempered glass

Reflector:

Semi-specular anodized aluminum

Replacement Lamps:

Sockets:

Porcelain bi-pin GY 8 base with gold plated contacts and 250° C socket wires

UL Listing:

Suitable for wet locations. Suitable for mounting within 4' of the ground

Patents:

RAB sensor and fixture designs are protected under U.S. and International Intellectual Property laws

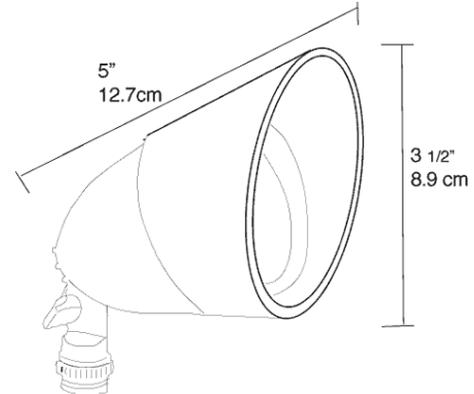
Color:

Black

Weight:

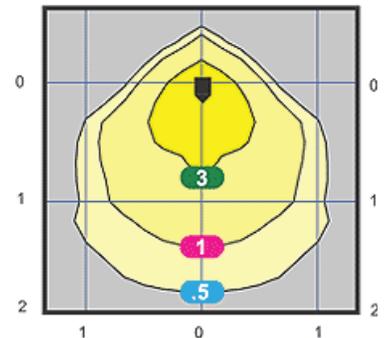
0.95

DIMENSIONS



PHOTOMETRIC

75w Quartz @ 10'
 mounting height aimed
 60° below horizon



Multiples of Mounting Height
 Values shown in Footcandles

ORDERING INFORMATION

Quartz Halogen Lamp supplied with fixture	Total Watts	Lamp Type	Lamp Base	Ballast	Starting Amps/ Operating Amps				Input Watts	LAMP ANSI	Initial Lumens	Lamp Hours
					120V	208V	240V	277V				
	75	T-4	bi-pin (GY8.0)	0	0	0	0	75	0	1500	1500	

Factory Installed Options
 Add suffix to Catalog Number

Note: Specifications may change without notice

SECTION 27 20 00

DATA COMMUNICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes all networking hardware.

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. D-Link Corporation/D-Link Systems, Inc.

2.2 DATA COMMUNICATION ROUTER

- A. EBR-2310 Ethernet Broadband Router
 1. Create a basic network to share Internet Connection
 2. Dimensions: 4.5" x 5.9" x 1.4"
 3. Operating Temperature: 32°F to 131 °F
 4. Weight: 0.5 lbs
 5. Local Network—10/100Mbps
 6. Certification: FCC
 7. Standards: IEEE 802.3 10Base-T Ethernet, IEEE 802.3u 100Base-TX Fast Ethernet, IEEE 802.3 NWay Auto-Negotiation

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with product installation manual and related NEC codes.

END OF SECTION



SECTION 28 40 00

ELECTRONIC MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes electronic equipment and systems for detention applications.

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules,
- B. Authorized lab approvals UL, CE, ISO, GOST

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Technologic System
- B. Satec Inc

2.2 PRODUCTS

- A. TS 7200 Programmable Logic Controller
 - 1. Compact Flash Card interface
 - 2. 10/100 Ethernet interface - autosense, LED indicator
 - 3. 200 MHz ARM9 processor with MMU
 - 4. 8 MB Flash disk used for RedBoot boot-loader, Linux kernel and root file system
 - 5. RS-485 support on COM2 with fully automatic TX enable control
 - 6. Standard Operating Temperature Range: Fanless -40° to +70° full-speed; +85°C with CPU at 166Mhz
- B. Satec BFM 136
 - 1. Nominal Frequency: 50/60 Hz
 - 2. Nominal AC Voltage: 120/240/277 VAC. 4 wires- 3 phases + neutral
 - 3. Nominal AC Current: 50A. 36 current circuits
 - 4. Voltage Inputs Terminal: 10AWG Max
 - 5. Weight: 1.850Kg



PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with product installation manual
<http://www.embeddedarm.com/documentation/ts-7200-manual.pdf>
- B. Comply with product installation manual
<http://www.byramlabs.com/pdf/satec/BFM13.pdf>

END OF SECTION



SECTION 31 39 13**FOUNDATION JACKS****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. Work Included: The Work of this Section shall include, but not be limited to, the following:
 - 1. Adjustable foundation Jacks.
- B. Related Work:
 - 1. Division 06 Section "Rough Carpentry" for wood blocking for mounting roller shades and accessories.
 - 2. Division 06 Section "Exterior Architectural Woodwork" for wood grounds for mounting roller shades and accessories.

1.3 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before materials are fabricated and delivered to the site.
- B. Shop Drawings: Submit shop drawings for work specified herein for approval and obtain approval prior to fabrication and shipment of materials to the job site.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer having ten years experience in producing jacks
- B. Fire-Test-Response Characteristics: Passes NFPA 701-99 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

PART 2 - PRODUCTS**2.1 MANUFACTURER**

- A. Ellis Manufacturing Company Mini Jack)

2.2 CHARACTERISTICS

- A. Type: Adjustable screw jack
- B. Load Capacity: 15,000 pounds
- C. Adjustment: 2.5 inches
- D. Handle: U Turn shaped



- E. Screw: Greased
- F. Base Plate: Cannot turn with screw

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 PREPARATION

- A. Examine the Contract Documents in order to insure the completeness of the work required under this Section.
- B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades.

3.3 INSTALLATION

- A. Install according to manufacturer's written instructions,

3.4 ADJUSTMENT, PROTECTION

- A. Adjust and level jacks for maximum stability.

END OF SECTION



SECTION 32 82 00

IRRIGATION PUMP

PART 1 – GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data;

1.2 SYSTEM DESCRIPTION

- A. Definition: Irrigation Sprinkler Pump

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Irri-Gator Sprinkler Pump

2.2 SPECIFICATIONS

- A. Self-Priming Design: Once pump is primed it never needs priming again even if water level drops below the end of the suction pipe.
- B. Pumping resumes once the water level rises above the end of the suction pipe.
- C. Specifically designed for the following uses:
 - a.Lawn sprinkling
 - b.Irrigation
 - c.Air conditioning systems
 - d.Heat pumps
 - e.Water transfer
 - f. Dewatering

2.3 PRODUCT DATA

- A. Manufacturer: <http://www.goulds.com/pdf/7305.pdf>
- B. <http://www.goulds.com/GP-Product-ID-88.asp>

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Residential Self Priming Centrifugal Pumps 60 Hz GT Irrigator: Follow manufacturer's instructions:

<http://www.goulds.com/pdf/IM049.pdf>

END OF SECTION



SECTION 32 84 13.13

Drip Irrigation Emitters

PART 1 - GENERAL

1.2 SUMMARY

- A. Submittals: Construction documents and product data

1.3 DEFINITIONS

- A. Definition: The Take Apart Emitter control water for irrigating the plants
- B. Sizing : 1gph

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Dripworks
www.dripworks.com

2.2 PRODUCTS

- A. DTA1 1gph

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturers instruction www.dripworks.com
- B. Follow NYC Plumbing Codes

END OF SECTION



SECTION 32 84 13.15

Drip Irrigation Tubing

PART 1 - GENERAL

1.2 SUMMARY

- A. Submittals: Construction documents and product data

1.3 DEFINITIONS

- A. Definition: The Emitter Tubing supplies the water to the irrigation system for the planting.
- B. Sizing : ½”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Dripworks
www.dripworks.com

2.2 PRODUCTS

- A. Emitter Tubing

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturers instruction www.dripworks.com
- B. Follow NYC Plumbing Codes

END OF SECTION



SECTION 32 84 13

Grey Water Filter

PART 1 - GENERAL

1.2 SUMMARY

- A. Submittals: Construction documents and product data

1.3 DEFINITIONS

- A. Definition: The Grey Water Filter Will be used to filter the grey water for irrigation purposes.
- B. Sizing : 14.6”(W)x15.7”(H)x 23.2”(L)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Matala
<http://www.matalausa.com/>

2.2 PRODUCTS

- A. Grey Water Recycling - Aqua2Use
- B. Product Number: gwdd

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturers instruction <http://www.matalausa.com/>
- B. Follow NYC Plumbing Codes

END OF SECTION



SECTION 32 93 33

PLANTS AND PLANTERS

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. Provide labor, materials, equipment and services, and perform operations required for installation of trees, shrubs, vines and groundcovers and related work as indicated on the drawings and specified herein.
- B. Work Included: The work of this section shall include, but not be limited to, the following:
 - 1. Groundcovers.
 - 2. Vegetables
 - 3. Grasses
 - 4. Topsoil.
 - 5. Fertilizer, limestone, humus, sand, mulch, tree wraps, tree stakes, phosphates.
 - 6. Planters
- C. Related Work Specified Elsewhere
 - 1. Exterior Architectural Woodwork: For decking and planter divisions

1.4 SUBMITTALS

- A. Submit written maintenance instructions recommending procedures for maintenance and care of landscaping work.
- B. Provide Plan for transportation

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Plants
 - 1. Provide CCNY grown plants, with healthy root systems
 - 2. Plants shall be typical of their species or variety, shall have a normal habit of growth and be first quality, sound, healthy, vigorous, well branched and densely foliated. Provide plants free of disease, insects, pests, sunscald, windburn, eggs or larvae, with healthy, well furnished root systems.
- C. Topsoil: Shall be as provided by class at CCNY
- D. Natural Organic Fertilizer: Similar to Milorganite, produced by the Sewerage Commission, having the following analysis:



Total Nitrogen (6.5 percent water insoluble nitrogen)	6.0 percent
Available Phosphoric Acid	2.0 percent
Soluble Potash	0.0 percent
Iron (Fe)	3.0 percent

- E. Humus: Shall be FS Q-P-166E Type IV natural domestic reed peat or sedge peat, but not peat-moss, free from sticks, stones, weeds, roots or other foreign matter and when delivered from stock piles containing between 35-50 percent moisture, suitable for mulch and of composition to provide ample water holding capacity and retention of plant food. Dark brown or black in color.
- F. Plants as shown on Drawings
- G. Planters
 - 1. Pots: Standard clay pots
 - 2. Larger Containers: Concrete mixing vessels

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 INSTALLATION AND APPLICATION

- A. Place planters as shown on Planting Drawings:

END OF SECTION



SECTION 33 11 13.45

Piping

PART 1 - GENERAL

1.2 SUMMARY

- A. Submittals: Construction documents and product data

1.3 DEFINITIONS

- A. Definition: The Piping supplies water to the house hydronic system
- B. Sizing : ¾"

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Muller
www.mullerindustries.com

2.2 PRODUCTS

- A. Cooper Tube Pipe
- B. Type-L

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturers instruction www.mullerindustries.com
- B. Follow NYC Plumbing Codes

END OF SECTION



SECTION 33 16 13.10

Pressure Pump Tank

PART 1 - GENERAL

1.2 SUMMARY

- A. Submittals: Construction documents and product data

1.3 DEFINITIONS

- A. Definition: The Air Pressure tank of Domestic Cold Water Supply is a pressure booster to obtain efficient water pressure in the house for the competition.
- B. Sizing : 16" x 29"

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. FLEXCON INDUSTRIES
www.flexconindustries.com

2.2 PRODUCTS

- A. Well-Rite Pressure Pump Tank WR-60
- B. Product Number: FWR-60, WX-202

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturers instruction www.flexconindustries/html/wellrite.html
- B. Follow NYC Plumbing Codes

END OF SECTION



SECTION 33 16 13.14

Grey Water Tank

PART 1 - GENERAL

1.2 SUMMARY

- A. Submittals: Construction documents and product data
- B. Related Section
 - 1. Section 22 11 13.23 Domestic Water Piping
 - 2. Section 33 32 13.13 Water Pumps

1.3 DEFINITIONS

- A. Definition: Grey Water Tank will hold the grey water responsible for irrigation for 24 hours at a time through the competition.
- B. Size 4'-6" (W) x 7'-6" (L) x 12" (H)
- C. Fill Fitting: Scotty Cap 4" 1-1/2" PVC Flange Fitting with PVC Ball Valve

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. GO TO TANKS :
www.gototanks.com
877-468-2657

2.2 PRODUCTS

- A. Grey Water Tank
- B. Material: Fabric Type PES 1000 Den
- C. Polymer PVC PVC
- D. Total Weight ASTM D 751 22 oz/yd²

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturers instruction <http://www.gototanks.com/750-Gallon-Pillow-Tank.aspx>

END OF SECTION



SECTION 33 32 13.13**Hydronic Pump****PART 1 – GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data;

1.2 SYSTEM DESCRIPTION

- A. Definition: Many of the Centriflo® Style PF Pumps perform excellent for pumping liquids at elevated temperatures

PART 2 – PRODUCTS**2.1 MANUFACTURER**

- A. Hydronic Pump: Bell & Gossett/Domestic Pump 8200 N. Austin Ave. Morton Grove, IL 60053 Tel. (847) 966-3700 Fax. (847) 966-9052

2.2 SPECIFICATIONS

- A. Domestic™ Centriflo® pumps are permanently aligned, close-coupled, and ready-to-run.
- B. Centriflo® centrifugal pumps are basic components of much of our line of condensate-handling equipment
- C. They are designed for the rigorous demands of this service. They are, therefore, suitable for many other types of service, including hot water heating, irrigation, evaporative condensers, cooling towers, air conditioning units, milk coolers, booster service, and many more.
- D. Vertical mounting of styles PF and PVF saves floor space and gets the motor up above dirt and water. In addition, the style PF flange-mounted pumps can be simply bolted on any vertical flat surface, such as coolant reservoir, eliminating suction piping completely.
- E. Operating parts of styles PF and PVF are readily accessible for cleaning or inspection without disturbing piping connections.
- F. Standard units feature bronze fitted construction, stainless steel shaft, end enclosed bronze impeller. The impellers have exceptionally smooth passages, are accurately machined, finished by hand to final diameter and balanced for top efficiency.
- G. Mechanical seals utilize carbon/ceramic seal faces and are designed to withstand temperatures to 250°F (121°C). This assures long life at the actual operating temperature.

2.3 PRODUCT DATA

- A. Manufacturer: <http://www.bellgossett.com/literature/files/496.pdf>

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Bell & Gossett® Domestic™ Centriflo® Series C35: Follow manufacturer's instructions:

<http://www.bellgossett.com/literature/files/128.pdf>

END OF SECTION



SECTION 41 22 00**Cranes and Hoists****PART 1 – GENERAL****1.1 SUMMARY**

- A. Section includes the following:
1. Cranes and Hoists

1.2 SUBMITTALS

- A. Attached is the manufacturer's published data sheet, including:
1. Product Details
 2. Dimensions and measurements

1.3 DELIVERY, STORAGE AND HANDLING

- A. Acceptance at site:
1. Inspect product upon delivery. Report any damaged or missing components directly to the manufacturer.
- B. Handling and Protection
1. Operated only by a certified individual. Operated a safe distance from any hazards and by passers.

PART 2 – PRODUCTS**2.1 MANUFACTURER**

- A. Crane Service Inc.
505 Murry Road SE
Albuquerque, NM 87105
Phone: (505) 877-1100
Website: <http://www.craneserviceinc.com/>

2.2 PRODUCTS

- A. Tadano All Terrain Crane Model # ATF110G-5
1. Capacity: 130 Ton (118.0 Metric Tons)
 2. Dimensions: L 48'11" x W 10'3" x H 13'1"

PART 3 – EXECUTION**3.1 INSTALLATION**

- A. Use safety precautions while operating. Operate only by a certified individual.

