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Summary of Changes
Summary of Changes

October 11, 2012

The first draft of the Project Manual was submitted.

November 20, 2012 Revision

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

- Changed Logo
- Added summary of Rules Compliant checklist and linked content locations
- Removed duplicate drawings and MasterSpec references
- Added Structural Narrative
- Updated and added Structural Calculations
- Added Radiant System Narrative
- Added Quantity Takeoff
- Added or updated MasterSpec sections:
  - 05 52 00 Metal Railings
  - 06 15 33 Wood Patio Decking
  - 06 43 00 Wood Stairs and Railings
  - 07 21 29 Sprayed Insulation
  - 07 53 23 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
  - 07 62 00 Sheet Metal Flashing and Trim
  - 10 28 00 Toilet, Bath, and Laundry Accessories
  - 11 31 23 Residential Laundry Appliances
  - 22 05 10 Plumbing Valves
  - 22 41 16 Residential Lavatories and Sinks
  - 22 41 23 Residential Showers
  - 22 41 39 Residential Faucets, Supplies, and Trim
  - 22 80 08 Domestic Hot Water
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  - 25 13 00 Integrated Automation Control & Monitoring Network
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  - 26 05 26 Grounding and Bonding for Electrical Systems
  - 26 05 33 Raceway and Boxes for Electrical Systems
  - 26 09 23 Lighting Control Devices
  - 26 24 16 Panelboards
  - 26 27 26 Wiring Devices
  - 26 09 23 Lighting Control Devices
  - 26 31 00 Photovoltaic Collectors
  - 26 32 13 Engine Generators
February 14, 2013 Revision

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

- Moved 4-7 Lot Conditions 1 to Structural Calculations
- Updated 6-1 Structural Narrative to reference Stamped Drawing Set and Stamped Structural Calculations
- Removed 9-2 Team Provided Liquids – replaced with reference to relevant MasterSpec sections
- Removed 9-6 Thermal Mass
- Removed 9-8 Water Delivery drawing - moved to Drawing Set
- Removed 9-9 Water Removal drawing - moved to Drawing Set
- Revised and Updated Structural Calculations
- Revised Structural Narrative
- Revised Bamboo Structural Bamboo Structural Systems Narrative
- Updated Detailed Water Budget
- Revised and updated Energy Analysis Results and Discussion
- Updated Quantity Takeoff
- Added or updated MasterSpec sections:
  - 06 15 33 Wood Patio Decking
  - 06 16 00 Sheathing
  - 07 21 29 Sprayed Insulation
  - 07 42 13 Metal Wall Panels
  - 07 53 23 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
  - 08 14 16 Interior Wood Doors
  - 08 14 17 Interior Wood Pocket Doors
  - 08 14 20 Exterior Metal Doors
  - 08 33 00 Sliding Glass Doors
  - 08 52 00 Windows
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  - 09 65 19 Tile Flooring
  - 09 69 00 Access Flooring
  - 09 74 10 Tile Wall Coverings
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21 10 00 Water-based Fire Suppression Systems
21 11 00 Water-based Fire Suppression Pumps
22 05 00 Common Work Results for Plumbing
22 05 10 Plumbing Valves
22 05 19 Meter and Gauges for Plumbing Piping
22 05 23 General-Duty
22 07 00 Plumbing Insulation
22 11 13 Facility Water Distribution Piping
22 11 16 Domestic Water Piping
22 11 23 Domestic Water Pumps
22 12 00 Facility Potable-Water Storage Tanks
22 13 00 Facility Sanitary Sewage and Vent Piping
22 13 53 Facility Septic Tanks
22 41 39 Residential Faucets, Supplies, and Trim
23 09 13 Sensors and Transmitters
23 31 00 HVAC Ducts and Casings
23 84 17 Refrigerant
25 13 00 Integrated Automation Control & Monitoring Network
26 09 23 Lighting Control Devices
32 93 00 Plants

- Removed MasterSpec sections
  - 06 15 13 Wood Floor Decking
  - 06 46 00 Wood Trim
  - 08 14 73 Sliding Wood Doors
  - 09 64 29 Wood Strip & Plank Flooring
  - 22 05 23 General-Duty Valves for Plumbing Piping
  - 23 71 00 Thermal Mass

April 5, 2013 Revision

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

- Updated Rules Compliant checklist and linked content locations
- Updated the Quantity Takeoff
- Updated 9-9 to include information on access to grey water tanks for water removal and corrected misleading wording
- Updated Structural Calculations
- Updated Construction Budget
- Updated Total Project Budget
- Added or updated MasterSpec sections:
  - 00 31 00 Available Project Information
  - 05 52 00 Metal Railings
  - 06 15 33 Wood Patio Decking
  - 07 72 00 Roof Accessories
08 13 20 Exterior Metal Doors
08 13 73 Sliding Metal Doors
08 53 13 Windows
09 65 15 Primed MDF Base Moulding
12 32 13 Manufactured Wood-Veneer-Faced Casework
21 30 00 Fire Pumps
22 05 19 Meter and Gauged for Water-Based Piping
22 05 23 General-Duty Valves for Water-Based Piping
22 12 00 Facility Potable-Water Storage Tanks
22 13 53 Facility Greywater Tanks
23 23 23 Refrigerant
23 83 16 Radiant-Heating Hydronic Piping
23 83 33 Electric Radiant Heaters
25 13 10 Integrated Automation Control & Monitoring Network Cabling
25 13 20 Integrated Automation Control & Monitoring Network Server
26 32 13 Engine Generators
26 50 00 Lighting
41 20 00 Crane and Hoists

- Removed MasterSpec sections
  - 06 20 23 Interior Finish Carpentry
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  - 06 46 00 Wood Trim
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  - 22 05 19 Meter and Gauges for Plumbing Piping
  - 22 05 23 General-Duty Valves for Plumbing Piping
  - 22 13 53 Facility Septic Tanks
  - 23 81 16 Radiant Heating Panels
  - 23 81 43 Air to Water Heat Pump
  - 23 85 17 Refrigerant
  - 41 22 13 Mobile Crane

**May 9, 2013 Revision**

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

- Updated the Quantity Takeoff
- Updated MasterSpec sections
  - 26 05 33 Raceway and Boxes for Electrical Systems
  - 26 31 00 Photovoltaic Collectors
August 22, 2013 Revision

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

- Changed the main title page design and all subsequent section title page designs
- Updated the locations in the Rules Compliance Checklist
- Updated the structural calculations page location and construction drawings page numbering in 6-1 Structural Design Approval
- Updated and added Structural Calculations including the Structural Narrative and Bamboo Structural Systems Narrative
- Revised and updated Energy Analysis Results and Discussion
- Updated the Quantity Takeoff
- Added or updated MasterSpec sections:
  - 00 31 00 Available Project Information
  - 01 10 00 Summary
  - 05 21 00 Structural Steel
  - 05 52 00 Metal Railings
  - 06 15 33 Wood Patio Decking
  - 07 21 29 Insulation
  - 07 42 13 Metal Wall Panels
  - 07 54 23 Thermoplastic Roofing Membrane (TPO)
  - 07 62 00 Sheet Metal Flashing and Trim
  - 07 72 00 Roof Accessories
  - 08 13 20 Exterior Metal Doors
  - 08 13 21 Exterior Fiberglass Doors
  - 08 13 73 Sliding Metal Doors
  - 08 14 16 Interior Wood Doors
  - 08 14 17 Interior Wood Pocket Doors
  - 08 53 13 Windows
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  - 09 65 15 Baseboard
  - 10 73 13 Awnings
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  - 11 52 00 Audio-Visual Equipment
  - 12 32 13 Manufactured Wood-Veneer-Faced Casework
  - 22 05 00 Common Work Results for Plumbing
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  - 22 80 08 Domestic Hot Water Tanks
- 22 81 81 Phase Change Material
- 23 09 13 Sensors and Transmitters
- 23 31 00 HVAC Ducts and Casings
- 23 37 13 Diffusers, Registers, and Grilles
- 23 56 13 Solar Thermal Collectors
- 23 72 15 Heat Recovery Ventilator (HRV)
- 23 83 33 Air to Water Heat Pump
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- 26 05 19 Low-Voltage Electrical Power Conductors and Cables
- 26 05 20 Controls Wiring
- 26 05 26 Grounding and Bonding for Electrical Systems
- 26 05 33 Raceway and Boxes for Electrical Systems
- 26 05 83 Wiring Connections
- 26 09 23 Lighting Control Devices
- 26 27 26 Wiring Devices
- 26 28 16 Enclosed Switches and Circuit Breakers
- 26 50 00 Lighting
- 26 50 01 Bathroom Exhaust Fan and Light
- 32 93 00 Plants

- Removed MasterSpec sections
  - 07 53 23 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
  - 09 65 15 Primed MDF Base Moulding
  - 09 69 00 Access Flooring
  - 25 13 10 Integrated Automation Control & Monitoring Network Cabling
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6-1 Structural Design Approval

The following is a list of the sheets and pages that are stamped in the hard copy by Dr. Mark Aschheim, PE. The sheets and pages can be found in the Construction Drawings and Project Manual at the locations listed below, or in a separate, but attached Stamped Drawing Set and Stamped Structural Calculations.

- Structural Calculations, pages 19-95 of the Project Manual
- Construction drawings, including:
  S-001 Structural Notes and Symbols
  S-101 Foundation Plan
  S-102 Module Separation
  S-103 Floor Framing Plan
  S-104 Wall Framing Plan
  S-105 Lower Roof Framing
  S-106 Upper Roof Module Framing Plan
  S-107 Deck Framing Plan
  S-108 Bearing Pressure Plan
  S-109 South Awning Plan
  S-201 Module A Wall Framing
  S-202 Module A Wall Framing
  S-203 Module B Wall Framing
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  S-206 Roof Elevation
  S-303 Roof Module Section
  S-311 Deck Section
  S-401 Awning Large Scale Plan
  S-501 Pier Details
  S-502 Pier Plate Details
  S-512 Bamboo Gravity Wall Details
  S-521 I-Joist Details
  S-531 Connection Details
  S-532 Timber to Steel Connections
  S-541 Railing Details
  S-551 Awning Details
  S-601 Schedules
- S.O.S. Steel Co. Shop drawings, including:
  D1
  D2
  D3
  D4
  D4.1
  D5
  D5.1
9-8 Water Delivery

Stage 1
- Water Truck pulls up to Radiant House on south side.

Stage 2
- Awaiting Team members move hose from truck and attach it to storage tank.
- When tank is full, water is turned off and the hose is prepped for the next lot.

Stage 3
- Water Truck moves to the next lot.
9-9 Water Removal 1

Stage 1

- Water Truck pulls up to Radiant House on south side.
- Awaiting team members move hose from truck and attach it to storage tanks (water has already been removed from radiant and sprinkler system).
- Excess water is removed from storage tanks.
- Hose is placed back in truck and made ready to move to stage 2.

Stage 2

- Water truck moves to stage 2.
- Team members grab hose and attach it to the greywater tank via bottom outlet which will be located flush with the outside perimeter of the deck for easy access.
- Wastewater is removed from greywater tank.
- Hose is placed back in truck and made ready to move.

*Reversed if the water truck is coming in from the other side.
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STRUCTURAL NARRATIVE

The 2013 Radiant House is the realization of Santa Clara’s goal to design a strong, efficient, and innovative symbol of sustainability. Utilizing a conventional system of joists, beams, studs, and shear walls, we implemented an innovative and original design to resist and transfer dead, live, wind, and seismic loads to the foundation.

The approach of our team is to substitute an initial conventional softwood design with one that makes use of a bamboo structural system. Research conducted at Santa Clara University has yielded results affirming bamboo’s suitability as a substitute for bamboo joists and gravity walls. The bamboo will be incorporated into the design as a primary structural component of Radiant House.

Radiant House will be composed of three base modules and an additional roof module. A perimeter structural steel channel or angle will serve as the backbone to each of these modules, serving to collect all gravity and lateral loads and distribute them into the foundation, which will consist of a series of seismic and standard piers. Roof gravity loads will be collected by bamboo joists and transferred through bamboo gravity walls into the steel channel. While lateral loads at the roof level will transfer through the roof diaphragm into the shear walls and into the perimeter steel channel. The floor joists will be hung such that a minimum clearance of 1-9/16 inch will be maintained above the bottom of the steel channel. Lateral loads will be collected by floor diaphragms and transferred into the steel perimeter channel.

The sloped roof module consists of a structural steel angle base that transmits roof diaphragm loads into the top plates of the base modules. The roof angle is 24 degrees and is supported on the low side by the above mentioned structural steel angle and a vierendeel truss at the high end of the slope. The vierendeel truss is created by vertical structural steel channels running between the base angle and a top horizontal steel angle. The vertical steel channels are placed at strategic locations to carry and transfer shear loading due to wind and seismic in the East-West directions and gravity loads, while still allowing windows for natural lighting. The roof slopes from the top steel at the north wall to the base steel on the south side in order to create a slope optimal for solar collection.

As Radiant House will be transported by truck from Santa Clara to Irvine, our greatest concern is maintaining the structural integrity of the completed house during transportation. The significant wind loads expected to act on the house’s modules during transportation will require thorough consideration during both the design and transportation phases in order to preserve structural stability. For example, steel beams will be placed parallel to the floor joists and flush with the bottom of the perimeter channel to support and transfer the gravity load to the truck bed during transportation.

Santa Clara’s 2013 Radiant House demonstrates the importance of structural engineering’s role in sustainable development and design. With its frugal and efficient design and its pioneering use of sustainable products, the structural engineering of Radiant House reaffirms Santa Clara’s enduring commitment to sustainability.
BAMBOO STRUCTURAL SYSTEMS NARRATIVE

Santa Clara seeks to implement a bamboo structural system in our 2013 Solar Decathlon house. We will provide a conventional softwood design and then, where sufficient capacity is demonstrated, will propose substitution of the following bamboo structural components:

- **Bamboo gravity walls:** Wall panels will be prefabricated, with hollow section bamboo culms at 16 inches on center, mounted to 4 ft. by 8 ft. woven bamboo panels. The assembly will have an integral bottom plate positioned to allow the wall panel be dropped in place on top of a field-installed bottom plate. Similarly, the lower of two top plates will be preinstalled in the panel assembly. Once the wall panel is in place, the upper of the two top plates will be field installed as a means to integrate the wall panels into the structural system. See Figure 18.

- **Bamboo joists:** Representing our third innovation in this category, our I-shaped bamboo joists consist of a woven bamboo sheet product used as a web, with solid section bamboo culms attached to the web to form flanges. See Figure 17.

These components are being developed in our laboratory in collaboration with a bamboo fabricator in Vietnam. Acceptance criteria for each component has been approved and quality assurance/quality control protocols for each component has also been approved to ensure the bamboo components used in construction adhere to design expectations.

- **Bamboo stud walls:** Stud walls were subjected to axial compression testing to establish design values and determine behavior under loading.

- **Bamboo joists:** Shear and bending tests are underway to establish design values.

Results obtained through testing have been compared to behavior displayed by conventional softwood components and to required demand loads to determine the suitability of bamboo as a substitute for components in Radiant House’s structural system. Santa Clara hopes to provide innovation in Radiant House with this bamboo structural system.

See S-512 and S-521 for relevant drawings.
## MATERIAL PROPERTIES

### Steel

<table>
<thead>
<tr>
<th>Material</th>
<th>fy =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channels</td>
<td>36 ksi</td>
</tr>
<tr>
<td>Angles</td>
<td>36 ksi</td>
</tr>
<tr>
<td>HSS beams</td>
<td>46 ksi</td>
</tr>
<tr>
<td>W beams</td>
<td>36 ksi</td>
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</table>

### Connections

<table>
<thead>
<tr>
<th>Element</th>
<th>Type</th>
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<tbody>
<tr>
<td>Welds</td>
<td>E70XX</td>
</tr>
<tr>
<td>High Strength Bolts</td>
<td>A490</td>
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<tr>
<td>Machine Bolts</td>
<td>A307</td>
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### Wood Framing

**Sawn Lumber**

### Horizontal Framing:

<table>
<thead>
<tr>
<th>Size</th>
<th>D.F.</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x6</td>
<td>D.F.</td>
<td>No.2</td>
</tr>
<tr>
<td>4x6</td>
<td>D.F.</td>
<td>No.2</td>
</tr>
<tr>
<td>6x6</td>
<td>D.F.</td>
<td>No.1</td>
</tr>
<tr>
<td>2x12</td>
<td>D.F.</td>
<td>No.1</td>
</tr>
<tr>
<td>4x12</td>
<td>D.F.</td>
<td>No.1</td>
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### Vertical Framing:

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<tr>
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<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>No.2</td>
</tr>
<tr>
<td>4x posts</td>
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**Mudsills & Ledgers:**

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<tbody>
<tr>
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<td></td>
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</tbody>
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---

Santa Clara Project Manual 2013
# Gravity Loads

## Flat Roof over the Mech Room

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofing</td>
<td>TPO Roofing</td>
<td>1.5</td>
</tr>
<tr>
<td>Sheathing</td>
<td>3/4&quot; T&amp;G Plywood</td>
<td>2.2</td>
</tr>
<tr>
<td>Framing</td>
<td>TJI 230 Joists @ 24&quot; O.C.</td>
<td>2.1</td>
</tr>
<tr>
<td>Insulation</td>
<td>ICYNENE MD-R-200</td>
<td>1.5</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>Free Hot Water</td>
<td>3.3</td>
</tr>
<tr>
<td>MEP</td>
<td>Messana Panels</td>
<td>2.8</td>
</tr>
<tr>
<td>Parapet</td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Misc.</td>
<td></td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Dead Load</strong></td>
<td></td>
<td><strong>16.0</strong></td>
</tr>
<tr>
<td><strong>Live Load</strong></td>
<td></td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>

## Flat Roof Not over the Mech Room

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofing</td>
<td>TPO Roofing</td>
<td>1.5</td>
</tr>
<tr>
<td>Sheathing</td>
<td>3/4&quot; T&amp;G Plywood</td>
<td>2.2</td>
</tr>
<tr>
<td>Framing</td>
<td>TJI 230 Joists @ 16&quot; O.C.</td>
<td>2.1</td>
</tr>
<tr>
<td>Insulation</td>
<td>ICYNENE MD-R-200</td>
<td>1.1</td>
</tr>
<tr>
<td>MEP</td>
<td>Messana Panels</td>
<td>2.8</td>
</tr>
<tr>
<td>Parapet</td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Misc.</td>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Dead Load</strong></td>
<td></td>
<td><strong>12.0</strong></td>
</tr>
<tr>
<td><strong>Live Load</strong></td>
<td></td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>

## Slope Roof

<table>
<thead>
<tr>
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<th>Description</th>
<th>Load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Panels</td>
<td>Bosch Solar Module c-Si M 60</td>
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</tr>
<tr>
<td>Racking System</td>
<td>Sunplanter</td>
<td>1.0</td>
</tr>
<tr>
<td>Roofing</td>
<td>TPO Roofing</td>
<td>1.5</td>
</tr>
<tr>
<td>Sheathing</td>
<td>3/4&quot; T&amp;G Plywood</td>
<td>2.2</td>
</tr>
<tr>
<td>Framing</td>
<td>TJI 230 Joists @ 16&quot; O.C.</td>
<td>2.1</td>
</tr>
<tr>
<td>Insulation</td>
<td>ICYNENE MD-R-200</td>
<td>1.5</td>
</tr>
<tr>
<td>MEP</td>
<td>Messana Panels</td>
<td>2.8</td>
</tr>
<tr>
<td>Misc.</td>
<td></td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Dead Load</strong></td>
<td></td>
<td><strong>15.0</strong></td>
</tr>
<tr>
<td><strong>Live Load</strong></td>
<td></td>
<td><strong>20</strong></td>
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</table>

## Floors

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Load (psf)</th>
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</thead>
<tbody>
<tr>
<td>Finish</td>
<td>Tate ConCore 1500 Posilock</td>
<td>8.8</td>
</tr>
<tr>
<td>Sheathing</td>
<td>3/4&quot; T&amp;G Plywood</td>
<td>2.2</td>
</tr>
<tr>
<td>Framing</td>
<td>TJI 230 Joists @ 16&quot; O.C.</td>
<td>2.1</td>
</tr>
<tr>
<td>Insulation</td>
<td>ICYNENE MD-R-200</td>
<td>1.1</td>
</tr>
<tr>
<td>MEP</td>
<td>Conduit, Ducting, and Piping</td>
<td>1</td>
</tr>
<tr>
<td>Misc</td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Dead Load</strong></td>
<td></td>
<td><strong>16.0</strong></td>
</tr>
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</table>
### Live Load

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exterior Wall</strong></td>
<td></td>
</tr>
<tr>
<td>Exterior Finish</td>
<td>Siding</td>
</tr>
<tr>
<td>Sheathing</td>
<td>15/32&quot; Str1 Plywood</td>
</tr>
<tr>
<td>Studs</td>
<td>2 x 4 @ 16&quot; staggered</td>
</tr>
<tr>
<td>Interior Finish</td>
<td>5/8&quot; EcoRock Gyp</td>
</tr>
<tr>
<td>Insulation</td>
<td>ICYNENE MD-R-200</td>
</tr>
<tr>
<td>Glazing</td>
<td>Windows and Mullion</td>
</tr>
<tr>
<td>Misc.</td>
<td></td>
</tr>
<tr>
<td><strong>Dead Load</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Exterior Side Wall Of Top Module</strong></td>
<td></td>
</tr>
<tr>
<td>Exterior Finish</td>
<td>Siding</td>
</tr>
<tr>
<td>Sheathing</td>
<td>15/32&quot; Str1 Plywood</td>
</tr>
<tr>
<td>Studs</td>
<td>2 x 4 @ 16&quot; staggered</td>
</tr>
<tr>
<td>Interior Finish</td>
<td>5/8&quot; EcoRock Gyp</td>
</tr>
<tr>
<td>Insulation</td>
<td>ICYNENE MD-R-200</td>
</tr>
<tr>
<td>Misc.</td>
<td></td>
</tr>
<tr>
<td><strong>Interior Wall</strong></td>
<td></td>
</tr>
<tr>
<td>Finish</td>
<td>(2) 5/8&quot; EcoRock Gyp</td>
</tr>
<tr>
<td>Framing</td>
<td>2 x 4 @ 16&quot; single stud</td>
</tr>
<tr>
<td>Misc.</td>
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<tr>
<td><strong>Other Loads</strong></td>
<td></td>
</tr>
<tr>
<td>Steel Foundation Track</td>
<td></td>
</tr>
<tr>
<td>Mechanical Equipment</td>
<td></td>
</tr>
</tbody>
</table>

### Dead Load

- **Exterior Wall**: 15 psf
- **Exterior Side Wall Of Top Module**: 13 psf
- **Interior Wall**: 8 psf

**Live Load**: 50 psf

**Other Loads**

- Steel Foundation Track: 33.9 psf
- Mechanical Equipment: 2000 lb
**SEISMIC DESIGN BASE SHEAR**

Santa Clara seismic conditions govern over Irvine Zip Code = 95053

Spectral Response Accelerations $S_s$ and $S_1$

$S_s$ and $S_1$ = Mapped Spectral Acceleration Values

Site Class B - $F_a = 1.0$, $F_v = 1.0$

Data are based on a 0.01 deg grid spacing

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Centroid $S_a$ (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.500 ($S_s$) Site Class D</td>
</tr>
<tr>
<td>1.0</td>
<td>0.600 ($S_1$) Site Class D</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Maximum $S_a$ (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.500 ($S_s$) Site Class D</td>
</tr>
<tr>
<td>1.0</td>
<td>0.600 ($S_1$) Site Class D</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Minimum $S_a$ (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.500 ($S_s$) Site Class D</td>
</tr>
<tr>
<td>1.0</td>
<td>0.600 ($S_1$) Site Class D</td>
</tr>
</tbody>
</table>

Occupancy Category = II (ASCE/SEI 7-10, Table 1.5-1)

Light Framed Walls w/ Panels For Shear Resistance

<table>
<thead>
<tr>
<th>$T_a$ = $C_t \cdot (h)^X$</th>
<th>0.175</th>
</tr>
</thead>
</table>

$S_s$ = 1.5 g

$S_1$ = 0.6 g < 0.6g

$F_a$ = 1

$F_v$ = 1.5

$S_{MS}$ = $F_a \cdot S_s$ = 1.5 g

$S_{M1}$ = $2 \cdot S_{MS}/3$ = 0.9 g

$S_{DS}$ = $F_v \cdot S_1$ = 1 g > 0.50 Seis. Design Cat.: D

$S_{D1}$ = $2 \cdot S_{M1}/3$ = 0.6 g

$C_s$ = $S_{ds}/(R/I)$ = 0.154 (ASCE/SEI 7-10, Eq 12.8-2)

$C_{s\,\text{max}}$ = $S_{dv}/T_a(R/I)$ = 0.528 (ASCE/SEI 7-10, Eq 12.8-3)

$C_{s\,\text{min}}$ = $0.044 \cdot S_{DS} \cdot I$ = 0.044 (ASCE/SEI 7-10, Eq 12.8-5)

$C_s$ = 0.154 (Controls)

$V$ = $C_s \cdot W$ = 0.154 W

$\rho$ = 1.300

$E$ = $\rho \cdot V$ = 0.200 W
SEISMIC DESIGN BASE SHEAR

Santa Clara seismic conditions govern over Irvine
Zip Code = 92618
Spectral Response Accelerations $S_s$ and $S_1$
$S_s$ and $S_1$ = Mapped Spectral Acceleration Values
Site Class B - $F_a = 1.0$, $F_v = 1.0$
Data are based on a 0.01 deg grid spacing

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Centroid Sa (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.470 ($S_s$)</td>
</tr>
<tr>
<td>1.0</td>
<td>0.520 ($S_1$)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Maximum Sa (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.500 ($S_s$)</td>
</tr>
<tr>
<td>1.0</td>
<td>0.546 ($S_1$)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Minimum Sa (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.401 ($S_s$)</td>
</tr>
<tr>
<td>1.0</td>
<td>0.498 ($S_1$)</td>
</tr>
</tbody>
</table>

Occupancy Category = II

- $I = 1$
- $h_x = 18$ ft
- $R = 6.5$
- $C_t = 0.02$
- $x = 0.75$

$T_a = C_t \times (h)^x = 0.175$
$S_s = 1.5 \ g$
$S_1 = 0.546 \ g < 0.6g$
$F_a = 1$
$F_v = 1$

$S_{MS} = F_a \times S_s = 1.5 \ g$
$S_{M1} = 2 \times S_{MS}/3 = 0.819 \ g$
$S_{DS} = F_v \times S_1 = 1 \ g > 0.50$
$S_{D1} = 2 \times S_{M1}/3 = 0.546 \ g$

$C_s = S_{D1}/(R/I) = 0.154$
$C_s_{max} = S_{D1}/T_a(R/I) = 0.481$
$C_s_{min} = .044 \ S_{DS} \times I = 0.044$

$C_s = 0.154$
$V = C_s \times W = 0.154 \ W$
$\rho = 1.300$
$E = \rho \times V = 0.200 \ W$

Light Framed Walls w/ Panels For Shear Resistance

Seis. Design Cat.: D

(ASCE/SEI 7-10, Table 1.5-1)
(ASCE/SEI 7-10, Eq 12.8-2)
(ASCE/SEI 7-10, Eq 12.8-3)
(ASCE/SEI 7-10, Eq 12.8-5)
### MODULE A

**Building Weight:**

<table>
<thead>
<tr>
<th>Level</th>
<th>N-S Seismic Load</th>
<th>E-W Seismic Load</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Area (sf)</td>
<td>Flat Load (psf)</td>
</tr>
<tr>
<td>Sloped Roof</td>
<td>144</td>
<td>15</td>
</tr>
<tr>
<td>Roof</td>
<td>257</td>
<td>12</td>
</tr>
<tr>
<td>Floor</td>
<td>388</td>
<td>16</td>
</tr>
<tr>
<td>Ext. Wall (N)</td>
<td>117</td>
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<td>Ext. Wall (S)</td>
<td>174</td>
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<tr>
<td>Ext. Wall (E)</td>
<td>315</td>
<td>15</td>
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<tr>
<td>Ext. Wall (W)</td>
<td>210</td>
<td>15</td>
</tr>
<tr>
<td>Roof Side Wall (W)</td>
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<td>13</td>
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<tr>
<td>Roof Wall (N)</td>
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<td>15</td>
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<tr>
<td>Top Steel</td>
<td>1171</td>
<td></td>
</tr>
<tr>
<td><strong>Total Wt.</strong></td>
<td><strong>25609</strong></td>
<td></td>
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</tbody>
</table>

**E = 5121.9 lbs.**

### MODULE A

**Force Distribution:**

<table>
<thead>
<tr>
<th>Level</th>
<th>h&lt;sup&gt;k&lt;/sup&gt; (ft)</th>
<th>N-S Seismic Load</th>
<th>E-W Seismic Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>wx&lt;sup&gt;k&lt;/sup&gt;</td>
<td>wx&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>Roof</td>
<td>18.0</td>
<td>13593</td>
<td>244668</td>
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<tr>
<td>Ground</td>
<td>2.5</td>
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<td>30041</td>
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<td><strong>Total</strong></td>
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<td><strong>274710</strong></td>
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### MODULE B

**Building Weight:**

<table>
<thead>
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<th>Level</th>
<th>N-S Seismic Load</th>
<th>E-W Seismic Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (sf)</td>
<td>Flat Load (psf)</td>
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<tr>
<td>Sloped Roof</td>
<td>247</td>
<td>15</td>
</tr>
<tr>
<td>Floor</td>
<td>228</td>
<td>16</td>
</tr>
<tr>
<td>Ext. Wall (N)</td>
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<td>Ext. Wall (S)</td>
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<tr>
<td>Roof Wall (N)</td>
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</tbody>
</table>

**E = 3197.9 lbs.**

### Module B

**Force Distribution:**

<table>
<thead>
<tr>
<th>Level</th>
<th>h&lt;sup&gt;k&lt;/sup&gt; (ft)</th>
<th>N-S Seismic Load</th>
<th>E-W Seismic Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>wx&lt;sup&gt;k&lt;/sup&gt;</td>
<td>wx&lt;sup&gt;k&lt;/sup&gt;</td>
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<tr>
<td>Roof</td>
<td>18.0</td>
<td>5953</td>
<td>171414</td>
</tr>
<tr>
<td>Ground</td>
<td>2.5</td>
<td>6466</td>
<td>16166</td>
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<td><strong>Total</strong></td>
<td><strong>15989</strong></td>
<td><strong>187580</strong></td>
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**MODULE C**

**Building Weight:**

<table>
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<tr>
<th>Level</th>
<th>Area (sf)</th>
<th>Flat Load (psf)</th>
<th>Weight (lbs)</th>
<th>Area (sf)</th>
<th>Flat Load (psf)</th>
<th>Weight (lbs)</th>
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<tbody>
<tr>
<td>Sloped Roof</td>
<td>144</td>
<td>15</td>
<td>2160</td>
<td>144</td>
<td>15</td>
<td>2160</td>
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<tr>
<td>Roof with water</td>
<td>108</td>
<td>16</td>
<td>1728</td>
<td>108</td>
<td>16</td>
<td>1728</td>
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<tr>
<td>Roof</td>
<td>197</td>
<td>12</td>
<td>2364</td>
<td>197</td>
<td>12</td>
<td>2364</td>
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<tr>
<td>Floor</td>
<td>436</td>
<td>16</td>
<td>6976</td>
<td>436</td>
<td>16</td>
<td>6976</td>
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<tr>
<td>Ext. Wall (N)</td>
<td>117</td>
<td>15</td>
<td>1755</td>
<td>117</td>
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<td>1755</td>
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<td>Ext. Wall (S)</td>
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<td>1755</td>
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<td>Ext. Wall (W)</td>
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<td>15</td>
<td>5314</td>
<td>354</td>
<td>15</td>
<td>5314</td>
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<tr>
<td>Ext. Wall (W)</td>
<td>319</td>
<td>15</td>
<td>4778</td>
<td>319</td>
<td>15</td>
<td>4778</td>
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<tr>
<td>Roof Side Wall (E)</td>
<td>276</td>
<td>8</td>
<td>2211</td>
<td>276</td>
<td>8</td>
<td>2211</td>
</tr>
<tr>
<td>Interior Walls</td>
<td>42</td>
<td>13</td>
<td>540</td>
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<td>13</td>
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<td>2000</td>
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<td>Roof Wall (N)</td>
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<td>15</td>
<td>1055</td>
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<td>15</td>
<td>1055</td>
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**E = 7001.0 lbs**

**MODULE C**

**Force Distribution:**

<table>
<thead>
<tr>
<th>Level</th>
<th>(h^k) (ft)</th>
<th>(w_x) (lbs)</th>
<th>(w_x \cdot h^k)</th>
<th>(\frac{w_x \cdot h^k}{S(w^*h)})</th>
<th>(F_x) (lbs)</th>
<th>(w_x) (lbs)</th>
<th>(w_x \cdot h^k)</th>
<th>(\frac{w_x \cdot h^k}{S(w^*h)})</th>
<th>(F_x) (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>18.0</td>
<td>16811</td>
<td>302592</td>
<td>0.87688</td>
<td>6139</td>
<td>16811</td>
<td>302592</td>
<td>0.87688</td>
<td>6139</td>
</tr>
<tr>
<td>Ground</td>
<td>2.5</td>
<td>16995</td>
<td>42486</td>
<td>0.12312</td>
<td>862</td>
<td>16995</td>
<td>42486</td>
<td>0.12312</td>
<td>862</td>
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<tr>
<td>Total</td>
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<td>345079</td>
<td>1</td>
<td>7001</td>
<td>33805</td>
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<td>1</td>
<td>7001</td>
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</tbody>
</table>
WIND LOAD
Per ASCE 7-10
Wind conditions for Santa Clara and Irvine are the same.

Basic Wind

- Speed: $V = 85$ mph
- Importance Factor: $I = 1.0$
- Exposure Category: $C$
- Velocity Pressure Exposure Coefficient: $K_Z = 0.9$
- Velocity Pressure Exposure Coefficient: $K_h = 0.85$
- Topographic Factor: $K_{Zt} = 1$
- Wind Directionality Factor: $K_d = 0.85$
- Gust Effect Factor: $G = 0.85$
- Enclosure Classification: Enclosed

Internal Pressure Coefficient
- $G_{C_{pi}} = 0.18$
- $G_{C_{pi}} = -0.18$

Wall External Pressure Coefficients
- $C_p = 0.8$ (Windward Wall)
- $C_p = -0.25$ (Leeward Wall)
- $C_p = -0.7$ (Side Wall)

Roof External Pressure Coefficients
- $C_p = -0.9$ (Windward Wall)
- $C_p = -0.5$ (Leeward Wall)

Velocity Pressure
- $q_z = (0.00256)(K_Z)(K_{Zt})(K_d)(V^2)(I) = 14.15$
- $q_h = (0.00256)(K_h)(K_{Zt})(K_d)(V^2)(I) = 13.36$

Design Wind Load

$p = qG_{Cp} - q_i(G_{Cpi}) = 12.027$ psf

---

Module A

- Width. N-S = 32.33 ft
- Width. E-W = 12 ft
- Height = 18.00 ft
- $V_{wind. N-S} = 2598$ lbs Seismic Governs
- $V_{wind. E-W} = 7000$ lbs Wind Governs

Module B

- Width. N-S = 12 ft
- Width. E-W = 21.10 ft
- Height = 18.00 ft
- $V_{wind. N-S} = 4569$ lbs Seismic Governs
- $V_{wind. E-W} = 2598$ lbs Wind Governs

Module C

- Width. N-S = 36.33 ft
- Width. E-W = 12 ft
- Height = 18.00 ft
- $V_{wind. N-S} = 2598$ lbs Seismic Governs
- $V_{wind. E-W} = 7866$ lbs Wind Governs
### SHEAR WALLS

#### MODULE A

**E-W Wind Load on Shear Walls**

<table>
<thead>
<tr>
<th>Shear Wall</th>
<th>Wall Type</th>
<th>Fx [lbs]</th>
<th>Px = Fx/1.4</th>
<th>b (ft)</th>
<th>h(ft)</th>
<th>Aspect Ratio (h:b)</th>
<th>v [ASD] (plf)</th>
<th>v. allow (plf)</th>
<th>Plywood (in.)</th>
<th>Edge Nailing (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Segmented</td>
<td>605</td>
<td>432.3</td>
<td>2.84</td>
<td>9.46</td>
<td>3.326</td>
<td>152.0</td>
<td>475</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
</tr>
<tr>
<td>B</td>
<td>Segmented</td>
<td>605</td>
<td>432.3</td>
<td>2.84</td>
<td>9.46</td>
<td>3.326</td>
<td>152.0</td>
<td>475</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
</tr>
<tr>
<td>C</td>
<td>Segmented</td>
<td>485</td>
<td>346.5</td>
<td>2.84</td>
<td>9.46</td>
<td>3.326</td>
<td>121.9</td>
<td>475</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
</tr>
<tr>
<td>D</td>
<td>Segmented</td>
<td>485</td>
<td>346.5</td>
<td>2.84</td>
<td>9.46</td>
<td>3.326</td>
<td>121.9</td>
<td>475</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
</tr>
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<td>H&amp;I</td>
<td>Collector A</td>
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<tr>
<td>K</td>
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<td>1635.3</td>
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</table>

**N-S Seismic Load on Shear Walls**

<table>
<thead>
<tr>
<th>Shear Wall</th>
<th>Wall Type</th>
<th>Fx [lbs]</th>
<th>Px = Fx/1.4</th>
<th>b (ft)</th>
<th>h(ft)</th>
<th>Aspect Ratio (h:b)</th>
<th>v [ASD] (plf)</th>
<th>v. allow (plf)</th>
<th>Plywood (in.)</th>
<th>Edge Nailing (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Segmented</td>
<td>1225</td>
<td>874.9</td>
<td>2.75</td>
<td>9.46</td>
<td>3.439</td>
<td>318.1</td>
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<td>15/32 Str 1</td>
<td>10d @ 6</td>
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<tr>
<td>F</td>
<td>Segmented</td>
<td>3340</td>
<td>2386.0</td>
<td>7.50</td>
<td>9.46</td>
<td>1.261</td>
<td>318.1</td>
<td>340</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
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<tr>
<td>G</td>
<td>Segmented</td>
<td>2281</td>
<td>1629.2</td>
<td>12.00</td>
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<td>0.788</td>
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#### MODULE B

**E-W Seismic Load on Shear Walls**

<table>
<thead>
<tr>
<th>Shear Wall</th>
<th>Wall Type</th>
<th>Fx [lbs]</th>
<th>Px = Fx/1.4</th>
<th>b (ft)</th>
<th>h(ft)</th>
<th>Aspect Ratio (h:b)</th>
<th>v [ASD] (plf)</th>
<th>v. allow (plf)</th>
<th>Plywood (in.)</th>
<th>Edge Nailing (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
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<td>3477</td>
<td>2483.3</td>
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<td>665</td>
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<td>10d @ 3</td>
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<tr>
<td>I</td>
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<td>2483.3</td>
<td>4.00</td>
<td>9.46</td>
<td>2.365</td>
<td>620.8</td>
<td>665</td>
<td>15/32 Str 1</td>
<td>10d @ 3</td>
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<td>K</td>
<td>Collector B</td>
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**N-S Wind Load on Shear Walls**

<table>
<thead>
<tr>
<th>Shear Wall</th>
<th>Wall Type</th>
<th>Fx [lbs]</th>
<th>Px = Fx/1.4</th>
<th>b (ft)</th>
<th>h(ft)</th>
<th>Aspect Ratio (h:b)</th>
<th>v [ASD] (plf)</th>
<th>v. allow (plf)</th>
<th>Plywood (in.)</th>
<th>Edge Nailing (in.)</th>
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<tr>
<td>E&amp;F</td>
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#### MODULE C

**E-W Wind Load on Shear Walls**

<table>
<thead>
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<th>Fx [lbs]</th>
<th>Px = Fx/1.4</th>
<th>b (ft)</th>
<th>h(ft)</th>
<th>Aspect Ratio (h:b)</th>
<th>v [ASD] (plf)</th>
<th>v. allow (plf)</th>
<th>Plywood (in.)</th>
<th>Edge Nailing (in.)</th>
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<tbody>
<tr>
<td>J</td>
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<td>1643</td>
<td>1173.8</td>
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<td>L</td>
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<td>10d @ 6</td>
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<td>H&amp;I</td>
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N-S Seismic Load on Shear Walls

<table>
<thead>
<tr>
<th>Shear Wall</th>
<th>Wall Type</th>
<th>Fx (lbs)</th>
<th>Px = Fx/1.4</th>
<th>b (ft)</th>
<th>h(ft)</th>
<th>Aspect Ratio (h:b)</th>
<th>v (ASD) (plf)</th>
<th>v. allow (plf)</th>
<th>Plywood (in.)</th>
<th>Edge Nailing (in.)</th>
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<tr>
<td>N</td>
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<td>340</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
</tr>
<tr>
<td>O</td>
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<td>1784.6</td>
<td>1274.7</td>
<td>4.00</td>
<td>9.46</td>
<td>2.365</td>
<td>318.7</td>
<td>340</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
</tr>
<tr>
<td>P</td>
<td>Segmented</td>
<td>1784.6</td>
<td>1274.7</td>
<td>4.00</td>
<td>9.46</td>
<td>2.365</td>
<td>318.7</td>
<td>340</td>
<td>15/32 Str 1</td>
<td>10d @ 6</td>
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<td>10d @ 6</td>
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</table>

Perforated Shear Walls

<table>
<thead>
<tr>
<th>Shear Wall</th>
<th>∑Li (ft)</th>
<th>Ltotal (ft)</th>
<th>Opening Height Ratio</th>
<th>Percent Full-Height Sheathing</th>
<th>Co</th>
<th>v (ASD) (plf)</th>
<th>v. allow (plf)</th>
<th>Plywood (in.)</th>
<th>Edge Nailing (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.00</td>
<td>8.04</td>
<td>h/3</td>
<td>0.75</td>
<td>1</td>
<td>0.0</td>
<td>561.58</td>
<td>15/32 Str 1</td>
<td>10d @ 4</td>
</tr>
</tbody>
</table>

**SHEAR WALL - A :**

Check Loads:
- P_x = 432.3 lbs
- W* = 0 lbs
- M_{ot} = 4088.7 lb-ft
- T_{asd} = 1437.79 lbs

Check Holdown: HDU2 3D52.5
- T_{a,hd} = 3075 lbs OK

Check Overturning
- W = 0 lbs
- M_r = 8744.5 lb-ft
- M_{ot} = 4088.7 lb-ft
- M_r > M_{ot} OK

Clips to Top Plate
- Clip A35
- Capacity 695 lbs
- Number Req'd 2
- Req'd Spacing 27 in.

* Assume weight of wall is 0 to be conservative

**SHEAR WALL - B :**

Check Loads:
- P_x = 432.3 lbs
- W* = 0 lbs
- M_{ot} = 4088.7 lb-ft
- T_{asd} = 1437.79 lbs

Check Holdown: HDU2 3D52.5
- T_{a,hd} = 3075 lbs OK

Check Overturning
- W = 0 lbs
- M_r = 8744.5 lb-ft
- M_{ot} = 4088.7 lb-ft
- M_r > M_{ot} OK

Clips to Top Plate
- Clip A35
- Capacity 695 lbs
- Number Req'd 2
- Req'd Spacing 27 in.

* Assume weight of wall is 0 to be conservative
SHEAR WALL - C:

Check Loads:
- \( P_x = 346.5 \) lbs
- \( W^* = 0 \) lbs
- \( M_{fd} = 3277.5 \) lb-ft
- \( T_{end} = 1152.51 \) lbs

Check Holdown:
- \( T_{hd} = 3075 \) lbs

Check Overturning:
- \( W = 0 \) lbs
- \( M_r = 8744.5 \) lb-ft
- \( M_{ot} = 3277.5 \) lb-ft
- \( M_r > M_{ot} \) OK

Clips to Top Plate:
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 27 in.

* Assume weight of wall is 0 to be conservative

SHEAR WALL - D:

Check Loads:
- \( P_x = 346.5 \) lbs
- \( W^* = 0 \) lbs
- \( M_{fd} = 3277.5 \) lb-ft
- \( T_{end} = 1152.51 \) lbs

Check Holdown:
- \( T_{hd} = 3075 \) lbs

Check Overturning:
- \( W = 0 \) lbs
- \( M_r = 8744.5 \) lb-ft
- \( M_{ot} = 3277.5 \) lb-ft
- \( M_r > M_{ot} \) OK

Clips to Top Plate:
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 27 in.

* Assume weight of wall is 0 to be conservative

SHEAR WALL - E:

Check Loads:
- \( P_x = 874.9 \) lbs
- \( W^* = 0 \) lbs
- \( M_{fd} = 8274.9 \) lb-ft
- \( T_{end} = 3009.04 \) lbs

Check Holdown:
- \( T_{hd} = 3075 \) lbs

Check Overturning:
- \( W = 0 \) lbs
- \( M_r = 8456.3 \) lb-ft
- \( M_{ot} = 8274.9 \) lb-ft
- \( M_r > M_{ot} \) OK

Clips to Top Plate:
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 26 in.

* Assume weight of wall is 0 to be conservative
**SHEAR WALL - F :**

Check Loads:
- \( P_x = 2386.0 \text{ lbs} \)
- \( W^* = 0 \text{ lbs} \)
- \( M_{zd} = 22567.8 \text{ lb-ft} \)
- \( T_{net} = 3009.04 \text{ lbs} \)

Check Holdown: HDU2 3D52.5
- \( T_{hd} = 3075 \text{ lbs} \) OK

Check Overturning:
- \( W = 0 \text{ lbs} \)
- \( M_x = 23062.5 \text{ lb-ft} \)
- \( M_{zd} = 22567.8 \text{ lb-ft} \)
- \( M_x > M_{zd} \) OK

Clips to Top Plate:
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 4
- Req'd Spacing: 30.00 in.

* Assume weight of wall is 0 to be conservative

---

**SHEAR WALL - G :**

Check Loads:
- \( P_x = 1629.2 \text{ lbs} \)
- \( W^* = 0 \text{ lbs} \)
- \( M_{zd} = 15409.5 \text{ lb-ft} \)
- \( T_{net} = 1284.12 \text{ lbs} \)

Check Holdown: HDU2 3D52.5
- \( T_{hd} = 3075 \text{ lbs} \) OK

Check Overturning:
- \( W = 0 \text{ lbs} \)
- \( M_x = 36900.0 \text{ lb-ft} \)
- \( M_{zd} = 15409.5 \text{ lb-ft} \)
- \( M_x > M_{zd} \) OK

Clips to Top Plate:
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 4
- Req'd Spacing: 48 in.

* Assume weight of wall is 0 to be conservative

---

**SHEAR WALL - H :**

Check Loads:
- \( P_x = 2483.3 \text{ lbs} \)
- \( W^* = 0 \text{ lbs} \)
- \( M_{zd} = 23488.3 \text{ lb-ft} \)
- \( T_{net} = 5872.07 \text{ lbs} \)

Check Holdown: HDU8 5D52.5
- \( T_{hd} = 6970 \text{ lbs} \) OK

Check Overturning:
- \( W = 0 \text{ lbs} \)
- \( M_x = 27880.0 \text{ lb-ft} \)
- \( M_{zd} = 23488.3 \text{ lb-ft} \)
- \( M_x > M_{zd} \) OK

* Assume weight of wall is 0 to be conservative
SHEAR WALL - I:

Check Loads:
- \( P_x = 2483.3 \) lbs
- \( W^* = 0 \) lbs
- \( M_{ed} = 23488.3 \) lb-ft
- \( T_{ed} = 5872.07 \) lbs

Check Holdown: HDU8 SDS2.5
- \( T_{a,hd} = 6970 \) lbs OK

Check Overturning:
- \( W = 0 \) lbs
- \( M_x = 27880.0 \) lb-ft
- \( M_{ot} = 23488.3 \) lb-ft
- \( M_x > M_{ot} \) OK

* Assume weight of wall is 0 to be conservative

SHEAR WALL - J:

Check Loads:
- \( P_x = 1173.8 \) lbs
- \( W^* = 0 \) lbs
- \( M_{ed} = 11102.6 \) lb-ft
- \( T_{ed} = 4099.42 \) lbs

Check Holdown: HDU4 SDS2.5
- \( T_{a,hd} = 4565 \) lbs OK

Check Overturning:
- \( W = 0 \) lbs
- \( M_x = 12363.5 \) lb-ft
- \( M_{ot} = 11102.6 \) lb-ft
- \( M_x > M_{ot} \) OK

Clips to Top Plate
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 30 in.

* Assume weight of wall is 0 to be conservative

SHEAR WALL - K:

Check Loads:
- \( P_x = 4516.1 \) lbs
- \( T_{ed} = V_h \) lbs
- \( T_{ed} = \sum Li \) lb-ft
- \( T_{ed} = 5400.00 \) lbs

Check Holdown: HDU5 SDS2.5
- \( T_{a,hd} = 5645 \) lbs OK

Clips to Top Plate
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 7
- Req'd Spacing: 21.00 in.

* Assume weight of wall is 0 to be conservative
**SHEAR WALL - L:**

**Check Loads:**

- $P_x = 245.6$ lbs
- $W^* = 0$ lbs
- $M_{ef} = 2323.4$ lb-ft
- $T_{red} = 817.0$ lbs

**Check Holdown:**

- HDU2 SDS2.5
- $T_{a,hd} = 3075$ lbs OK

**Check Overturning**

- $W = 0$ lbs
- $M_r = 8744.5$ lb-ft
- $M_{ef} = 2323.4$ lb-ft
- $M_r > M_{ef}$ OK

**Clips to Top Plate**

- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 26 in.

*Assume weight of wall is 0 to be conservative*

---

**SHEAR WALL - M:**

**Check Loads:**

- $P_x = 245.6$ lbs
- $W^* = 0$ lbs
- $M_{ef} = 2323.4$ lb-ft
- $T_{red} = 817.00$ lbs

**Check Holdown:**

- HDU2 SDS2.5
- $T_{a,hd} = 3075$ lbs OK

**Check Overturning**

- $W = 0$ lbs
- $M_r = 8744.5$ lb-ft
- $M_{ef} = 2323.4$ lb-ft
- $M_r > M_{ef}$ OK

**Clips to Top Plate**

- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 26 in.

*Assume weight of wall is 0 to be conservative*

---

**SHEAR WALL - N:**

**Check Loads:**

- $P_x = 1274.7$ lbs
- $W^* = 0$ lbs
- $M_{ef} = 12056.9$ lb-ft
- $T_{red} = 3014.24$ lbs

**Check Holdown:**

- HDU2 SDS2.5
- $T_{a,hd} = 3075$ lbs OK

**Check Overturning**

- $W = 0$ lbs
- $M_r = 0.0$ lb-ft
- $M_{ef} = 12056.9$ lb-ft
- $M_r > M_{ef}$ OK

**Clips to Top Plate**

- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 24 in.

*Assume weight of wall is 0 to be conservative*
SHEAR WALL - O:

Check Loads:
- \( P_x = 1274.7 \text{ lbs} \)
- \( W^* = 0 \text{ lbs} \)
- \( M_{df} = 12056.9 \text{ lb-ft} \)
- \( T_{red} = 3014.24 \text{ lbs} \)

Check Holdown: HDU2 SD52.5
- \( T_{ahd} = 3075 \text{ lbs} \) OK

Check Overturning:
- \( W = 0 \text{ lbs} \)
- \( M_r = 12300.0 \text{ lb-ft} \)
- \( M_{ot} = 12056.9 \text{ lb-ft} \)
- \( M_r > M_{ot} \) OK

Clips to Top Plate
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 24 in.

* Assume weight of wall is 0 to be conservative

---

SHEAR WALL - P:

Check Loads:
- \( P_x = 1274.7 \text{ lbs} \)
- \( W^* = 0 \text{ lbs} \)
- \( M_{df} = 12056.9 \text{ lb-ft} \)
- \( T_{red} = 3014.24 \text{ lbs} \)

Check Holdown: HDU2 SD52.5
- \( T_{ahd} = 3075 \text{ lbs} \) OK

Check Overturning:
- \( W = 0 \text{ lbs} \)
- \( M_r = 12300.0 \text{ lb-ft} \)
- \( M_{ot} = 12056.9 \text{ lb-ft} \)
- \( M_r > M_{ot} \) OK

Clips to Top Plate
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 2
- Req'd Spacing: 24 in.

* Assume weight of wall is 0 to be conservative

---

SHEAR WALL - Q:

Check Loads:
- \( P_x = 2192.5 \text{ lbs} \)
- \( W^* = 0 \text{ lbs} \)
- \( M_{df} = 20737.6 \text{ lb-ft} \)
- \( T_{red} = 2704.91 \text{ lbs} \)

Check Holdown: HDU2 SD52.5
- \( T_{ahd} = 3075 \text{ lbs} \) OK

Check Overturning:
- \( W = 0 \text{ lbs} \)
- \( M_r = 23575.0 \text{ lb-ft} \)
- \( M_{ot} = 20737.6 \text{ lb-ft} \)
- \( M_r > M_{ot} \) OK

Clips to Top Plate
- Clip: A35
- Capacity: 695 lbs
- Number Req'd: 3
- Req'd Spacing: 30 in.