END OF SECTION

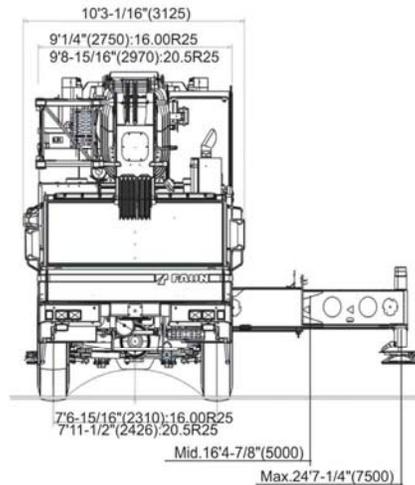
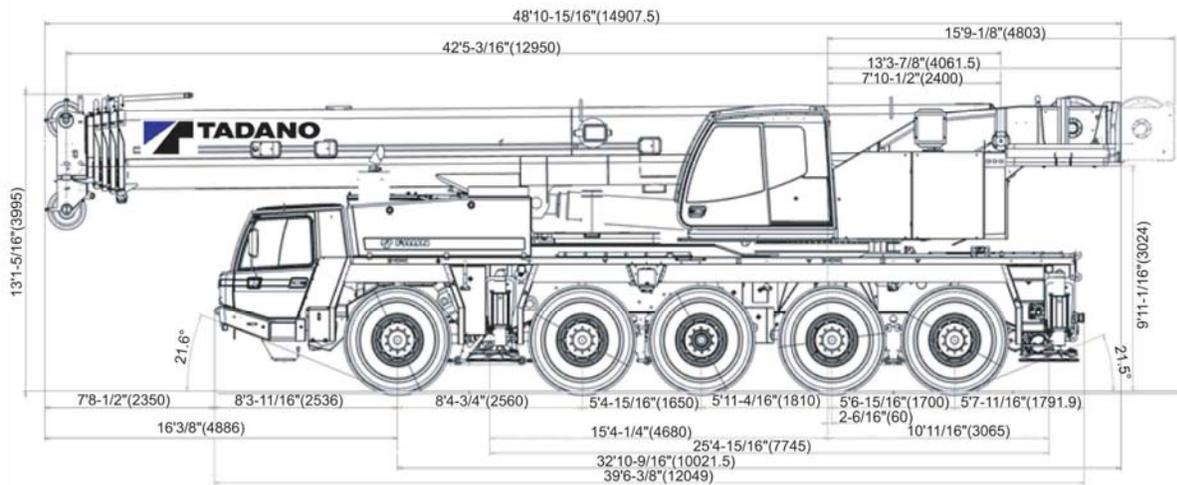


ATF110G-5

130 Ton Capacity (118.0 Metric Tons)

ALL TERRAIN CRANE

DIMENSIONS



TURNING RADIUS

Steering	Front wheel (10x4)	All wheel (10x8)
Carrier inside	19' 8-1/4" (6.0m)	16' 4-7/8" (5.0m)
Over carrier	38' 3-5/8" (11.675m)	34' 1-7/16" (10.4m)
Over boom	41' 4-1/16" (12.6m)	37' 8-3/4" (11.5m)
Over boom extension	43' 7-5/8" (13.3m)	39' 7-3/8" (12.075m)

Specifications are subject to change without notice.

1. CRANE CARRIER

1.1 FRAME

FAUN purpose built, 5 axle, box-type, torsion resistant, welded construction made of high tensile steel with integrated outrigger housings. Equipped with front and rear fenders, front and rear towing and tie-down lugs and 2 access steps. Centralized lubrication system.

1.2 OUTRIGGERS

Four point, fully hydraulic, double telescopic outriggers with horizontal and vertical motions are independently controlled by electro-magnetic valves. Push button controls with level gauges on both sides of carrier and in super-structure cab. Vertical cylinders with integral holding valves. Large sized floats can be stored on vertical cylinders or on carrier for road travel. Outrigger base: length 24'7-1/4" (7.5m), width 25' 4-3/4"(7.74m) Mid. extension 16' 4-7/8" (5.0m).

Outrigger floats: 1'9-5/16"(542mm) x 1'9-5/16"(542mm)

1.3 CARRIER ENGINE

Mercedes Benz 8 cylinder water-cooled diesel engine, model OM 502 LA (EUROMOT2,EPA), with hydrostatically driven fan and thermostatically controlled cooler.

Displacement 971.98 in³, Rating 517 hp at 1,800 rpm:
Torque 1,770 ft-lbs at 1,200 rpm.

1.4 TRANSMISSION

ZF AS-Tronic, type 16AS2602, with integrated intarder. Electro-pneumatically controlled dry clutch and fully automatic control system, 16 forward speeds and 2 reverse gears.

Gear ratios: Forward: 14.12 / 11.68 / 9.54 / 7.89 / 6.52 / 5.39 / 4.57
3.78 / 3.09 / 2.56 / 2.09 / 1.73 / 1.43 / 1.18 / 1.00 / 0.83
Reverse: 13.07 / 10.81

1.5 TRANSFER CASE

Two-step transfer box, type VG3750, with on/off road drive.

Gear ratios: On-road: 0.8
Off-road: 1.836

1.6 DRIVE

10x6 : 2nd, 4th and 5th axle are driven
10x8 (OPTIONAL) : 1st, 2nd, 4th and 5th axle are driven

1.7 AXLES

1st axle : steered, non driven (10x6)
steered, driven (10x8)
2nd axle : steered, driven with transverse differential lock,
reduction : 8.47
3rd axle : non steered, non driven, lift axle
4th axle : steered, driven with longitudinal differential lock and
transverse differential lock,
reduction : 8.47
5th axle : steered, driven with transverse differential lock,
reduction : 8.47

All steering knuckle bearings designed for minimum maintenance (yearly inspection).

1.8 SUSPENSION

Hydro-pneumatic, lockable with level adjustment. All axles have longitudinal and transverse trailing arms. With leveling adjustment and locked cylinders, the chassis can be tilted laterally and longitudinally by push buttons in the carrier cab, or from the control panel of the outrigger which adjust the stroke of each individual suspension cylinder.

Cylinder stroke: - 4-5/8" (- 118mm)
+6-1/4" (+ 158mm)

1.9 BRAKE SYSTEM

Service brake : Dual circuit compressed air system with air-dryer. ABS(OPTIONAL)
Parking brake : Spring loaded type, acting on 2nd,4th and 5th axles.
Auxiliary brake : Interder,engine exhaust brake and constant throttle engine brake system.

1.10 WHEELS AND TIRES

(10)11.00-25 steel disc wheels with (10)16.00R25 on / off-road profile tires and mud flaps.
Carrier width: 9'1/4" (2.75m) with 16.00R25 tires

1.11 STEERING SYSTEM

ZF semi block dual circuit hydraulic steering, Mechanical steering of two front axles with hydraulic booster and a emergency steering pump is flange-mounted to the transfer box.

Rear axles can also be steered electronically depends on the speed according to the steering angle of the front axles. Rear axles are locked in "centered" position automatically.

1.12 POWER TRAIN

Drive-shafts with cross-geared flanges virtually maintenance-free.

1.13 FUEL TANK CAPACITY

132 gal (500 l) filler cap lockable.

1.14 CARRIER CAB

Two man full width cab of composite structure (steel sheet metal and fiber glass), windshield of laminated safety glass with windshield wiper and washer, sliding side windows of tempered glass. Driver and co-driver seats adjustable and air-suspended with integrated 3 point safety belts and headrests. 2 rear-view mirrors (electrically adjustable), 1 wide angle mirror and additional curb mirror, all mirrors heated, Radio with CD player and connections for wireless. Engine dependent warm-water heater with defroster nozzles for windshield and cab floor. Cruise control function. Single-key system. Instrumentation includes speedometer, odometer, tachograph, rpm counter with hour meter, fuel level gauge, warning light for the engine temperature, gearbox display, colour display indicating further warning signals and operating functions and the compressed air system. Air conditioner(OPTIONAL)

1.15 ELECTRICAL SYSTEM

24 volt DC system with 100 ampere 3-phase generator, and two 12 volt, 170 Ah batteries.
Front lighting includes 2 main head lights, 2 high beam lights, 2 directional indicators and 2 parking lights.
Rear lighting includes 2 rear combi panels each with directional indicator, parking light, brake light, fog light, reversing light and license plate light.
Side lighting includes 2 front directional indicators and reflectors on carrier.
Other equipment includes hazard warning light system, cab light, instrument panel light, signal horn and amber rotating beacon on cab roof.
Charging plugbox. Back up alarm. 2 front fog lights.
4 lights to illuminate the area of the extended outriggers. Lighting according to EEC regulations.

1.16 TOOLS AND ACCESSORIES

Special tool set, hazard warning triangle, hazard flashing lamp, fire extinguisher and first aid kit.

1.17 PAINTING

Standard TADANO colors

1.18 DIMENSIONS

Overall width : 9'1/4" (2.75m) with 16.00R25 tires
 9'10-1/8" (3.0m) with 20.5R25 tires (OPTIONAL)
 Overall height : 12'11-1/2" (3.95m)
 In travel condition, the overall height can be adjusted - 4-5/8" / + 6-1/4"
 Overall length : 49' 7/16" (14.946m)
 51' 4-1/8" (15.649m) with Aux. winch
 Carrier length : 39'6-7/16" (12.05m)
 Wheel base : 8' 4-13/16" + 5' 4-15/16" + 5'11-1/4" + 5' 6-15/16"
 (2.56m + 1.65m + 1.81m + 1.7m)

1.19 CARRIER OPTIONAL EQUIPMENT

1. Air conditioning
2. 20.5R25 on/off road profile tires
3. Spare wheel & tire
4. 10x8(1st, 2nd, 4th, 5th axles driven)
5. ABS
6. Eddy current brake (retarder)
7. Rear view camera(image displayed in carrier cab)
8. Spark arrester
9. Toolbox rear
10. Towing attachment(D-Value 190 kN)
11. Pneumatic and electrical quick disconnect connectors mounted on rear bumper for boom dolly

2. TRAVEL PERFORMANCE (according to DIN 70020)

Max. travel speed : 52.8 mph
 Max. gradeability : 61 %

Gear	16.00R25 / 20.5R25 tires, GVW 132,275 lb			
	Travelling speed (mph)		Gradabilities (%)	
	Off-road gear	On -road gear	Off-road gear	On -road gear
1st	1.9	3.7	61	47
2nd	1.9	4.3	47	39
3rd	2.5	5.0	37	31
4th	2.5	6.2	30	25
5th	3.1	7.5	24	20
6th	4.3	9.3	19	16
7th	5.0	11.2	16	14
8th	5.6	13.0	13	11
9th	6.8	16.2	11	9
10th	8.7	19.3	8	7
11th	10.6	23.6	7	6
12th	12.4	28.6	5	4
13th	14.9	34.8	4	3
14th	19.6	42.3	3	3
15th	21.7	49.7	3	2
16th	26.1	52.8	2	1
1st Rev.	1.9	3.7	55	45
2nd Rev.	1.9	4.3	43	36

The gradeability is based on theoretical values and depends on ground conditions and the coefficient of friction.
 A minimum speed of 0.6 MPH is in 1st gear(off-road) at 800 rpm.

3. SUPERSTRUCTURE

3.1 SUPERSTRUCTURE FRAME

Connected to carrier by a single-race ball bearing slewing ring with external gearing providing 360° continuous rotation. Central lubrication system for slewing device, boom elevation cylinder and basic bearing.

3.2 CRANE ENGINE

Mercedes Benz 4 cylinder water-cooled diesel engine, model OM 904 LA(EUROMOT 2,EPA), with 177 hp at 2,200 rpm, 486.80 ft-lbs torque at 1,200 - 1,600 rpm. Stepless control of engine rpm by foot pedal.

Fuel tank capacity : 84.53 gal (320 l)

3.3 HYDRAULIC SYSTEM

Three circuit diesel hydraulic system with 1 axial piston variable displacement (hydraulically controlled) double pump with cumulative control for telescoping, derricking and hoisting plus 1 axial piston pump for swing and pilot controls.

3.4 HYDRAULIC CONTROLS

2 joy-stick levers and 4 three-way electrically operated valves for independent simultaneous operation of all crane motions with stepless speed control.

3.5 TELESCOPIC BOOM

Five section box type construction of high tensile, fine grained steel, consisting of 1 base section and 4 telescopic sections. The boom is extended by means of 1 double acting single stage cylinders with integrated holding valves.

All telescope sections can be extended and retracted fully automatic and locked in the selected working position.

All telescope sections are extendable under partial load.

Total retracted length : 42' 5-13/16" (12.95m)

Total extended length : 170' 7-1/4" (52.0m)

Max. sheave height : 180' 5-3/8" (55.0m)

Telescoping speed out : 320 sec.

3.6 BOOM EXTENSION

Swing around lattice type boom extension 31.17'(9.5m) / 53.15'(16.2m), offsets 0° / 20° / 35° with anti-two block system.

24.6'(7.5m) top jib to extended to 79.07'(24.1m).

19.7'(6.0m) intermediate section to extend to 98.75'(30.1m).

3.7 AUXILIARY LIFTING SHEAVE (SINGLE TOP) (OPTIONAL)

Single sheave mounted to main boom head for single line operation (stowable). Equipped with anti-two block system .

3.8 BOOM HOIST

1 double acting hydraulic cylinder with integral holding valve.

Boom elevation : -2° to +82°

Boom elevation speed : 84 sec. normal speed /

42 sec. high speed (only derricking up)

3.9 MAIN WINCH

Axial piston constant displacement motor, grooved hoist drum, integral planetary gear, automatic hydraulically controlled spring-loaded multiple disc brake and integral free wheeling (no sagging of load by hoisting).

Winch drive assembly connected to open hydraulic system. Wire rope with "Superstop" easy reeving system.

Lower limit switch and drum turn indicator.

Drum diameter : 20.67" (525mm)

Rope diameter : 0.83" (21mm)

Rope length : 820' (250m)

Max. line pull 1st layer : 21,356 lbs. (95 kN)

Max. line speed 4th layer : 426.5 ft/min (130m/min)

3.10 AUXILIARY WINCH (OPTIONAL)

Axial piston constant displacement motor, grooved hoist drum, integral planetary gear, automatic hydraulically controlled spring-loaded multiple disc brake and integral free wheeling (no sagging of load by hoisting).

Winch drive assembly connected to open hydraulic system. Wire rope with "Superstop" easy reeving system. Lower limit switch and drum turn indicator.

Drum diameter : 20.67" (525mm)

Rope diameter : 0.83" (21mm)

Rope length : 820' (250m)

Max. line pull 3rd layer : 21,356 lbs. (95 kN)

Max. line speed 4th layer : 426.5 ft/min (130m/min)

3.11 SLEWING GEAR

Constant displacement motor with three stage planetary gear, a foot actuated or automatic service brake and a parking brake. Open hydraulic circuit with free slewing function.

Slewing speed infinitely variable: 0 - 1.7 rpm

3.12 COUNTERWEIGHT

Total 77,160 lbs, divisible, assembled and disassembled by hydraulic cylinders controlled from crane cab.

Tail swing : 13' 5-7/16" (4.10m)

3.13 SUPERSTRUCTURE CAB

Spacious comfortable panoramic cab with sliding door, extra-large tinted glass windows, electrical fold-out front window with windshield washer and wiper, fixed cab roof window with armoured glass and washer/wiper, sun visor, cab light, tiltable cockpit with adjustable hydraulically cushioned seat with headrest, signal horn, radio with CD player, and connection for wireless (12 volt).

Engine dependent hot-water heater and engine independent hot water heater with engine pre-heat.