* Assume weight of wall is 0 to be conservative
# FLAT ROOF DIAPHRAGM

## MODULE A

### Unblocked Diaphragm Design

#### Direction 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of Story</td>
<td>H₁</td>
</tr>
<tr>
<td>N-S</td>
<td></td>
</tr>
<tr>
<td>Dead Load</td>
<td>Dₗ</td>
</tr>
<tr>
<td>Length of Building</td>
<td>Lₖ₁</td>
</tr>
<tr>
<td></td>
<td>L₂₂</td>
</tr>
<tr>
<td>Applied Load</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>Wₗ=(12.027 psf) * H₁</td>
</tr>
<tr>
<td>Seismic</td>
<td>Wₛ=0.2<em>Dₗ</em>Lₖ₁</td>
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<tr>
<td>Vₘ₉₉</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>Vₘ₉₉=Wₗ*L₂₂/2</td>
</tr>
<tr>
<td>Seismic</td>
<td>Vₛ₉₉=Wₛ*L₂₂/2</td>
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<tr>
<td>vₜ₉₉</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>vₜ₉₉=Vₘ₉₉/Lₖ₁</td>
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<tr>
<td>Seismic</td>
<td>vₛ₉₉=Vₛ₉₉/Lₖ₁</td>
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<td>Ω</td>
</tr>
<tr>
<td>Vₜ₉₉ₙₐ₉₉</td>
<td>vₜ₉₉ₙₐ₉₉=Vₜ₉₉*Ω</td>
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#### Direction 2

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<td>E-W</td>
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<tr>
<td>Dead Load</td>
<td>Dₗ</td>
</tr>
<tr>
<td>Length of Building</td>
<td>Lₖ₁</td>
</tr>
<tr>
<td></td>
<td>L₂₂</td>
</tr>
<tr>
<td>Applied Load</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>Wₗ=(12.027 psf) * H₁</td>
</tr>
<tr>
<td>Seismic</td>
<td>Wₛ=0.2<em>Dₗ</em>Lₖ₁</td>
</tr>
<tr>
<td>Vₘ₉₉</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>Vₘ₉₉=Wₗ*L₂₂/2</td>
</tr>
<tr>
<td>Seismic</td>
<td>Vₛ₉₉=Wₛ*L₂₂/2</td>
</tr>
<tr>
<td>vₜ₉₉</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>vₜ₉₉=Vₘ₉₉/Lₖ₁</td>
</tr>
<tr>
<td>Seismic</td>
<td>vₛ₉₉=Vₛ₉₉/Lₖ₁</td>
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<td>Nominal Capacities</td>
<td>Ω</td>
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<td>Vₜ₉₉ₙₐ₉₉</td>
<td>vₜ₉₉ₙ₉₉=Vₜ₉₉*Ω</td>
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<td>vₛ₉₉ₙ₉₉=vₛ₉₉*Ω</td>
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</table>

*Use 3/4" T&G, 8d nails @ 6 inch edge nail spacing

*Use 15 gauge staples @ 12 inches for field stapling
### FLAT ROOF DIAPHRAGM

#### MODULE C

**Unblocked Diaphragm Design**

**Direction 1**

- **Height of Story** $H_1$ 12.00 ft
- **Dead Load** $D_L$ 16.00 psf
- **Length of Building** $L_{B1}$ 16.50 ft  
  $L_{B2}$ 12.00 ft

**Applied Load**

- **Wind** $W_L=(12.027 \text{psf}) \times H_1$ 144.32 plf
- **Seismic** $W_S=0.2 \times D_L \times L_{B1}$ 52.80 plf

**$V_{\text{max}}$**

- **Wind** $V_{\text{MAX}}=W_L \times L_{B2}/2$ 865.95 lb
- **Seismic** $V_{\text{MAX}}=W_S \times L_{B2}/2$ 316.80 lb

**$V_{\text{ad}}$**

- **Wind** $V_{\text{AD}}=V_{\text{MAX}}/L_{B1}$ 52.48 plf
- **Seismic** $V_{\text{AD}}=V_{\text{MAX}}/L_{B1}$ 19.20 plf

**Nominal Capacities**

- $\Omega$ 2

- **$V_{\text{wdnom}}$** $V_{\text{wdnom}}=V_{\text{wd}} \times \Omega$ 104.96 plf
- **$V_{\text{sdnom}}$** $V_{\text{sdnom}}=V_{\text{sd}} \times \Omega$ 38.40 plf

**Direction 2**

- **Height of Story** $H_1$ 12.00 ft
- **Length of Building** $L_{B1}$ 12.00 ft  
  $L_{B2}$ 16.50 ft

**Applied Load**

- **Wind** $W_L=(12.027 \text{psf}) \times H_1$ 144.32 plf
- **Seismic** $W_S=0.2 \times D_L \times L_{B1}$ 38.40 plf

**$V_{\text{max}}$**

- **Wind** $V_{\text{MAX}}=W_L \times L_{B2}/2$ 1190.68 lb
- **Seismic** $V_{\text{MAX}}=W_S \times L_{B2}/2$ 316.80 lb

**$V_{\text{ad}}$**

- **Wind** $V_{\text{AD}}=V_{\text{MAX}}/L_{B1}$ 99.22 plf
- **Seismic** $V_{\text{AD}}=V_{\text{MAX}}/L_{B1}$ 26.40 plf

**Nominal Capacities**

- $\Omega$ 2

- **$V_{\text{wdnom}}$** $V_{\text{wdnom}}=V_{\text{wd}} \times \Omega$ 198.45 plf
- **$V_{\text{sdnom}}$** $V_{\text{sdnom}}=V_{\text{sd}} \times \Omega$ 52.80 plf

*Use 3/4” T&G, 8d nails @ 6 inch edge nail spacing

*Use 15 gauge staples @ 12 inches for field stapling
# Floor Diaphragm

## Module A

**Unblocked Diaphragm Design**

<table>
<thead>
<tr>
<th>Direction 1</th>
<th>Height of Story</th>
<th>$H_1$</th>
<th>8.00 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-S</td>
<td>Dead Load</td>
<td>$D_L$</td>
<td>16.00 psf</td>
</tr>
<tr>
<td></td>
<td>Length of Building</td>
<td>$L_{B1}$</td>
<td>32.33 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$L_{B2}$</td>
<td>12.00 ft</td>
</tr>
<tr>
<td>Applied Load</td>
<td>Wind</td>
<td>$W_L=(12.027 \text{psf}) \times H_1$</td>
<td>96.22 plf</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>$W_S=0.2 \times D_L \times L_{B1}$</td>
<td>103.47 plf</td>
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<tr>
<td>$V_{\text{max}}$</td>
<td>Wind</td>
<td>$V_{\text{wmax}}=W_L \times L_{B2}/2$</td>
<td>577.30 lb</td>
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<td>Seismic</td>
<td>$V_{\text{smax}}=W_S \times L_{B2}/2$</td>
<td>620.80 lb</td>
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<tr>
<td>$V_{\text{wd}}$</td>
<td>Wind</td>
<td>$V_{\text{wd}}=V_{\text{wmax}}/L_{B1}$</td>
<td>17.85 plf</td>
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<td>Seismic</td>
<td>$V_{\text{sd}}=V_{\text{smax}}/L_{B1}$</td>
<td>19.20 plf</td>
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<td>Nominal Capacities</td>
<td>$\Omega$</td>
<td>$V_{\text{wdnom}}=V_{\text{wd}} \times \Omega$</td>
<td>35.71 plf</td>
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<td>$V_{\text{sdnom}}=V_{\text{sd}} \times \Omega$</td>
<td>38.40 plf</td>
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<table>
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<th>Direction 2</th>
<th>Height of Story</th>
<th>$H_1$</th>
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<td>E-W</td>
<td>Dead Load</td>
<td>$D_L$</td>
<td>16.00 psf</td>
</tr>
<tr>
<td></td>
<td>Length of Building</td>
<td>$L_{B1}$</td>
<td>12.00 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$L_{B2}$</td>
<td>32.33 ft</td>
</tr>
<tr>
<td>Applied Load</td>
<td>Wind</td>
<td>$W_L=(12.027 \text{psf}) \times H_1$</td>
<td>96.22 plf</td>
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<tr>
<td></td>
<td>Seismic</td>
<td>$W_S=0.2 \times D_L \times L_{B1}$</td>
<td>38.40 plf</td>
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<tr>
<td>$V_{\text{max}}$</td>
<td>Wind</td>
<td>$V_{\text{wmax}}=W_L \times L_{B2}/2$</td>
<td>1555.50 lb</td>
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<td>Seismic</td>
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<tr>
<td>$V_{\text{wd}}$</td>
<td>Wind</td>
<td>$V_{\text{wd}}=V_{\text{wmax}}/L_{B1}$</td>
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<td></td>
<td>$V_{\text{sdnom}}=V_{\text{sd}} \times \Omega$</td>
<td>103.47 plf</td>
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</tbody>
</table>

**Load with cut panel sections**

- **Diaphragm Edge Shear**: $V_{\text{wdnom}} \times L_{B2}$
  - 8382.39 lbs
- **Length with cut panels**: $L_{B3}$
  - 28.33 ft
- **$V_{\text{wdnom}}$**: $V_{\text{wdnom}} \times L_{B2}$
  - 295.85 plf
- **Diaphragm Edge Shear**: $V_{\text{sdnom}} \times L_{B2} / L_{B3}$
  - 3345.42 lbs
- **$V_{\text{sdnom}}$**: $V_{\text{sdnom}} \times L_{B2} / L_{B3}$
  - 118.07 plf

*Use 3/4" T&G, 10d nails @ 6 inch edge nail spacing

*Use 15 gauge staples @ 12 inches for field stapling*
# Floor Diaphragm

## Module B

### Unblocked Diaphragm Design

<table>
<thead>
<tr>
<th>Direction 1</th>
<th>Height of Story</th>
<th>$H_1$</th>
<th>8.00 ft</th>
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</thead>
<tbody>
<tr>
<td><strong>E-W</strong></td>
<td>Dead Load</td>
<td>$D_L$</td>
<td>16.00 psf</td>
</tr>
<tr>
<td></td>
<td>Length of Building</td>
<td>$L_{B1}$</td>
<td>21.50 ft</td>
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<tr>
<td></td>
<td></td>
<td>$L_{B2}$</td>
<td>12.00 ft</td>
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<tr>
<td>Applied Load</td>
<td>Wind</td>
<td>$W_L=(12.027 \text{psf})^*H_1$</td>
<td>96.22 plf</td>
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<tr>
<td></td>
<td>Seismic</td>
<td>$W_S=0.2<em>D_L</em>L_{B1}$</td>
<td>68.80 plf</td>
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<td></td>
<td>$V_{\text{max}}$</td>
<td>Wind</td>
<td>$V_{\text{emax}}=W_L*L_{B2}/2$</td>
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<tr>
<td></td>
<td></td>
<td>Seismic</td>
<td>$V_{\text{emax}}=W_S*L_{B2}/2$</td>
</tr>
<tr>
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<td>$V_{\text{wd}}$</td>
<td>Wind</td>
<td>$V_{\text{wd}}=V_{\text{emax}}/L_{B1}$</td>
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<td>$V_{\text{sd}}$</td>
<td>Seismic</td>
<td>$V_{\text{sd}}=V_{\text{emax}}/L_{B1}$</td>
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<td>$V_{\text{wdnom}}$</td>
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### Direction 2

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<td>$D_L$</td>
</tr>
<tr>
<td></td>
<td>Length of Building</td>
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<td></td>
<td></td>
<td>$L_{B2}$</td>
</tr>
<tr>
<td>Applied Load</td>
<td>Wind</td>
<td>$W_L=(12.027 \text{psf})^*H_1$</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>$W_S=0.2<em>D_L</em>L_{B1}$</td>
</tr>
<tr>
<td></td>
<td>$V_{\text{max}}$</td>
<td>Wind</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seismic</td>
</tr>
<tr>
<td></td>
<td>$V_{\text{wd}}$</td>
<td>Wind</td>
</tr>
<tr>
<td></td>
<td>$V_{\text{sd}}$</td>
<td>Seismic</td>
</tr>
<tr>
<td>Nominal Capacities</td>
<td>$\Omega$</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>$V_{\text{wdnom}}$</td>
<td>$V_{\text{wdnom}}=V_{\text{wd}}^*\Omega$</td>
</tr>
<tr>
<td></td>
<td>$V_{\text{sdnom}}$</td>
<td>$V_{\text{sdnom}}=V_{\text{sd}}^*\Omega$</td>
</tr>
</tbody>
</table>

**Load with cut panel sections**

<table>
<thead>
<tr>
<th>Diaphragm Edge Shear</th>
<th>$V_{\text{wdnom}}^*L_{B2}$</th>
<th>2068.65 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length with cut panels</td>
<td>$L_{B3}$</td>
<td>8.00 ft</td>
</tr>
<tr>
<td>$V_{\text{wdnom}}$</td>
<td>$V_{\text{wdnom}}^*L_{B2}$</td>
<td>258.58 plf</td>
</tr>
<tr>
<td>Diaphragm Edge Shear</td>
<td>$V_{\text{sdnom}}^*L_{B2}/L_{B3}$</td>
<td>825.60 lbs</td>
</tr>
<tr>
<td>$V_{\text{sdnom}}$</td>
<td>$V_{\text{sdnom}}^*L_{B2}/L_{B3}$</td>
<td>103.20 plf</td>
</tr>
</tbody>
</table>

*Use 3/4" T&G, 10d nails @ 6 inch edge nail spacing

*Use 15 gauge staples @ 12 inches for field stapling
**FLOOR DIAPHRAGM**

**MODULE C**

**Unblocked Diaphragm Design**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Height of Story</th>
<th>( H_1 )</th>
<th>8.00 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction 1</td>
<td>Dead Load</td>
<td>( D_L )</td>
<td>16.00 psf</td>
</tr>
<tr>
<td>Length of Building</td>
<td>( L_{B1} )</td>
<td>36.33 ft</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( L_{B2} )</td>
<td>12.00 ft</td>
<td></td>
</tr>
<tr>
<td>Applied Load</td>
<td>Wind</td>
<td>( W_L = (12.027 \text{psf}) \times H_1 )</td>
<td>96.22 plf</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>( W_S = 0.2 \times D_L \times L_{B1} )</td>
<td>116.27 plf</td>
</tr>
<tr>
<td>( V_{\text{max}} )</td>
<td>Wind</td>
<td>( V_{\text{wmax}} = W_L \times L_{B2}/2 )</td>
<td>577.30 lb</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>( V_{\text{smax}} = W_S \times L_{B2}/2 )</td>
<td>697.60 lb</td>
</tr>
<tr>
<td>( V_{\text{wd}} )</td>
<td>Wind</td>
<td>( V_{\text{wmax}} = V_{\text{wmax}} \times L_{B1} )</td>
<td>15.89 plf</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>( V_{\text{smax}} = V_{\text{wmax}} \times L_{B1} )</td>
<td>19.20 plf</td>
</tr>
<tr>
<td>Nominal Capacities</td>
<td>( \Omega )</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>( V_{\text{wdnom}} )</td>
<td>( V_{\text{wdnom}} = V_{\text{wd}} \times \Omega )</td>
<td>31.78 plf</td>
<td></td>
</tr>
<tr>
<td>( V_{\text{sdnom}} )</td>
<td>( V_{\text{sdnom}} = V_{\text{sd}} \times \Omega )</td>
<td>38.40 plf</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Direction 2</th>
<th>Height of Story</th>
<th>( H_1 )</th>
<th>8.00 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction 2</td>
<td>Dead Load</td>
<td>( D_L )</td>
<td>16.00 psf</td>
</tr>
<tr>
<td>Length of Building</td>
<td>( L_{B1} )</td>
<td>12.00 ft</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( L_{B2} )</td>
<td>36.33 ft</td>
<td></td>
</tr>
<tr>
<td>Applied Load</td>
<td>Wind</td>
<td>( W_L = (12.027 \text{psf}) \times H_1 )</td>
<td>96.22 plf</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>( W_S = 0.2 \times D_L \times L_{B1} )</td>
<td>38.40 plf</td>
</tr>
<tr>
<td>( V_{\text{max}} )</td>
<td>Wind</td>
<td>( V_{\text{wmax}} = W_L \times L_{B2}/2 )</td>
<td>1747.93 lb</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>( V_{\text{smax}} = W_S \times L_{B2}/2 )</td>
<td>697.60 lb</td>
</tr>
<tr>
<td>( V_{\text{wd}} )</td>
<td>Wind</td>
<td>( V_{\text{wmax}} = V_{\text{wmax}} \times L_{B1} )</td>
<td>145.66 plf</td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>( V_{\text{smax}} = V_{\text{wmax}} \times L_{B1} )</td>
<td>58.13 plf</td>
</tr>
<tr>
<td>Nominal Capacities</td>
<td>( \Omega )</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>( V_{\text{wdnom}} )</td>
<td>( V_{\text{wdnom}} = V_{\text{wd}} \times \Omega )</td>
<td>291.32 plf</td>
<td></td>
</tr>
<tr>
<td>( V_{\text{sdnom}} )</td>
<td>( V_{\text{sdnom}} = V_{\text{sd}} \times \Omega )</td>
<td>116.27 plf</td>
<td></td>
</tr>
</tbody>
</table>

**Load with cut panel sections**

<table>
<thead>
<tr>
<th>Diaphragm Edge Shear</th>
<th>( V_{\text{wdnom}} \times L_{B2} )</th>
<th>10584.67 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length with cut panels</td>
<td>( L_{B3} )</td>
<td>32.33 ft</td>
</tr>
<tr>
<td>( V_{\text{wdnom}} )</td>
<td>( V_{\text{wdnom}} \times L_{B2} )</td>
<td>327.36 plf</td>
</tr>
<tr>
<td>Diaphragm Edge Shear</td>
<td>( V_{\text{sdnom}} \times L_{B2} / L_{B3} )</td>
<td>4224.36 lbs</td>
</tr>
<tr>
<td>( V_{\text{sdnom}} )</td>
<td>( V_{\text{sdnom}} \times L_{B2} / L_{B3} )</td>
<td>130.65 plf</td>
</tr>
</tbody>
</table>

*Use 3/4” T&G, 10d nails @ 6 inch edge nail spacing*

*Use 15 gauge staples @ 12 inches for field stapling*
TJI ® 230 JOISTS PROVIDED INFORMATION

TJI Depth = 9 1/2 "

ROOF JOISTS

40 PSF Live Load/20 PSF Dead Load > 20 PSF Live Load/16 PSF Dead Load  OK

L/480 Live Load Deflection

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Allowable Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>16&quot; o.c.</td>
<td>16'-8&quot;</td>
</tr>
</tbody>
</table>

>11'  OK

L/360 Live Load Deflection (Minimum criteria per code)

40 PSF Live Load/20 PSF Dead Load

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Allowable Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>16&quot; o.c.</td>
<td>18'-1&quot;</td>
</tr>
</tbody>
</table>

>11'  OK

FLOOR JOISTS

\[ \Delta = \frac{22.5wl^4}{EI} + \frac{2.67wl^2}{d} = \frac{0.1583}{10^5} \text{ in.} \]

\[ w = \text{uniform live load in pounds per linear foot} = 66.67 \]

\[ L = \text{span in feet} = 11.625 \]

\[ d = \text{out-to-out depth of the joist in inches} = 9.5 \]

\[ EI = 206 \times 10^6 \text{ in}^2\cdot\text{lb} \]

\[ \frac{L}{480} = 0.2906 \text{ in.} \]

\[ \frac{L}{360} = 0.3875 \text{ in.} \]

\[ \frac{L}{480} \& \frac{L}{360} > \Delta \quad \text{OK} \]
FLAT ROOF JOIST CALCULATIONS

2x12 Trimmed Joist - DFL No. 1

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>138 in</td>
</tr>
<tr>
<td>Depth</td>
<td>9.75 in</td>
</tr>
<tr>
<td>Width</td>
<td>1.5 in</td>
</tr>
<tr>
<td>Area</td>
<td>14.63 in²</td>
</tr>
<tr>
<td>Sx</td>
<td>23.77 in³</td>
</tr>
<tr>
<td>Ix</td>
<td>115.86 in⁴</td>
</tr>
</tbody>
</table>

Reference Design Values

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fb</td>
<td>1000 psi</td>
</tr>
<tr>
<td>Fv</td>
<td>180 psi</td>
</tr>
<tr>
<td>E</td>
<td>1700000 psi</td>
</tr>
</tbody>
</table>

Adjustment Factors - NDS Table 4.3.1

<table>
<thead>
<tr>
<th>CD</th>
<th>CM</th>
<th>Cf</th>
<th>Cl</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1.075</td>
<td>1</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Structural Analysis:

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead load</td>
<td>20 psf</td>
</tr>
<tr>
<td>Live load</td>
<td>25 psf</td>
</tr>
<tr>
<td>W: D+L</td>
<td>60 pfl</td>
</tr>
<tr>
<td>Mload</td>
<td>11902.5 lb-in</td>
</tr>
</tbody>
</table>

O.C. spacing | 16 in

Design Calculations

**Bending Check**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth nominal</td>
<td>10.5 in</td>
</tr>
<tr>
<td>Width nominal</td>
<td>2 in</td>
</tr>
<tr>
<td>Dn/Wn : Block @ 16” o.c. with TJI</td>
<td>5.25</td>
</tr>
<tr>
<td>Cl</td>
<td>1</td>
</tr>
<tr>
<td>Fb</td>
<td></td>
</tr>
<tr>
<td>Fb<em>Cd</em>cm<em>Cr</em>cl</td>
<td></td>
</tr>
<tr>
<td>Fb</td>
<td>1236.25 psi</td>
</tr>
<tr>
<td>fb : M/S</td>
<td>500.8 psi</td>
</tr>
<tr>
<td>fb&lt;Fb ?</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Deflection Check**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length/360</td>
<td>0.383 in</td>
</tr>
<tr>
<td>L</td>
<td>2.778 lb/in</td>
</tr>
<tr>
<td>∆</td>
<td>0.067 in</td>
</tr>
<tr>
<td>∆ &lt; Length/360?</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Shear Check**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fv</td>
<td></td>
</tr>
<tr>
<td>Fv<em>cd</em>cm<em>cr</em>ci</td>
<td></td>
</tr>
<tr>
<td>Fv</td>
<td>180 psi</td>
</tr>
<tr>
<td>V : wL/2</td>
<td>345 lb</td>
</tr>
<tr>
<td>fv : 3v/2a</td>
<td>35.4 psi</td>
</tr>
<tr>
<td>fv&lt;fv ?</td>
<td>OK</td>
</tr>
</tbody>
</table>
FLOOR JOIST CALCULATIONS

DFL No. 2 - 2x4 Floor Joists in Module B from Lines 2-2.5 and 4.5-5

<table>
<thead>
<tr>
<th>Reference Design Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_b$</td>
</tr>
<tr>
<td>$F_v$</td>
</tr>
<tr>
<td>$E$</td>
</tr>
</tbody>
</table>

| Length | 42 in |
| Depth | 3.5 in |
| Width | 1.5 in |
| Area | 5.25 in$^2$ |
| $S_x$ | 3.06 in$^3$ |
| $I_x$ | 5.36 in$^4$ |

Adjustment Factors - NDS Table 4.3.1

<table>
<thead>
<tr>
<th>$C_0$</th>
<th>$C_M$</th>
<th>$C_t$</th>
<th>$C_f$</th>
<th>$C_i$</th>
<th>$C_r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Structural Analysis

| Dead Load | 16 psf |
| Live Load | 50 psf |
| W: D+L    | 66 psf |
| W          | 94.29 plf |
| $M_{load}$ | 1732.5 in-lb |

Worst Case Tributary Area: 5 ft$^2$

Design Calculations

**Bending Check**

$D_{nominal}$: 4 in

$W_{nominal}$: 2 in

$D_{nom}/W_{nom}$: 2 OK

$C_L$: 1

$F_b$: $F_b = C_M * C_r * C_{f} * C_{i} * C_{m} * C_{t} * C_{l}$

$F_b$: 1035 psi

$V_{b}: M/S$: 565.7 psi

$F_b < F_v$: OK

**Deflection Check**

| Length/360 | 0.117 in |
| L          | 5.556 lb/in |
| $\Delta$   | 5$L*\text{Length}^4/(384*E*I)$ |
| $\Delta$   | 0.026 in |
| $\Delta < \text{Length}/360^\circ$: OK |

**Shear Check**

$F_v$: $F_v = C_D * C_M * C_i * C_r * C_{f} * C_{l}$

$F_v$: 180 psi

$V: wL/2$: 165 lb

$I_v: 3V/2A$: 47.1 psi

$F_v < F_v$: OK
FOUNDATIONS

MODULE A

DIMENSIONS

LENGTH: 32.33 FT
HEIGHT: 18 FT
WIDTH: 12 FT
WIND: 12.027 PSF

GRAVITY

DEAD LOAD
TOTAL MODULE 25609 LBS

LIVE LOAD
FLOOR 50 PSF 19400 LBS
ROOF 20 PSF 8020 LBS

27420 LBS

1500 PSF BEARING PRESSURE REQUIRES: 19 SQ FT FOR FOOTINGS

LATERAL - FOR IRVINE, CA

Mo = 0 =>
\[ c = \frac{(WIND)(18') + (DEAD)(12'\over 2)}{12'} \]
\[ c = 18251.4 \text{ LBS} \]

1500 PSF BEARING PRESSURE REQUIRES: 12.2 SQ FT FOR FOOTINGS PER SIDE

EAST:

<table>
<thead>
<tr>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEISMIC PIERS</td>
<td>2</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>3</td>
</tr>
<tr>
<td><strong>13.33 SQ FT PROVIDED</strong></td>
<td></td>
</tr>
</tbody>
</table>

WEST:

<table>
<thead>
<tr>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEISMIC PIERS</td>
<td>2</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>3</td>
</tr>
<tr>
<td><strong>13.33 SQ FT PROVIDED</strong></td>
<td></td>
</tr>
</tbody>
</table>

26.7 TOTAL SQ FT PROVIDED
1369 PSF PER FOOTING
FOUNDATIONS

MODULE B

DIMENSIONS

LENGTH: 21.17 FT
HEIGHT: 18 FT
WIDTH: 12 FT
WIND: 12.027 PSF

GRAVITY

DEAD LOAD

TOTAL MODULE 15989 LBS

LIVE LOAD

FLOOR 50 PSF 11400 LBS
ROOF 20 PSF 4937 LBS

16337 LBS

1500 PSF BEARING PRESSURE REQUIRES: 11 SQ FT FOR FOOTINGS

LATERAL - FOR IRVINE, CA

\[ M_o = 0 \Rightarrow c = \frac{([WIND](18') + (DEAD)(12/2))/12'}{12'} \]
\[ c = 14407.2 \text{ LBS} \]

1500 PSF BEARING PRESSURE REQUIRES: 9.6 SQ FT FOR FOOTINGS PER SIDE

NORTH:

<table>
<thead>
<tr>
<th></th>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEISMIC PIERS</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>9.78</td>
<td>SQ FT</td>
</tr>
<tr>
<td></td>
<td>9.78</td>
<td>PROVED</td>
</tr>
</tbody>
</table>

SOUTH:

<table>
<thead>
<tr>
<th></th>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEISMIC PIERS</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>9.78</td>
<td>SQ FT</td>
</tr>
<tr>
<td></td>
<td>9.78</td>
<td>PROVED</td>
</tr>
</tbody>
</table>

19.6 TOTAL SQ FT PROVIDED
1473 PSF PER FOOTING
**FOUNDATIONS**

**MODULE C**

**DIMENSIONS**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH</td>
<td>36.33</td>
<td>FT</td>
</tr>
<tr>
<td>HEIGHT</td>
<td>18</td>
<td>FT</td>
</tr>
<tr>
<td>WIDTH</td>
<td>12</td>
<td>FT</td>
</tr>
<tr>
<td>WIND</td>
<td>12.027</td>
<td>PSF</td>
</tr>
</tbody>
</table>

**GRAVITY**

**DEAD LOAD**

TOTAL MODULE 35005 LBS

**LIVE LOAD**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOOR</td>
<td>50</td>
<td>PSF</td>
</tr>
<tr>
<td>ROOF</td>
<td>20</td>
<td>PSF</td>
</tr>
</tbody>
</table>

TOTAL 30780 LBS

1500 PSF BEARING PRESSURE REQUIRES: 21 SQ FT FOR FOOTINGS

**LATERAL - FOR IRVINE, CA**

![Diagram](image)

Mo = 0 =>

\[ c = \frac{[\text{WIND})(18') + (\text{DEAD})(12'/2)]}{12'} \]

\[ c = \frac{22529.5}{12'} \]

WIND: 4760 LBS

DEAD: 30780 LBS

1500 PSF BEARING PRESSURE REQUIRES: 15.0 SQ FT FOR FOOTINGS PER SIDE

**EAST:**

<table>
<thead>
<tr>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEISMIC PIERS</td>
<td>2</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>5</td>
</tr>
</tbody>
</table>

16.89 SQ FT PROVIDED

**WEST:**

<table>
<thead>
<tr>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEISMIC PIERS</td>
<td>2</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>5</td>
</tr>
</tbody>
</table>

16.89 SQ FT PROVIDED

33.8 TOTAL SQ FT PROVIDED

1334 PSF PER FOOTING
ANCHORAGE
SEISMIC ANCHOR LOADS

<table>
<thead>
<tr>
<th>Shear Load (lb)</th>
<th>Allowable Design Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module N-S</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>4890</td>
</tr>
<tr>
<td>Module E-W</td>
<td>1558</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumed Pullout Design Capacity (per Solar Decathlon rules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1250 lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shear Load (lb) per Seismic Pier</th>
<th>Allowable Design Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module (lbs)</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>1223</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumed Shear Design Capacity (per Solar Decathlon rules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shear Load per Anchor</th>
<th>Allowable Design Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module (lbs)</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>1223</td>
</tr>
</tbody>
</table>

ALLOWABLE SHEAR STRENGTH OF THREADED ROD ANCHOR

AS PER THE DOE, USE A 1” DIAMETER ANCHOR

\[ R_n = F_n A_b / \Omega \]

where \( \Omega = 2 \)

\[ F_n = F_{nv} = 20.772 \text{ ksi for A36} \]

\[ A_b = 0.785 \text{ in}^2 \]

\[ R_n = 8157 \text{ lbs per anchor} \]

8157 lbs > 1500 lbs \hspace{1cm} \text{OK}

8157 lbs > 1242 lbs \hspace{1cm} \text{OK}

PULLOUT STRENGTH - THREADED ROD ANCHOR IN CONCRETE

Embedment length = 36 in.