Complete controls and instrumentation plus LCD graphic display for crane operation.

Outtrigger controls from superstructure cab and supported forces display.(OPTIONAL)

Air conditioner.(OPTIONAL)

3.14 ELECTRICAL SYSTEM

24 volt system with 30 A 3-phase alternator, two 12 V (110 Ah) batteries, 1 rotating beacon on left-hand side of main winch, 2 working lights on cab front flap, 1 working light on boom base section and 2 side lights on boom head.

3.15 SAFETY DEVICES

Electronic load moment device (ASLI) with interpolation and automatic overload shut-off, hoist limit switch with shut-off, overload warning and load moment gauge. Anemometer.

Digital display of boom angle, boom length, sheave height, working radius, hook load and further information.

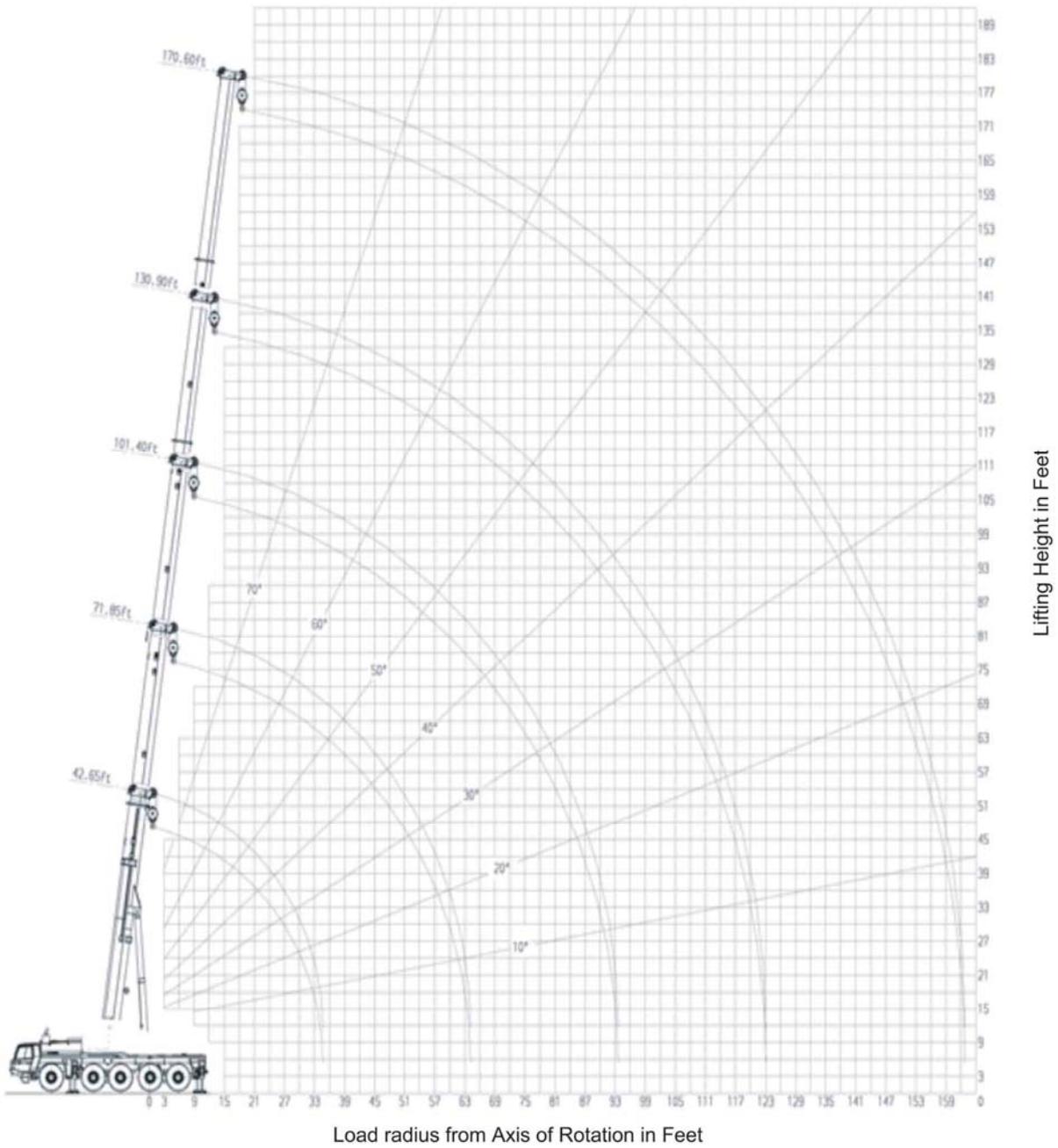
Working area limitation for lifting height, load radius, boom angle and swing range.

Safety valves against pipe and hose rupture, holding valves on hydraulic cylinders.

3.16 SUPERSTRUCTURE OPTIONAL EQUIPMENT

1. Air conditioning
2. 11 ton headache ball
3. 27.5 ton, 1 sheave single hook block
4. 69.4 ton, 3 sheave ram's horn hook block
5. 88.0 ton, 5 sheave ram's horn hook block
6. 138.0 ton, 7 sheave ram's horn hook block
7. Auxiliary winch
8. Auxiliary lifting sheave
9. 24.6' top jib for boom extension
10. 19.7' intermediate section for boom extension
11. 11.48' Heavy-lift jib
12. Spark arrester
13. Aircraft warning lamp
14. Drive/steer and outrigger control from crane cab
15. Outtrigger load monitors with display in superstructure cab and outrigger control panels.
16. Additional hydraulic oil cooler
17. Working area limitation(Slew limit)
18. Free slewing and free boom elevation circuits for boom dolly.
19. 360° positive swing lock (NYC requirement).

ATF110G-5 WORKING RANGE CHART



NOTE: Boom and jib geometry shown are for unloaded condition and machine standing level on firm supporting surface. Boom deflection and subsequent radius and boom angle change must be accounted for when applying load to hook.

Counterweight 19,180 lbs

Work Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on telescopic boom On outriggers, 360° working area Outrigger base 24.61 ft														Work Radius (ft)
	Boom length (ft)														
	42.7	57.1	57.1	57.1	71.9	71.9	71.9	71.9	86.6	86.6	86.6	86.6	86.6	86.6	
10	69 260.0 ¹⁾	228.0 ¹⁾	75 194.0	75 114.0	75 104.0	79 162.0	79 114.0	79 104.0	79 96.6						10
12	66 213.5	203.0	73 192.0	73 114.0	73 104.0	77 158.0	77 114.0	77 104.0	77 91.8						12
14	63 183.5	182.5	71 179.0	71 114.0	71 104.0	75 151.5	75 114.0	75 104.0	75 86.8	78 119.5	78 114.0	78 101.5	78 81.4		14
16	60 160.5	160.5	68 158.5	68 114.0	68 104.0	73 141.0	73 114.0	73 104.0	73 81.7	77 116.5	77 114.0	77 101.5	77 78.8		16
18	57 143.5	143.5	67 141.0	67 114.0	67 101.5	72 131.5	72 114.0	72 104.0	72 76.5	76 113.5	76 111.5	76 101.5	76 76.3		18
20	53 127.0	127.0	65 125.0	65 113.0	65 98.2	71 121.0	71 113.0	71 103.5	71 71.5	75 110.0	75 108.5	75 101.5	75 73.9		20
25	44 88.4	88.4	59 86.1	59 90.2	59 87.9	66 84.4	66 91.2	66 61.4	66 61.4	71 86.4	71 90.0	71 90.3	71 67.5		25
30	30 62.8	62.8	52 60.3	52 65.0	52 65.5	62 59.5	62 65.4	62 68.2	62 54.0	68 60.6	68 64.1	68 68.0	68 61.3		30
35			45 46.3	45 50.1	45 51.5	57 45.0	57 50.5	57 52.8	57 47.8	64 46.1	64 49.2	64 52.7	64 53.6		35
40			37 36.3	37 40.1	37 41.4	51 35.0	51 40.5	51 42.5	51 41.1	60 36.3	60 39.2	60 42.5	60 44.3		40
45			25 28.7	25 32.5	25 33.8	46 27.8	46 32.7	46 35.1	46 35.3	56 28.7	56 31.6	56 34.9	56 36.9		45
50						39 22.1	39 27.1	39 29.4	39 29.8	51 23.0	51 26.0	51 29.1	51 30.8		50
55						32 17.5	32 22.5	32 24.7	32 25.1	47 18.3	47 21.4	47 24.5	47 26.0		55
60						23 13.6	23 18.7	23 20.6	23 21.1	42 14.7	42 17.7	42 20.8	42 22.2		60
65										36 11.8	36 14.7	36 17.8	36 19.3		65
70										29 9.5	29 12.3	29 15.4	29 16.9		70
75										22 7.4	22 9.9	22 13.0	22 14.5		75
80															80
85															85
90															90
95															95
100															100
110															110
120															120
130															130
140															140
150															150
Telescoping sequence %															
Tel. 1	0		46	0	0	92	46	0	0	92	46	0	0		Tel. 1
Tel. 2	0		0	0	0	0	46	0	0	46	46	46	0		Tel. 2
Tel. 3	0		0	46	0	0	0	46	0	46	46	46	46		Tel. 3
Tel. 4	0		0	0	46	0	0	46	92	0	0	46	92		Tel. 4

1) Over rear with superstructure pin engaged

*With additional lifting equipment.

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 0 lbs

Work Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on telescopic boom On outriggers, 360° working area Outrigger base 24.61 ft														Work Radius (ft)
	Boom length (ft)														
	42.7	57.1	57.1	57.1	71.9	71.9	71.9	71.9	86.6	86.6	86.6	86.6	86.6	86.6	
10	69 235.0 ¹⁾	217.5 ¹⁾	75 194.0	75 114.0	75 104.0	79 162.0	79 114.0	79 104.0	79 96.6						10
12	66 198.5	195.0	73 189.0	73 114.0	73 104.0	77 158.0	77 114.0	77 104.0	77 91.8						12
14	63 170.5	170.5	71 168.5	71 114.0	71 104.0	75 151.5	75 114.0	75 104.0	75 86.8	78 119.5	78 114.0	78 101.5	78 81.4		14
16	60 149.0	149.0	68 147.0	68 114.0	68 104.0	73 141.0	73 114.0	73 104.0	73 81.7	77 116.5	77 114.0	77 101.5	77 78.8		16
18	57 126.5	126.5	67 124.0	67 114.0	67 101.5	72 121.0	72 114.0	72 104.0	72 76.5	76 110.4	76 111.5	76 101.5	76 76.3		18
20	53 104.5	104.5	65 101.5	65 110.9	65 97.2	71 100.0	71 110.9	71 102.0	71 71.5	75 101.7	75 106.5	75 100.0	75 73.9		20
25	44 66.8	66.6	59 64.3	59 69.3	59 71.0	66 62.8	66 69.8	66 73.0	66 61.4	71 64.2	71 68.2	71 72.7	71 67.5		25
30	30 46.9	45.8	52 43.5	52 48.2	52 49.9	62 41.9	62 48.6	62 51.7	62 51.2	68 43.5	68 47.2	68 51.5	68 53.7		30
35			45 31.3	45 35.3	45 36.7	57 30.0	57 35.8	57 38.5	57 38.9	64 31.3	64 34.5	64 38.3	64 40.5		35
40			37 23.5	37 27.5	37 28.6	51 22.0	51 27.5	51 30.1	51 30.5	60 23.3	60 26.6	60 29.9	60 31.9		40
45			25 17.4	25 21.4	25 22.7	46 16.1	46 21.8	46 24.1	46 24.5	56 17.4	56 20.5	56 24.0	56 25.8		45
50						39 11.4	39 17.2	39 19.6	39 20.0	51 12.6	51 16.0	51 19.5	51 21.3		50
55						32 7.7	32 13.5	32 16.0	32 16.3	47 8.9	47 12.3	47 15.7	47 17.6		55
60						23 4.7	23 10.5	23 12.8	23 13.3	42 6.2	42 9.3	42 12.6	42 14.5		60
65										36 4.0	36 6.9	36 10.2	36 12.2		65
70										29 5.0	29 8.2	29 10.1	29 11.1		70
75										22 3.1	22 6.1	22 8.1	22 9.1		75
80															80
85															85
90															90
95															95
100															100
110															110
120															120
130															130
140															140
150															150
Telescoping sequence %															
Tel. 1	0		46	0	0	92	46	0	0	92	46	0	0		Tel. 1
Tel. 2	0		0	0	0	0	46	0	0	46	46	46	46		Tel. 2
Tel. 3	0		0	46	0	0	0	46	0	46	46	46	46		Tel. 3
Tel. 4	0		0	0	46	0	0	46	92	0	0	46	92		Tel. 4

1) Over rear with superstructure pin engaged

*With additional lifting equipment.

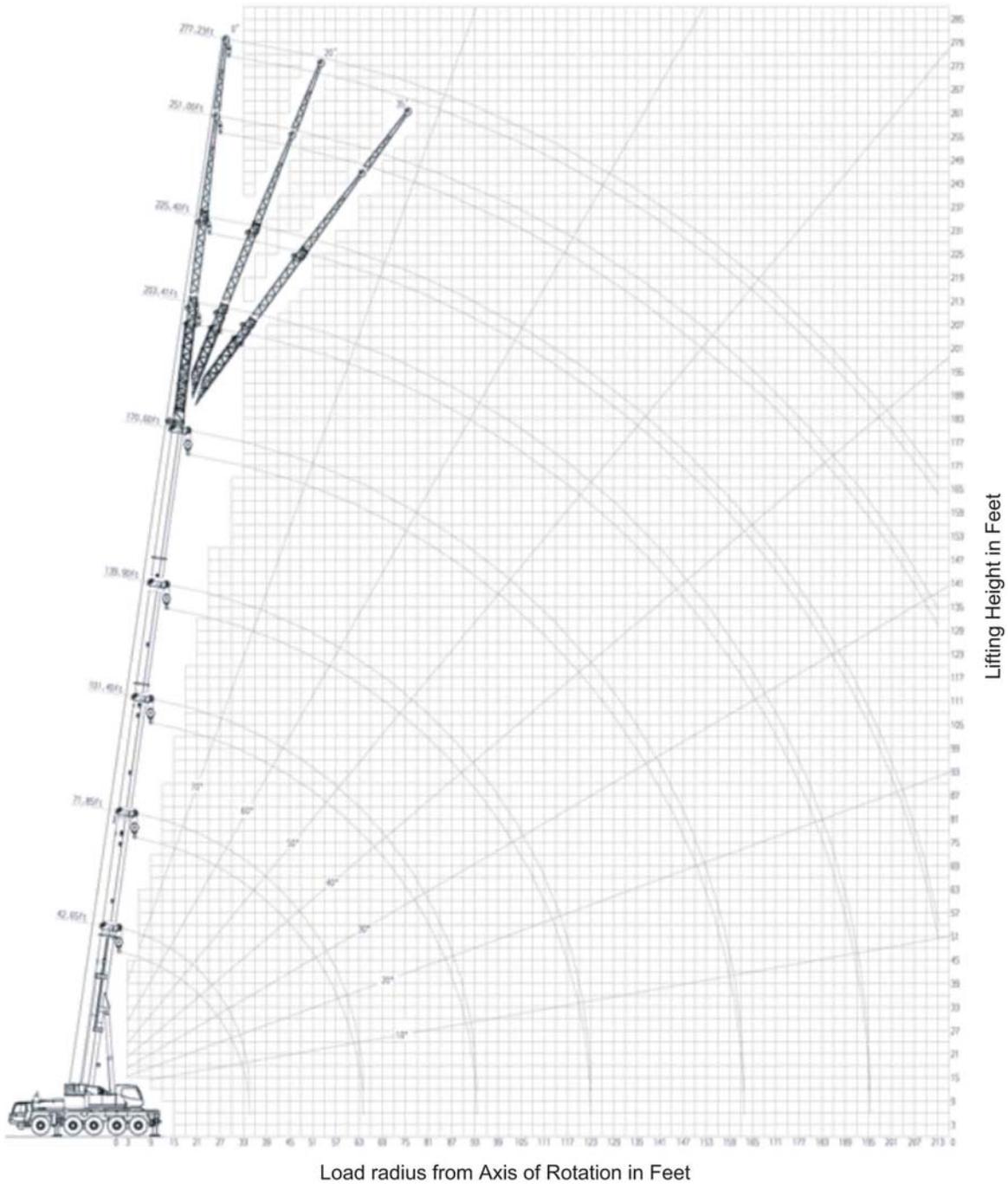
Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 0 lbs