Pullout Surface Area = \( \pi^*1.4142^2H^2 = 5758 \text{ in}^2 \)

Shear Strength of Concrete = 800 psi

\[ \text{Force (lbs)} = 4606336.85 \text{ lbs} \]

4606337 lbs > 1250 lbs \hspace{1cm} \text{OK}
GRADE VARIABILITY

Standard Piers, fabricated by Central Piers Inc., serve as the footings required to comply with the allowable bearing capacity. See S-101 for the foundation plan and bearing plan. Central Piers Inc. supplies various sized piers for varying ground heights. Central Piers Inc. stocks seismic piers that range from 7"-10" up to 19"-33". Each Standard Pier has a height adjustment of 2". Santa Clara plans to bring a set of all of the available sized piers listed on the Footing Adjustability Schedule on S-601 if shimming is needed. Therefore, no additional structural calculations are needed for our method of pier adjustability because an appropriately sized pier will be used where piers are needed.
MOMENT STABILITY

Overturning Moment  =  wind * height
Resisting Moment  =  weight * base/2

MODULE A
Overturning Moment  =  29519 lb-ft
Resisting Moment  =  153656 lb-ft
OM < RM  OK

Factor of Safety  =  5.2052659  >1.67  OK

MODULE B
Overturning Moment  =  40550 lb-ft
Resisting Moment  =  140988 lb-ft
OM < RM  OK

Factor of Safety  =  3.4768858  >1.67  OK

MODULE C
Overturning Moment  =  46407 lb-ft
Resisting Moment  =  210031 lb-ft
OM < RM  OK

Factor of Safety  =  4.5258548  >1.67  OK

ROOF MODULE
Overturning Moment  =  24312 lb-ft
Resisting Moment  =  95548 lb-ft
OM < RM  OK

Factor of Safety  =  3.9301247  >1.67  OK
WALL POST DESIGN

Member Information: 4 x 6, No. 1 DF-L

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>100.75</td>
<td>in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>5.5</td>
<td>in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>3.5</td>
<td>in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>19.25</td>
<td>in²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reference Design Values

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fc</td>
<td>1500</td>
</tr>
<tr>
<td>E</td>
<td>1700000</td>
</tr>
<tr>
<td>Emin</td>
<td>620000</td>
</tr>
</tbody>
</table>

Adjustment Factors - NDS Table 4.3.1

<table>
<thead>
<tr>
<th>CD</th>
<th>Cm_c</th>
<th>Ct</th>
<th>Cf</th>
<th>Ci</th>
<th>Cm_e</th>
<th>Cm_fc</th>
<th>Ct</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Design Calculations

Compression Check

*Worst Case Scenario: Column at A2 or A5

\[
P_{\text{load}} = 1300 \text{ lbs}
\]

\[
E'_{\text{min}} = E_{\text{min}} \times C_{\text{M,E}} \times C_{\text{C}} \times C_{\text{T}}
\]

620000 psi

\[
F_{\text{c}} = 0.822 \times E'_{\text{min}} / (L/width)^2
\]

615 psi

\[
F_{\text{c}} = F_{\text{c}} \times C_{\text{D}} \times C_{\text{M,fc}} \times C_{\text{T}} \times C_{\text{F}} \times C_{\text{i}}
\]

1650 psi

\[
C_{\text{F}} = 0.338
\]

\[
F_{\text{c}} = F_{\text{c}} \times C_{\text{D}} \times C_{\text{M}} \times C_{\text{T}} \times C_{\text{F}} \times C_{\text{i}} \times C_{\text{D}}
\]

558.0 psi

\[
f_{\text{c}} = P_{\text{load}} / \text{Area}
\]

67.53 psi

\[
f_{\text{c}} < F_{\text{c}} \quad \text{OK}
\]
**WALL STUD DESIGN**

**Member Information: 2 x 4, No. 2 DF-L**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>100.75 in</td>
</tr>
<tr>
<td>Depth</td>
<td>3.5 in</td>
</tr>
<tr>
<td>Width</td>
<td>1.5 in</td>
</tr>
<tr>
<td>Area</td>
<td>5.25 in²</td>
</tr>
</tbody>
</table>

**Reference Design Values**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fc</td>
<td>1350 psi</td>
</tr>
<tr>
<td>E</td>
<td>1600000 psi</td>
</tr>
<tr>
<td>Emin</td>
<td>580000 psi</td>
</tr>
</tbody>
</table>

**Adjustment Factors - NDS Table 4.3.1**

<table>
<thead>
<tr>
<th>CD</th>
<th>CM_E</th>
<th>C_i</th>
<th>C_t</th>
<th>C_P</th>
<th>CM_Fc</th>
<th>C_I</th>
<th>C_T</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1.15</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Design Calculations**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pload</td>
<td>288 lbs</td>
</tr>
</tbody>
</table>

{*Worst Case Scenario: Between A5 & A6*}

- \( E'_{\text{min}} \): \( E_{\text{min}} \cdot C_{M_E} \cdot C_i \cdot C_t \cdot C_P \) = 580000 psi
- \( F_{\text{ce}} \): \( 0.822 \cdot \frac{E'_{\text{min}}}{(L/\text{width})^2} \) = 106 psi
- \( F_{\text{ce}}^* \): \( F_{\text{ce}} \cdot C_D \cdot C_{M_Fc} \cdot C_t \cdot C_P \) = 1552.5 psi
- \( C_r \): 0.067
- \( F_{\text{ce}} \): \( F_{\text{ce}} \cdot C_D \cdot C_{M} \cdot C_i \cdot C_t \cdot C_P \) = 104.2 psi
- \( f_{\text{ce}} \): \( P_{\text{load}}/\text{Area} \) = 54.9 psi

\( f_{\text{ce}} < F_{\text{ce}} \)  OK
**HEADER CALCULATIONS**

**Header - 4 x 6 DFL No. 1**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>72 in.</td>
</tr>
<tr>
<td>Depth</td>
<td>5.5 in.</td>
</tr>
<tr>
<td>Width</td>
<td>3.5 in.</td>
</tr>
<tr>
<td>Area</td>
<td>19.25 in²</td>
</tr>
<tr>
<td>S_x</td>
<td>17.65 in³</td>
</tr>
<tr>
<td>I_x</td>
<td>48.53 in⁴</td>
</tr>
</tbody>
</table>

**Reference Design Values**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F_b</td>
<td>900 psi</td>
</tr>
<tr>
<td>F_v</td>
<td>180 psi</td>
</tr>
<tr>
<td>E</td>
<td>1600000 psi</td>
</tr>
</tbody>
</table>

**Adjustment Factors - NDS Table 4.3.1**

<table>
<thead>
<tr>
<th>C_D</th>
<th>C_M</th>
<th>C_L</th>
<th>C_F</th>
<th>C_I</th>
<th>C_R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Structural Analysis**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead Load</td>
<td>16 psf</td>
</tr>
<tr>
<td>Live Load</td>
<td>20 psf</td>
</tr>
<tr>
<td>W: D+L</td>
<td>36 psf</td>
</tr>
<tr>
<td>W</td>
<td>220 plf</td>
</tr>
<tr>
<td>M</td>
<td>11880 in-lb</td>
</tr>
</tbody>
</table>

**Trib. Area of roof over header**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>36 ft²</td>
</tr>
</tbody>
</table>

*(plus 4 plf for 2 - 2x6 plates above header)*

**Design Calculations**

**Bending Check**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth nominal</td>
<td>6 in.</td>
</tr>
<tr>
<td>Width nominal</td>
<td>4 in.</td>
</tr>
<tr>
<td>Dn/Wn</td>
<td>1.5</td>
</tr>
<tr>
<td>C_I</td>
<td>1</td>
</tr>
<tr>
<td>F_b</td>
<td>F_b<em>C_I</em>C_M<em>C_L</em>C_F<em>C_D</em>C_R</td>
</tr>
<tr>
<td>F_b</td>
<td>1170 psi</td>
</tr>
<tr>
<td>F_b : M/S</td>
<td>673.25 psi</td>
</tr>
<tr>
<td>F_b &lt; F_b ?</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Deflection Check**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length/360</td>
<td>0.2 in.</td>
</tr>
<tr>
<td>L</td>
<td>1.667 lb/in</td>
</tr>
<tr>
<td>Δ</td>
<td>5<em>L</em>Length²/(384<em>E</em>I)</td>
</tr>
<tr>
<td>Δ</td>
<td>0.007511 in.</td>
</tr>
<tr>
<td>Δ &lt; Length/360°</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Shear Check**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F_v</td>
<td>180 psi</td>
</tr>
<tr>
<td>V: wL/2</td>
<td>660 lb</td>
</tr>
<tr>
<td>f_v : 3V/2A</td>
<td>51.43 psi</td>
</tr>
<tr>
<td>f_v &lt; F_v ?</td>
<td>OK</td>
</tr>
</tbody>
</table>

*USE 4X6 HEADERS ON OPENINGS BETWEEN 4-6 ft*
HEADER CALCULATIONS

Header - 2 x 6 DFL No. 2

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>48 in.</td>
</tr>
<tr>
<td>Depth</td>
<td>5.5 in.</td>
</tr>
<tr>
<td>Width</td>
<td>1.5 in.</td>
</tr>
<tr>
<td>Area</td>
<td>8.25 in²</td>
</tr>
<tr>
<td>Sx</td>
<td>7.56 in³</td>
</tr>
<tr>
<td>Ix</td>
<td>20.80 in³</td>
</tr>
</tbody>
</table>

Reference Design Values

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fb</td>
<td>900 psi</td>
</tr>
<tr>
<td>Fv</td>
<td>180 psi</td>
</tr>
<tr>
<td>E</td>
<td>1600000 psi</td>
</tr>
</tbody>
</table>

Adjustment Factors - NDS Table 4.3.1

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CD</td>
<td>CM</td>
<td>C1</td>
<td>CF</td>
<td>CI</td>
<td>Cr</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Structural Analysis

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead Load</td>
<td>16 psf</td>
</tr>
<tr>
<td>Live Load</td>
<td>20 psf</td>
</tr>
<tr>
<td>W: D+L</td>
<td>36 psf</td>
</tr>
<tr>
<td>W</td>
<td>220 plf</td>
</tr>
<tr>
<td>M</td>
<td>5280 in-lb</td>
</tr>
</tbody>
</table>

Trib. Area of roof over header | 24 ft²

* (plus 4 plf for 2 - 2x6 plates above header)

Design Calculations

Bending Check

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Depthnominal</td>
<td>6 in.</td>
</tr>
<tr>
<td>Widthnominal</td>
<td>2 in.</td>
</tr>
<tr>
<td>Dw/Wn</td>
<td>3 OK</td>
</tr>
<tr>
<td>C1</td>
<td>1</td>
</tr>
<tr>
<td>Fb</td>
<td></td>
</tr>
<tr>
<td>Fb</td>
<td></td>
</tr>
<tr>
<td>fb : M/S</td>
<td>698.18 psi</td>
</tr>
<tr>
<td>fb &lt; Fb ?</td>
<td>OK</td>
</tr>
</tbody>
</table>

Deflection Check

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length/360</td>
<td>0.13 in.</td>
</tr>
<tr>
<td>L</td>
<td>1.667 lb/in</td>
</tr>
<tr>
<td>L</td>
<td>0.003462 in.</td>
</tr>
<tr>
<td>L &lt; Length/360?</td>
<td>OK</td>
</tr>
</tbody>
</table>

Shear Check

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fv</td>
<td></td>
</tr>
<tr>
<td>Fv</td>
<td>180 psi</td>
</tr>
<tr>
<td>V: wL/2</td>
<td>440 lb</td>
</tr>
<tr>
<td>fV : 3V/2A</td>
<td>80.00 psi</td>
</tr>
<tr>
<td>fV &lt; Fv ?</td>
<td>OK</td>
</tr>
</tbody>
</table>

* USE 2X6 HEADERS ON OPENINGS LESS THAN 4 ft
STEEL

BOTTOM STEEL CHANNEL : C15X33.9

SUPPORTS AT : 0', 6', 14', 22.33', 30.33', & 36.33'

LOADS

D+L  330.0  plf

PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>33.9  lb/ft</td>
</tr>
<tr>
<td>A</td>
<td>10 in²</td>
</tr>
<tr>
<td>d</td>
<td>15 in</td>
</tr>
<tr>
<td>b</td>
<td>3.375 in</td>
</tr>
<tr>
<td>t</td>
<td>0.625 in</td>
</tr>
<tr>
<td>Sx</td>
<td>42 in³</td>
</tr>
<tr>
<td>Ix</td>
<td>315 in⁴</td>
</tr>
<tr>
<td>I</td>
<td>36.33 ft</td>
</tr>
<tr>
<td>E</td>
<td>29000000 psi</td>
</tr>
<tr>
<td>Fy</td>
<td>36 ksi</td>
</tr>
</tbody>
</table>

DEFLECTION

\[
\Delta_{\text{allowable}} = \frac{l}{480} = 0.076' \\
\Delta_{\text{max}} = 0.009' \quad \text{OK}
\]

Max Allowable Uniform Load = 91.3 klf  
Actual Uniform Load = 0.33 klf  
Max > Actual  OK

FLEXURE

Yielding

\[
M_i = 91.3 \text{ kip-ft} \\
M_{\text{max}} = 2.074 \text{ kip-ft} \quad \text{OK}
\]

SHEAR

\[
V_i = 77.6 \text{ kips} \\
V_{\text{max}} = 1.888 \text{ kips} \quad \text{OK}
\]
# Steel

**Bottom Short Edge Steel Channel - Module B: C8x11.5**

*SUPPORTS AT: 0', 6', & 12'*

**Loads**

**D + L** 216.0 plf

**Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>11.5 lb/ft</td>
</tr>
<tr>
<td>A</td>
<td>3.37 in²</td>
</tr>
<tr>
<td>d</td>
<td>8 in</td>
</tr>
<tr>
<td>b</td>
<td>2.25 in</td>
</tr>
<tr>
<td>t</td>
<td>0.375 in</td>
</tr>
<tr>
<td>Sₓ</td>
<td>8.14 in³</td>
</tr>
<tr>
<td>Iₜ</td>
<td>32.5 in⁴</td>
</tr>
<tr>
<td>I</td>
<td>6 ft</td>
</tr>
<tr>
<td>E</td>
<td>29000000 psi</td>
</tr>
<tr>
<td>Fᵧ</td>
<td>36 ksi</td>
</tr>
</tbody>
</table>

**Deflection**

\[
\Delta_{\text{max}} = 0.007' = \text{OK}
\]

\[
\Delta_{\text{allowable}} = l/480 = 0.013'
\]

Max Allowable Uniform Load = 17.3 klf
Actual Uniform Load = 0.216 klf
Max > Actual OK

**Flexure**

*Yielding*

\[
M_{\text{N}} = 17.3 \text{ kip-ft}
\]

\[
M_{\text{max}} = 1.024 \text{ kip-ft} = \text{OK}
\]

**Shear**

\[
V_{\text{N}} = 22.8 \text{ kips}
\]

\[
V_{\text{max}} = 0.832 \text{ kips} = \text{OK}
\]
**STEEL**

**BOTTOM STEEL: HSS 8X3X3/8**

**LOADS**

\[ \text{Point load during transportation} = 2143.2 \text{ lbs} \]

**PROPERTIES**

\[
\begin{align*}
\text{b/t} &= 5.6 \\
\text{h/t} &= 19.9 \\
\text{Cantilevered Length} &= 18.6875''
\end{align*}
\]

*Need to check yielding, flange local buckling, and web local buckling*

**DEFLECTION**

\[
\begin{align*}
\Delta \text{allowable} &= \frac{l}{480} = 0.039'' \\
\Delta \text{max} &= 0.0033'' = \text{OK}
\end{align*}
\]

**FLEXURE**

*Yielding*

\[
\begin{align*}
M_{n} &= 61.72 \text{ kip-ft} \\
M_{\text{max}} &= 3.34 \text{ kip-ft} = \text{OK}
\end{align*}
\]

**SHEAR**

\[
V_n = 0.6F_yA_wC_v \quad A_w = 5.4375 \text{ in}^2 \quad C_v = 1 \quad F_y = 46 \text{ ksi}
\]

\[
\begin{align*}
V_{n} &= 89.87 \text{ kips} \\
V_{\text{max}} &= 2.14 \text{ kips} = \text{OK}
\end{align*}
\]

**FLANGE LOCAL BUCKLING**

\[
1.12\sqrt{\frac{V(E/F_y)}{b/t}} = 28.12 > b/t \quad \text{FLB DOES NOT APPLY}
\]

**WEB LOCAL BUCKLING**

\[
2.42\sqrt{\frac{V(E/F_y)}{b/t}} = 60.76 > h/t \quad \text{WLB DOES NOT APPLY}
\]
STEEL

STEEL COLUMNS: HSS 3.5X3.5X5/16

LOADS

\[ \text{Point Load} = 3 \text{ kips} \]

PROPERTIES

\begin{align*}
W & = 12.7 \text{ lb/ft} \\
S_x & = 3.34 \text{ in}^3 \\
r & = 1.29 \text{ in} \\
A_g & = 3.52 \text{ in}^2 \\
l_x & = 5.84 \text{ in}^4 \\
b/t & = 9.03 \\
d & = 3.5 \text{ in} \\
E & = 29000000 \text{ psi} \\
I & = 8.79 \text{ ft} \\
F_y & = 46 \text{ ksi} \\
KL/r & = 81.77
\end{align*}

Need check local buckling and flexural buckling

FLEXURAL BUCKLING

When \( KL/r < 4.71 \sqrt{E/F_y} \):

\[ F_{cr} = \left[ 0.658 \frac{F_y}{F_e} \right] F_y \]

where \( F_e = \frac{\pi^2 E}{(KL/r)^2} \)

\[ F_{cr} = 29.34 \text{ ksi} \]

\[ P_n = 0.9F_{cr}A_g = 92.94 \text{ kips} > 3 \text{ kips} \quad \text{OK} \]

LOCAL BUCKLING

\[ 1.4\sqrt{(E/I)} = 59.07 > b/t \quad \text{NONSLENDER - LB DOES NOT APPLY} \]
STEEL

TOP MODULE CONNECTOR BEAM : W5X19

LOADS

\[ D + L = 300.0 \text{ plf} \]

PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( W )</td>
<td>16</td>
<td>lb/ft</td>
</tr>
<tr>
<td>( A )</td>
<td>5.56</td>
<td>in²</td>
</tr>
<tr>
<td>( A_w )</td>
<td>2.24</td>
<td>in²</td>
</tr>
<tr>
<td>( d )</td>
<td>5.125</td>
<td>in</td>
</tr>
<tr>
<td>( b_t )</td>
<td>5</td>
<td>in</td>
</tr>
<tr>
<td>( t_w )</td>
<td>0.4375</td>
<td>in</td>
</tr>
<tr>
<td>( h_o )</td>
<td>4.72</td>
<td>in</td>
</tr>
<tr>
<td>( S_c )</td>
<td>10.2</td>
<td>in³</td>
</tr>
<tr>
<td>( I_c )</td>
<td>26.3</td>
<td>in⁴</td>
</tr>
<tr>
<td>( I_{p} )</td>
<td>9.13</td>
<td>in⁴</td>
</tr>
<tr>
<td>( E )</td>
<td>29000000</td>
<td>psi</td>
</tr>
<tr>
<td>( F_y )</td>
<td>50</td>
<td>ksi</td>
</tr>
<tr>
<td>( C_v )</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>( J_o )</td>
<td>0.316</td>
<td>in³</td>
</tr>
<tr>
<td>( I_y )</td>
<td>9.13</td>
<td>in⁴</td>
</tr>
<tr>
<td>( Z_x )</td>
<td>9.63</td>
<td>in³</td>
</tr>
<tr>
<td>( L_o )</td>
<td>11.583</td>
<td>ft</td>
</tr>
<tr>
<td>( L )</td>
<td>21.25</td>
<td>ft</td>
</tr>
<tr>
<td>( A_w )</td>
<td>2.24</td>
<td></td>
</tr>
<tr>
<td>( C_v )</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{Need to check yielding and lateral torsional buckling.} \]

DEFLECTION

\[
\Delta_{\text{allowable}} = \frac{L_o}{480} = 0.024' \\
\Delta_{\text{max}} = 0.0133' = \text{OK}
\]

Max Allowable Uniform Load = 91.3 klf
Actual Uniform Load = 0.33 klf
Max > Actual = OK

FLEXURE

Yielding

\[
M_{h} = 481.5 \text{ kip-in} \\
M_{\text{max}} = 60.4 \text{ kip-in} = \text{OK}
\]

SHEAR

\[ V_n = 0.6F_y A_w C_v \]

\[
V_n = 67.27 \text{ kips} \\
V_{\text{max}} = 1.738 \text{ kips} = \text{OK}
\]
LATERAL - TORSIONAL BUCKLING

\[
L_p = 1.76r_y \sqrt{\frac{E}{F_y}} = 54.25 \text{ in}
\]

\[
L_b = 139 \text{ in}
\]

\[
L_r = 1.95r_y \left( \frac{E}{0.7F_y} \right) \sqrt{\left( \frac{J_c}{S_x} \right) + \sqrt{\left( \frac{J_c}{S_x} \right)^2 + 6.76 \left( \frac{0.7F_y}{E} \right)^2}}
\]

\[
r_n^2 = \frac{l_yh_y}{2S_x} \rightarrow r_n = 1.453
\]

\[
L_r = 276.25 \text{ in.}
\]

When \( L_p < L < L_r \):

\[
M_{n} = C_b \left( M_p - \left[ M_p - 0.7F_y S_x \right] \frac{\left( L_0 - L_p \right)}{\left( L_r - L_p \right)} \right) \leq M_p
\]

\[
M_n = 339.4 \text{ k-in} \leq M_p \quad \text{OK}
\]

\[
M_n > M_{\text{max}} \quad \text{OK}
\]
STEEL
LATERAL COLLECTOR BEAM: W5X19

LOADS

E-W Seismic and Wind Loads = 7.1 kips

PROPERTIES

<table>
<thead>
<tr>
<th>b/t</th>
<th>5.85</th>
<th>E</th>
<th>29000 ksi</th>
<th>L</th>
<th>141.81 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_g</td>
<td>5.56</td>
<td>in²</td>
<td>F_y</td>
<td>50 ksi</td>
<td>r_y</td>
</tr>
<tr>
<td>C_w</td>
<td>50.9</td>
<td>in⁶</td>
<td>I_x</td>
<td>26.3 in⁴</td>
<td>I_y</td>
</tr>
<tr>
<td>J</td>
<td>0.316</td>
<td>in⁴</td>
<td>G</td>
<td>11200 ksi</td>
<td>KL/r</td>
</tr>
</tbody>
</table>

Need to check flexural buckling and torsional buckling.

FLEXURAL BUCKLING

When \( KL/r < 4.71\sqrt{(E/F_y)} \):

\[
F_{cr} = 0.658 \frac{F_y}{F_e} \]

where \( F_e = \frac{n^2E}{(KL/r)^2} \) = 22.59 ksi

\( F_{cr} = 19.80 \) ksi

\( P_n = 0.9F_eA_g = 99.09 \) kips \( \geq 7.1 \) kips OK

TORSIONAL BUCKLING

For doubly symmetric members:

\[
F_u = \frac{[n^2EC_w/(K_2L)^2 + GJ] \times 1/(I_x + I_y)}{K_1}
\]

\( F_u = 120.34 \) ksi

\( F_{cr} = 42.02 \) ksi

\( P_n = 0.9F_uA_g = 210.26 \) kips \( \geq 7.1 \) kips OK
STEEL

W5x19 TO COLUMN PLATE CONNECTION

LOADS

\[
\begin{align*}
W_{\text{wind}} & \quad 5244 \text{ lb} \\
W_{\text{seismic}} & \quad 5783 \text{ lb} \quad \text{*(Seismic Governs)}
\end{align*}
\]

(2) 1/2" A307 threaded bolt

ALLOWABLE SHEAR STRENGTH

\[
R_n = \phi * F_{nv} * A_b
\]

\[
\begin{align*}
F_{nv} & \quad 27 \text{ ksi} \\
A_b & \quad 0.196 \text{ in}^2 \\
\phi & \quad 0.75
\end{align*}
\]

\[
R_n = 0.75 \times 27 \times 0.196 = 3976.08 \text{ lbs}
\]

\[
2R_n = 7952.16 \text{ lbs}
\]

\[
7952.16 > 5783.00 \quad \text{OK}
\]

AVAILABLE TENSILE STRENGTH

\[
R_n = \phi * F'_{nt} * 2A_b
\]

\[
\begin{align*}
f_{rv} & \quad 13.4 \text{ ksi} \quad \text{(WIND LOAD)} \\
F'_{nt} & \quad 28.83 \leq 45
\end{align*}
\]

\[
R_n = 0.75 \times 28.83 \times 2 \times 0.196 = 8490 \text{ lbs} \quad \text{OK}
\]
STEEL

W5X19 SPLICE CONNECTION

(Details 2 & 3 on SOS E2)

\[ A_r \cdot U = A_u \]
\[ \phi A_u F_v \geq 7.87^A \]
\[ A_u = 0.5625 \text{ in}^2 \]
\[ F_v = 21.6 \text{ ksi} \]
\[ \phi A_u F_v = 9.1125 \text{ kips} \geq 7.87^A \quad \text{OK} \]

1/2" A325 bolts

\[ F_v A_u = R_n = 10.60 \text{ kips} \]
\[ \phi R_n = 7.95 \text{ kips} \geq 7.87^A \quad \text{OK} \]
STEEL

C15X33.9 to C8X11.5 MODULE CONNECTION

MODULE A TO B  Detail 4 on SOS E2

LOADS

\[ W_{\text{wind}} = 5122 \text{ lb} \quad * \text{(Wind Governs)} \]
\[ W_{\text{seismic}} = 4569 \text{ lb} \]

1" A307 threaded bolt

ALLOWABLE SHEAR STRENGTH

\[ F_{nv} = 27 \text{ ksi} \]
\[ A_b = 0.785 \text{ in}^2 \]
\[ \phi = 0.75 \]
\[ R_n = \phi \cdot F_{nv} \cdot A_b = 15904.31 \text{ lbs} \]
\[ 15904.31 > 5122.00 \quad \text{OK} \]

AVAILABLE TENSILE STRENGTH

\[ f_{\text{sl}} = 6.5 \text{ ksi} \quad \text{(WIND LOAD)} \]
\[ F'_{nt} = 44.01 \leq 45 \]
\[ R_n = \phi \cdot F'_{nt} \cdot A_b = 25923 \text{ lbs} \quad \text{OK} \]
STEEL

C15x33.9 to C8x11.5 MODULE CONNECTION
MODULE B TO C  Detail 4 on SOS E2

LOADS

\[ W_{\text{wind}} = 7866 \text{ lb} \quad * \text{(Wind Governs)} \]
\[ W_{\text{seismic}} = 7001 \text{ lb} \]

| 1" A307 threaded bolt |

ALLOWABLE SHEAR STRENGTH

\[ F_{nv} = 27 \text{ ksi} \]
\[ A_0 = 0.785 \text{ in}^2 \]
\[ \phi = 0.75 \]
\[ R_n = \phi * F_{nv} * A_0 = 15904.31 \text{ lbs} \]
\[ 15904.31 > 7866.00 \quad \text{OK} \]

AVAILABLE TENSILE STRENGTH

\[ f_v = 10.0 \text{ ksi} \quad \text{(WIND LOAD)} \]
\[ F'_{nt} = 36.24 \leq 45 \]

\[ R_n = \phi * F'_{nt} * A_0 = 21349 \text{ lbs} \quad \text{OK} \]
STEEL

TEMPORARY BRACING : L2X2X1/4

For Transportation

*Design Load:* 20 kips in tension or compression

**TENSION**

\[ A_g = 0.944 \text{ in}^2 \]

\[ A_u = 0.75A_g = 0.708 \text{ in}^2 \]

Available Strength in Axial Tension

**Yielding**

\[ \varphi P_n = 30.6 \text{ kips} \quad > \quad 20 \text{ kips} \]

**Rupture**

\[ \varphi P_n = 30.8 \text{ kips} \quad > \quad 20 \text{ kips} \]

**COMPRESSION**

\[ 0.45\sqrt{E/F_y} = 12.77 \]

\[ \text{b/t} = 8 \]

\[ \text{b/t} < 0.45\sqrt{E/F_y} \rightarrow \text{nonslender} \]

\[ P_n = F_y A_g \]

\[ KL/r = 261.47 \]

\[ 4.71\sqrt{E/F_y} = 133.68 \]

\[ KL/r > 4.71\sqrt{E/F_y} \rightarrow F_{cr} = 0.877 F_y \]

\[ F_{cr} = 3.672 \text{ ksi} \]

\[ P_n = 3.466 \text{ kips Per brace} \]

→ Need 6 braces per module B to take 20 kips load in compression and tension

→ Add bracing in other modules for additional support to their existing shear walls
CONNECTIONS

DTT2Z-SDS2.5 HOLDOWN CONNECTION

NORTH SIDE
LOAD

\[(12.027 \text{ PSF}) \times (7/2) \times (41.5/2) = 873.46 \text{ LBS}\]

\[(12.027 \text{ PSF}) \times (9.2/2) \times (21.1/2) = 583.67 \text{ LBS}\]

\[\sum = 1457.13 \text{ LBS}\]

HOLDOWN:
DTT2Z-SDS2.5

2145 LBS > 1457.13 LBS \hspace{1cm} \text{OK}

SOUTH SIDE
LOAD

\[(12.027 \text{ PSF}) \times (7) \times (41.5/2) = 1746.92 \text{ LBS}\]

\[(12.027 \text{ PSF}) \times (7/2) \times (16.8/2) = 353.59 \text{ LBS}\]

\[\sum = 2100.52 \text{ LBS}\]

PERCENT THAT GOES TO HOLDOWN : 51.3%

HOLDOWN:
DTT2Z-SDS2.5

2145 LBS > 1077.56 LBS \hspace{1cm} \text{OK}
ROOF MODULE
STEEL

ROOF BOTTOM STEEL ANGLE : L8X4X1/2

SUPPORTS AT : 0.1667', 9.75', 31.21', 40.79'

LOADS

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Live Load</th>
<th>Dead Load</th>
<th>D + L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>20 psf</td>
<td>15.5 psf</td>
<td>35.5 psf</td>
</tr>
<tr>
<td>Loads</td>
<td>120 plf</td>
<td></td>
<td>212.7 plf</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Tributary Width</th>
<th>Average Wall Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loads</td>
<td>6 ft</td>
<td>6.083 ft</td>
</tr>
</tbody>
</table>

PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>19.6 lb/ft</td>
</tr>
<tr>
<td>A</td>
<td>5.8 in²</td>
</tr>
<tr>
<td>d</td>
<td>4 in</td>
</tr>
<tr>
<td>b</td>
<td>8 in</td>
</tr>
<tr>
<td>t</td>
<td>0.5 in</td>
</tr>
<tr>
<td>Sx</td>
<td>7.48 in²</td>
</tr>
<tr>
<td>Ix</td>
<td>38.6 in⁴</td>
</tr>
<tr>
<td>l</td>
<td>0.1667 ft</td>
</tr>
<tr>
<td>E</td>
<td>29000000 psi</td>
</tr>
<tr>
<td>Fy</td>
<td>36 ksi</td>
</tr>
</tbody>
</table>