Work. Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on telescopic boom On outriggers, 360° working area Outrigger base 16.40 ft												Work. Radius (ft)					
	Boom length (ft)																	
	42.7	57.1	57.1	57.1	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9						
10	69	161.0	75	127.0	75	114.0	75	104.3	79	103.3	79	111.9	79	104.0	79	96.6	10	
12	66	114.0	73	93.4	73	105.0	73	99.3	77	79.0	77	87.4	77	96.7	77	91.8	12	
14	63	86.1	71	72.5	71	78.4	71	80.8	75	62.0	75	70.2	75	73.8	75	78.1	14	
16	60	68.6	68	57.8	68	63.0	68	65.6	73	50.0	73	57.6	73	61.1	73	61.6	16	
18	57	57.1	67	48.1	67	53.1	67	55.4	72	41.9	72	48.8	72	52.1	72	52.8	18	
20	53	46.8	65	39.9	65	44.7	65	46.6	71	34.9	71	41.1	71	44.1	71	45.0	20	
25	44	29.5	59	26.9	59	31.3	59	32.7	66	23.4	66	29.4	66	32.2	66	32.8	25	
30	30	19.6	52	17.7	52	21.6	52	22.9	62	16.0	62	21.7	62	24.3	62	24.7	30	
35			45	11.7	45	15.4	45	16.6	57	10.6	57	15.7	57	18.0	57	18.4	35	
40			37	7.8	37	11.3	37	12.4	51	6.7	51	11.5	51	13.7	51	14.1	40	
45			25	4.8	25	8.1	25	9.2	46	3.6	46	8.3	46	10.5	46	10.8	45	
50												39	5.9	39	8.0	39	8.4	50
55												32	4.0	32	6.0	32	6.3	55
60												23	2.3	23	4.3	23	4.5	60
65																		65
70																		70
75																		75
80																		80
85																		85
90																		90
95																		95
100																		100
110																		110
120																		120
130																		130
140																		140
150																		150
Telescoping sequence %																		
Tel. 1	0		46	0	0	92	46	0	0	0	0	0	0	0	0	0	0	Tel. 1
Tel. 2	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	Tel. 2
Tel. 3	0	0	0	46	0	0	0	0	0	46	0	46	0	46	0	0	0	Tel. 3
Tel. 4	0	0	0	0	46	0	0	0	0	46	92	46	92	46	92	46	92	Tel. 4

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

ATF110G-5 WORKING RANGE CHART



NOTE: Boom and jib geometry shown are for unloaded condition and machine standing level on firm supporting surface. Boom deflection and subsequent radius and boom angle change must be accounted for when applying load to hook.

Counterweight 63,490 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)												
	On outriggers, 360° working area																								
	Outrigger base 24.81 ft																								
	Boom length 42.7 ft to 160.4 ft																								
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset															
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°													
35	79	17.0												35											
40	78	17.0	81	17.0										40											
45	76	17.0	79	17.0										45											
50	75	17.0	78	16.7										50											
55	74	17.0	76	16.3	78	12.7	76	12.3	80	10.9				79	7.7			55							
60	73	17.0	75	15.9	77	12.3	75	12.3	79	10.9				82	7.0			79	5.6	56					
65	71	17.0	74	15.6	75	11.9	73	12.3	77	10.7				75	7.7	81	6.8		76	5.6	56				
70	70	17.0	73	15.2	74	11.8	72	12.3	76	10.3	79	7.1		74	7.7	80	6.4		75	5.6	56				
75	68	16.5	71	14.7	72	11.4	71	12.3	75	10.0	77	7.0		73	7.6	79	6.0		75	5.6	81	4.7	56		
80	67	15.8	70	14.2	71	11.1	70	12.3	74	9.6	76	6.8		72	7.4	78	5.8		74	5.6	80	4.5	56		
85	65	15.2	68	13.6	69	10.9	68	12.1	72	9.3	75	6.5	71	7.2	76	5.5			73	5.3	79	4.3	56		
90	64	14.6	66	13.1	68	10.8	67	11.8	71	8.9	74	6.3	70	7.0	75	5.3	79	3.9		72	5.2	78	4.0	56	
95	62	14.0	64	12.6	66	10.6	66	11.5	69	8.5	72	6.2	69	6.7	74	5.1	78	3.8	71	5.1	77	3.8	56		
100	61	13.4	63	12.2	65	10.4	65	11.2	68	8.2	71	6.1	68	6.3	73	4.9	77	3.7	70	4.9	76	3.7	81	2.6	100
110	57	11.7	59	11.5	61	10.0	64	10.1	64	7.6	67	5.9	64	5.7	69	4.6	73	3.6	67	4.4	73	3.4	78	2.5	110
120	53	9.5	55	10.2	57	9.6	58	9.3	61	7.2	64	5.7	62	5.1	67	4.2	71	3.4	65	3.9	71	3.1	75	2.3	120
130	49	7.7	52	8.3	53	8.5	55	8.6	58	6.8	60	5.5	59	4.7	64	3.9	68	3.3	62	3.5	68	2.9	73	2.2	130
140	46	5.9	47	6.5	48	6.6	51	7.4	55	6.3	57	5.3	56	4.3	61	3.7	65	3.2	60	3.2	66	2.6	70	2.1	140
150	40	4.7	42	5.0	43	5.0	48	6.0	51	6.1	53	5.2	53	3.9	58	3.4	62	3.1	57	2.8	63	2.4	67	2.0	150
160	34	3.3	36	3.6	36	3.6	44	4.8	47	5.3	49	5.0	50	3.6	55	3.3	58	2.9	55	2.6	60	2.3	64	2.0	160
170	27	2.5	29	2.5	29	2.4	39	3.7	42	4.1	44	4.2	47	3.3	52	3.1	55	2.9	52	2.3	57	2.1			170
180	18	1.8	19	1.8			34	2.7	37	3.1	38	3.1	44	3.1	49	2.8	51	2.8	49	2.2	54	2.0			180
190							28	2.0	31	2.0	30	2.0	40	2.4	44	2.7	47	2.7	46	2.0					190
200													36	1.8	40	2.3	42	2.5							200
210																									210
220																									220
230																									230
240																									240
250																									250
Telescoping sequence %																									
Tel. 1													92				Tel. 1								
Tel. 2													92				Tel. 2								
Tel. 3													92				Tel. 3								
Tel. 4													92				Tel. 4								

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 63,490 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)												
	On outriggers, 360° working area																								
	Outrigger base 24.81 ft																								
	Boom length 43.3 ft to 170.6 ft																								
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset															
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°													
35	80	14.6												35											
40	79	14.6												40											
45	77	14.6												45											
50	76	14.6	79	14.6										50											
55	75	14.6	77	14.6	79	12.9	77	10.9						78	7.3			79	5.1	51	56				
60	74	14.6	76	14.6	78	12.5	76	10.9	79	9.7				77	7.3			78	5.1	51	56				
65	72	14.6	75	14.6	77	12.2	74	10.9	78	9.7				76	7.3			77	5.1	51	56				
70	71	14.6	74	14.4	76	12.0	73	10.9	77	9.4				75	7.3	80	6.5		76	5.1	51	56			
75	70	14.6	72	14.0	74	11.7	72	10.9	76	9.0	78	6.1	74	7.3	79	6.1			76	5.1	82	4.8	56		
80	69	14.3	71	13.5	73	11.3	71	10.9	75	8.6	77	5.9	73	7.2	78	5.9			75	5.1	81	4.6	56		
85	67	13.5	69	12.8	71	11.1	69	10.9	73	8.3	76	5.7	72	7.1	77	5.7			73	5.1	80	4.3	56		
90	66	12.7	68	12.1	70	10.8	68	10.8	72	8.1	75	5.7	71	7.0	76	5.4			72	5.0	79	4.1	56		
95	64	11.9	66	11.4	68	10.6	67	10.4	70	7.8	73	5.5	70	6.8	75	5.2	79	3.9	72	5.0	78	3.9	56		
100	63	11.1	65	10.7	67	10.3	66	10.0	69	7.4	72	5.3	69	6.6	74	5.0	78	3.8	71	4.9	77	3.7	81	2.6	100
110	59	9.8	61	9.5	63	9.4	62	8.9	66	7.0	68	5.1	66	5.9	71	4.7	75	3.6	68	4.6	74	3.5	78	2.5	110
120	55	8.7	58	8.4	59	8.4	60	8.0	63	6.4	65	4.9	64	5.4	69	4.4	72	3.5	66	4.0	72	3.2	76	2.4	120
130	52	7.5	54	7.5	56	7.5	57	7.1	60	6.1	62	4.8	61	4.9	66	4.0	69	3.3	64	3.7	70	2.9	74	2.2	130
140	48	5.9	50	6.5	52	6.6	54	6.4	57	5.8	59	4.6	59	4.5	63	3.8	67	3.3	62	3.3	67	2.7	72	2.2	140
150	44	4.5	46	4.9	47	5.0	50	5.7	54	5.5	56	4.5	56	4.1	61	3.5	64	3.1	59	3.1	65	2.5	69	2.1	150
160	39	3.3	41	3.6	42	3.7	47	4.6	50	5.0	52	4.4	53	3.8	58	3.4	61	3.0	57	2.7	62	2.4	66	2.0	160
170	33	2.4	36	2.5	36	2.5	43	3.5	46	3.9	48	4.1	50	3.5	55	3.2	58	2.9	54	2.4	60	2.2			170
180			29	1.8	29	1.8	39	2.6	42	3.0	43	3.1	47	3.1	52	3.0	54	2.8	52	2.3	57	2.0			180
190							34	1.8	37	2.2	37	2.2	44	2.4	48	2.9	50	2.8	49	2.1	54	2.0			190
200													40	1.8	45	2.2	47	2.4	46	1.9					200
210																									210
220																									220
230																									230
240																									240
250																									250
Telescoping sequence %																									
Tel. 1													100				Tel. 1								
Tel. 2													100				Tel. 2								
Tel. 3													100				Tel. 3								
Tel. 4													100				Tel. 4								

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 45,855 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)													
	On outriggers, 360° working area																									
	Outrigger base 24.61 ft																									
	Boom length 42.7 ft to 160.4 ft																									
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset																
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°														
35	79	17.0												35												
40	78	17.0	81	17.0										40												
45	76	17.0	79	17.0										45												
50	75	17.0	78	16.7										50												
55	74	17.0	76	16.3	78	12.7	76	12.3	80	10.9				55												
60	73	17.0	75	15.9	77	12.3	75	12.3	79	10.9				60												
65	71	17.0	74	15.6	75	11.9	73	12.3	77	10.7				65												
70	70	17.0	73	15.2	74	11.8	72	12.3	76	10.3	79	7.1		70												
75	68	16.5	71	14.7	72	11.4	71	12.3	75	10.0	77	7.0	73	7.6	79	6.0	75	5.6	81	4.7	75					
80	67	15.8	70	14.2	71	11.1	70	12.3	74	9.6	76	6.8	72	7.4	78	5.8	74	5.6	80	4.5	80					
85	65	15.2	68	13.6	69	10.9	68	12.1	72	9.3	75	6.5	71	7.2	76	5.5	73	5.3	79	4.3	85					
90	64	13.9	66	13.1	68	10.8	67	11.8	71	8.9	74	6.3	70	7.0	75	5.3	79	3.9	72	5.2	78	4.0	90			
95	62	12.3	64	12.5	66	10.6	66	11.5	69	8.5	72	6.2	69	6.7	74	5.1	78	3.8	71	5.1	77	3.8	95			
100	61	10.7	63	11.6	65	10.4	65	11.2	68	8.2	71	6.1	68	6.3	73	4.9	77	3.7	70	4.9	76	3.7	81	2.6	100	
110	57	8.4	59	9.0	61	9.5	64	9.8	64	7.6	67	5.9	64	5.7	69	4.6	73	3.6	67	4.4	73	3.4	78	2.5	110	
120	53	6.5	55	6.9	57	7.4	58	7.7	61	7.2	64	5.7	62	5.1	67	4.2	71	3.4	65	3.9	71	3.1	75	2.3	120	
130	49	4.8	52	5.3	53	5.5	55	6.0	58	6.8	60	5.5	59	4.7	64	3.9	68	3.3	62	3.5	68	2.9	73	2.2	130	
140	45	3.3	47	3.6	48	3.9	51	4.6	55	5.4	57	5.3	56	4.3	61	3.7	65	3.2	60	3.2	66	2.6	70	2.1	140	
150	40	2.1	42	2.3	43	2.6	48	3.5	51	4.0	53	4.4	53	3.9	58	3.4	62	3.1	57	2.8	63	2.4	67	2.0	150	
160																										160
170																										170
180																										180
190																										190
200																										200
210																										210
220																										220
230																										230
240																										240
250																										250
Telescoping sequence %																										
Tel. 1													92	Tel. 1												
Tel. 2													92	Tel. 2												
Tel. 3													92	Tel. 3												
Tel. 4													92	Tel. 4												

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 48,855 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)													
	On outriggers, 360° working area																									
	Outrigger base 24.61 ft																									
	Boom length 43.3 ft to 170.6 ft																									
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset																
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°														
35	80	14.6												35												
40	79	14.6												40												
45	77	14.6												45												
50	76	14.6	79	14.6										50												
55	75	14.6	77	14.6	79	12.9	77	10.9						55												
60	74	14.6	76	14.6	78	12.5	76	10.9	79	9.7				60												
65	72	14.6	75	14.6	77	12.2	74	10.9	78	9.7				65												
70	71	14.6	74	14.4	76	12.0	73	10.9	77	9.4				70												
75	70	14.6	72	14.0	74	11.7	72	10.9	76	9.0	78	6.1	74	7.3	79	6.1	76	5.1	82	4.8	75					
80	69	14.3	71	13.5	73	11.3	71	10.9	75	8.6	77	5.9	73	7.2	78	5.9	75	5.1	81	4.6	80					
85	67	13.5	69	12.8	71	11.1	69	10.9	73	8.3	76	5.7	72	7.1	77	5.7	73	5.1	80	4.3	85					
90	66	12.7	68	12.1	70	10.8	68	10.8	72	8.1	75	5.7	71	7.0	76	5.4	72	5.0	79	4.1	90					
95	64	11.8	66	11.4	68	10.6	67	10.4	70	7.8	73	5.5	70	6.8	75	5.2	79	3.9	72	5.0	78	3.9	95			
100	63	10.7	65	10.7	67	10.3	66	10.0	69	7.4	72	5.3	69	6.6	74	5.0	78	3.8	71	4.9	77	3.7	81	2.6	100	
110	59	8.4	61	9.0	63	9.3	62	8.9	66	7.0	68	5.1	66	5.9	71	4.7	75	3.6	68	4.6	74	3.5	78	2.5	110	
120	55	6.2	58	6.9	59	7.4	60	7.7	63	6.4	65	4.9	64	5.4	69	4.4	72	3.5	66	4.0	72	3.2	76	2.4	120	
130	52	4.6	54	5.1	56	5.5	57	5.8	60	6.1	62	4.8	61	4.9	66	4.0	69	3.3	64	3.7	70	2.9	74	2.2	130	
140	48	3.2	50	3.6	52	3.9	54	4.5	57	5.3	59	4.6	59	4.5	63	3.8	67	3.3	62	3.3	67	2.7	72	2.2	140	
150	44	2.1	46	2.3	47	2.6	50	3.2	54	4.0	56	4.4	56	3.9	61	3.5	64	3.1	59	3.1	65	2.5	69	2.1	150	
160																										160
170																										170
180																										180
190																										190
200																										200
210																										210
220																										220
230																										230
240																										240
250																										250
Telescoping sequence %																										
Tel. 1													100	Tel. 1												
Tel. 2													100	Tel. 2												
Tel. 3													100	Tel. 3												
Tel. 4													100	Tel. 4												