DEFORMATION

- Beam Allowable Deflection: \( \Delta_{allowable} = \frac{l}{480} = 0.537 \) in
- Beam Maximum Deflection: \( \Delta_{max} = 0.272 \) in, OK

- Cantilever Allowable Deflection: \( \Delta_{allowable} = \frac{l}{480} = 0.004 \) in
- Cantilever Maximum Deflection: \( \Delta_{max} = 0.000 \) in, OK

FLEXURE

- Yield Moment: \( M_y = 215.42 \) kip-in
- Moment at Mid-span: \( M_{mid} = 1.5 \times M_y = 26.93 \) kip-ft
- Moment at End: \( M_{max} = 7.63 \) kip-ft, OK

SHEAR

- Shear: \( h/t = \frac{b}{t} = 18.7 < 63.58 \)
- Shear at Mid-span: \( V_{mid} = 0.6 F_y b^* t' C_v = 57.6 \) kips
- Shear at End: \( V_{max} = 2.542 \) kips, OK
LATERAL TORSIONAL BUCKLING

Continuous Lateral Support - N/A

LEG LOCAL BUCKLING

Compact Section - N/A

CHECK INTERNAL BENDING

Load (1’ span)

\[ P = (35.5 \text{ psf} \times \cos(24) + 12.027 \text{ psf}) \times 11.25 \text{ ft}^2 = 500.15 \text{ lb} \]

\[ l = 8 \text{ in} \]

\[ b = 5.625 \text{ in} \]

\[ M_{\text{MINX}} = P \times b = 234.45 \text{ lb-ft} \text{ OK} \]

\[ M_{\text{allowable}} = 0.8S_{f_y} = 2585088 \text{ lb-ft} \]

\[ \Delta_{\text{allowable}} = \frac{l}{360} = 0.0222 \text{ in} \]

\[ \Delta_{\text{MINX}} = \frac{(Pb^2/6EI)(3l-b)}{3l} = 0.0201 \text{ in} \text{ OK} \]
STEEL

ROOF BOTTOM STEEL ANGLE : L8X4X1/2

SUPPORTS AT : 0.1667', 9.75', 31.21', 40.79'

LOADS

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Load</th>
<th>plf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Load</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Dead Load</td>
<td>114.8</td>
<td></td>
</tr>
<tr>
<td>D + L</td>
<td>234.8</td>
<td></td>
</tr>
</tbody>
</table>

Tributary Width 6 ft
Average Wall Height 6.083 ft

PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>19.6 lb/ft</td>
</tr>
<tr>
<td>S_x</td>
<td>7.48 in²</td>
</tr>
<tr>
<td>A</td>
<td>5.8 in²</td>
</tr>
<tr>
<td>I</td>
<td>38.6 in⁴</td>
</tr>
<tr>
<td>d</td>
<td>4 in</td>
</tr>
<tr>
<td>b</td>
<td>8 in</td>
</tr>
<tr>
<td>t</td>
<td>0.5 in</td>
</tr>
<tr>
<td>E</td>
<td>29000000 psi</td>
</tr>
<tr>
<td>F_y</td>
<td>36 ksi</td>
</tr>
</tbody>
</table>

DEFLECTION

<table>
<thead>
<tr>
<th>Type</th>
<th>Δ allowable</th>
<th>Δ max (21.46' span)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam</td>
<td>l/480 = 0.537</td>
<td>0.356 OK</td>
</tr>
<tr>
<td>Cantilever</td>
<td>l/480 = 0.004</td>
<td>0.000 in. OK</td>
</tr>
</tbody>
</table>

FLEXURE

Yielding

<table>
<thead>
<tr>
<th>Moment</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M_y</td>
<td>215.42 kip-in</td>
</tr>
<tr>
<td>M_n</td>
<td>1.5*M_y  = 26.93 kip-ft</td>
</tr>
<tr>
<td>M_max</td>
<td>8.19 kip-ft OK</td>
</tr>
</tbody>
</table>

SHEAR

h/t = b/t < 63.58

<table>
<thead>
<tr>
<th>Shear</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_n</td>
<td>0.6F_ybC_v/Ω = 57.6 kips</td>
</tr>
<tr>
<td>V_max</td>
<td>2.73 kips OK</td>
</tr>
</tbody>
</table>
LATERAL TORSIONAL BUCKLING

Continuous Lateral Support - N/A

LEG LOCAL BUCKLING

Compact Section - N/A

CHECK INTERNAL BENDING

Load (1' span)

\[
P = (35.5 \text{ psf} \times \cos (24) + 12.027 \text{ psf}) \times 11.25 \text{ ft}^2 = 500.15 \text{ lb}
\]

\[
I = 8 \text{ in}
\]

\[
b = 5.625 \text{ in}
\]

<table>
<thead>
<tr>
<th>Moment</th>
<th>Calculations</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_{\text{MAX}}$</td>
<td>$P \times b$</td>
<td>234.45 lb-ft</td>
</tr>
<tr>
<td>$M_{\text{allowable}}$</td>
<td>$0.8S_xF_y$</td>
<td>2585088 lb-ft</td>
</tr>
</tbody>
</table>

\[
\Delta_{\text{allowable}} = \frac{I}{360} = 0.0222 \text{ in}
\]

\[
\Delta_{\text{MAX}} = \frac{(Pb^2/6EI)(3I-b)}{3} = 0.0201 \text{ in} \quad \text{OK}
\]
STEEL
NORTH WALL ROOF STEEL COLUMNS : C3X3.5

LOADS

\[ \begin{align*}
W_{\text{wind EW}} & = 12.027 \text{ psf} & 144.32 \text{ plf} & \text{Tributary Width} & = 12.00 \text{ ft} \\
W_{\text{seismic}} & = 7499.52 \text{ lb} & 308.20 \text{ plf} & \text{Beam Length} & = 6.083 \text{ ft} \\
W_{\text{seismic}} & = 1874.88 \text{ lb per column} & \star (\text{Seismic Governs})
\end{align*} \]

SECTION PROPERTIES

\[ \begin{align*}
\text{Weight} & = 3.5 \text{ lb/ft} & \text{Weight} & = 85.167 \text{ lb per column} \\
A & = 1.09 \text{ in} & I_y & = 1.57 \text{ in}^4 & E & = 29000000 \text{ psi} & \text{d} & = 3 \text{ in} & Z_y & = 1.24 \text{ in}^3 & F_y & = 36 \text{ ksi} & b_t & = 1.37 \text{ in} & S_y & = 1.04 \text{ in}^3 & F_u & = 58 \text{ ksi} & t_w & = 0.132 \text{ in} & r_y & = 1.2 \text{ in} & b/t & = 5.02 & t_b & = 0.273 \text{ in} & L & = 6.0833 \text{ ft} & h/t_w & = 14.5
\end{align*} \]

DEFLECTION

\[ \begin{align*}
\Delta_{\text{allowable}} & = \frac{l}{480} = 0.152 \text{ in} \\
\Delta_{\text{max (21.46' span)}} & = \frac{5wl^4}{384EI} = 0.0024 \text{ in} & \text{OK}
\end{align*} \]

FLEXURE

\[ \begin{align*}
\Omega_b & = 1.67 \\
M_{\text{y}} & = M_{\text{y}}/\Omega = F_y Z_y/\Omega = 26.73 \text{ k-in} = 2.228 \text{ k-ft}
\end{align*} \]

SHEAR

\[ \begin{align*}
V_{\text{Il}} & = 0.6F_y A_c C_v/\Omega = 5.7024 \text{ kips} \\
V_{\text{max}} & = 0.93744 \text{ kips} & \text{OK}
\end{align*} \]

\[ \Omega = 1.5 \quad k_r = 5 \quad C_v = 1 \]
LATERAL TORSIONAL BUCKLING

$L_p$ = 147.929 in
$L_b$ = 6.083 in
$L_b$ < \(L_p\)

→ NO LATERAL TORSIONAL BUCKLING

\[
M_{\text{max}} = \frac{wl^2}{12} = 0.95 \text{ kip-ft} \quad \text{OK}
\]
\[
M_p = 2.23 \text{ kip-ft}
\]

TENSION

\[P_{\text{max}} = 0.1259 \text{ kips} \quad \text{OK}\]

Yielding

\[P_y = \frac{F_yA_y}{\Omega} = 23.50 \text{ kips}\]

Rupture

\[P_u = \frac{F_uA_u}{\Omega} = 33.27 \text{ kips}\]
NORTH WALL ROOF - TIMBER FRAMING

DOUG FIR LARCH 2X6 STUDS

LOADS

<table>
<thead>
<tr>
<th>Description</th>
<th>psf</th>
<th>plf</th>
<th>Load Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Load</td>
<td>20</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Dead Load</td>
<td>18</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Wind N-S</td>
<td>12.027</td>
<td>55.1</td>
<td>plf</td>
</tr>
<tr>
<td>D + L +W</td>
<td>50.027</td>
<td>283.1</td>
<td>plf</td>
</tr>
</tbody>
</table>

fc = P/A 126.7 psi
fb = M/S 404.6 psi

fc = P/A

fc = P/A

fc = P/A

M 254.99 lb-ft

SECTION PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>1.5 in</td>
</tr>
<tr>
<td>W</td>
<td>1.9 plf</td>
</tr>
<tr>
<td>A</td>
<td>8.25 in²</td>
</tr>
<tr>
<td>E</td>
<td>160000 psi</td>
</tr>
<tr>
<td>E_min</td>
<td>58000 psi</td>
</tr>
<tr>
<td>S_x</td>
<td>7.563 in³</td>
</tr>
<tr>
<td>F_b</td>
<td>900 psi</td>
</tr>
<tr>
<td>I_x</td>
<td>20.8 in⁴</td>
</tr>
<tr>
<td>F_c</td>
<td>1350 psi</td>
</tr>
<tr>
<td>S_y</td>
<td>2.063 in⁴</td>
</tr>
<tr>
<td>F_v</td>
<td>180 psi</td>
</tr>
<tr>
<td>I_y</td>
<td>1.547 in⁴</td>
</tr>
</tbody>
</table>

Grav Tributary Width 6 ft
Wind Tributary Width 4.58 ft
Average Wall Height = l 6.08 ft

MAX TRIB LENGTH

BEAM COLUMN ANALYSIS

\[(I_f/F_{c_1})^2 + (F_{c_0}/(F_{c_0}^* (1-(U/F_{c_0}))))/(U_{f_0}/(F_{c_0}^* (U/F_{c_0}))) + (I_{f_0}/(F_{c_0}^* (I_{f_0}/F_{c_0}^* (I_{f_0}/F_{c_0}^*)))) \leq 1.0\]

Adjustment Factors:

<table>
<thead>
<tr>
<th>C</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_d</td>
<td>1.6</td>
</tr>
<tr>
<td>C_u</td>
<td>1.0</td>
</tr>
<tr>
<td>C_{F,Fc}</td>
<td>1.1</td>
</tr>
<tr>
<td>C_T</td>
<td>1.0</td>
</tr>
<tr>
<td>C_{F,fb}</td>
<td>1.3</td>
</tr>
<tr>
<td>C_i</td>
<td>1.0</td>
</tr>
<tr>
<td>C_{M,fb}</td>
<td>1.0</td>
</tr>
<tr>
<td>C_{M,E}</td>
<td>1.0</td>
</tr>
<tr>
<td>C_{M,Fc}</td>
<td>1.0</td>
</tr>
</tbody>
</table>
STRUCTURAL ANALYSIS

Major Axis Bending

\[ M_{x,\text{Max}} = 1309.7 \text{ lb-ft} \] (Simple Assumed)
\[ F_{b1} = 2078.0 \text{ psi} \]

Minor Axis Bending

\[ F_{b1} = 0 \text{ psi} \] (Concentric Axial Force)

Axial Load

\[ P_{\text{axial}} = 1722.33 \text{ lb} \]
\[ F_c = 208.77 \text{ psi} \]

MEMBER CAPACITIES

Axial Capacity

\[ F'_{c} = F_c C_D C_M C_T C_i C_P \]
\[ E'_{\text{min}} = E_{\text{min}} C_D C_M C_T \]
\[ F_{cE} = 0.822 \left( \frac{E'_{\text{min}}}{l_e/d} \right)^2 \]
\[ K_a = 1 \]
\[ \frac{l_e}{d} = 13.27 \text{ OK} \]
\[ F^{*}_{c} = F_{c} C_D C_M C_T C_i \]
\[ C_p = 0.734 \]

Flexural Capacity

\[ F'_{b} = F_b C_D C_M C_i C_O C_C C_r \]
\[ F_b = 1872 \text{ psi} \]

CHECK

\[ \left( \frac{l_e}{F'_{b}} \right)^2 + \left( \frac{E'_{\text{min}}}{F'_{c}} \right) \left( 1 - \left( \frac{l_e}{F'_{c}} \right) \right) + \left( \frac{E'_{\text{min}}}{F'_{c}} \right) \left( \frac{l_e}{F'_{c}} \right) - \left( \frac{l_e}{F'_{c}} \right)^2 \] \leq 1.0

\[ 0.232 \leq 1.0 \text{ OK} \]
**TJI ® 230 JOISTS PROVIDED INFORMATION**

TJI Depth = 9 1/2"

**ROOF JOISTS**

40 PSF Live Load/20 PSF Dead Load > 20 PSF Live Load/16 PSF Dead Load

OK

**L/480 Live Load Deflection**

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Allowable Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>16&quot; o.c.</td>
<td>16' 8&quot; &gt;13'</td>
</tr>
</tbody>
</table>

OK

**L/360 Live Load Deflection (Minimum criteria per code)**

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Allowable Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>16&quot; o.c.</td>
<td>18' 1&quot; &gt;13'</td>
</tr>
</tbody>
</table>

OK
ROOF CHORD FORCES

Chord Force = M/d = T = C

LOADS

\[ W_{\text{Live Load}} = 0 \text{ psf} \quad 0 \text{ plf} \]
\[ W_{\text{Dead Load}} = 18 \text{ psf} \]  
Chord Depth \( (d) = 12 \text{ ft} \)
\[ D + L = 18 \text{ psf} \quad 216 \text{ plf} \]  
Length \( (l) = 43.00 \text{ ft} \)

CHORD FORCE ANALYSIS

\[ M = \frac{Wl^2}{8} = 49923 \text{ lb-ft} \]

\[ M/d = 4.16025 \text{ kips} \]

MEMBER ALLOWABLE

A36 - L8X4X1/2 - Braced Column Analysis

\[ T_{\text{allow}} = 188 \text{ kips} \]  
(Table 5-2) AISC Steel Construction Manual
\[ C_{\text{allow}} = 34.6 \text{ kips} \]  
(Table 4-11) AISC Steel Construction Manual

Chord Force\( \text{Capacity} = 34.6 > \) Chord Force\( \text{Demand} = 4.16025 \) \text{ OK}
# Sloped Roof Diaphragm

## Roof Module

### Unblocked Diaphragm Design

#### Direction 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of Story</td>
<td>( H_1 )</td>
<td>6.00 ft</td>
</tr>
<tr>
<td>Dead Load</td>
<td>( D_L )</td>
<td>16.00 psf</td>
</tr>
<tr>
<td>Length of Building</td>
<td>( L_{B1} )</td>
<td>41.06 ft</td>
</tr>
<tr>
<td>( L_{B2} )</td>
<td>12.00 ft</td>
<td></td>
</tr>
</tbody>
</table>

#### Applied Load

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( W_W = (12.027 \text{ psf}) \times H_1 )</td>
<td>72.16 plf</td>
</tr>
<tr>
<td>Seismic</td>
<td>( W_S = 0.2 \times D_L \times L_{B1} )</td>
<td>131.40 plf</td>
</tr>
</tbody>
</table>

#### \( V_{\text{max}} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( V_{\text{max}} = W_W \times L_{B2}/2 )</td>
<td>432.97 lb</td>
</tr>
<tr>
<td>Seismic</td>
<td>( V_{\text{seismic}} = W_S \times L_{B2}/2 )</td>
<td>788.38 lb</td>
</tr>
</tbody>
</table>

#### \( V_{\text{wd}} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( V_{\text{wd}} = V_{\text{max}} / L_{B1} )</td>
<td>10.54 plf</td>
</tr>
<tr>
<td>Seismic</td>
<td>( V_{\text{sd}} = V_{\text{seismic}} / L_{B1} )</td>
<td>19.20 plf</td>
</tr>
</tbody>
</table>

#### Nominal Capacities

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( V_{\text{wdnom}} = V_{\text{wd}} \times \Omega )</td>
<td>21.09 plf</td>
</tr>
<tr>
<td>Seismic</td>
<td>( V_{\text{sdnom}} = V_{\text{sd}} \times \Omega )</td>
<td>38.40 plf</td>
</tr>
</tbody>
</table>

#### Direction 2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of Story</td>
<td>( H_1 )</td>
<td>6.00 ft</td>
</tr>
<tr>
<td>Dead Load</td>
<td>( D_L )</td>
<td>16.00 psf</td>
</tr>
<tr>
<td>Length of Building</td>
<td>( L_{B1} )</td>
<td>12.00 ft</td>
</tr>
<tr>
<td>( L_{B2} )</td>
<td>41.06 ft</td>
<td></td>
</tr>
</tbody>
</table>

#### Applied Load

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( W_W = (12.027 \text{ psf}) \times H_1 )</td>
<td>72.16 plf</td>
</tr>
<tr>
<td>Seismic</td>
<td>( W_S = 0.2 \times D_L \times L_{B1} )</td>
<td>38.40 plf</td>
</tr>
</tbody>
</table>

#### \( V_{\text{max}} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( V_{\text{max}} = W_W \times L_{B2}/2 )</td>
<td>1481.55 lb</td>
</tr>
<tr>
<td>Seismic</td>
<td>( V_{\text{seismic}} = W_S \times L_{B2}/2 )</td>
<td>788.38 lb</td>
</tr>
</tbody>
</table>

#### \( V_{\text{wd}} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( V_{\text{wd}} = V_{\text{max}} / L_{B1} )</td>
<td>123.46 plf</td>
</tr>
<tr>
<td>Seismic</td>
<td>( V_{\text{sd}} = V_{\text{seismic}} / L_{B1} )</td>
<td>65.70 plf</td>
</tr>
</tbody>
</table>

#### Nominal Capacities

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>( V_{\text{wdnom}} = V_{\text{wd}} \times \Omega )</td>
<td>246.92 plf</td>
</tr>
<tr>
<td>Seismic</td>
<td>( V_{\text{sdnom}} = V_{\text{sd}} \times \Omega )</td>
<td>131.40 plf</td>
</tr>
</tbody>
</table>

*Use 3/4" T&G, 8d nails @ 6 inch edge nail spacing*

*Use 15 gauge staples @ 12 inches for field stapling*
C15X33.9 TO C8X11.5 INTERMODULAR CONNECTION

LOADS
\[ \begin{align*}
W_{\text{wind}} & : 3146 \text{ lb} & \text{*(Wind Governs)} \\
W_{\text{seismic}} & : 1857.6 \text{ lb} \\
\end{align*} \]

1/2" A307 threaded bolt

ALLOWABLE SHEAR STRENGTH

\[ R_n = \phi F_{nv} A_b \]

\[ R_n = 0.75 \times 27 \text{ ksi} \times 0.196 \text{ in}^2 = 3976.08 \text{ lbs} \]

\[ 3976.08 > 3146.07 \text{ OK} \]

AVAILABLE TENSILE STRENGTH

\[ F'_{nt} = 16.0 \text{ ksi} \text{ (WIND LOAD)} \]

\[ F'_{nt} = 22.89 \text{ ksi} \leq 45 \]

\[ R_n = \phi F'_{nt} A_b = 3371 \text{ lbs} \text{ OK} \]

NORTH WALL TIMBER STUDS

Simpson Strong-Tie A34 Connection Framing Angle

Max Load = 490 psf > 50.03 psf OK

JOIST HANGER CONNECTION

Simpson Strong-Tie LSSU135 Sloped Hanger

Max Load = 1275 psf > 38 psf OK
### C3X3.5 TO L8X4X1/2 : TOP & BOTTOM CONNECTION

**LOADS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value1</th>
<th>Value2</th>
<th>Value3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W_{\text{wind,Na}}$</td>
<td>3146.07 lb</td>
<td>73.164396 plf</td>
<td></td>
</tr>
<tr>
<td>$W_{\text{seismic}}$</td>
<td>1857.6 lb</td>
<td>43.2 plf</td>
<td></td>
</tr>
</tbody>
</table>

*(Wind Governs)*

- Tributary Width: 12.00 ft
- Wall Height = 'Beam Length': 6.083 ft

Industry Designed Filet Welded Connection
SUNPLANTER

(2) 5/16” Ceramic Coated lag screw

UPLIFT

\[
\begin{align*}
SA &= 546 \text{ ft}^2 \\
WIND_{ud} &= 12.027 \text{ psf} \\
WIND_{perp} &= 12.027 \tan(24) = 5.34 \text{ psf} \\
&= 21.86 \text{ lb} \\
UPLIFT &= 2915.64 \text{ lb over whole roof} \\
UPLIFT &= 208.26 \text{ lb per column end} \\
GRAVITY &= 96.6 \text{ lb per column end}
\end{align*}
\]

CAPACITY

\[
\begin{align*}
\text{TENSION} &= 893 \text{ lb per bolt} \\
\text{SHEAR} &= 432 \text{ lb per bolt} \\
\text{T&S} &= 447 \text{ lb per bolt} \\
893 \text{ lb} &> 208 \text{ lb OK} \\
431 \text{ lb} &> 21.86 \text{ lb OK}
\end{align*}
\]
DECK GIRDER CALCULATIONS

**DFL No. 2 - 4x6**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>96 in</td>
</tr>
<tr>
<td>Depth</td>
<td>5.5 in</td>
</tr>
<tr>
<td>Width</td>
<td>3.5 in</td>
</tr>
<tr>
<td>Area</td>
<td>19.25 in²</td>
</tr>
<tr>
<td>Sx</td>
<td>17.65 in³</td>
</tr>
<tr>
<td>Ix</td>
<td>48.53 in⁴</td>
</tr>
</tbody>
</table>

**Reference Design Values**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fb</td>
<td>900 psi</td>
</tr>
<tr>
<td>Fv</td>
<td>180 psi</td>
</tr>
<tr>
<td>E</td>
<td>160000 psi</td>
</tr>
</tbody>
</table>

**Adjustment Factors** - NDS Table 4.3.1

<table>
<thead>
<tr>
<th>C₀</th>
<th>Cₘₖ</th>
<th>Cₜ</th>
<th>Cₚ</th>
<th>Cᵢ</th>
<th>Cᵣ</th>
<th>Cₘₗₜ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.85</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.97</td>
</tr>
</tbody>
</table>

**Structural Analysis**

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead Load</td>
<td>1.96 psf</td>
</tr>
<tr>
<td>Live Load</td>
<td>100 psf</td>
</tr>
<tr>
<td>W; D+L</td>
<td>135.95 plf</td>
</tr>
<tr>
<td>Moad.</td>
<td>13050.88 lb-in</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>O.C. spacing</td>
<td>16 in</td>
</tr>
</tbody>
</table>

**Design Calculations**

**Bending Check**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depthnominal</td>
<td>4 in</td>
</tr>
<tr>
<td>Widthnominal</td>
<td>2 in</td>
</tr>
<tr>
<td>Dn/Wn</td>
<td>2</td>
</tr>
<tr>
<td>Cₜ</td>
<td>1</td>
</tr>
<tr>
<td>Fb</td>
<td>994.5 psi</td>
</tr>
<tr>
<td>Fb : Fₜ * Cₜ * Cₘₖ * Cₚ * Cᵢ * Cᵣ</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fb = Fₜ * Cₜ * Cₘₖ * Cₚ * Cᵢ * Cᵣ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fb = 994.5 psi</td>
</tr>
<tr>
<td>fₜ &lt; Fₜ ?</td>
</tr>
</tbody>
</table>

**Deflection Check**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length/360</td>
<td>0.267 in</td>
</tr>
<tr>
<td>L</td>
<td>11.111 lb/in</td>
</tr>
<tr>
<td>Δ</td>
<td>5<em>L</em>Length^4 /(384<em>E</em>I)</td>
</tr>
<tr>
<td>Δ</td>
<td>0.158 in</td>
</tr>
<tr>
<td>Δ &lt; Length/360</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Shear Check**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fv</td>
<td>174.6 psi</td>
</tr>
<tr>
<td>Fv =</td>
<td>174.6 psi</td>
</tr>
<tr>
<td>V: wL/2</td>
<td>543.79 lb</td>
</tr>
<tr>
<td>fₜ : 3V/2A</td>
<td>42.4 psi</td>
</tr>
<tr>
<td>fₜ &lt; Fₜ ?</td>
<td>OK</td>
</tr>
</tbody>
</table>
DECK JOIST CALCULATIONS

DFL No. 2 - 2x6

<table>
<thead>
<tr>
<th>Length</th>
<th>48 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>5.5 in</td>
</tr>
<tr>
<td>Width</td>
<td>1.5 in</td>
</tr>
<tr>
<td>Area</td>
<td>8.25 in²</td>
</tr>
<tr>
<td>Sx</td>
<td>7.56 in³</td>
</tr>
<tr>
<td>Ix</td>
<td>20.80 in⁴</td>
</tr>
</tbody>
</table>

Reference Design Values

<table>
<thead>
<tr>
<th>Fb</th>
<th>900 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fv</td>
<td>180 psi</td>
</tr>
<tr>
<td>E</td>
<td>1600000 psi</td>
</tr>
</tbody>
</table>

Adjustment Factors - NDS Table 4.3.1

<table>
<thead>
<tr>
<th>Co</th>
<th>CMb</th>
<th>Cl</th>
<th>Cf</th>
<th>Ci</th>
<th>Cr</th>
<th>CMv</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.85</td>
<td>1</td>
<td>1.3</td>
<td>1</td>
<td>1.15</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Structural Analysis

<table>
<thead>
<tr>
<th>Dead Load</th>
<th>1.96 psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Load</td>
<td>100 psf</td>
</tr>
<tr>
<td>W: D+L</td>
<td>135.95 plf</td>
</tr>
<tr>
<td>Mload:</td>
<td>3262.72 lb-in</td>
</tr>
</tbody>
</table>

O.C. spacing | 16 in

Design Calculations

Bending Check

<table>
<thead>
<tr>
<th>Depthnominal</th>
<th>6 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Widthnominal</td>
<td>2 in</td>
</tr>
<tr>
<td>Dn/Wn :</td>
<td>3</td>
</tr>
<tr>
<td>Cl</td>
<td>1</td>
</tr>
<tr>
<td>Fb</td>
<td>1143.675 psi</td>
</tr>
<tr>
<td>Fv</td>
<td>431.4 psi</td>
</tr>
<tr>
<td>f&lt;9Fb ?</td>
<td>OK</td>
</tr>
</tbody>
</table>

Deflection Check

| Length/360 | 0.133 in. |
| L          | 11.111 lb/in |
| Δ          | 5*L*Length⁴/(384*E*I) |
| Δ          | 0.023 in |
| Δ < Length/360% | OK |

Shear Check

<table>
<thead>
<tr>
<th>Fv</th>
<th>Fv <em>CD</em>CM<em>Cl</em>Ci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fv</td>
<td>174.6 psi</td>
</tr>
<tr>
<td>V: wL/2</td>
<td>271.89 lb</td>
</tr>
<tr>
<td>Fr : 3V/2A</td>
<td>49.4 psi</td>
</tr>
<tr>
<td>f&lt;9Fv ?</td>
<td>OK</td>
</tr>
</tbody>
</table>

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### DECK SLATS

**TIGER DECK**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>16 in</td>
</tr>
<tr>
<td>Depth</td>
<td>3.44 in</td>
</tr>
<tr>
<td>Width</td>
<td>0.94 in</td>
</tr>
<tr>
<td>Area</td>
<td>3.2336 in²</td>
</tr>
<tr>
<td>$S_x$</td>
<td>1.85 in³</td>
</tr>
<tr>
<td>$I_x$</td>
<td>3.19 in⁴</td>
</tr>
</tbody>
</table>

- **Bending Strength (psi @ 12%)**: 16620
- **Max Crushing Strength (psi @ 12%)**: 10320
- **Weight (lb/cu.ft.)**: 77