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 24,250 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)												
	On outriggers, 360° working area																								
	Outrigger base 24.61 ft																								
	Boom length 42.7 ft to 160.4 ft																								
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset															
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°													
35	79	17.0												35											
40	78	17.0	81	17.0										40											
45	76	17.0	79	17.0										45											
50	75	17.0	78	16.7										50											
55	74	17.0	76	16.3	78	12.7	76	12.3	80	10.9				55											
60	73	17.0	75	15.9	77	12.3	75	12.3	79	10.9				60											
65	71	17.0	74	15.6	75	11.9	73	12.3	77	10.7				65											
70	70	15.5	73	15.2	74	11.8	72	12.3	76	10.3	79	7.1		70											
75	68	13.6	71	14.3	72	11.4	71	12.3	75	10.0	77	7.0	73	7.6	79	6.0	75	5.6	81	4.7	75				
80	67	11.7	70	12.9	71	11.1	70	12.1	74	9.6	76	6.8	72	7.4	78	5.8	74	5.6	80	4.5	80				
85	65	9.8	68	11.0	69	10.9	68	11.2	72	9.3	75	6.5	71	7.2	76	5.5	73	5.3	79	4.3	85				
90	64	8.5	66	9.5	68	10.0	67	9.8	71	8.9	74	6.3	70	7.0	75	5.3	79	3.9	72	5.2	78	4.0	90		
95	62	7.2	64	8.1	66	8.8	66	8.5	69	8.5	72	6.2	69	6.7	74	5.1	78	3.8	71	5.1	77	3.8	95		
100	61	5.9	63	6.9	65	7.4	65	7.4	68	8.1	71	6.1	68	6.3	73	4.9	77	3.7	70	4.9	76	3.7	81	2.6	100
110	57	3.9	59	4.7	61	5.2	64	5.4	64	6.6	67	5.9	64	5.7	69	4.6	73	3.6	67	4.4	73	3.4	78	2.5	110
120	53	2.4	55	3.1	57	3.4	58	3.8	61	4.8	64	5.5	62	4.6	67	4.2	71	3.4	65	3.9	71	3.1	75	2.3	120
130					53	2.0	55	2.4	58	3.4	60	4.0	59	3.1	64	3.9	68	3.3	62	3.5	68	2.9	73	2.2	130
140									55	2.2	57	2.6	56	2.0	61	3.2	65	3.2	60	2.4	66	2.6	70	2.1	140
150															58	2.1	62	2.9			63	2.4	67	2.0	150
160																	58	2.0					64	2.0	160
170																									170
180																									180
190																									190
200																									200
210																									210
220																									220
230																									230
240																									240
250																									250
Telescoping sequence %																									
Tel. 1													92	Tel. 1											
Tel. 2													92	Tel. 2											
Tel. 3													92	Tel. 3											
Tel. 4													92	Tel. 4											

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 24,250 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)												
	On outriggers, 360° working area																								
	Outrigger base 24.61 ft																								
	Boom length 43.3 ft to 170.6 ft																								
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset															
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°													
35	80	14.6												35											
40	79	14.6												40											
45	77	14.6												45											
50	76	14.6	79	14.6		78	10.9							50											
55	75	14.6	77	14.6	79	12.9	77	10.9						55											
60	74	14.6	76	14.6	78	12.5	76	10.9	79	9.7				60											
65	72	14.6	75	14.6	77	12.2	74	10.9	78	9.7				65											
70	71	14.6	74	14.4	76	12.0	73	10.9	77	9.4				70											
75	70	13.4	72	14.0	74	11.7	72	10.9	76	9.0	78	6.1	74	7.3	79	6.1	76	5.1	82	4.8	75				
80	69	11.5	71	12.9	73	11.3	71	10.9	75	8.6	77	5.9	73	7.2	78	5.9	75	5.1	81	4.6	80				
85	67	9.8	69	11.0	71	11.1	69	10.9	73	8.3	76	5.7	72	7.1	77	5.7	73	5.1	80	4.3	85				
90	66	8.3	68	9.5	70	10.1	68	9.7	72	8.1	75	5.7	71	7.0	76	5.4	72	5.0	79	4.1	90				
95	64	7.0	66	8.0	68	8.8	67	8.4	70	7.8	73	5.5	70	6.8	75	5.2	79	3.9	72	5.0	78	3.9	95		
100	63	5.9	65	6.7	67	7.4	66	7.2	69	7.4	72	5.3	69	6.6	74	5.0	78	3.8	71	4.9	77	3.7	81	2.6	100
110	59	3.9	61	4.7	63	5.2	62	5.1	66	6.5	68	5.1	66	5.8	71	4.7	75	3.6	68	4.6	74	3.5	78	2.5	110
120	55	2.4	58	2.9	59	3.4	60	3.6	63	4.8	65	4.9	64	4.3	69	4.4	72	3.5	66	4.0	72	3.2	76	2.4	120
130					56	1.8	57	2.3	60	3.4	62	4.0	61	3.0	66	4.0	69	3.3	64	3.3	70	2.9	74	2.2	130
140									57	1.9	59	2.6			63	3.2	67	3.3	62	2.2	67	2.7	72	2.2	140
150															61	2.1	64	2.7			65	2.5	69	2.1	150
160																							66	2.0	160
170																									170
180																									180
190																									190
200																									200
210																									210
220																									220
230																									230
240																									240
250																									250
Telescoping sequence %																									
Tel. 1													100	Tel. 1											
Tel. 2													100	Tel. 2											
Tel. 3													100	Tel. 3											
Tel. 4													100	Tel. 4											

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 19,180 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)													
	On outriggers, 360° working area																									
	Outrigger base 24.61 ft																									
	Boom length 42.7 ft to 160.4 ft																									
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset																
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°														
35	79	17.0												35												
40	78	17.0	81	17.0										40												
45	76	17.0	79	17.0										45												
50	75	17.0	78	16.7										50												
55	74	17.0	76	16.3	78	12.7	76	12.3	80	10.9				55												
60	73	16.9	75	15.9	77	12.3	75	12.3	79	10.9				60												
65	71	16.5	74	15.6	75	11.9	73	12.3	77	10.7				65												
70	70	14.2	73	14.9	74	11.8	72	12.3	76	10.3	79	7.1		70												
75	68	12.1	71	13.4	72	11.4	71	12.3	75	10.0	77	7.0	73	7.6	79	6.0	75	5.6	81	4.7	75					
80	67	10.3	70	11.4	71	11.0	70	11.7	74	9.6	76	6.8	72	7.4	78	5.8	74	5.6	80	4.5	80					
85	65	8.6	68	9.6	69	10.5	68	10.0	72	9.3	75	6.5	71	7.2	76	5.5	73	5.3	79	4.3	85					
90	64	7.1	66	8.2	68	9.1	67	8.6	71	8.9	74	6.3	70	7.0	75	5.3	72	5.2	78	4.0	90					
95	62	5.8	64	6.9	66	7.7	66	7.3	69	8.3	72	6.2	69	6.7	74	5.1	78	3.8	71	5.1	77	3.8	95			
100	61	4.8	63	5.7	65	6.4	65	6.2	68	7.6	71	6.1	68	6.3	73	4.9	77	3.7	70	4.9	76	3.7	81	2.6	100	
110	57	2.9	59	3.7	61	4.1	64	4.4	64	5.6	67	5.9	64	5.1	69	4.6	73	3.6	67	4.4	73	3.4	78	2.5	110	
120			55	2.2	57	2.6	58	2.9	61	3.8	64	4.7	62	3.6	67	4.2	71	3.4	65	3.8	71	3.1	75	2.3	120	
130									60	3.1	63	3.1	60	2.3	64	3.7	68	3.3	62	2.6	68	2.9	73	2.2	130	
140									57	2.1	61	2.4	65	3.1	65	3.1	62	2.3	66	2.6	70	2.1	70	2.1	140	
150																										150
160																										160
170																										170
180																										180
190																										190
200																										200
210																										210
220																										220
230																										230
240																										240
250																										250
Telescoping sequence %																										
Tel. 1													92	Tel. 1												
Tel. 2													92	Tel. 2												
Tel. 3													92	Tel. 3												
Tel. 4													92	Tel. 4												

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 19,180 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)													
	On outriggers, 360° working area																									
	Outrigger base 24.61 ft																									
	Boom length 43.3 ft to 170.6 ft																									
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset																
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°														
35	80	14.6												35												
40	79	14.6												40												
45	77	14.6												45												
50	76	14.6	79	14.6		78	10.9							50												
55	75	14.6	77	14.6	79	12.9	77	10.9						55												
60	74	14.6	76	14.6	78	12.5	76	10.9	79	9.7				60												
65	72	14.6	75	14.6	77	12.2	74	10.9	78	9.7				65												
70	71	13.6	74	14.4	76	12.0	73	10.9	77	9.4				70												
75	70	12.0	72	13.2	74	11.7	72	10.9	76	9.0	78	6.1	74	7.3	79	6.1	76	5.1	82	4.8	75					
80	69	10.0	71	11.3	73	11.2	71	10.7	75	8.6	77	5.9	73	7.2	78	5.9	75	5.1	81	4.6	80					
85	67	8.4	69	9.5	71	10.5	69	9.8	73	8.3	76	5.7	72	7.1	77	5.7	73	5.1	80	4.3	85					
90	66	7.0	68	8.0	70	9.1	68	8.5	72	8.1	75	5.7	71	7.0	76	5.4	72	5.0	79	4.1	90					
95	64	5.8	66	6.8	68	7.5	67	7.2	70	7.8	73	5.5	70	6.8	75	5.2	79	3.9	72	5.0	78	3.9	95			
100	63	4.8	65	5.7	67	6.2	66	6.0	69	7.3	72	5.3	69	6.5	74	5.0	78	3.8	71	4.9	77	3.7	81	2.6	100	
110	59	2.9	61	3.7	63	4.1	62	4.1	66	5.4	68	5.1	66	4.9	71	4.7	75	3.6	68	4.6	74	3.5	78	2.5	110	
120			58	2.2	59	2.4	60	2.6	63	3.8	65	4.6	64	3.4	69	4.4	72	3.5	66	3.6	72	3.2	76	2.4	120	
130									60	2.4	62	3.1	61	2.1	66	3.5	69	3.3	64	2.4	70	2.9	74	2.2	130	
140															63	2.4	67	3.2	64	2.4	70	2.9	74	2.2	140	
150																										150
160																										160
170																										170
180																										180
190																										190
200																										200
210																										210
220																										220
230																										230
240																										240
250																										250
Telescoping sequence %																										
Tel. 1													100	Tel. 1												
Tel. 2													100	Tel. 2												
Tel. 3													100	Tel. 3												
Tel. 4													100	Tel. 4												

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 77,160 lbs

Working Radius (ft)		Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft On outriggers, 360° working area Outrigger base 16.40 ft Boom length 42.7 ft to 160.4 ft												Working Radius (ft)							
		Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset										
		0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°								
35	79	17.0																	35		
40	78	17.0	81	17.0															40		
45	76	17.0	79	17.0															45		
50	75	17.0	78	16.7															50		
55	74	17.0	76	16.3	78	12.7	76	12.3	80	10.9									55		
60	73	17.0	75	15.9	77	12.3	75	12.3	79	10.9									60		
65	71	17.0	74	15.6	75	11.9	73	12.3	77	10.7									65		
70	70	17.0	73	15.2	74	11.8	72	12.3	76	10.3	79	7.1	74	7.7	80	6.4			70		
75	68	16.3	71	14.7	72	11.4	71	12.3	75	10.0	77	7.0	73	7.6	79	6.0			75		
80	67	14.9	70	14.2	71	11.1	70	12.3	74	9.6	76	6.8	72	7.4	78	5.8			80		
85	65	13.1	68	13.6	69	10.9	68	12.1	72	9.3	75	6.5	71	7.2	76	5.5			85		
90	64	11.6	66	12.5	68	10.8	67	11.8	71	8.9	74	6.3	70	7.0	75	5.3	79	3.9	90		
95	62	10.3	64	11.1	66	10.6	66	11.2	69	8.5	72	6.2	69	6.7	74	5.1	78	3.8	95		
100	61	9.1	63	9.8	65	10.1	65	10.2	68	8.2	71	6.1	68	6.3	73	4.9	77	3.7	100		
110	57	6.9	59	7.6	61	8.0	64	8.2	64	7.6	67	5.9	64	5.7	69	4.6	73	3.6	110		
120	53	5.3	55	5.9	57	6.1	58	6.5	61	7.1	64	5.7	62	5.1	67	4.2	71	3.4	120		
130	49	3.9	52	4.4	53	4.6	55	5.0	58	5.9	60	5.5	59	4.7	64	3.9	68	3.3	130		
140	45	2.6	47	3.0	48	3.2	51	3.7	55	4.6	57	4.9	56	4.2	61	3.7	65	3.2	140		
150			42	1.9	43	2.1	48	2.7	51	3.4	53	3.7	53	3.4	58	3.4	62	3.1	150		
160									47	2.4	49	2.6	50	2.5	55	3.2	58	2.9	160		
170													52	2.5	55	2.8	52	2.0	170		
180															51	2.0			180		
190																			190		
200																			200		
210																			210		
220																			220		
230																			230		
240																			240		
250																			250		
Telescoping sequence %																					
Tel. 1		92																		Tel. 1	
Tel. 2		92																		Tel. 2	
Tel. 3		92																		Tel. 3	
Tel. 4		92																		Tel. 4	

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 77,160 lbs

Working Radius (ft)		Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft On outriggers, 360° working area Outrigger base 16.40 ft Boom length 43.3 ft to 170.6 ft												Working Radius (ft)							
		Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset										
		0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°								
35	80	14.6																		35	
40	79	14.6																		40	
45	77	14.6																		45	
50	76	14.6	79	14.6																50	
55	75	14.6	77	14.6	79	12.9	77	10.9												55	
60	74	14.6	76	14.6	78	12.5	76	10.9	79	9.7										60	
65	72	14.6	75	14.6	77	12.2	74	10.9	78	9.7										65	
70	71	14.6	74	14.4	76	12.0	73	10.9	77	9.4										70	
75	70	14.6	72	14.0	74	11.7	72	10.9	76	9.0	78	6.1	74	7.3	79	6.1				75	
80	69	14.2	71	13.5	73	11.3	71	10.9	75	8.6	77	5.9	73	7.2	78	5.9				80	
85	67	13.0	69	12.8	71	11.1	69	10.9	73	8.3	76	5.7	72	7.1	77	5.7				85	
90	66	11.6	68	12.1	70	10.8	68	10.8	72	8.1	75	5.7	71	7.0	76	5.4				90	
95	64	10.2	66	11.0	68	10.6	67	10.4	70	7.8	73	5.5	70	6.8	75	5.2	79	3.9	95		
100	63	8.9	65	9.8	67	10.1	66	9.9	69	7.4	72	5.3	69	6.6	74	5.0	78	3.8	100		
110	59	6.9	61	7.6	63	8.0	62	8.0	66	7.0	68	5.1	66	5.9	71	4.7	75	3.6	110		
120	55	5.2	58	5.9	59	6.1	60	6.4	63	6.4	65	4.9	64	5.4	69	4.4	72	3.5	120		
130	52	3.7	54	4.4	56	4.6	57	4.8	60	5.7	62	4.8	61	4.9	66	4.0	69	3.3	130		
140	48	2.6	50	3.0	52	3.2	54	3.7	57	4.4	59	4.6	59	4.2	63	3.8	67	3.3	140		
150			46	1.9	47	2.1	50	2.7	54	3.2	56	3.7	56	3.2	61	3.5	64	3.1	150		
160									50	2.3	52	2.6	53	2.3	58	3.2	61	3.0	160		
170															55	2.3	58	2.8	170		
180																	54	2.0	180		
190																			190		
200																			200		
210																			210		
220																			220		
230																			230		
240																			240		
250																			250		
Telescoping sequence %																					
Tel. 1		100																		Tel. 1	
Tel. 2		100																		Tel. 2	
Tel. 3		100																		Tel. 3	
Tel. 4		100																		Tel. 4	

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 63,490 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)		
	On outriggers, 360° working area														
	Outrigger base 16.40 ft														
	Boom length 42.7 ft to 160.4 ft														
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset					
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°			
35	79	17.0											35		
40	78	17.0	81	17.0									40		
45	76	17.0	79	17.0									45		
50	75	17.0	78	16.7			77	12.3		78	7.7		50		
55	74	17.0	76	16.3	78	12.7	76	12.3	80	10.9		77	7.7	55	
60	73	17.0	75	15.9	77	12.3	75	12.3	79	10.9		76	7.7	60	
65	71	17.0	74	15.6	75	11.9	73	12.3	77	10.7		75	7.7	65	
70	70	15.5	73	15.2	74	11.8	72	12.3	76	10.3	79	7.1	74	7.7	70
75	68	13.8	71	14.5	72	11.4	71	12.3	75	10.0	77	7.0	73	7.6	75
80	67	12.1	70	13.3	71	11.1	70	12.2	74	9.6	76	6.8	72	7.4	80
85	65	10.5	68	11.6	69	10.9	68	11.7	72	9.3	75	6.5	71	7.2	85
90	64	9.1	66	10.1	68	10.4	67	10.4	71	8.9	74	6.3	70	7.0	90
95	62	7.9	64	8.9	66	9.4	66	9.2	69	8.5	72	6.2	69	6.7	95
100	61	6.7	63	7.2	65	8.1	65	8.1	68	8.2	71	6.1	68	6.3	100
110	57	4.9	59	5.7	61	6.0	64	6.2	64	7.3	67	5.9	64	5.7	110
120	53	3.4	55	4.0	57	4.3	58	4.6	61	5.7	64	5.7	62	5.0	120
130	49	2.1	52	2.7	53	2.9	55	3.3	58	4.2	60	4.8	59	4.0	130
140					51	2.3	55	3.0	57	3.5	56	2.9	61	3.7	140
150					51	2.0	53	2.3	53	2.0	58	3.1	62	3.1	150
160											55	2.1	58	2.6	160
170															170
180															180
190															190
200															200
210															210
220															220
230															230
240															240
250															250
Telescoping sequence %															
Tel. 1	92												Tel. 1		
Tel. 2	92												Tel. 2		
Tel. 3	92												Tel. 3		
Tel. 4	92												Tel. 4		

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 63,490 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)				
	On outriggers, 360° working area																
	Outrigger base 16.40 ft																
	Boom length 43.3 ft to 170.6 ft																
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset							
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°					
35	80	14.6											35				
40	79	14.6											40				
45	77	14.6											45				
50	76	14.6	79	14.6		78	10.9						50				
55	75	14.6	77	14.6	79	12.9	77	10.9		78	7.3		79	5.1	55		
60	74	14.6	76	14.6	78	12.5	76	10.9	79	9.7		77	7.3	78	5.1	60	
65	72	14.6	75	14.6	77	12.2	74	10.9	78	9.7		76	7.3	77	5.1	65	
70	71	14.6	74	14.4	76	12.0	73	10.9	77	9.4		75	7.3	80	6.5	70	
75	70	13.6	72	14.0	74	11.7	72	10.9	76	9.0	78	6.1	74	7.3	79	6.1	75
80	69	12.0	71	13.5	73	11.3	71	10.9	75	8.6	77	5.9	73	7.2	78	5.9	80
85	67	10.5	69	11.6	71	11.1	69	10.9	73	8.3	76	5.7	72	7.1	77	5.7	85
90	66	9.1	68	10.1	70	10.4	68	10.0	72	8.1	75	5.7	71	7.0	76	5.4	90
95	64	7.9	66	8.8	68	9.4	67	9.0	70	7.8	73	5.5	70	6.8	75	5.2	95
100	63	6.7	65	7.6	67	8.1	66	7.9	69	7.4	72	5.3	69	6.6	74	5.0	100
110	59	4.9	61	5.7	63	6.0	62	6.0	66	7.0	68	5.1	66	5.9	71	4.7	110
120	55	3.4	58	4.0	59	4.3	60	4.5	63	5.6	65	4.9	64	5.1	69	4.4	120
130	52	2.1	54	2.6	56	2.9	57	3.2	60	4.2	62	4.6	61	3.8	66	4.0	130
140					54	2.1	57	3.0	59	3.5	59	2.8	63	3.7	67	3.3	140
150					54	2.0	56	2.3	56	1.8	61	3.0	64	3.1	59	2.1	150
160											58	2.0	61	2.6			160
170																	170
180																	180
190																	190
200																	200
210																	210
220																	220
230																	230
240																	240
250																	250
Telescoping sequence %																	
Tel. 1	100												Tel. 1				
Tel. 2	100												Tel. 2				
Tel. 3	100												Tel. 3				
Tel. 4	100												Tel. 4				

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 45,855 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)		
	On outriggers, 360° working area														
	Outrigger base 16.40 ft														
	Boom length 42.7 ft to 160.4 ft														
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset					
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°			
35	79	17.0												35	
40	78	17.0	81	17.0										40	
45	76	17.0	79	17.0										45	
50	75	17.0	78	16.7			77	12.3			78	7.7		50	
55	74	16.1	76	16.3	78	12.7	76	12.3	80	10.9		77	7.7	55	
60	73	14.4	75	15.9	77	12.3	75	12.3	79	10.9		76	7.7	60	
65	71	12.6	74	14.1	75	11.9	73	12.3	77	10.7		75	7.7	65	
70	70	10.9	73	12.3	74	11.8	72	12.2	76	10.3	79	7.1	74	7.7	70
75	68	9.4	71	10.7	72	11.3	71	11.0	75	10.0	77	7.0	73	7.6	75
80	67	8.1	70	9.4	71	10.3	70	9.2	74	9.6	76	6.8	72	7.4	80
85	65	6.9	68	8.0	69	8.9	68	8.0	72	9.3	75	6.5	71	7.2	85
90	64	5.9	66	6.8	68	7.6	67	7.0	71	8.6	74	6.3	70	7.0	90
95	62	4.9	64	5.8	66	6.4	66	6.1	69	7.6	72	6.2	69	6.5	95
100	61	3.9	63	4.8	65	5.4	65	5.2	68	6.5	71	6.1	68	5.8	100
110	57	2.4	59	3.1	61	3.6	64	3.6	64	4.7	67	5.4	64	4.2	110
120					57	1.9	58	2.4	58	2.1	60	2.6	59	1.9	120
130															130
140															140
150															150
160															160
170															170
180															180
190															190
200															200
210															210
220															220
230															230
240															240
250															250
Telescoping sequence %															
Tel. 1													92	Tel. 1	
Tel. 2													92	Tel. 2	
Tel. 3													92	Tel. 3	
Tel. 4													92	Tel. 4	

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

Counterweight 45,855 lbs

Working Radius (ft)	Lifting capacities in 1,000 lbs according per SAE J765 on fly jib 31.17 ft / 53.15 ft / 79.07 ft / 98.75 ft												Working Radius (ft)		
	On outriggers, 360° working area														
	Outrigger base 16.40 ft														
	Boom length 43.3 ft to 170.6 ft														
	Fly jib 31.17 ft offset			Fly jib 53.15 ft offset			Fly jib 79.07 ft offset			Fly jib 98.75 ft offset					
	0°	20°	35°	0°	20°	35°	0°	20°	35°	0°	20°	35°			
35	80	14.6												35	
40	79	14.6												40	
45	77	14.6												45	
50	76	14.6	79	14.6			78	10.9						50	
55	75	14.6	77	14.6	79	12.9	77	10.9						55	
60	74	14.2	76	14.6	78	12.5	76	10.9	79	9.7				60	
65	72	12.2	75	14.6	77	12.2	74	10.9	78	9.7				65	
70	71	10.6	74	12.3	76	12.0	73	10.9	77	9.4				70	
75	70	9.2	72	10.4	74	11.4	72	10.1	76	9.0	78	6.1	74	7.3	75
80	69	7.9	71	9.0	73	10.3	71	8.7	75	8.6	77	5.9	73	7.2	80
85	67	6.7	69	7.8	71	8.7	69	7.6	73	8.3	76	5.7	72	7.1	85
90	66	5.7	68	6.8	70	7.5	68	6.7	72	8.1	75	5.7	71	7.0	90
95	64	4.8	66	5.8	68	6.3	67	5.9	70	6.3	73	5.5	70	6.3	95
100	63	3.9	65	4.8	67	5.2	66	5.0	69	6.3	72	5.3	69	5.3	100
110	59	2.4	61	3.1	63	3.6	62	3.5	66	4.7	68	5.1	66	4.0	110
120					59	1.9	60	2.2	63	3.3	65	3.9	64	2.7	120
130															130
140															140
150															150
160															160
170															170
180															180
190															190
200															200
210															210
220															220
230															230
240															240
250															250
Telescoping sequence %															
Tel. 1													100	Tel. 1	
Tel. 2													100	Tel. 2	
Tel. 3													100	Tel. 3	
Tel. 4													100	Tel. 4	

Operation and maintenance of this machine must be in compliance with the information provided in the "Operation and Maintenance Manual" supplied with this machine.

WARNING AND OPERATING INSTRUCTIONS FOR LIFTING CAPACITIES

GENERAL

- Total rated load shown on the TADANO load rating chart apply only to the machine as originally manufactured and normally equipped by TADANO. Modifications to the machine or use of optional equipment other than that specified can result in a reduction of capacity.
- Hydraulic cranes can be hazardous if improperly operated or maintained. Operation and maintenance of this machine must be in compliance with the information in the **Operation and Maintenance Manual** supplied with the crane. If this manual is missing, order replacement through the distributor.
- The operator and other personnel associated with this machine shall fully acquaint themselves with the latest applicable American National Standards Institute (ANSI) safety standards for cranes.

SET UP

- Total rated loads shown on the TADANO load rating chart are the maximum allowable crane capacities. They are based on the machine standing level on firm supporting surface under ideal job conditions. Depending on the nature of the supporting surface, it may be necessary to have structural supports under the outrigger floats to spread the load to a larger bearing surface.
- For an outrigger operation, outriggers shall be extended to the dimension according to the TADANO LOAD RATING CHART and secured by pins with tires free of supporting surface, before operating crane.
- Working on tires are travelling with load is not allowed.
- The weight of the auxiliary winch with 3,100 lbs is taken into account as a part of counterweight. Therefore the auxiliary winch must be attached always at the superstructure for crane operation.

OPERATION

- Total rated loads with outriggers fully extended do not exceed 85% of the tipping loads. Total rated loads with outriggers half extended are determined from the formula:
total rated load = (tipping load - 0.1 tip reaction) / 1.25
- The crane's structural steelwork is in accordance with DIN 15018, part 3. Design and construction of the crane comply with DIN 15018, part 2 and with F.E.M. regulations.
- Total rated loads above the bold lines in the TADANO load rating chart are based on crane strength and those below the bold lines on crane stability.
- Total rated loads include the weight of main hook block, auxiliary hook ball, sling and other auxiliary lifting devices and all their weights shall be subtracted from the listed capacities to obtain the net load to be lifted.

Hookball/ Hookblock(ton)	11.0	27.5										
No. of parts of line	1	2	3									
Max. lifting capacity (ton)	8.8	18.7	27.5									
Weight (lbs.)	440	660										
	69.5	88	138									
	4	5	6	7	8	9	10	11	12	13	14	15
	37.0	46.0	54.9	63.7	72.4	81.0	88.0	97.9	106.2	114.4	122.5	130.0
	1,320		1,765		2,650							

- Total rated loads are based on freely suspended loads and make no allowance for such factors as the effect of wind, sudden stopping of loads, supporting surface conditions, operating speeds, side loads, etc. Side pull on boom or jib is extremely dangerous.
- Total rated loads do not account for wind on lifted load or boom.
- Total rated loads and boom length shall be appropriately reduced, when wind velocity is above 18 mph (26 ft/sec.) for main boom operation and above 11 mph (16 ft/sec.) for jib operation.
- Total rated loads at load radius shall not be exceeded. Do not tip the crane to determine allowable loads.
- Do not operate at boom lengths beyond radii or boom angles where no capacities are shown. Crane may overturn without any load on the hook.
- Slewing of the superstructure is admissible only when the crane is supported on half or fully extended outriggers.
- The lifting capacity ratings specified in the TADANO load rating chart apply to the telescopic boom without fly jib fixed in transport position or working position.
If the fly jib is secured to the telescopic boom in transport position or working position, the lifting capacities of the telescopic boom are reduced by the values specified below. The weight of the fly jib(3,650 lbs) is detected in terms of a load, and the load moment limiter will shut off earlier.