### JOIST SPACING

<table>
<thead>
<tr>
<th>JOIST SPACING</th>
<th>ALLOWABLE LOAD</th>
<th>MAX DEFLECTION</th>
<th>MAX FLEXURAL STRESS</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>(in)</td>
<td>(psf)</td>
<td></td>
<td>(psi)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>40</td>
<td>0.00022</td>
<td>37</td>
<td>L/54096</td>
</tr>
<tr>
<td>16</td>
<td>40</td>
<td>0.0007</td>
<td>66</td>
<td>L/22822</td>
</tr>
<tr>
<td>19.2</td>
<td>40</td>
<td>0.00145</td>
<td>95</td>
<td>L/13207</td>
</tr>
<tr>
<td>24</td>
<td>40</td>
<td>0.00355</td>
<td>148</td>
<td>L/6762</td>
</tr>
<tr>
<td>12</td>
<td>60</td>
<td>0.00033</td>
<td>58</td>
<td>L/38085</td>
</tr>
<tr>
<td>16</td>
<td>60</td>
<td>0.00105</td>
<td>99</td>
<td>L/15215</td>
</tr>
<tr>
<td>19.2</td>
<td>60</td>
<td>0.00218</td>
<td>143</td>
<td>L/6805</td>
</tr>
<tr>
<td>24</td>
<td>60</td>
<td>0.00532</td>
<td>224</td>
<td>L/4508</td>
</tr>
<tr>
<td>12</td>
<td>90</td>
<td>0.0005</td>
<td>84</td>
<td>L/24043</td>
</tr>
<tr>
<td>16</td>
<td>90</td>
<td>0.00158</td>
<td>149</td>
<td>L/10143</td>
</tr>
<tr>
<td>19.2</td>
<td>90</td>
<td>0.00327</td>
<td>215</td>
<td>L/5870</td>
</tr>
<tr>
<td>24</td>
<td>90</td>
<td>0.00799</td>
<td>335</td>
<td>L/3005</td>
</tr>
<tr>
<td>16</td>
<td>100</td>
<td>0.00176</td>
<td>165.6</td>
<td>L/9090</td>
</tr>
</tbody>
</table>

**THROUGH EXTRAPOLATION:**

- **FLEXURE**: 165.6 psi < 335 psi, OK
- **DEFLECTION**: L/9090 < L/360, OK
**DECK FOUNDATION**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>L</td>
<td>Total</td>
<td>Trib B</td>
<td>w</td>
</tr>
<tr>
<td>(psf)</td>
<td>(psf)</td>
<td>(psf)</td>
<td>(ft)</td>
<td>(plf)</td>
</tr>
<tr>
<td>20.00</td>
<td>100</td>
<td>120.00</td>
<td>4.00</td>
<td>480</td>
</tr>
</tbody>
</table>

$$w = 480 \text{ plf}$$

$$L = 8.00 \text{ ft}$$

$$R_A = R_B = 1920 \text{ LBS}$$

AT 1500psf BEARING PRESSURE THIS REQUIRES: 1.3 SQ FT FOR FOOTINGS

<table>
<thead>
<tr>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: SEISMIC PIERS</td>
<td>0</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>2</td>
</tr>
</tbody>
</table>

3.6 SQ FT PROVIDED

533.3 PSF PER FOOTING

AT 1500psf BEARING PRESSURE THIS REQUIRES: 1.3 SQ FT FOR FOOTINGS

<table>
<thead>
<tr>
<th>QTY</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>B: SEISMIC PIERS</td>
<td>0</td>
</tr>
<tr>
<td>STANDARD PIERS</td>
<td>2</td>
</tr>
</tbody>
</table>

3.6 SQ FT PROVIDED

533.3 PSF PER FOOTING
DECK

DECK CONNECTIONS

SLAT TO JOIST:

STANDARD: (2) No. 8 screws per slat per supporting joist

JOIST TO GIRDER:

16 penny nails

NOTE: Blocking at ~ 4’ intervals for rigidity

GIRDER TO SUPPORT:

Simpson Strong Tie: GLS & GLT

HOUSE LEDGER:

N/A – self supported deck via piers

SUPPORT TO PIER:

Central Piers: Marriage Top (201) to 4x6 In Place Girder
AWNINGS
DESIGN WIND LOAD
ASCE 7-02 6.4.2.2: WIND DESIGN METHOD I

\[ P_{net} = \lambda * I * P_{net30} \]

BASIC WIND LOAD

\begin{align*}
\text{Angle (<7°)} & : 4.5 \degree \\
\text{Table 6.3 for permeable components & cladding (6.4.3)} & \\
I & : 1 \\
\lambda & : 1.21 \\
\text{Basic Wind Speed} & : 90 \text{ mph} \\
\text{ } & \\
\text{ } & \\
\text{Permeability Factor} & : 30 \\
\end{align*}

(For Zone 2 @ 100 ft^2)

\[ P_{net30} = -19.8 \text{ psf} \]

(Minimum allowed per 6.4.2.2.1)

\[ P_{net30} = -10 \text{ psf} \]

\[ \text{Approximate Effective Area} = 400 \text{ ft}^2 \]

\[ P_{net30} = -19.8 \text{ psf} \]
AWNINGS

MEMBER A (114 IN): HSS 2X2X1/8

PROPERTIES - AISC Shapes Database

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_g )</td>
<td>0.84 in(^2)</td>
</tr>
<tr>
<td>( d )</td>
<td>2 in</td>
</tr>
<tr>
<td>( L_{\text{member}} )</td>
<td>9.5 ft</td>
</tr>
<tr>
<td>( E )</td>
<td>29000000 psi</td>
</tr>
<tr>
<td>( F_y )</td>
<td>46 ksi</td>
</tr>
<tr>
<td>( Z )</td>
<td>0.584 in(^3)</td>
</tr>
<tr>
<td>( I )</td>
<td>0.486 in(^4)</td>
</tr>
<tr>
<td>( r )</td>
<td>0.761 in</td>
</tr>
<tr>
<td>( K L/r )</td>
<td>149.8 in/in</td>
</tr>
</tbody>
</table>

EFFECTIVE AREA

Effective Width 50 in
Effective Length 114 in

\( A_{\text{eff}} = 39.6 \text{ ft}^2 \)

EFFECTIVE WIND LOAD

1/2 tributary area of wind load (assume aspect ratio 2:1)

\( \text{WIND}_{\text{eff}} = A_{\text{eff}} \times \text{WIND} = -783.8 \text{ lb} \)

\( W = \text{WIND}_{\text{eff}} / \text{Member L} = -6.875 \text{ lb/in} \)

DEFLECTION CHECK

\[ \Delta_{\text{allowable}} = \frac{L}{80} \quad 1.43 \text{ in} \quad \text{(conservative)} \]

\[ \Delta_{\text{max}} = 5WL^3/(384EI) \quad 1.07 \text{ in} \]

\( \Delta_{\text{max}} < \Delta_{\text{allowable}} \text{ OK} \)

FLEXURE

Yielding

\[ M_{\text{all}} = F_y \times Z = 26.9 \text{ kip-in} \]
\[ M_{\text{allow}} = M_n/\Omega = 1.3 \text{ kip-ft} \]
\[ M_{\text{max}} = WL^2/8 = 0.9 \text{ kip-ft} \]

\( M_{\text{max}} < M_{\text{allow}} \text{ OK} \)
**FLEXURAL BUCKLING**

*Due to tension of shade fabric on beams distributed as axial load on Member A*

**Assume:** Fabric weight << than tension & wind loads

75 lb tension/gromet (gromets attached @ 6" O.C. on fabric and weaved into beams)

- Tension Force = 150 plf
- Length of Fabric = 139 in
- Length of Beam = 114 in
- Intermediate Braces, Member A = 3 members
- Total Axial Load on Member A = 579 lb

\[
F_{\text{actual}} = 0.689 \text{ ksi}
\]

When \( KL/r > 4.71 \sqrt{(E/F_y)} = 118.3 \text{ in/in} \)

\[
F_{cr} = 0.877 F_a
\]

where \( F_a = \frac{\pi^2 E}{(KL/r)^2} = 12.8 \text{ ksi} \)

\[
F_{cr} = 11.19 \text{ ksi}
\]

\[
F_n = \frac{F_{cr}}{\Omega} = 6.7 \text{ ksi}
\]

\[
F_n = 6.7 \text{ ksi}
\]

\[
F_{\text{actual}} = 0.689 \text{ ksi}
\]

\[
F_{\text{actual}} < F_n \quad \text{OK}
\]
AWNINGS

TRUSS BRACE STIFFENER (186 IN): HSS 2X2X1/8

PROPERTIES
\[ \begin{align*}
A_g & = 0.84 \text{ in}^2 \\
I & = 0.486 \text{ in}^4 \\
r & = 0.761 \text{ in} \\
E & = 29000000 \text{ psi} \\
KL_{eff}/r & = 122.2 \text{ in/in} \\
Member L & = 15.5 \text{ ft} \\
F_y & = 46 \text{ ksi} \\
\Omega & = 1.67
\end{align*} \]

EFFECTIVE AREA

<table>
<thead>
<tr>
<th>Effective Width</th>
<th>WIND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width 1</td>
<td>47 in</td>
</tr>
<tr>
<td>Width 2</td>
<td>57 in</td>
</tr>
</tbody>
</table>

Member L 186 in
\[ A_{eff} = 134.3 \text{ ft}^2 \]

EFFECTIVE WIND LOAD

\[ \frac{1}{2} \text{ tributary area of wind load (assume aspect ratio 2:1)} \]
\[ WIND_{eff} = A_{eff} \times WIND = 2660 \text{ lb} \]

\[ \text{NOTE: Conservative for assumed aspect ratio & assume self-weight << effective wind load} \]

Using the method of sections,

\[ \text{Axial Load in bottom chord of truss:} \]
\[ \Sigma F_x = 0 = HG + HC + BC \]
\[ \Sigma M_H = 0 = BC (9\text{"}) + A (43\text{"}) = BC (9\text{"}) + (1330.5\text{ lb}) (43\text{")} \]
\[ BC = -(43\text{") \times 1330.5\text{ lb}} \]
\[ F_{axial} = BC = -6356.83 = 6357 \text{ lb (compression)} \]

Due to Symmetry, end reactions are equal.
\[ A_y = B_y = (3 \times 887)/2 = 1330.50 \text{ lb} \]
FLEXURAL BUCKLING

Due to axial force from uplift

When \( KL/r > 4.71 \sqrt[2]{(E/F_y)} = 118.3 \text{ in/in} \)

\[
F_{cr} = 0.877F_u \\
\text{where } F_u = \frac{\pi^2E}{(KL/r)^2} = 19.2 \text{ ksi}
\]

\[
F_{cr} = 16.81 \text{ ksi}
\]

<table>
<thead>
<tr>
<th>( F_n )</th>
<th>( F_{cr} / \Omega )</th>
<th>10.1 ksi</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{actual} )</td>
<td>( F_{axial} / A_g )</td>
<td>7.57 ksi</td>
</tr>
</tbody>
</table>

\( F_{actual} < F_n \) **OK**
RAILINGS

DESIGN BOLT STRENGTH FOR TYPICAL GUARDRAIL POST

(2) 3/8" A307 threaded bolt

DEMAND TENSILE STRENGTH

\[ \sum M_A = 0 \Rightarrow B = \frac{\text{LOAD} \times 40.125^\circ}{4.5^\circ} \]

\[ B_{\text{load}} = 1961.1 \text{ lb} \]

\[ \sum F_X = 0 \Rightarrow A = B + \text{LOAD} \]

\[ A_{\text{load}} = 2161.1 \text{ lb} \]

ALLOWABLE TENSILE STRENGTH

\[ F_{\text{nt}} = 45 \text{ ksi} \]  

\[ A_b = 0.110 \text{ in}^2 \]

\[ \Omega = 2.00 \]

\[ R_n = \frac{F_{\text{nt}} \times A_b}{\Omega} \]

\[ R_n = 2485.05 \text{ lb} \]

(\text{AISC Steel Construction Manual EQ. J3-1})

Check \[ R_n \] \[ > \] Demand

\begin{array}{cccc}
\text{Check} & R_n & > & \text{Demand} \\
2485 \text{ lb} & > & 1961 \text{ lb} & \text{Bolt}_B \text{ OK} \\
2485 \text{ lb} & > & 2161 \text{ lb} & \text{Bolt}_A \text{ OK}
\end{array}
Detailed Water Budget
**Detailed Water Budget**

We will use approximately 1100 gallons of water throughout the competition. However, we request about 1468 gallons to include a 33% safety factor. This water will be stored in a tank behind Radiant House and will be used for cooking, appliances, fire protection, closed-loop solar mechanical systems, and irrigation.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.</td>
<td></td>
<td>5.</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gallons/load</td>
<td>3.5</td>
<td></td>
<td>Clothes Washer</td>
<td>11.928</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load for Contests</td>
<td>5.0</td>
<td></td>
<td>Dishwasher</td>
<td>3.47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Test Runs</td>
<td>5.0</td>
<td></td>
<td>Hot Water</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total (gal)</td>
<td>34.7</td>
<td></td>
<td><strong>Subtotal</strong></td>
<td>30.398</td>
<td></td>
</tr>
<tr>
<td>Clothes Washer</td>
<td></td>
<td>13</td>
<td></td>
<td>Clothes Washer</td>
<td>11.928</td>
<td></td>
</tr>
<tr>
<td>Gallons/load</td>
<td>11.9</td>
<td></td>
<td></td>
<td>Cooking</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td># Loads for Contest</td>
<td>8.0</td>
<td></td>
<td></td>
<td>Hot Water (2 draws)</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td># of Test Runs</td>
<td>5.0</td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
<td>42.928</td>
<td></td>
</tr>
<tr>
<td>Hot Water Draws</td>
<td></td>
<td>14</td>
<td></td>
<td>Clothes Washer</td>
<td>11.928</td>
<td></td>
</tr>
<tr>
<td>Gallons/draw</td>
<td>15.0</td>
<td></td>
<td></td>
<td>Dishwasher</td>
<td>3.47</td>
<td></td>
</tr>
<tr>
<td>Draws</td>
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<td></td>
<td></td>
<td>Cooking</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Test Runs</td>
<td>1.0</td>
<td></td>
<td></td>
<td>Hot Water</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Total (gal)</td>
<td>255.0</td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
<td>31.398</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td>15</td>
<td></td>
<td>Clothes Washer (2 draws)</td>
<td>23.856</td>
<td></td>
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<tr>
<td>Fire Sprinklers</td>
<td>300.0</td>
<td></td>
<td></td>
<td>Hot Water (3 draws)</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Thermal Collectors</td>
<td>20.0</td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
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<td></td>
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<tr>
<td>Irrigation</td>
<td>300</td>
<td></td>
<td></td>
<td>Dishwasher</td>
<td>3.47</td>
<td></td>
</tr>
<tr>
<td>PV Cleaning</td>
<td>15.0</td>
<td></td>
<td></td>
<td>Hot Water (3 draws)</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Buffer</td>
<td>20.0</td>
<td></td>
<td></td>
<td>Cooking</td>
<td>1</td>
<td></td>
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<tr>
<td>Messana</td>
<td>15</td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
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<td></td>
</tr>
<tr>
<td>Total (gal)</td>
<td>670.0</td>
<td></td>
<td></td>
<td>Clothes Washer (2 draws)</td>
<td>23.856</td>
<td></td>
</tr>
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<td>Cooking</td>
<td></td>
<td>17</td>
<td></td>
<td>Hot Water (2 draws)</td>
<td>3.47</td>
<td></td>
</tr>
<tr>
<td>Gallons/task</td>
<td>1.0</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td># of Tasks</td>
<td>4.0</td>
<td></td>
<td></td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4.0</td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
<td>70.856</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Total Minimum Gallons of Water Needed | 1118.8 |
| 33% Safety Factor Total | 1428.0 |</p>
<table>
<thead>
<tr>
<th>Activity</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishwasher</td>
<td>3.47</td>
</tr>
<tr>
<td>Cooking</td>
<td>1</td>
</tr>
<tr>
<td>Hot Water</td>
<td>15</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>31.398</strong></td>
</tr>
</tbody>
</table>

**Minimum Gallons of Water for Competition**

358.8

Figure 1: Water budget breakdown
Energy Analysis
results & Discussion
**Energy Analysis Results & Discussion**

This energy analysis will provide a comprehensive account of all the energy to be produced and consumed by Radiant House during the 2013 Solar Decathlon Competition. It will also supply detailed descriptions of the executions of contests that deal with energy consumption and the corresponding components used for each of these contests.

**HVAC**

Radiant House will use Messana Ray Magic radiant heating and cooling in conjunction with a split-system Daikin Altherma heat pump as its HVAC system. The Messana Ray Magic system provides radiant heating and cooling from the ceiling to create a comfortable interior temperature. The radiant system can provide up to 23,351 Btu/h of cooling when running at 45°F performance; however, the typical cooling capacity of the system is approximately 18,000 Btu/h. The system runs more efficiently when the supply water temperature is 55°F. The standard heating capacity of the system is 16,384 Btu/h when the supply temperature is 100°F. By covering 75% of the ceiling space in Messana panels, the supply water can be run at a temperature closer to the room temperature, which allows for increased efficiency within the system. This system will be supported by an under-floor air distribution (UFAD) system which will be coupled with a heat recovery ventilator (HRV) and a Messana dehumidification system. The ventilation system distributes air throughout the house by collecting air near the ceiling and routing it through the ducting located beneath the finished floor. Minimal ducting is required because of the low air flow (110 CFM) necessary for an air distribution system used for circulation purposes only.

The heating and cooling loads for Radiant House were calculated using two different approaches in order to obtain an accurate estimate of the load requirements during the competition. The first method gives a rough estimate based on the ambient temperature, the desired indoor temperature, the R-values and the thicknesses of the insulation, the total surface area of the floor, roof, and walls of the house, as well as the square footage of the windows and their respective R-values. The calculations take into account the internal heat gains of the house in order to get an accurate worst-case scenario for the heating loads. The internal gain included in the calculations is the heat generated by people, appliances, and lighting. When calculating the heat losses, the calculations ignore the internal heat gains of the house so as to get a worse-case scenario for the cooling load. The weather data (ambient temperature) is based on above-average temperatures of typical October weather in El Toro, CA.

The heating and cooling loads were also calculated using the energy analysis program, HAP (Hourly Analysis Program), an engineering software program designed to calculate heating and cooling loads of a house along with the energy consumption and the monetary cost of running standard HVAC systems. For this project, only the heating and cooling load data were utilized due to the nonstandard HVAC system. Spaces are defined within the program (i.e., Kitchen, Dining Room, Living Room, etc.) based on their geometry and orientation. The inputs for the spaces include R-values for the walls, roof, and floor space as well as the square footage of windows. The walls and ceiling were assumed to have an R-value of 26 and 43, respectively.
The windows were assigned R-values of 3.3. Lighting and thermostat schedules were created based on their respective competition schedules. The weather data is from an internal weather database and uses warmer-than-average temperatures when determining the outside air temperature. The results of both analyses appear in the following tables. Additionally, the energy consumption of the heat pump HVAC system is provided below by Hydronic Heat Pumps and details the energy consumption on a monthly and yearly basis.

Table 1: Design Heating and Cooling Loads for Radiant House in Irvine, CA

<table>
<thead>
<tr>
<th>ZONE LOADS</th>
<th>Details</th>
<th>Sensible (BTU/hr)</th>
<th>Latent (BTU/hr)</th>
<th>Details</th>
<th>Sensible (BTU/hr)</th>
<th>Latent (BTU/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Window &amp; Skylight Solar Loads</td>
<td>445 ft²</td>
<td>13168</td>
<td>-</td>
<td>445 ft²</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wall Transmission</td>
<td>1151 ft²</td>
<td>834</td>
<td>-</td>
<td>1151 ft²</td>
<td>1169</td>
<td>-</td>
</tr>
<tr>
<td>Roof Transmission</td>
<td>903 ft²</td>
<td>1524</td>
<td>-</td>
<td>903 ft²</td>
<td>673</td>
<td>-</td>
</tr>
<tr>
<td>Window Transmission</td>
<td>445 ft²</td>
<td>1976</td>
<td>-</td>
<td>445 ft²</td>
<td>4539</td>
<td>-</td>
</tr>
<tr>
<td>Skylight Transmission</td>
<td>0 ft²</td>
<td>0</td>
<td>-</td>
<td>0 ft²</td>
<td>0</td>
<td>-</td>
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<tr>
<td>Door Loads</td>
<td>21 ft²</td>
<td>328</td>
<td>-</td>
<td>21 ft²</td>
<td>290</td>
<td>-</td>
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<tr>
<td>Floor Transmission</td>
<td>811 ft²</td>
<td>575</td>
<td>-</td>
<td>811 ft²</td>
<td>254</td>
<td>-</td>
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<tr>
<td>Partitions</td>
<td>0 ft²</td>
<td>0</td>
<td>-</td>
<td>0 ft²</td>
<td>0</td>
<td>-</td>
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<tr>
<td>Ceiling</td>
<td>44 ft²</td>
<td>369</td>
<td>-</td>
<td>44 ft²</td>
<td>155</td>
<td>-</td>
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<tr>
<td>Overhead Lighting</td>
<td>0 W</td>
<td>205</td>
<td>-</td>
<td>0 W</td>
<td>0</td>
<td>-</td>
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<tr>
<td>Task Lighting</td>
<td>0 W</td>
<td>170</td>
<td>-</td>
<td>0 W</td>
<td>0</td>
<td>-</td>
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<tr>
<td>Electric Equipment</td>
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<td>0</td>
<td>-</td>
<td>0 W</td>
<td>0</td>
<td>-</td>
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<tr>
<td>People</td>
<td>7</td>
<td>1310</td>
<td>1130</td>
<td>0</td>
<td>0</td>
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<td>Infiltration</td>
<td>-</td>
<td>152</td>
<td>49</td>
<td>-</td>
<td>359</td>
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<td>Miscellaneous</td>
<td>-</td>
<td>263</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Safety Factor</td>
<td>0% / 0%</td>
<td>0</td>
<td>0</td>
<td>0% / 0%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Zone Loads</strong></td>
<td>-</td>
<td>20874</td>
<td>1081</td>
<td>-</td>
<td>7440</td>
<td>12</td>
</tr>
<tr>
<td>Zone Conditioning</td>
<td>-</td>
<td>20545</td>
<td>1081</td>
<td>-</td>
<td>6818</td>
<td>12</td>
</tr>
<tr>
<td>Plenum Wall Load</td>
<td>0%</td>
<td>0</td>
<td>-</td>
<td>0%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Plenum Roof Load</td>
<td>0%</td>
<td>0</td>
<td>-</td>
<td>0%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Plenum Lighting Load</td>
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<td>0</td>
<td>-</td>
<td>0%</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Return Fan Load</td>
<td>1682 CFM</td>
<td>0</td>
<td>-</td>
<td>1682 CFM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ventilation Load</td>
<td>0 CFM</td>
<td>0</td>
<td>0</td>
<td>0 CFM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supply Fan Load</td>
<td>1682 CFM</td>
<td>0</td>
<td>-</td>
<td>1682 CFM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Space Fan Coil Fans</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Duct Heat Gain / Loss</td>
<td>0%</td>
<td>0</td>
<td>-</td>
<td>0%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total System Loads</strong></td>
<td>-</td>
<td>20545</td>
<td>1081</td>
<td>-</td>
<td>6818</td>
<td>12</td>
</tr>
<tr>
<td>Central Cooling Coil</td>
<td>-</td>
<td>24402</td>
<td>1130</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Central Heating Coil</td>
<td>-</td>
<td>-3857</td>
<td>-</td>
<td>-</td>
<td>6818</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Conditioning</strong></td>
<td>-</td>
<td>20545</td>
<td>1130</td>
<td>-</td>
<td>6818</td>
<td>0</td>
</tr>
</tbody>
</table>

Key: Positive values are clg loads Negative values are htg loads

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Table 2: Sample heating and cooling loads for a typical day in October in Irvine, CA.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour</td>
<td>(°F)</td>
<td>(°F)</td>
<td>(BTU/hr)</td>
<td>(BTU/hr)</td>
</tr>
<tr>
<td>0</td>
<td>70.1</td>
<td>73.2</td>
<td>5089.5</td>
<td>5815.4</td>
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<tr>
<td>100</td>
<td>68.8</td>
<td>73.5</td>
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<td>4406.2</td>
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<td>200</td>
<td>67.5</td>
<td>73.1</td>
<td>3640.4</td>
<td>4498.7</td>
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<td>300</td>
<td>66.4</td>
<td>73.4</td>
<td>3000.7</td>
<td>3131.9</td>
</tr>
<tr>
<td>400</td>
<td>65.7</td>
<td>73.4</td>
<td>2431.6</td>
<td>2593.1</td>
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<tr>
<td>500</td>
<td>65.4</td>
<td>73.2</td>
<td>1966.6</td>
<td>2403</td>
</tr>
<tr>
<td>600</td>
<td>65.9</td>
<td>73</td>
<td>2611.4</td>
<td>3427.7</td>
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<td>67.2</td>
<td>73.4</td>
<td>5605.4</td>
<td>5600.2</td>
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<td>73.8</td>
<td>8539.1</td>
<td>7803.8</td>
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<td>900</td>
<td>72.9</td>
<td>73.4</td>
<td>10790</td>
<td>10912.4</td>
</tr>
<tr>
<td>1000</td>
<td>76.8</td>
<td>73.9</td>
<td>12482.8</td>
<td>11378.6</td>
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<td>1100</td>
<td>81.3</td>
<td>73.5</td>
<td>13817</td>
<td>13645</td>
</tr>
<tr>
<td>1200</td>
<td>85.4</td>
<td>73.6</td>
<td>15376.2</td>
<td>14969.8</td>
</tr>
<tr>
<td>1300</td>
<td>88.5</td>
<td>74.2</td>
<td>17180.2</td>
<td>15663.6</td>
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<tr>
<td>1400</td>
<td>90.6</td>
<td>74</td>
<td>18507.9</td>
<td>17542</td>
</tr>
<tr>
<td>1500</td>
<td>91.4</td>
<td>74</td>
<td>18642.6</td>
<td>17590.2</td>
</tr>
<tr>
<td>1600</td>
<td>90.6</td>
<td>74</td>
<td>16609.1</td>
<td>15572.3</td>
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<tr>
<td>1700</td>
<td>88.8</td>
<td>74</td>
<td>13819.2</td>
<td>12852.1</td>
</tr>
<tr>
<td>1800</td>
<td>85.9</td>
<td>73.9</td>
<td>11866.2</td>
<td>11226.8</td>
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<tr>
<td>1900</td>
<td>82.6</td>
<td>73.9</td>
<td>11187</td>
<td>10579</td>
</tr>
<tr>
<td>2000</td>
<td>79.2</td>
<td>73.8</td>
<td>9904.1</td>
<td>9530.9</td>
</tr>
<tr>
<td>2100</td>
<td>76.3</td>
<td>73.5</td>
<td>8747.6</td>
<td>8870.6</td>
</tr>
<tr>
<td>2200</td>
<td>73.7</td>
<td>73.7</td>
<td>7690.7</td>
<td>7522.6</td>
</tr>
<tr>
<td>2300</td>
<td>71.6</td>
<td>73.3</td>
<td>6335.6</td>
<td>6969.4</td>
</tr>
</tbody>
</table>
Table 3: HVAC Equipment Energy Consumption

<table>
<thead>
<tr>
<th>Use</th>
<th>Manufacturer</th>
<th>Model</th>
<th>kW</th>
<th>Hours Used</th>
<th>Total kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Pump</td>
<td>Daikin</td>
<td>EKHBX054BA3VJU</td>
<td>-</td>
<td>-</td>
<td>15.75</td>
</tr>
<tr>
<td>DHW</td>
<td>Daikin</td>
<td>EKHWS050BA3VJU</td>
<td>-</td>
<td>-</td>
<td>5.80</td>
</tr>
<tr>
<td>Pump (Solar Thermal)</td>
<td>Grundfos</td>
<td>ALPHA 15-55</td>
<td>0.045</td>
<td>80</td>
<td>3.60</td>
</tr>
<tr>
<td>Pump (Messana Panels)</td>
<td>Grundfos</td>
<td>ALPHA 15-55</td>
<td>0.045</td>
<td>54</td>
<td>2.43</td>
</tr>
<tr>
<td>Pressure Pump</td>
<td>Grundfos</td>
<td>MQ3-35 B</td>
<td>0.900</td>
<td>10</td>
<td>9.00</td>
</tr>
<tr>
<td>Mixing Valve</td>
<td>Belimo</td>
<td>LRB24-SR-T</td>
<td>0.001</td>
<td>10</td>
<td>0.01</td>
</tr>
<tr>
<td>Recirculation Pump</td>
<td>Grundfos</td>
<td>UP15-29SU</td>
<td>0.045</td>
<td>25</td>
<td>1.13</td>
</tr>
<tr>
<td>Pump (PCM Tank)</td>
<td>Grundfos</td>
<td>ALPHA 15-55</td>
<td>0.045</td>
<td>50</td>
<td>2.25</td>
</tr>
<tr>
<td>Dehumidifier</td>
<td>Messana</td>
<td>HI250</td>
<td>0.290</td>
<td>22.5</td>
<td>6.53</td>
</tr>
<tr>
<td>HRV</td>
<td>Messana</td>
<td>RR250</td>
<td>0.100</td>
<td>22.5</td>
<td>2.25</td>
</tr>
<tr>
<td>HVAC Control</td>
<td>Messana</td>
<td>Control Magic</td>
<td>0.010</td>
<td>180</td>
<td>1.80</td>
</tr>
</tbody>
</table>

Total: 50.55 kWh

Figure 2: Daikin Split-System Heat Pump Monthly Energy Consumption
### Radiant System

The Messana Ray Magic product is a radiant distribution system that provides heating and cooling throughout the house. The radiant panels are 4 x 8 foot drywall panels that contain plastic tubing and a thin aluminum sheet to increase the effective radiant surface area. Radiant heating and cooling provides a more comfortable living environment by eliminating harsh bursts of warm or cool air. The panels also provide additional insulation to the house and are more sound proof than standard drywall. Easy to install, the panels feature laser engraving to mark where they can be attached to ceiling joists without damaging the water delivery tubes. Installation is made even easier by the snap connections that join the ends of PEX piping in adjacent panels.