Jib status	Load rating reduction (tons)											
	42.7	57.1	71.9	86.8	101.4	116.1	130.9	145.7	160.4	170.6		
31.2ft/53.1ft fly jib, mounted in transport position	0.66	0.29	0.29	0.19	0.19	0.14	0.14	0.12	0.11	0.10		
31.2ft fly jib, mounted to the boom head	2.59	2.12	1.94	1.84	1.80	1.73	1.70	1.68	1.61	1.54		
53.1ft fly jib, mounted to the boom head	3.18	2.59	2.24	2.07	2.02	1.89	1.85	1.78	1.71	1.65		
79.1ft fly jib, mounted to the boom head	5.18	3.77	3.23	2.94	2.87	2.63	2.63	2.44	2.32	2.15		
98.8ft fly jib, mounted to the boom head	7.06	4.99	4.30	3.78	3.67	3.33	3.33	3.11	2.88	2.59		

- When making lifts at a load radius not shown, use the next longer radius to determine allowable capacity.
- Load per part line should not exceed 18,650 lbs. for the main winch and for the auxiliary winch.
- Loaded boom angles are approximate. The boom angle before loading should be greater to account for deflection.
- The 42.7ft boom length capacities are based on the telescoping boom being fully retracted. If not fully retracted (less than 57.1ft boom length), use the total rated loads for the 57.1ft boom length according to the telescoping sequence.
- Extension or retraction of the telescopic boom with loads may be attempted within the limits of the TADANO LOAD RATING CHART. The ability to telescope loads is limited by hydraulic pressure, boom angle, boom length, crane maintenance, etc.
- When erecting or stowing the fly jib, be sure to retain it by hand or by other means to prevent its free movement.
- Use the Anti-Two Block (OVERWIND CUTOUT) disable switch when erecting or stowing the extendible fly jib and stowing the hook block. While the switch is pushed, the hoist will not stop, even when an overwind condition occurs.
- The working radius specified in the TADANO LOAD RATING CHARTS for the fly jib apply only if the telescopic boom is extended according to the TADANO LOAD RATING CHARTS. If one or more elements of the telescopic boom are retracted partially or completely, the specified boom angles will be decisive in determining total rated lifting capacities.
- When lifting a load by using the fly jib (auxiliary hoist) and telescopic boom (main hoist) simultaneously, do the following:
 - Select the correct program for the load moment device in accordance with jib length, jib offset angle, counterweight and outrigger base.
 - Before starting the operation, make sure that the weight of the load is within the total rated load for the fly jib.
- Safe Load Indicator (S.L.I.)
Before working with the telescopic boom or fly jib, make sure that the S.L.I. code is set according to the desired telescoping sequence while the telescopic boom is completely retracted. A change of the telescoping sequence is not permissible when the boom has been partially or fully extended. In order to change the S.L.I. code number, the boom must be fully retracted.
- Working with Single Top
Operation with the single top is allowed with the main winch and the auxiliary winch. The maximum allowed capacity is limited by the selected S.L.I. code for main boom operation according to existing counterweight and outrigger base at one side and by the single line pull which is limited by hydraulic pressure at the other side.
For operations with the single top mounted, use the TADANO LOAD RATING CHART for the telescopic boom in accordance with existing counterweight and outrigger base to find the total rated lifting capacity and also select the correct S.L.I. code for the telescopic boom in accordance with the existing counterweight and outrigger base. Find the total rated lifting capacity based on boom length and working radius. From that value, subtract 1,100 lbs and the weights of all lifting equipment used including hook block, sling and other auxiliary lifting devices. The result (<total rated lifting capacity> - <1,100 lbs> - <lifting equipment>) is the total rated lifting capacity for a single top lift.

DEFINITIONS

- Working Radius:** Horizontal distance from a projection of the axis of rotation to supporting surface before loading to the center of the vertical hoist line or tackle with load applied. The deflection of the boom due to its deadweight and the rated load are taken into account.
- Loaded Boom Angle:** The angle between the boom base section and the horizontal, after lifting the total rated load at the working radius.
- Working Area:** Area measured in a circular arc about the centerline of rotation.
- Freely Suspended Load:** Load hanging free with no direct external force applied except by the hoist line.
- Side Load:** Horizontal side force applied to the lifted load either on the ground or in the air.

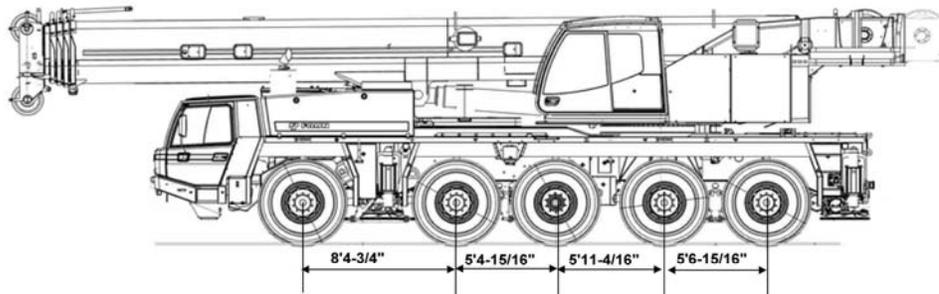
Safe Load Indicator

The Safe Load Indicator is intended as an aid to the operator. Under no condition should it be relied upon to replace of Load Rating Charts and Operating Instructions. Sole reliance upon the Safe Load Indicator Aids in place of good operating practice can cause an accident. The operator must exercise caution to assure safety.

ATF110G-5 Axle weight distribution chart

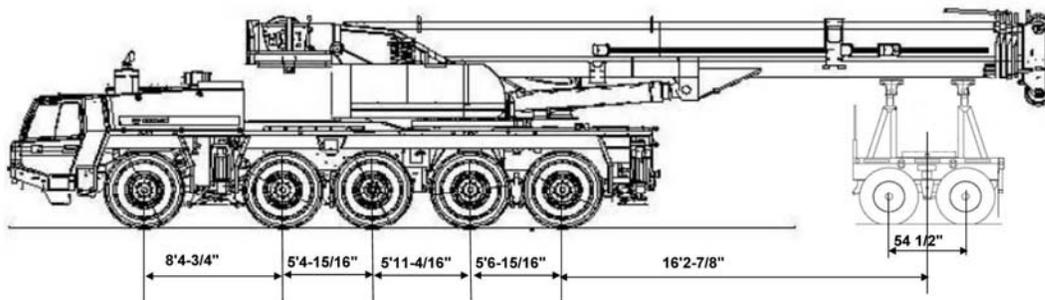
1) Normal traveling condition

	GVW	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5
Base machine with 16.00R25 tires, no counterweight, no fuel, no driver	104,471	22,213	22,978	22,050	18,713	18,517
Add:						
1. 11.0 ton hook ball (in carrier storage)	441	73	73	0	148	148
2. 27.5 ton hook block in front	662	592	592	0	-261	-261
3. 69.4 ton hook block in front	1,323	1,195	1,195	0	-534	-534
4. 88.0 ton hook block in front	1,764	1,618	1,618	0	-736	-736
5. Boom extension (31.2ft/53.1ft) stored on main boom	3,669	2,277	2,277	0	-443	-443
6. Auxiliary winch with cable	3,109	-949	-949	0	2,503	2,503
7. Auxiliary boom point sheave (single top)	181	185	185	0	-95	-95
8. Drive 10x8	298	147	147	0	2	2
9. Drive/steer and outrigger control from crane cab	93	37	37	0	10	10
10. Air conditioning in carrier cab	108	77	77	0	-23	-23
11. Air conditioning in crane cab	106	-12	-12	0	65	65
12. Tool box at rear	154	-39	-39	0	116	116
13. Additional Hydraulic oil cooler	88	-7	-7	0	51	51
14. 20.5R25 tires in lieu of 16:00R25	1,036	207	207	207	207	207
15. Air & electrical circuits to rear for boom dolly	24	-4	-4	0	16	16
16. Free swing & boom hoist circuit for boom dolly	62	4	4	0	27	27



2) Traveling with boom dolly

	GVW	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Boom Dolly
Base machine with 16.00R25 tires, no counterweight, no fuel, no driver	104,471	16,118	16,916	17,237	16,314	16,118	21,768
Add:							
1. 11.0 ton hook ball (in carrier storage)	441	73	73	0	148	148	0
2. 27.5 ton hook block at boom head	662	0	0	0	0	0	662
3. 69.4 ton hook block at boom head	1,323	0	0	0	0	0	1,323
4. 88.0 ton hook block at boom head	1,764	0	0	0	0	0	1,764
5. Boom extension (31.2ft/53.1ft) stored on main boom	3,669	-1,680	-1,680	0	3,514	3,514	0
6. Auxiliary winch with cable	3,109	1,455	1,455	0	100	100	0
7. Auxiliary boom point sheave (single top)	181	0	0	0	0	0	181
8. Drive 10x8	298	147	147	0	2	2	0
9. Drive/steer and outrigger control from crane cab	93	-37	-37	0	83	83	0
10. Air conditioning in carrier cab	108	77	77	0	-23	-23	0
11. Air conditioning in crane cab	106	29	29	0	24	24	0
12. Tool box at rear	154	-39	-39	0	116	116	0
13. Additional Hydraulic oil cooler	88	22	22	0	23	23	0
14. 20.5R25 tires in lieu of 16:00R25	1,036	207	207	207	207	207	0
15. Dolly brackets at boom	141	0	0	0	0	0	141
16. Towing attachment(190 kN)	198	0	0	0	99	99	0
17. Air & electrical circuits to rear for boom dolly	24	-3	-3	0	15	15	0
18. Free swing & boom hoist circuit for boom dolly	62	7	7	0	24	24	0
19. 2 Axle Dolly	6,000	0	0	0	0	0	6,000
20. 3 Axle Dolly	9,000	0	0	0	0	0	9,000



TADANO AMERICA CORPORATION

333 NORTH PARK CENTRAL DR, SUITE Z
HOUSTON, TEXAS 77073 U.S.A.
PHONE: (281) 869-0030 EXT.315
FAX: (281) 869-0040
Web site: www.tadanoamerica.com
E-mail: sales@tadano-cranes.com

Form No. TAC-ATF110G-5-050224

SECTION 41 62 19

Truck Trailers

PART 1 – GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Fontaine Trailer Company
 - 430 Letson Road
 - Haleyville, AL 35565
 - Phone: +1 800 821 6535
 - Website: <http://www.fontainetrailer.com>

2.2 PRODUCTS

- A. Infinity Flatbed Trailer
 - 1. Construction: Composite
 - 2. Mainbeams and Crossbeams: Steel
 - 3. Floor, siderails and rear skirt: Aluminum
 - 4. Concentrated Load: 55,000lbs in 4ft
 - 5. Weight ($\pm 3\%$): 10,056lbs
 - 6. Dimensions: L 48ft x W 8.5ft
- B. Renegade LXT40 Lowbed
 - 1. Mainbeams: Steel
 - 2. Concentrated Load: 40 tons in 16ft
 - 3. Weight ($\pm 3\%$): 22,150lbs
 - 4. Dimensions: L 48ft x W 8.5ft

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Use of the Fontaine Trailers shall be per manufacturer's instructions and with use of a certified operator.

END OF SECTION



SECTION 41 65 16**Mobile Generators****PART 1 – GENERAL****1.1 SUMMARY**

- A. Section includes the following:
1. Mobile Generator

1.2 SUBMITTALS

- A. Link to manufacturer's published data sheet, including:
1. Product Details
 2. Dimensions and measurements
- http://www.multiquip.com/multiquip/pdfs/PS%20-%20product-brochures/DCA25USI_Rev_9.pdf

1.3 DELIVERY, STORAGE AND HANDLING

- A. Acceptance at site:
1. Inspect product upon delivery. Report any damaged or missing components directly to the manufacturer.
- B. Packing, Shipping, Handling and Unloading
1. Store product in manufacturer's packaging until ready for installation.
- C. Storage and Protection
1. Store packed product in a safe location as designated by the construction coordinator.

PART 2 – PRODUCTS**2.1 MANUFACTURER**

- A. MQ Power
- 1800 Waters Ridge Drive, Suite 500
Luisville, TX 75057
Phone: +1 800 883 2551
Website: <http://www.multiquip.com/multiquip/DCA25USI.htm>

2.2 PRODUCTS

- A. Whisper Watt Ultra-Silent Generator Model # DCA25USI
1. Engine: Isuzu / BV-4LE2
 2. Displacement 2179 cc
 3. AC Output: 120/240AV 6500W max. (54 1/ 27.1A) 5500W rated (45.8/22.9A)
 4. Receptacles: 20A 125V Duplex (2), 30A 125V Locking Plug, 30A 125/250V Locking Plug
 5. Starting system: electric
 6. Fuel Tank Capacity: 41.7 gals
 7. Run time per tank: 25.12hrs at full load, 49.06hrs at ½ load
 8. Dimensions: L 70.47 x W 31.10 x H 49.61
 9. Noise level: 59dB at 23ft of full load
 10. Dry Weight: 1808lbs
 11. Residential Warranty: 3 years



PART 3 – EXECUTION

3.1 INSTALLATION

- A. Refer to manufacturer's published installation instructions for detailed installation description

END OF SECTION





DCA25USI

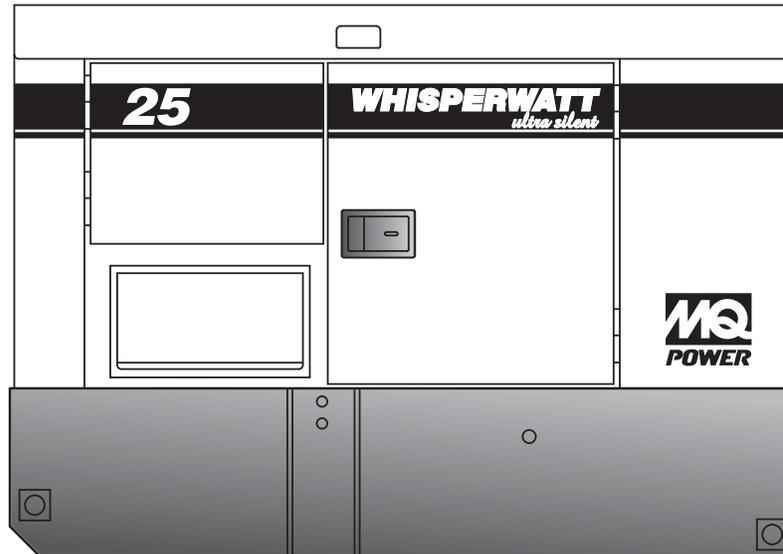
MQ POWER Series Generator

WhisperWatt™ 25

Prime Rating — 20 kW (25 kVA)

Standby Rating — 22 kW (27.5 kVA)

60 Hertz



STANDARD FEATURES

- Heavy duty, 4-cycle, direct injection, diesel engine provides maximum reliability.
- Brushless alternator reduces service and maintenance requirements and meets temperature rise standards for Class F insulation systems.
- Open delta excitation design provides virtually unlimited excitation for maximum motor starting capability.
- Automatic voltage regulator (AVR) provides precise regulation.
- Full load acceptance of standby nameplate rating in one step (NFPA 110, para 5-13.2.6).
- Sound attenuated, weather resistant, steel housing provides operation at 59 dB(A) at 23 feet. Fully lockable enclosure allows safe unattended operation.
- Internal fuel tank with direct reading of fuel gauge.
- Seven stage powder coat paint system provides durability and weather protection.
- Fuel/water separator removes condensation from fuel for extended engine life. Panel mounted alarm light included.
- Complete engine analog instrumentation includes DC ammeter, oil pressure gauge, water temp. gauge, fuel level gauge, tachometer/hour meter, preheat indicator, emergency shutdown monitors, and keyed start switch.
- Complete generator analog instrumentation includes voltage regulator control, ammeter phase selector switch, voltmeter phase selector switch, AC voltmeter, AC ammeter, frequency meter, panel light, and circuit breaker.
- Automatic safety shutdown system monitors the engine oil pressure and coolant temperature. Warning lights indicate abnormal conditions.
- Complete power panel. Fully covered; three-phase terminals and single phase receptacles allow fast and convenient hookup for most applications including temporary power boxes, tools and lighting equipment. The GFCI receptacles are NEMA 5-20, and the auxiliary outputs use CS6369 twist-lock receptacles.
- Simultaneous single and three phase power.
- Voltage selector switch offers the operator a wide range of voltages that are manually selectable. Fine tuning of the output voltage can be accomplished by adjusting the voltage regulator control knob to obtain the desired voltage.
- EPA emissions certified - Interim Tier 4 emissions compliant.