### Water

Water will be stored in multiple storage tanks on site, including a 1500 gallon storage tank and two 500 gallon waste water tanks, for the entirety of the competition. The 1500 gallon storage tank has ample room for the expected 1119 gallons of water to be used during the competition. Waste water, including discharges from hot water draws and laundry cycles, will be stored in the two 500 gallon tanks. The total amount of waste water is expected to be approximately 448 gallons. All tanks are designed to hold more water than expected in order to account for unforeseen additional water draws. Each tank is located for easy removal at the conclusion of the competition.

Water usage for Radiant House can be divided into 4 systems: HVAC, hot water, cold water, and fire suppression. Water from the 1500 gallon storage tank will be directed via two different pumps to either the fire suppression system or to a manifold in the mechanical room dedicated to the hot and cold water distribution. Water for the radiant system will be contained within a closed loop that must be filled separately from the 1500 gallon storage tank.

PEX piping will be used for the majority of the water distribution throughout Radiant House because the material is cheap, easily available, and easy to install due to its flexibility. Flexibility is important in designing the plumbing system because of the need for quick connections between the four modules of the house.

Hot water will be provided by a 50-gallon domestic hot water tank. The tank will be heated primarily by a solar thermal collector with supplemental heat provided by a Daikin heat pump and an electrical booster heater located within the tank itself.

---

**Table 4: Daikin Split-System Heat Pump Yearly Energy Consumption**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly energy consumption (heating)</td>
<td>602 kWh</td>
</tr>
<tr>
<td>Yearly energy consumption (cooling)</td>
<td>2379 kWh</td>
</tr>
<tr>
<td>Total yearly energy consumption (heat/cool)</td>
<td>2981 kWh</td>
</tr>
</tbody>
</table>
The solar thermal collector will be connected directly to the hot water tank by a solar thermal kit and will provide most of the heating during the course of the day, while the heat pump and booster heater within the tank will provide the necessary heating during the nighttime hours. Over the course of the competition there will be 16 hot water draws of 15 gallons each, which must be at a temperature of 110°F. This will be handled primarily by the 12.4 KWh/day solar thermal collector with any additional heating provided by the heat pump.

**Appliances**

Table 5: Appliance Energy Consumption

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Retail Price</th>
<th>kWh/hour or kWh/cycle</th>
<th>Hrs or Cycles Used</th>
<th>Total kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clothes Dryer</td>
<td>Bosch</td>
<td>WTV6100US</td>
<td>$895</td>
<td>2</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Clothes Washer</td>
<td>Bosch</td>
<td>WAS2016UC</td>
<td>$850</td>
<td>0.24</td>
<td>8</td>
<td>1.94</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>Bosch</td>
<td>SHX2AR55UC</td>
<td>$699</td>
<td>1.3</td>
<td>5</td>
<td>6.5</td>
</tr>
<tr>
<td>Induction Stove</td>
<td>Bosch</td>
<td>NIT3065UC</td>
<td>$1,699</td>
<td>2.8</td>
<td>10</td>
<td>28.0</td>
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<tr>
<td>Oven</td>
<td>Bosch</td>
<td>HBL3350UC</td>
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<td>1</td>
<td>2</td>
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<td>Refrigerator</td>
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<td>n/a</td>
<td>0</td>
<td>n/a</td>
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</tbody>
</table>

Appliances featured in Radiant House were chosen with aesthetics and energy efficiency in mind. During the 10 days of competition, the Sun Frost refrigerator will operate in the range of 34°F and 40°F and the freezer will operate between -20°F and 5°F, using a total of 2.59 kWh. Over this 10 day period, both the Bosch clothes washer and dryer will run through 6 cycles and use 0.24 kWh/cycle and 2.00 kWh/cycle, totaling to 1.94 kWh and 16 kWh respectively. The Bosch induction stove will be used to boil water and to cook for two dinner parties, resulting in approximately 10 hours of stove use, for a total of 28.0 kWh. The Bosch oven will be used to prepare food for one dinner party, using a total of 2 kWh. The Bosch dishwasher will run through 5 cycles, each time reaching 120°F during the cycle and consuming a total of 6.5 kWh. The total energy used by the appliances during the 10 day competition will be 57.03 kWh. The following pie chart demonstrates the energy consumption of each appliance used by Radiant House.
Santa Clara’s Radiant House will use lighting design to establish an inviting, comfortable, and peaceful atmosphere for its residents. This will be accomplished by balancing natural and artificial light, taking full advantage of the 300-plus annual days of California sun. Three main factors will be considered in the design process: clear connections between indoor and outdoor space, the development of a simple yet intelligent control system that residents can intuitively understand and use, and cost, in order to maintain the affordability of the house.

Radiant House will showcase cutting-edge LED lights in all living spaces except for the bathroom. 2-inch LED linear and down lights will be recessed into the radiant heating and cooling panels for a seamless design. LED pendant lights and under cabinet lighting will serve as accent lighting to warm the work space in the kitchen. Unique to all LED lights featured in Radiant House is the color temperature changing feature that mimics the natural warm light generated by incandescent light bulbs when dimming. These lights dim not only in intensity, but in color as well. Overall, the indoor lighting design will serve to promote the comfort of the residents in Radiant House while remaining energy efficient.

Exterior lights will connect interior and exterior spaces by providing seamless transitions between the two spaces. Solar powered rope lights will highlight the entrance and exit ramps,
guiding residents to and from the house. Additional small, circular lights placed in the south-side exterior deck will create an intimate, private setting. Radiant House will be a welcoming home even at night, as these features will softly light the house and its most distinguishing features.

The lighting control system will also establish an inviting and comfortable living atmosphere for residents. Lights will be dimmable in the kitchen, bedroom, living, and dining rooms in order to create a smooth transition from natural light during the day to artificial light after the sun sets. The high clerestory windows along the roof line will also help to smooth the transition from daylight to artificial light as the setting sun will strike the vaulted ceiling with natural light through the windows and reflect downward into the great room.

Cost is an integral factor in Radiant House’s lighting schematic. While LED lights can often be expensive, we are confident in our decisions and believe that these lights are economic and cut many energy costs. Accent lights will be kept to a minimum to take advantage of the ample natural light and to reduce cost.

The following table includes all lighting used throughout Radiant House. Lighting will consume approximately 32.5 kWh during the competition.
Table 6: Lighting energy consumption for Radiant House during the competition in Irvine, CA.

<table>
<thead>
<tr>
<th>Function</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Watts (per ft./ fixture)</th>
<th>Hours Used</th>
<th>Total Energy (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interior</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedroom LED Down Lights (qty. 5)</td>
<td>EST</td>
<td>DL 2 BL</td>
<td>10</td>
<td>35</td>
<td>1.75</td>
</tr>
<tr>
<td>Bedroom Table Lamps (qty. 2)</td>
<td>Lamps Plus</td>
<td>84182</td>
<td>60</td>
<td>35</td>
<td>4.20</td>
</tr>
<tr>
<td>Closet LED Linear Light (4 ft)</td>
<td>EST</td>
<td>M110</td>
<td>5</td>
<td>35</td>
<td>0.70</td>
</tr>
<tr>
<td><strong>Bathroom Vanity Light (qty. 1)</strong></td>
<td>Oxygen Lighting</td>
<td>Zenith Vanity</td>
<td>28</td>
<td>35</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Bathroom Fan Light (qty. 1)</strong></td>
<td>NuTone</td>
<td>769RL</td>
<td>100</td>
<td>35</td>
<td>3.50</td>
</tr>
<tr>
<td>Living Room LED Linear Lighting (32 ft)</td>
<td>EST</td>
<td>M109</td>
<td>5</td>
<td>35</td>
<td>5.60</td>
</tr>
<tr>
<td><strong>Dining Room LED Down Lights (qty. 6)</strong></td>
<td>EST</td>
<td>DL 2 BL</td>
<td>10</td>
<td>35</td>
<td>2.10</td>
</tr>
<tr>
<td><strong>Kitchen LED Down Lights (qty. 4)</strong></td>
<td>EST</td>
<td>DL 2 BL</td>
<td>8</td>
<td>35</td>
<td>1.12</td>
</tr>
<tr>
<td>Kitchen Under Cabinet Lights (14 ft)</td>
<td>EST</td>
<td>M109</td>
<td>5</td>
<td>35</td>
<td>2.45</td>
</tr>
<tr>
<td><strong>Kitchen Pendants (qty. 3)</strong></td>
<td>EST</td>
<td>P 38</td>
<td>5</td>
<td>35</td>
<td>0.53</td>
</tr>
<tr>
<td><strong>Exterior</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardwired LED Deck Lights (3 sets of 8)</td>
<td>Hampton Bay</td>
<td>667 347</td>
<td>10</td>
<td>35</td>
<td>1.05</td>
</tr>
<tr>
<td>Hard Wired Door Lights (qty. 7)</td>
<td>Possini</td>
<td>R7825</td>
<td>35</td>
<td>35</td>
<td>8.56</td>
</tr>
</tbody>
</table>

**TOTAL ENEGY:** 32.5 kWh

**Energy Budget and Results**

Radiant House’s 28 panel array is rated at a peak of 7.14 kW. Referencing historical data for Irvine, CA, and PV Watts Calculator Version 2, the average insolation during the month of October is 5.23 kWh/m²/day. Combined with the 24° angle of the roof and a de-rate factor of 0.82, we estimate about 281 kWh of energy will be produced by the solar array during the length of the competition, averaging to about 28.1 kWh per day. We plan to consume an average of 16.7 kWh energy per day, which is well under our projected production.
Over the course of a year in Irvine, CA, Radiant House’s solar array is projected to produce 10,979 kWh. Based upon a utility energy cost of $0.13/kWh provided by Southern California Edison, Radiant House produces approximately $1,647 worth of usable household energy per year. With an estimated installation cost of $18,000 for the solar system, the homeowner will see a return on investment in 11 years.

Below is a breakdown of projected energy consumption by various appliances and equipment during the competition.

Table 7: Appliance and Equipment Energy Consumption for Contest Week

<table>
<thead>
<tr>
<th>Appliance</th>
<th>kW/hour or kW/cycle</th>
<th>Hours Used/Total Cycles</th>
<th>Total Energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction Stove</td>
<td>2.80</td>
<td>6</td>
<td>28.20</td>
</tr>
<tr>
<td>Oven</td>
<td>2.00</td>
<td>4</td>
<td>8.00</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>1.30</td>
<td>5</td>
<td>6.50</td>
</tr>
<tr>
<td>Fridge/Freezer</td>
<td>0.02</td>
<td>203</td>
<td>3.95</td>
</tr>
<tr>
<td>Clothes Washer</td>
<td>0.24</td>
<td>8</td>
<td>1.94</td>
</tr>
<tr>
<td>Clothes Dryer</td>
<td>2.00</td>
<td>8</td>
<td>16.00</td>
</tr>
<tr>
<td>Entertainment (TV, DVD, Surround Sound)</td>
<td>0.07</td>
<td>100</td>
<td>7.00</td>
</tr>
<tr>
<td>Computer</td>
<td>0.11</td>
<td>34</td>
<td>3.74</td>
</tr>
<tr>
<td>Lighting</td>
<td>-</td>
<td>35</td>
<td>32.50</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>-</td>
<td>-</td>
<td>15.75</td>
</tr>
<tr>
<td>Hot Water Tank</td>
<td>-</td>
<td>-</td>
<td>5.80</td>
</tr>
<tr>
<td>Pressure Pump</td>
<td>0.90</td>
<td>10</td>
<td>9.00</td>
</tr>
<tr>
<td>Dehumidifier</td>
<td>0.29</td>
<td>23</td>
<td>6.67</td>
</tr>
<tr>
<td>ERV</td>
<td>0.10</td>
<td>23</td>
<td>2.30</td>
</tr>
<tr>
<td>Solar Thermal Pump</td>
<td>0.05</td>
<td>80</td>
<td>4.00</td>
</tr>
<tr>
<td>Other Mechanical Equipment (Mixing Valve, PCM Tank, Recirculation Pump)</td>
<td>-</td>
<td>-</td>
<td>7.61</td>
</tr>
</tbody>
</table>

Total Energy Use during Competition: **167 kWh**
Average Energy Use per Day: **16.7 kWh**
Figure 4: Projected appliance and equipment energy consumption during the competition.

Table 8: Annual Radiant House solar energy production for Irvine, CA (Data provided by PV Watts Calculator Version 2 with a tilt angle 24 degrees and de-rate factor of 0.82).

<table>
<thead>
<tr>
<th>Month</th>
<th>Solar Radiation (kWh/m²/day)</th>
<th>AC Energy (kWh)</th>
<th>Energy Value ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>4.08</td>
<td>692</td>
<td>103.84</td>
</tr>
<tr>
<td>February</td>
<td>4.75</td>
<td>735</td>
<td>110.23</td>
</tr>
<tr>
<td>March</td>
<td>5.42</td>
<td>918</td>
<td>137.66</td>
</tr>
<tr>
<td>April</td>
<td>6.31</td>
<td>1,022</td>
<td>153.36</td>
</tr>
<tr>
<td>May</td>
<td>6.41</td>
<td>1,064</td>
<td>159.60</td>
</tr>
<tr>
<td>June</td>
<td>6.45</td>
<td>1,037</td>
<td>155.62</td>
</tr>
<tr>
<td>July</td>
<td>6.99</td>
<td>1,142</td>
<td>171.29</td>
</tr>
<tr>
<td>August</td>
<td>6.97</td>
<td>1,125</td>
<td>168.70</td>
</tr>
<tr>
<td>September</td>
<td>6.14</td>
<td>973</td>
<td>145.99</td>
</tr>
<tr>
<td>October</td>
<td>5.23</td>
<td>871</td>
<td>130.69</td>
</tr>
<tr>
<td>November</td>
<td>4.46</td>
<td>730</td>
<td>109.53</td>
</tr>
<tr>
<td>December</td>
<td>3.96</td>
<td>669</td>
<td>100.42</td>
</tr>
<tr>
<td><strong>Annual</strong></td>
<td><strong>5.60</strong></td>
<td><strong>10,979</strong></td>
<td><strong>$1,647</strong></td>
</tr>
</tbody>
</table>
Summary of Unlisted Electrical Components
Summary of Unlisted Electrical Components

Electric Clothes Dryer Modification

The clothes dryer for Radiant House will be modified through the inclusion of a simple cross flow heat exchanger inside the dryer housing and below the drum. Hot exhaust air is channeled through the tubes of a compact heat exchanger on the way to the vent. The ambient air is drawn over the heated tubes before passing over the heating coils on the way to the dryer drum. Through this simple process of pre-heating the incoming air, we have found that the energy needed to dry a set of six towels can be reduced by about 10-20%. We have also begun studies in which dryer air is drawn from ducting underneath the solar panels, which has an even higher energy savings potential.

Design of the compact heat exchanger was accomplished so that the net air flow through the dryer was minimally affected. Studies have shown that reduced airflow (commonly due to clogged lint screens) is the leading cause of dryer fires. No other potential risk factors are anticipated with this design innovation.

Figure 5: Prototype heat exchanger unit (HEX)
Summary of Reconfigurable Features
Summary of Reconfigurable Features

Radiant House does not currently include reconfigurable features.
Interconnection Application Form

Lot #118

Table 7: PV Systems

<table>
<thead>
<tr>
<th>Module Manufacturer</th>
<th>Short Description of Array</th>
<th>DC Rating of Array</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosch c-Si M 60 NA 30119</td>
<td>We will have 4 parallel strings. Each string will have 7 panels in series. Each string will have three Tigo MM-2ES units and one Tigo MM-ES unit to prevent module mismatch and increase panel efficiency.</td>
<td>28 panels rated at 255 Watts each 7.14 kW</td>
</tr>
</tbody>
</table>

Total DC power of all arrays is **7.14 kW**.

Table 8: Inverters

<table>
<thead>
<tr>
<th>Inverter Manufacturer</th>
<th>Model Number</th>
<th>Max DC Voltage</th>
<th>Max DC Power</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunny Boy</td>
<td>8000TL - US</td>
<td>600 V</td>
<td>8.3 kW</td>
<td>1</td>
</tr>
</tbody>
</table>

Total AC power of all inverters is **8 kW**.

Notes:

- One-Line Electrical diagram can be found on E-611 of the drawing set.
- Calculations of service/feeder net computer load and neutral load are described in the chart on the following page.
- A plan view of the lot showing the house, decks, ramps, tour paths, and terminal box can be found on G-103 of the drawing set.

Contacts:

Santa Clara’s Electrical Engineer is Margaret Jones. Her contact information can be found in the Team Officer Contact Information database on the Solar Decathlon Yahoo Group.
## Quantity Take-off

<table>
<thead>
<tr>
<th>System</th>
<th>Element</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Foundation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seismic pier</td>
<td>7&quot;</td>
<td>3</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11&quot;</td>
<td>9</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td>Standard pier</td>
<td>6&quot;</td>
<td>4</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8&quot;</td>
<td>5</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10&quot;</td>
<td>4</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12&quot;</td>
<td>4</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14&quot;</td>
<td>2</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16&quot;</td>
<td>3</td>
<td>Ea</td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td>Steel C-channel</td>
<td>C15x33.9</td>
<td>222</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C8x11.5</td>
<td>24</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C3x4.1 (6 posts, upper roof framing)</td>
<td>30</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td>Steel hollow structural sections (HSS)</td>
<td>HSS8x3x3/8 (9 beams)</td>
<td>105</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HSS3 1/2x3 1/2x5/16 (12 posts, vertical framing)</td>
<td>105</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td>Wide flange steel beam</td>
<td>W5x19 (lower roof framing)</td>
<td>86</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td>Steel angle</td>
<td>L8x4x1/2 (upper roof framing)</td>
<td>147</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td>Steel plate</td>
<td>PL1/4x4 (11.5&quot; length)</td>
<td>12</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PL1/4x5 (8&quot; length)</td>
<td>12</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td>Steel stud</td>
<td>1/2 o x studs; 1.5&quot; length</td>
<td>96</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 3.5&quot; length (lower roof)</td>
<td>36</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 2&quot; length (lower roof)</td>
<td>62</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 1&quot; length (lower roof)</td>
<td>19</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 3&quot; length (base)</td>
<td>40</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 3.5&quot; length (base framing)</td>
<td>69</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 2.5&quot; length (base framing)</td>
<td>69</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 1&quot; length (upper roof)</td>
<td>12</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 3.5&quot; length (upper roof)</td>
<td>12</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x studs; 2.5&quot; length (upper roof)</td>
<td>48</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td>Field bolt</td>
<td>1/2 o x M.B.; 1.5&quot; length</td>
<td>32</td>
<td>Ea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 o x M.B.; 1.5&quot; length (lower roof)</td>
<td>24</td>
<td>Ea</td>
</tr>
<tr>
<td>Item Description</td>
<td>Quantity</td>
<td>Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>----------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 o x M.B.; 1.5&quot; length (lower roof)</td>
<td>18</td>
<td>Ea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 o x M.B.; 2.5&quot; length (base framing)</td>
<td>12</td>
<td>Ea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2 o x M.B.; 1.5&quot; length (upper roof)</td>
<td>22</td>
<td>Ea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel plates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL 3/8x3 11/16; 5&quot; length (lower roof)</td>
<td>2</td>
<td>Ea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL 3/8x3 1/2; 1'-1/2&quot; length (lower roof)</td>
<td>4</td>
<td>Ea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL 3/8x3; 1'-1 15/16&quot; length (base framing)</td>
<td>15</td>
<td>Ea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL 3/8x3; 6.5&quot; length (base framing)</td>
<td>18</td>
<td>Ea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erection brace (for TRANSPORTATION ONLY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2x2x1/4 (6 braces)</td>
<td>76</td>
<td>LF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rim joist</td>
<td>2x10 lumber</td>
<td>221</td>
<td>LF</td>
<td></td>
</tr>
<tr>
<td>4x12 (roof)</td>
<td></td>
<td>82</td>
<td>LF</td>
<td></td>
</tr>
<tr>
<td>Steel beam joist</td>
<td>2x4 lumber (stacked pair)</td>
<td>256</td>
<td>LF</td>
<td></td>
</tr>
<tr>
<td>Bamboo joist</td>
<td>133&quot; each; made using: 1&quot; bamboo culms (4/joist), 1/2&quot; woven bamboo plywood webs</td>
<td>36</td>
<td>Ea</td>
<td></td>
</tr>
<tr>
<td>Joist</td>
<td>133&quot; each; TJI 1230 Trus joist</td>
<td>15</td>
<td>Ea</td>
<td></td>
</tr>
<tr>
<td>Joist hanger</td>
<td>10&quot; IUS 2.37/9.5 Simpson Strong Tie joist hanger</td>
<td>102</td>
<td>Ea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8&quot; LUS 210 Simpson Strong Tie joist hanger</td>
<td>8</td>
<td>Ea</td>
<td></td>
</tr>
<tr>
<td>Nailer</td>
<td>2x6 lumber</td>
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<td>Gold Bond 8’ x 4’ x 5/8” drywall panel; model number: GB99500800</td>
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<td>Gold Bond 8’ x 4’ x 1/2” high strength lite gypsum board; model number: GB00090800</td>
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<td><strong>Wall Finishes</strong></td>
<td>Tile wall coverings</td>
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<td>Yukon Cliff Brick 10 1/2” x 11 3/4” glass and travertine mosaic wall tile</td>
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<td><strong>Casework</strong></td>
<td>Wood casework</td>
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<td>Plyboo base shoe; model number: QRD-100PN</td>
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<td><strong>Tile flooring - Bathroom</strong></td>
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<td><strong>Exterior doors</strong></td>
<td>Masonite flush series prehung veneered flush birch door, 36x80</td>
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<td>Masonite 72x80 full lite steel patio door; SKU: 511213</td>
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<td><strong>Windows</strong></td>
<td>Picture window Milgard 920 TB PW, argon fill; 3060 rough opening</td>
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<td>Milgard 920 TB PW, argon fill; 4030 RO</td>
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<td>Milgard 920 TB PW, argon fill; 7030 RO</td>
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<td>Milgard 920 TB PW, argon fill; 2930 RO</td>
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<td>Single hung window Milgard 1520 TB SH, argon fill; 2036 RO</td>
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<td>Half vent window Milgard 1120 TB HV, argon fill; 3740 RO</td>
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<td>Milgard 1120 TB HV, argon fill; 6030 RO</td>
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<td>Full awning window Milgard 920 TV FA, argon fill; 5630 RO</td>
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<td><strong>Glass blocks</strong></td>
<td>Pittsburgh Corning premiere IceScapes glass blocks; model number: 110504; 8&quot; x 8&quot; x 4&quot;</td>
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<td>Pittsburgh Corning premiere IceScapes glass blocks; model number: 110351; 6&quot; x 8&quot; x 4&quot;</td>
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<td><strong>Sliding glass door</strong></td>
<td>Masonite sliding patio door; finished slider 143 1/2&quot; x 82 1/2; 4 panel; lowe tempered E II with Argon</td>
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<td>Roofing</td>
<td>TPO roofing</td>
<td>Carlisle 45mil TPO roofing system</td>
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<td>Parapet drain</td>
<td>Thunderbird TPO-clad inside-wall parapet drain</td>
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<td>Roof drain</td>
<td>Bottom outlet roof drain with overflow</td>
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<td>Tapered installation board</td>
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<td>Underlayment</td>
<td>Grace Ultra self-adhered roofing underlayment for high temperature applications; MFG model #: 5003000</td>
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<td>Flashing</td>
<td>JM Permaflash system</td>
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<td>Box gutter</td>
<td>Galvanized steel</td>
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</table>

**Weatherproofing**

| Weatherproofing               | Grace Ultra self-adhered underlayment for high temperature applications; MFG model #: 5003000 | 1633 | SF |

**Lighting**

<p>| Lighting                      | Interior lighting            | Energy Savings Technology, LLC, M 109 UC LED Light, M 109; part number: M 109-S-2735-60-2-012-3, length: 5’ | 1 | Ea |
|-------------------------------|------------------------------| EST M 109 UC LED Light, M 109; part number: M 109-S-2735-50-01-XX-01, length: 6’ | 1 | Ea |
|                               |                              | EST CCF-109 Connector cable; part number: CCF-109-10; length: 10’ | 1 | Ea |
|                               |                              | EST CCF-109 Connector cable; part number: CCF-109-15, length: 15’ | 1 | Ea |
|                               |                              | EST PCU UC Power supply; part number: PCU 109 100 | 1 | Ea |
|                               |                              | EST DL 2 BL 2” downlight; part number: DL 2 BL MP | 4 | Ea |
|                               |                              | EST PCU DL power supply; part number: PCU DL 100 | 1 | Ea |
|                               |                              | EST P38 pendant light; part number: DL 2 BL MP | 3 | Ea |
|                               |                              | EST PCU P38 power supply; part number: PCU P38 100 | 1 | Ea |
|                               |                              | EST DL 2 BL 2” downlight; part number: DL 2 BL MP | 6 | Ea |</p>
<table>
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<td>EST PCU DL power supply; part number: PCU DL 100</td>
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<tr>
<td>EST M 109 LED linear light; part number: M 109-S-2735-60-W-012-3, length: 5'</td>
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<td>EST M 109 LED linear light; part number: M 109-S-2735-48-W-012-3, length: 4'</td>
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<td>EST M 109 LED linear light; part number: M 109-S-2735-36-W-012-3, length: 3'</td>
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<td>EST M 109 LED linear light; part number: M 109-S-2735-24-W-012-3, length: 2'</td>
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<td>EST M 109 housing LED linear light; part number: M 109-H-60, length: 5'</td>
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<td>EST M 109 housing LED linear light; part number: M 109-H-36, length: 3'</td>
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<td>EST M 109 housing LED linear light; part number: M 109-H-24, length: 2'</td>
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<td>EST CCF 109-F-20; part number: CCF 109-F-20, length: 20'</td>
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<td>EST DL 2 BL 2&quot; downlight; part number: DL 2 BL MP</td>
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<td>NuTone 70 CFM fan/light with transparent polymeric lens and resin grille; model number: 769RLF</td>
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<td>Y Lighting zenith vanity light; item number: OXY-ZENITH-VANITY, model: 2-5142</td>
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<td>Lamps Plus matte silver up and down wall light; style number: R7830</td>
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<td>Exterior lighting</td>
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<td>Hampton Bay 12V low voltage LED 8 piece stainless steel deck light kit; model number: HD28101BS8</td>
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<td>Possini hard wired door lights; model number: R7825</td>
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<td>Lighting control devices</td>
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<td>WattStopper 0-10V fluorescent architectural dimmer; model number: ADF-120277</td>
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<td>SainSmart DC controlled relay board; model number: 20-018-102</td>
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<td>Duplex GFCI convenience receptacles; model number: S7899-GY</td>
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<td>3/4&quot; liquidtight flexible metal conduit (LFMC)</td>
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<td>3/4&quot; EMT conduit clamp</td>
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<td>3/4&quot; EMT screw clip</td>
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<td>3/4&quot; EMT screw corner</td>
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<td>Thomas &amp; Betts Carlon 1-gang 21 cubic in. adjustable electrical box; model number: B121ADJ</td>
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<td>Thomas &amp; Betts Carlon 2-gang 34 cubic in. adjustable switch and outlet box; model number: B234ADJC</td>
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<td>RACO 1-gang 6 cubic in round ceiling pan</td>
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<td>Bosch mono-crystalline photovoltaic module</td>
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<td>Sunplanter aluminum rails; 150&quot;x6&quot;</td>
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<td>Motors</td>
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<tr>
<td>Autoslide motor system for sliding door, SlideRight AS011</td>
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<td>Somfy Sonesse 30 shade stepper motor for window blinds</td>
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<td>Marvel power window system; model number: 4290</td>
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<td>Rollertrol tubular motor; reference number: TMDC-12-25-15-28-NR</td>
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<tr>
<td>Solar radiation sensor</td>
<td>Davis instruments 6450 solar radiation sensor; SKU: 6450</td>
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<td>Weather station</td>
<td>Campbell Scientific RM Young wind sentry set; model number: 03002</td>
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<tr>
<td>Temperature and humidity sensor</td>
<td>Viasala HMP60 humidity and temperature probe for volume applications</td>
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<tr>
<td>Cabling</td>
<td>Jameco jacketed, braided Cat 5e ethernet cable; manufacturer number: 10X5-804TH-100VP</td>
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<tr>
<td></td>
<td>Jameco wire hook-up solid 22 AWG; black, red</td>
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<td>C2G Cat5 modular plug for round stranded cable</td>
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<td>Southwire 22-4 CL3R shielded security cable; model number: 56910544</td>
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<td>Ray Magic blank filler panel, part number: RM1623; 4’x8’x2’</td>
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<td>PureTemp phase change material; PureTemp53</td>
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<td>SHEM32 differential controller</td>
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<td>Stainless rectangle 316/316L annealed; .5&quot;x1&quot;</td>
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<td>Cold finish stainless round 316/316L; .3125&quot;</td>
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<td>Flat nylon washers; FW0283A</td>
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<td>Free Hot Water 4x10 flat collector, 8000 series; item code: FHWFC1005</td>
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<td>Genova products 2&quot; schedule 40 ABS</td>
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<td></td>
<td>2&quot; PEX</td>
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<tr>
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<td>Oatey 2&quot; WMOB Quadtro box with 1/4 turn brass hammer ball valves, copper sweat standard pack</td>
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<td>Oatey plastic icemaker box with 1/4 turn low lead brass hammer valve, copper sweat standard pack</td>
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<td>Badger E-series water meter; 5/8&quot; (ESM-T-01)</td>
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<tr>
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<td>Nibco 6-port manifold; MSC part #: 75924340, manufacturer number: PX01120; inlet size: 3/4&quot;,&quot; outlet size: 1/2&quot;</td>
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<td><strong>Heat pump</strong></td>
<td>Daikin Altherma split type heat pump, outdoor unit; model number: ERLQ018BAVJU</td>
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<td>Loomis Tank custom fabricated potable-water 1500 gallon storage tank; model number: LNW1500W</td>
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<td>Polyethylene greywater tank; 500 gal</td>
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<td>Daikin domestic hot water tank; model number: EKHWS050BA3VJU</td>
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<tr>
<td>Plumbing fixtures</td>
<td>Toilet tissue holder Kohler Purist horizontal toilet tissue holder; model number: K-14377-CP</td>
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<td>Grab bar Kohler Purist 32&quot; grab bar; model number: K-11894-S</td>
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<td>Kohler Lawnfield ; top-mount, single bowl sink; model number: K-5832</td>
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<td>Kohler Simplice pull-down kitchen sink faucet; model number: K-596</td>
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<td>Escale bathroom sink overflow cap; model number: K-4061-CP</td>
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<td>3/8&quot; NPT angle supplies with stop, cross handle, and annealed vertical tube; model number: K-7605-P-CP</td>
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<td>Kohler bathroom sink grid drain with overflow; model number: K-7129-A-CP</td>
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<td>Kohler duostrainer manual sink strainer with tailpiece; model number: K-8801-VS</td>
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<td>tall single-hold bathroom sink faucet with straight lever handle; model number: K-14404-4A-CP</td>
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<td>Kohler Maax Evidence walk-in enclosure, right; model number: 137346-900-084-002</td>
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<td>Kohler Maax Evidence wood drip-tray accessory</td>
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<td>Kohler Forte Essentials performance shower package; model number: K-10827-4-CP</td>
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12 36 40  Stone Countertops