DCA25USI

MQ POWER Series Generator

SPECIFICATIONS

Generator Specifications		
Design	Revolving field, self-ventilated Drip-proof, single bearing	
Armature Connection	Star with Neutral	Zig Zag
Phase	3	Single
Standby Output	22 KW (27.5 KVA)	15.3 KW
Prime Output	20 KW (25 KVA)	14.4 KW
3Ø Voltage (L-L/L-N) Voltage Selector Switch at 3Ø 240/139	208Y/120, 220Y/127, 240Y/139	N/A
3Ø Voltage (L-L/L-N) Voltage Selector Switch at 3Ø 480/277	416Y/240, 440Y/254, 480Y/277	N/A
1Ø Voltage (L-L/L-N) (Voltage Selector Switch at 1Ø 240/120)	N/A	240/120
Power Factor	0.8	1.0
Voltage Regulation (No load to full load)	±0.5%	
Generator RPM	1800	
Frequency	60 Hz	
No. of Poles	4	
Excitation	Brushless with AVR	
Frequency	60 Hz	
Frequency Regulation: No Load to Full Load	3-5% under varying loads from no load to 100% rated load	
Frequency Regulation: Steady State	±0.5% of mean value for constant loads from no load to full load.	
Insulation	Class F	
Sound Level dB(A) Full load at 23 feet	59	

Engine Specifications	
Make / Model	Isuzu / BV-4LE2
Emissions	EPA Interim Tier 4 Certified
Starting System	Electric
Design	4-cycle, water cooled, direct injection
Displacement	133.0 in ³ (2179 cc)
No. cylinders	4
Bore x Stroke (mm)	85 x 96
Gross Engine Power Output	35.9 bhp (26.8 kWm)
BMEP	100 psi (691 kPa)
Piston Speed	1134 ft./min. (5.76 m/s)
Compression Ratio	18:1
Engine Speed	1800 rpm
Overspeed Limit	2100 rpm
Oil Capacity	2.25 gallons (8.5 liters)
Battery	12V 53Ah x 1

Fuel System		
Recommended Fuel	ASTM-D975-No.1 & No.2-D	
Maximum Fuel Flow (per hour)	3.7 gallons (14.0 liters)	
Maximum Inlet Restriction (Hg)	8.66 in. (220 mm)	
Fuel Tank Capacity	41.7 gallons (158 liters)	
Fuel Consumption	gph	lph
At full load	1.66	6.3
At 3/4 load	1.21	4.6
At 1/2 load	0.85	3.2
At 1/4 load	0.58	2.2

Cooling System	
Fan Load	0.13 hp (0.1 kW)
Coolant Capacity (with radiator)	1.70 gallons (6.4 liters)
Coolant Flow Rate (per minute)	15.6 gallons (59 liters)
Heat Rejection to Coolant (per minute)	862 Btu (0.91 MJ)
Heat Rejection to Room (per minute)	209 Btu (0.22 MJ)
Maximum Coolant Friction Head	3.1 psi (21.6 kPa)
Maximum Coolant Static Head	21 feet (6.4 meters)
Ambient Temperature Rating	104°F (40°C)

Air	
Combustion Air	56 cfm (1.6 m ³ /min)
Maximum Air Cleaner Restriction	24.9 in. H ₂ O (6.2 kPa)
Alternator Cooling Air	388 cfm (11 m ³ /min)
Radiator Cooling Air	1059 cfm (30 m ³ /min)

Exhaust System	
Gas Flow (full load)	152 cfm (4.08 m ³ /min)
Gas Temperature	1004°F (570°C)
Maximum Back Pressure	28.0 in. H ₂ O (7.0 kPa)

Amperage	
Rated Voltage	Maximum Amps
1Ø 120 Volt	55.6 Amps (4 wire) 60A x 2 (Zigzag)
1Ø 240 Volt	27.8 Amps (4 wire) 60A (Zigzag)
3Ø 240 Volt	60 Amps
3Ø 480 Volt	30 Amps
Main Line Circuit Breaker Rating	60 Amps
Over Current Relay Trip Set Point 480V Mode Only	30 Amps

WARRANTY*

Isuzu Engine

12 months from date of purchase with unlimited hours or 24 months from date of purchase with 2000 hours (whichever comes first).

Generator

24 months from date of purchase or 2000 hours (whichever occurs first).

Trailer

12 months excluding normal wear items.

*Refer to the express written, one-year limited warranty sheet for additional information.

NOTICE

Generator is not intended for use in enclosed areas or where free flow of air is restricted.

Backfeed to a utility system can cause electrocution, shock and/or property damage. **DO NOT** connect to any building's electrical system except through an approved device.

Specifications are subject to change without notice.



DCA25USI

MQ POWER Series Generator

MQ POWER DECIBEL LEVELS

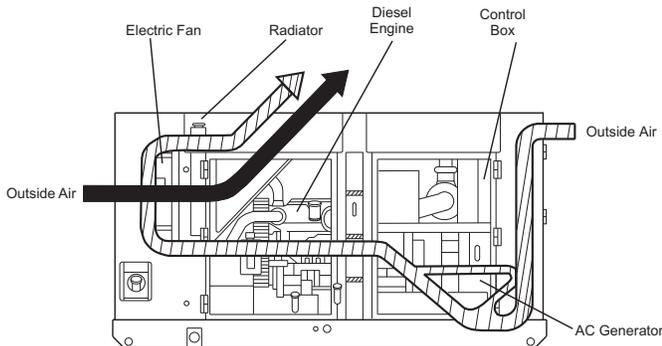
Our soundproof housing allows substantially lower operating noise levels than competitive designs. WhisperWatts are at home on construction sites, in residential neighborhoods, and at hospitals — just about anywhere.

- 90 — Subway / truck traffic
- 80 — Average city traffic
- 70 — Inside car at 60 mph
- 60 — Air conditioner at 20 feet
Ultra Silent at 23 feet
- 50 — Normal conversation

59.0
DECIBELS

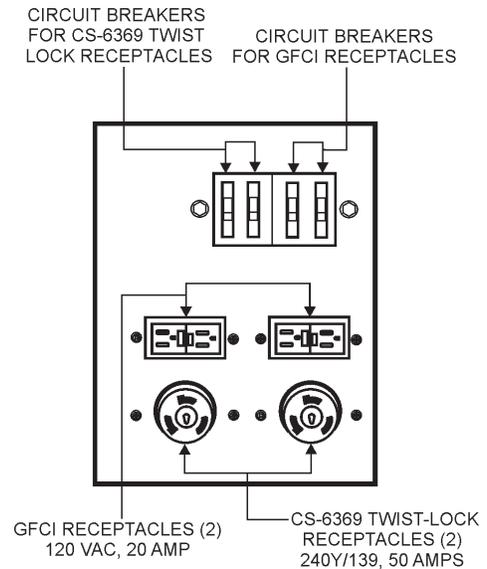
ULTRA-SILENT FEATURES

- **Low Noise Muffler** — Large capacity low noise muffler minimizes exhaust sound.
- **Soundproof Casing** — The new design divides the cabinet into three sections, separating the engine, muffler and radiator for more efficient cooling and reduces noise from the engine and fans.
- **New Cooling System** — An advanced design uses two separate air intake systems to cool the generator. The engine fan draws air in to cool the engine and generator housing while a second electric fan directly cools the radiator. With less air being drawn into the generator through each fan, considerably less noise is produced through the top of the generator.
- **Environmental Design** — Constructed using an integrated environmental skid and fuel tank. This design fully contains fuel leakage and any liquid that might leak from the engine such as lube oil or radiator coolant. All potentially hazardous liquids are contained without contaminating the surrounding area.



Flow of Cooling Air

GENERATOR OUTPUT PANEL



OPTIONAL CONTROL FEATURES

- **Emergency Stop Switch** — when manually activated shuts down generator in the event of an emergency.
- **Audible alarm** — alerts operator of abnormal conditions.
- **Automatic Start / Stop Control** — automatically starts the generator set during a commercial power failure when used in conjunction with a transfer switch.

OPTIONAL GENERATOR FEATURES

- **Electronic Governor Control (Crystal Sync)** — maintains frequency to within $\pm 0.25\%$ from no load to full load.
- **Battery Charger** — provides fully automatic and self-adjusting charging to the generator's battery system.
- **Jacket Water Heater** — for easy starting in cold weather climates.
- **Low Coolant Level Shutdown** — provides protection from critically low coolant levels. Includes control panel warning light.
- **Trailer Mounted Package** — meets National Highway Traffic Safety Administration (NHTSA) regulations. Trailer is equipped with electronic or surge brakes with single axle configuration.

OPTIONAL OUTPUT CONNECTIONS

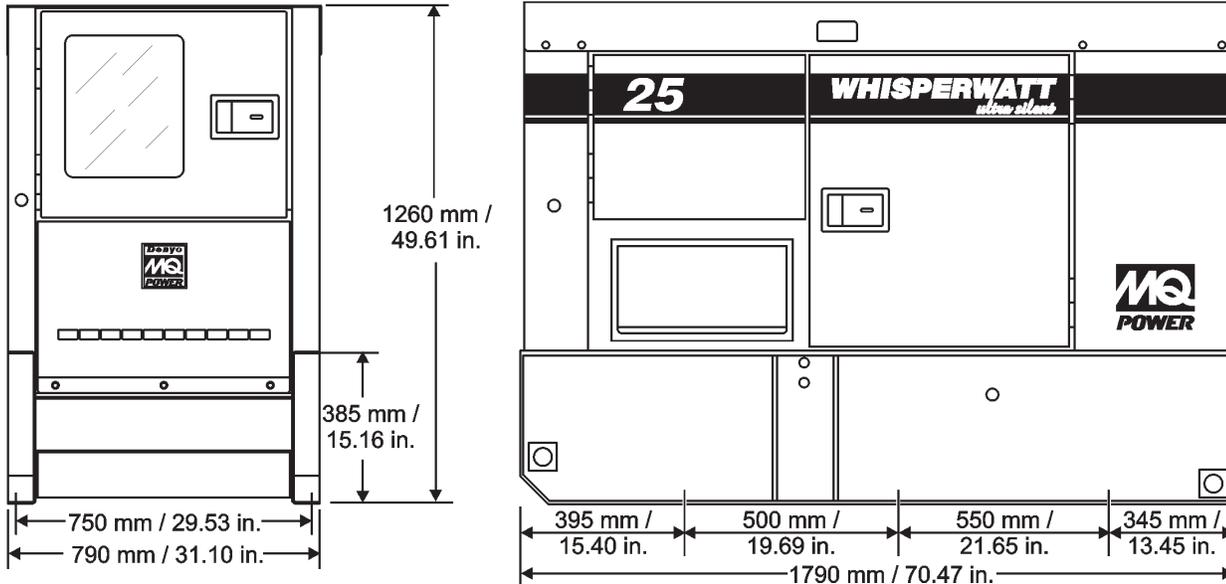
- **Pin and Sleeve Connectors** — provides industry standard connectors for all voltage requirements.



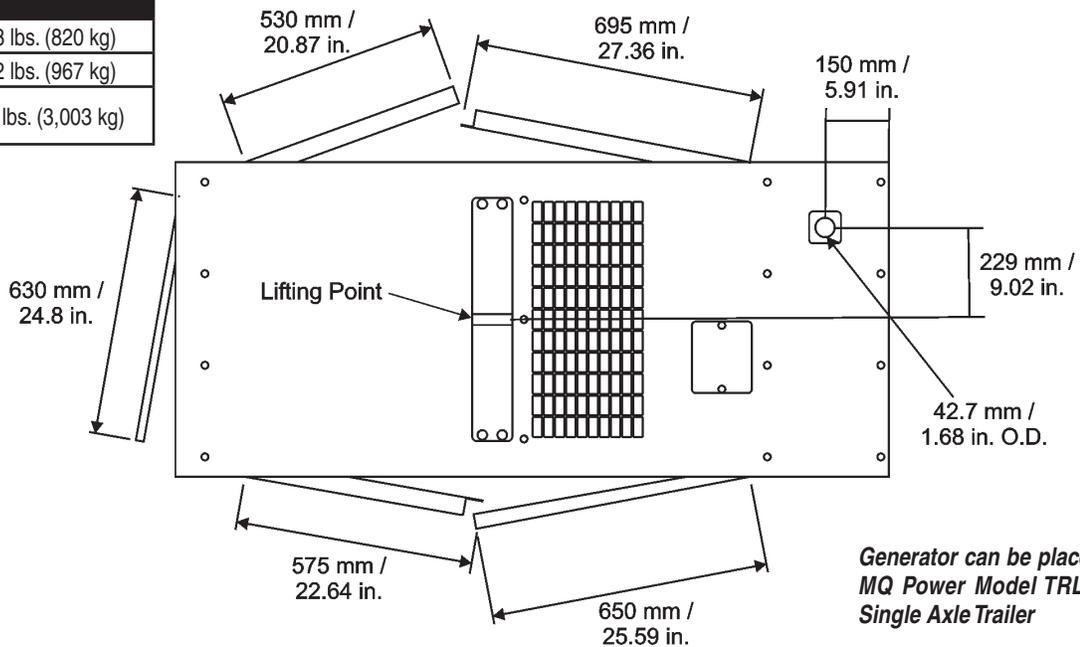
DCA25USI

MQ POWER Series Generator

DIMENSIONS



Weight	
Dry Weight	1,808 lbs. (820 kg)
Wet Weight	2,132 lbs. (967 kg)
Max. Lifting Point Capacity	6,620 lbs. (3,003 kg)



Generator can be placed on a MQ Power Model TRLR25US Single Axle Trailer

Manufactured by Denyo Co.

Your Multiquip dealer is:





Progress Solar Solutions™

Saving Energy and the Environment



Solar Light Tower – SLT600 (Portable)

Brilliant White Lighting – On-Demand
Cost Effective - Saves Energy and the Environment

www.ProgressSolarSolutions.com

Solar Light Tower – SLT600 (Portable)

The Progress Solar™ Light Tower (SLT600) is a rugged, mobile light system that provides high-intensity, bright white lighting on-demand, where and when you need it. This system is durable and built to perform, it is equipped with high quality solar power modules; solid-state LED flood lights; and no maintenance, long-life, deep-cycle batteries. The light tower is fully adjustable from 12-30ft in height, able to tilt up/down and rotated 360 degrees. The solid-state LED flood lights provide a tremendous amount of light with very little power required; instant-on/off with no flickering; extremely reliable, vibration and shatter resistant; and designed to provide up to 5x longer run time between bulb changes than metal halide lights. The solar/light controller protects the batteries from over/under charging and the lights can be turned on/off manually or automatically by photo-sensor with timer. The system is within industrial quality housing on a portable trailer that can be easily towed to its destination.



- **No Noise or Diesel Smell – Just Great Light, Complete Silence and Fresh Air!**
- **No Diesel Fuel Required – Eliminates Expensive Fuel Costs & Time Consuming Trips**
- **No Engine Maintenance – Convenient, Saves Time & Money**
- **No Frequent Light Bulb Changes – LED Lights Last up to 5x Longer than Metal Halide**
- **No Fossil Fuels (Carbon Dioxide) – Just Free, Renewable Energy From The Sun!**
- **No Financial Downside – Competitive Price – Significantly Reduced Operating Cost**

Great Federal & State Solar Incentives

Ideal for

Special Events – Recreation & Camp Sites – Golf
Construction & Work Sites – Mining - Security & Emergency
Airports - Military Operations – Storm or Disaster Recovery

Anywhere a Light-On-Demand Application is Needed

Progress Solar Solutions, LLC 2420 Reliance Avenue, Apex NC 27539 USA
Toll-free: 888-298-6657 Phone: 919-363-3738 Fax: 919-481-2520

www.ProgressSolarSolutions.com

SECTION 43 41 19

Liquid Storage

PART 1 – GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Ronco Plastics
 - 15022 Parkway Loop Suite B
 - Tustin, CA 92780
 - Phone: +1 714 259 1385
 - Website: <http://www.ronco-plastics.com/>

2.2 PRODUCTS

- A. Rectangular Water Tank Model #: B543
 - 1. Capacity: 60 gallons
 - 2. Dimensions: L 55" x W 20" x H 14"
 - 3. Fittings: 3
 - 4. Material: 3/8" polyethylene

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Refer to published manufacturer's installation instructions for proper installation.

END OF SECTION