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21 10 00  Water-Based Fire Suppression Systems
21 30 00  Fire Pumps

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<td>Water Pumps</td>
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<td>22 12 00</td>
<td>Facility Potable-Water Storage Tanks</td>
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<td>22 13 00</td>
<td>Facility Sanitary Sewage and Vent Piping</td>
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<td>22 13 53</td>
<td>Facility Greywater Tanks</td>
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<td>22 41 16</td>
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<td>Residential Showers</td>
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<td>22 41 39</td>
<td>Residential Faucets, Supplies, and Trim</td>
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<td>22 80 08</td>
<td>Domestic Hot Water</td>
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<td>22 81 81</td>
<td>Phase Change Material</td>
</tr>
</tbody>
</table>

**Division 23** Heating, Ventilating, & Air Conditioning (HVAC)

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<thead>
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<th>Code</th>
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<td>Sensors and Transmitters</td>
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<td>23 23 23</td>
<td>Refrigerant</td>
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<td>HVAC Ducts and Casings</td>
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<td>23 37 13</td>
<td>Diffusers, Registers, and Grilles</td>
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<td>23 56 13</td>
<td>Solar Thermal Collectors</td>
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<td>23 72 15</td>
<td>Heat Recovery Ventilator (HRV)</td>
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<td>23 83 16</td>
<td>Radiant-Heating Hydronic Piping</td>
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<td>23 83 33</td>
<td>Air to Water Heat Pump</td>
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<td>23 84 16</td>
<td>Dehumidifier</td>
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**Division 25** Integrated Automation

<table>
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<th>Code</th>
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<tr>
<td>25 13 10</td>
<td>Integrated Automation Control &amp; Monitoring Network Cabling</td>
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<td>25 13 20</td>
<td>Integrated Automation Control &amp; Monitoring Network</td>
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**Division 26** Electrical

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>26 05 19</td>
<td>Low-Voltage Power Connectors &amp; Conductors</td>
</tr>
<tr>
<td>26 05 20</td>
<td>Controls Wiring</td>
</tr>
<tr>
<td>26 05 26</td>
<td>Grounding and Bonding for Electrical Systems</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------</td>
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<tr>
<td>26 05 33</td>
<td>Raceway and Boxes for Electrical Systems</td>
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<td>26 05 83</td>
<td>Wiring Connections</td>
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<td>26 09 23</td>
<td>Lighting Control Devices</td>
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<td>26 24 16</td>
<td>Panelboards</td>
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<td>26 27 13</td>
<td>Electricity Metering</td>
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<td>26 27 26</td>
<td>Wiring Devices</td>
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<td>26 28 16</td>
<td>Enclosed Switches and Circuit Breakers</td>
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<td>26 31 00</td>
<td>Photovoltaic Collectors</td>
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<tr>
<td>26 32 13</td>
<td>Engine Generators</td>
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<td>26 33 13</td>
<td>Batteries</td>
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<td>26 50 00</td>
<td>Lighting</td>
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<tr>
<td>26 50 01</td>
<td>Bathroom Exhaust Fan and Light</td>
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</table>

**Division 32** Exterior Improvements

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>32 93 00</td>
<td>Plants</td>
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</table>

**Division 41** Exterior Improvements

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>41 20 00</td>
<td>Crane and Hoists</td>
</tr>
<tr>
<td>41 23 23</td>
<td>Boom Lift</td>
</tr>
<tr>
<td>41 62 23</td>
<td>Fork Lifts</td>
</tr>
</tbody>
</table>

**Division 48** Electrical Power Generation

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>48 19 16</td>
<td>Electrical Power Generation Inverters</td>
</tr>
</tbody>
</table>
SECTION 00 31 00
Available Project Information

PART 1 – GENERAL

1.1 PRELIMINARY PHASE SCHEDULE

A. Schematic Design Phase January 2012 – April 2012
B. Design Development Phase May 2012 – October 2012
C. Construction Documents Phase October 2012 – February 2013
D. Construction Phase January 2013 – June 2013
E. System and Building Testing Phase June 2013 – August 2013
F. Competition Phase September 22, 2013 – October 18, 2013

1.2 PROJECT BUDGET INFORMATION

A. Construction Budget: $340,000.00
B. Total Project Budget: $950,000.00

1.3 CONSTRUCTION FACILITY

A. The SCU Solar Decathlon 2013 House will be constructed in a contained area provided by Santa Clara University
   1. 500 El Camino Real
      Santa Clara, CA 95053

END OF SECTION 00 31 00
PART 2 - GENERAL

1.1 PROJECT INFORMATION

B. Project Location: Santa Clara University
   500 El Camino Real
   Santa Clara, CA 95053
C. Owner: Santa Clara University
D. Architect: The Santa Clara University Solar Decathlon Team
E. Project Manager: Jake Gallau
   (408) 806-9392
   jgallau@gmail.com
F. Project description: Radiant House is the Santa Clara University entry for the 2013 Solar Decathlon. Utilizing highly efficient materials and technologies, cutting-edge photovoltaics, and fully integrated control systems, Radiant House will blend elegance, efficiency, and economy in a truly revolutionary way.
G. Mission: The vision of Santa Clara’s Radiant House is a vision of a brighter future, a future of energy independence and environmental integrity. Our goal is to expand and enable the accessibility of solar energy, demonstrating that a sustainable lifestyle is not something that must wait until the future, but is something that can be achieved today. As a team, Santa Clara combines the expertise of undergraduate students from a variety of disciplines to bring an original perspective not only to the quantitative building elements, but also the qualitative relations of space and utility. Incorporating the three E’s of our philosophy – Efficiency, Economy, and Elegance – we have created a home that strikes a balance between comfort, aesthetics, and technological innovation. It is
because of our commitment to the Jesuit values of competence, conscience, and compassion that we have built an extensive outreach program and have conducted thorough ethical examinations of each team decision. Together, these elements represent more than just a house; they define a vision for a greener and healthier tomorrow, available and amenable to everyone.

END OF SECTION 01 10 00
PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the steel structure, foundations, and framing

1.2 SECTION REQUIREMENTS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. SOS Steel Co.

1160 Richard Ave
Santa Clara, CA 95050
Phone: 408.727.6363
Website: www.sossteelco.com

B. Central Piers Inc.

284 North Thorne Ave
Fresno, CA 93706
Phone: 1.800.653.0387
Website: www.centralpiers.com

2.2 PRODUCTS

A. SOS steel C-channels

1. Types:
   a. C15x33.9
   b. C8x11.5
   c. C3x4.1

B. SOS steel hollow structural sections
1. Types:
   a. HSS8x3x3/8
   b. HSS3 1/2x3 1/2x5/16

C. SOS steel wide flange steel beams
   1. Types:
      a. W5x19

D. SOS steel angles
   1. Types:
      a. L8x4x1/2

E. SOS steel plates
   1. Types:
      a. PL1/4x4, 11.5”
      b. PL1/4x5, 8”
      c. PL3/8x3 11/16, 5”
      d. PL3/8x3 1/2, 1’-1/2”
      e. PL3/8x3, 1’-1 15/16”
      f. PL3/8x3, 6.5”

F. Central Pier seismic pier
   1. Model number: SPA 30-5F
   2. Heights:
      a. 7”
      b. 11”
   3. See manufacturer’s specifications for further information:
      http://www.centralpiers.com/piers.html

G. Central Pier standard pier
   1. Heights:
a. 6"
b. 8"
c. 10"
d. 12"
e. 14"
f. 16"

2. See manufacturer's specifications for further information:
   http://www.centralpiers.com/piers.html

PART 3 - INSTALLATION

3.1 INSTALLATION

   A. Install according to manufacturer’s instructions

   END OF SECTION 05 21 00
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes metal railings

1.2 SUBMITT07ALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Heinzen Manufacturing International (HMI)
   405 Mayock St.
   Gilroy, CA 95020
   Phone: 408.842.7233
   Website: www.heinzen.com

2.2 Products

A. Powder Coated Steel Posts

B. Stainless Steel Tube Railing

2.3 FABRICATION

A. Assemble railing systems in shop to the greatest extent possible

B. Use connections that maintain structural value of joined pieces

C. Form changes in direction of railing members by use of prefabricated fittings

D. Fabricate railing systems and handrails for connecting members with concealed mechanical fasteners and fittings

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fit exposed connections accurately together to form tight, hairline joints
B. Set railings accurately in location, alignment, and elevation and free of rack

C. Coat concealed surfaces of aluminum that will be in contact with cementations materials or dissimilar metals, with a heavy coat of bituminous paint

D. Anchor posts to structural base and blocking of the exterior wood deck

END OF SECTION 05 52 00
PART 1 – GENERAL

1.1 SUMMARY

A. Tiger Deck to be used for wood patio decking

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Tiger Deck

31244 N Spirit Dr.
Spirit Lake, ID
Phone: 503.625.1747
Website: http://www.tigerdeck.com/

2.2 PRODUCTS

A. Tiger Deck

1. Location: Outside Patio and Decking

2. Nominal Size: 1” X 6”

3. See manufacturer’s specifications for further information:

http://www.tigerdeck.com/technical-data/

PART 3 – EXECUTION

3.1 INSTALLATION

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted

B. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction
C. Framing Standard: Comply with AF&PA’s “Details for Conventional Wood Frame Construction” unless otherwise indicated

D. Securely attach work to substrates, complying with the following:
   1. CABO NER-272 for power-driven fasteners
   2. Published requirements of metal framing anchor manufacturer
   3. Tiger Deck resurfacing guide on their website

E. Secure decking to framing with concealed decking fasteners or secure paver grid to the deck surface with approved fasteners

F. Secure stair treads and risers by gluing and nailing screwing to carriages

G. Countersink fastener heads, fill flush, and sand filler

H. Extend treads over carriages and finish with bullnose edge

END OF SECTION 06 15 33
SECTION 06 16 00
Sheathing

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the sheathing of Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Pinecone Lumber

895 E Evelyn Ave.
Sunnyvale, CA 94086
Phone: 408.736.5491
Website: http://www.pineconelumber.com/

2.2 PRODUCTS

A. Wood Panel Products, General

1. Plywood: DOC PS 1.

2. See manufacturer’s specifications for further information:

   http://www.pineconelumber.com/

B. Treated Plywood


2. Use treatment containing no arsenic or chromium

3. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

C. Wall Sheathing

1. Structural 1 Plywood Wall Sheathing

2. Thickness: 15/32" Structural 1
3. See manufacturer’s specifications for further information:

http://www.pineconelumber.com/

D. Roof Sheathing

1. Plywood Roof Sheathing: Structural Sheathing
2. Thickness: 3/4” Tongue and Groove
3. See manufacturer’s specifications for further information:

http://www.pineconelumber.com/

E. Subflooring and Underlayment

1. Plywood Floor Sheathing: Structural Sheathing
2. Thickness: 3/4” Tongue and Groove and 5/8” Tongue and Groove
3. See manufacturer’s specifications for further information:

http://www.pineconelumber.com/

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasteners


B. Fastening Methods:

1. Wall, Floor and Roof Sheathing:

   a. Nail to wood framing

C. Install products in accordance with manufacturer’s recommendations

END OF SECTION 06 16 00
SECTION 07 21 29

Insulation

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes specifications for the polyurethane spray foam insulation

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Rhino Linings

9151 Rehco Road
San Diego, CA 92121
Phone: 858.450.0441
Website: http://www.rhinolinings.com/home

B. Owens Corning

1 Owens Corning Pkwy
Toledo, OH 43659
Phone: 419.248.8000
Website: http://www.owenscorning.com/

C. ICYNENE

6747 Campobello Road
Mississauga, ON
L5N 2L7 Canada
Phone: 1.800.758.7325
Website: http://www.icynene.com/
2.2 PRODUCT

A. DuraTite 2.0 Closed-Cell Spray Foam Insulation
   1. R-value of 6.3 per inch
   2. 3% bio-based content
   3. 3% pre-consumer recycled content
   4. See manufacturer’s specifications for further information:
      http://rhinoliningsindustrial.com/products/spray_polyurethane_foams/duratite%E2%84%A2_2.0/48/233

B. R-13 EcoTouch PINK FIBERGLAS Insulation with PureFiber Technology
   1. R-value of 13 per 3 1/2”
   2. 99% natural ingredients
   3. 58% total recycled content
   4. See manufacturer’s specifications for further information:

C. ICYNENE LD-R-50 Open Cell Spray Foam Insulation
   1. R-value of 3.7 per inch
   2. Made with environmentally friendly and renewable castor oil
   3. See manufacturer’s specifications for further information:

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, under which work is to be performed

B. Do NOT proceed until unsatisfactory conditions have been corrected
1. Review placement area to determine final location will not be within 3 inches of any heat source where the temperature will exceed 180 degrees °F per ASTM C 411 or in accordance with authorities having jurisdiction

3.2 PREPARATION

A. Clean substrates and cavities of loose materials capable of interfering with placement

3.3 APPLICATION

A. Site Mix liquid components supplied by Icyene and installed by Independent Icyene Licensed Dealer

B. Apply insulation to substrates in compliance with manufacturer’s written instructions

C. Apply insulation to produce thickness require for indicated R Value

D. Extend insulation thickness indicated to envelop entire area to be insulated

E. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is places on warm side of insulation encapsulates piping

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes

B. Provide temporary coverings where insulation is subject to abuse

END OF SECTION 07 21 29
PART 1 – GENERAL

1.3 SUMMARY

A. This section includes specifications on metal wall panels

1.4 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. Metal Sales U.S.

545 South 3rd Street, Suite 200
Louisville, KY 40202
Phone: 1.800.406.7387
Website: http://www.metasales.us.com/home/

2.2 PRODUCTS

A. 24 Gauge Steel Soffit Panel

1. Dimensions: 12"

2. Location: Exterior Siding

3. See manufacturer’s specifications for further information:

   http://www.metasales.us.com/panel/soffit-panel/

PART 3 – EXECUTION

3.2 INSTALLATION

A. Install siding according to manufacturer’s instructions.

END OF SECTION 07 42 13
SECTION 07 53 23

Thermoplastic Roofing Membrane (TPO)

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes TPO Roofing

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Distributed by:
   
   Alliance Roofing
   
   1250 Campbell Ave.
   
   San Jose, CA 95126
   
   Phone: 408.261.2595
   
   Website: http://www.allianceroofingcal.com/

2.2 PRODUCTS

A. Thermoplastic Roofing Membrane (TPO)

1. Test Method: ASTM D4637

2. Type: Type I

3. Reinforcement: Non-reinforced

4. Thickness: 45 mils (1.1 mm)

5. See Manufacturer’s Specifications for Further Information:

   me=starringworldlw.en.alibaba.com

PART 3 – EXECUTION
3.1 INSTALLATION

A. Install EPDM sheet according to roofing system manufacturer's instructions

B. Seams: Clean splices and prime splices areas for applying splice tape; firmly roll side and end laps of overlapping sheets

C. Seal exposed edges of sheet terminations

D. Install sheet flashings and preformed flashing accessories and adhere to substrates

E. Apply coatings to membrane roofing or base flashings according to manufacturer's written recommendations

END OF SECTION 07 53 23
SECTION 07 62 00
Sheet Metal Flashing and Trim

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes sheet metal flashing and trim

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. Metal Sales U.S.

545 South 3rd Street, Suite 200
Louisville, KY 40202
Phone: 1.800.406.7387
Website: http://www.metalsales.us.com/home/

2.2 PRODUCTS

A. 24 Gauge Steel Flashing and Trim

1. Location: Exterior Siding

2. See manufacturer’s specifications for further information:

   http://www.metalsales.us.com/panel/soffit-panel/

B. Aluminum Roof Flashing

1. Material: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, not less than 0.032 inch (0.8 mm) thick

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install around exterior joints and seems according to manufacturer’s specifications

END OF SECTION 07 62 00
SECTION 07 72 00

Roof Accessories

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes roof accessories

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Thunderbird Products

   1148 North Marshall Avenue

   El Cajon, CA 92020

   Phone: 619.448.3567

   Website: www.thunderbirdproducts.com

2.2 PRODUCTS

A. TPO-clad inside-wall parapet drain

   1. Model number: TPO-PDND2NH

   2. Location: roof

   3. Dimensions: 12” x 7” x 5”

   4. Features:

      a. Includes aluminum dome strainer

   5. See manufacturer’s specifications for further information:


B. Bottom outlet roof drain with overflow

   1. Model number: RDCB2TA

   2. Location: roof
3. Features:
   a. 2” male thread drain and overflow
   b. Heavy duty ABS Cycolac dome strainer
   c. 20 oz. seamless copper basin

4. See manufacturer’s specifications for further information:

C. Thermoplastic membrane roof drain

D. Tapered installation board

   1. Features:
      a. Two degree incline

PART 3 – EXECUTION

3.1 INSTALLATION

   A. Install according to manufacturer’s instructions

   END OF SECTION 07 72 00
SECTION 08 13 20
Exterior Metal Doors

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes all metal exterior doors for Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Masonite Co

1 North Dale Mabry Hwy
Suite 950
Tampa, FL 33809
Phone: 1.800.895.2723
Website: www.masonite.com

1. Available at Home Depot

2435 Lafayette St.
Santa Clara, CA 95050
Phone: 408.492.9600

2.2 PRODUCT

A. Masonite 72" x 80" Full Lite Steel Patio Door

1. SKU: 511213

2. Rough Opening: 72" x 80"

3. Finished Door: 71.25" x 78.25"

4. Material: Painted steel
5. Type: prehung outswing French door

6. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/202888039

2.3 ACCESSORIES

   A. Door hardware

PART 3 – EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s recommendations

   END OF SECTION 08 13 20
SECTION 08 13 21
Exterior Fiberglass Doors

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes all fiberglass exterior doors for Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Masonite Co

1 North Dale Mabry Hwy
Suite 950
Tampa, FL 33809
Phone: 1.800.895.2723
Website: www.masonite.com

1. Available at Home Depot

2435 Lafayette St.
Santa Clara, CA 95050
Phone: 408.492.9600

2.2 PRODUCT

A. Masonite 36" x 80" Full Lite Entry Door

1. SKU: 476575

2. Location: South patio

3. Rough Opening: 37.5" x 81.5"

4. Finished Door: 36" x 80"
5. Material: Belleville Smooth Fiberglass

6. Type: Prehung, outswing, entry door with Full Lite clear glass rectangle

7. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/Masonite-Full-Lite-Primed-Smooth-Fiberglass-Entry-Door-with-Brickmold-46248/202896282#.Ug0RvVdAeUI

B. Masonite 36” x 80” Full Lite Entry Door

1. SKU: 476575

2. Location: Exterior bedroom

3. Rough Opening: 37.5” x 81.5”

4. Finished Door: 36” x 80”

5. Material: Belleville Smooth Fiberglass

6. Type: Prehung, outswing entry door with 1/2 Lite clear glass rectangle and 1 panel

7. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/Masonite-Vent-Lite-Primed-Smooth-Fiberglass-Entry-Door-with-No-Brickmold-27277/202518481#.Ug0ScVdAeUI

C. Masonite 36” x 80” Full Lite Entry Door

1. SKU: 476575

2. Location: Front entrance

3. Rough Opening: 37.5” x 81.5”

4. Finished Door: 36” x 80”

5. Material: Belleville Smooth Fiberglass

6. Type: Prehung, inswing entry door with 1/2 Lite clear glass rectangle and 1 panel

7. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/Masonite-Vent-Lite-Primed-Smooth-Fiberglass-Entry-Door-with-No-Brickmold-27277/202518481#.Ug0ScVdAeUI

2.3 ACCESSORIES
A. Door hardware

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendations

END OF SECTION 08 13 21
SECTION 08 13 73
Sliding Metal Doors

PART 1 - GENERAL

1.1 SUMMARY
   A. This section includes the sliding glass doors used in the Radiant House

1.2 SUBMITTALS
   A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Masonite Co
       1 North Dale Mabry Hwy
       Suite 950
       Tampa, FL 33809
       Phone: 1.800.895.2723
       Website: www.masonite.com

2.2 PRODUCTS
   A. Sliding Patio Door
       1. Finished Slider: 143 1/2" X 82 1/2"
       2. Lowe tempered E II with Argon

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in accordance with manufacturer’s instructions

END OF SECTION 08 13 73
SECTION 08 14 16
Interior Wood Doors

PART 1 – GENERAL

1.1 SUMMARY
   A. This section includes all wood doors for interior spaces of Radiant House

1.2 SUBMITTALS
   A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS
   A. Masonite Co
      1 North Dale Mabry Hwy
      Suite 950
      Tampa, FL 33809
      Phone: (800) 895-2723
      Website: www.masonite.com
      1. Available at Home Depot
         2435 Lafayette St.
         Santa Clara, CA 95050
         Phone: 408.492.9600

2.2 PRODUCT
   A. Masonite Flush Series Prehung Veneered Flush Birch Door
      1. Location: Bedroom
      2. Rough Opening: 37.5” x 81.69”
      3. Finished Door: 36” x 80”
      4. Thickness: 1-3/8”
5. See manufacturer’s specifications for further information:

http://www.homedepot.com/p/Masonite-Smooth-Flush-Hardwood-Hollow-Core-Birch-Veneer-Composite-Prehung-Interior-Door-17729/202872493#.Ug0JMVdAeUJ

2.3 ACCESSORIES

A. Door hardware

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendations

END OF SECTION 08 14 16
SECTION 08 14 17
Interior Wood Pocket Doors

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes all wood pocket doors for interior spaces of Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Masonite Co

1 North Dale Mabry Hwy
Suite 950
Tampa, FL 33809
Phone: 1.800.895.2723
Website: [www.masonite.com](http://www.masonite.com)

1. Available at Home Depot

2435 Lafayette St.
Santa Clara, CA 95050
Phone: (408) 492-9600

2.2 PRODUCT

A. Masonite Flush Series Veneered Flush Birch Pocket Door

1. Location: Bathroom and Closet

2. Rough Opening: 37.5" x 81.69"

3. Finished Door: 36" x 80"

4. Thickness: 1-3/8"
5. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/Masonite-Smooth-Flush-Hardwood-Hollow-Core-
   Birch-Veneer-Composite-Prehung-Interior-Door-
   17729/202872493#.Ug0JMVeAeUJ

2.3 ACCESSORIES

   A. Door hardware

PART 3 – EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s recommendations

   END OF SECTION 08 14 17
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the windows and window accessories used in the Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Milgard

1010 54th Ave East
Tacoma, WA 98424
Phone: 1.800.645.4273
Website: www.milgard.com

B. Pittsburgh Corning

800 Presque Isle Dr.
Pittsburgh, PA 15239
Phone: 724.327.6100
Website: www.pittsburghcorning.com

2.2 PRODUCTS

A. Milgard Picture Windows

1. Model: 920 TB PW

2. Glass O/Is:
   a. TX/2C
   b. M2/C2

3. Rough opening dimensions:
a. 3060  
b. 4030  
c. 7030  
d. 2930  

4. Features:  
   a. 1/8 Sun coat Max  
   b. 1/8 clear temp  
   c. Fill: Argon  
   d. See manufacturer’s specifications for further information: 
      

B. Milgard Single-hung Window  
   1. Model: 1520 TB SH  
   2. Glass O/I: TX/2C  
   3. Rough opening dimension: 2036  
   4. Features:  
      a. 1/8 Sun coat Max  
      b. 1/8 clear temp  
      c. Horizontal set: 21  
      d. Fill: Argon  
      e. See manufacturer’s specifications for further information: 
         

C. Milgard Half Vent Windows  
   1. Model: 1120 TB HV
2. Glass O/Is:
   a. TX/2C
   b. M2/C2

3. Rough opening dimensions:
   a. 3740
   b. 6030
   c. 4040
   d. 3020
   e. 6040

4. Features:
   a. 1/8 Sun coat Max
   b. 1/8 clear temp
   c. Fill: Argon
   d. See manufacturer’s specifications for further information:

D. Milgard Full Awning Window
   1. Model: 920 TV FA
   2. Glass O/I: M2/C2
   3. Rough opening dimension: 5630
   4. Features:
      a. 1/8 Sun coat Max
      b. 1/8 clear temp
      c. Fill: Argon
d. See manufacturer’s specifications for further information:


E. Pittsburgh Corning Premiere IceScapes Glass Blocks

1. Model number: 110504
2. R-value: 1.96
3. Material: glass
4. Dimensions: 8” x 8” x 4”
5. See distributor’s specifications for further information:

http://www.homedepot.com/p/Pittsburgh-Corning-Premiere-8-in-x-8-in-x-4-in-IceScapes-Glass-Blocks-8-Pack-110504/100540309#.Ug0dZ8rgpqM

F. Pittsburgh Corning Premiere Decora Glass Blocks

1. Model number: 110351
2. R-value: 1.96
3. Material: glass
4. Dimensions: 6” x 8” x 4”
5. See distributor’s specifications for further information:

http://www.homedepot.com/p/Pittsburgh-Corning-Premiere-6-in-x-8-in-x-4-in-Decora-Glass-Block-9-Pack-110351/100268806#.Ug0e7MrgpqM

G. Pittsburgh Corning Glass-Block Expansion Strips

1. Model number: 120951
2. Material: plastic foam
3. See distributor’s specifications for further information:

http://www.homedepot.com/p/Pittsburgh-Corning-Glass-Block-Expansion-Strips-12-Pack-
H. Pittsburgh Corning ProVantage Vertical Spacer
   1. Model number: 104004
   2. See distributor’s specifications for further information:
      http://www.homedepot.com/p/Pittsburgh-Corning-ProVantage-Vertical-Spacer-10-Pack-
      104004/100538687?keyword=Zoom+Videos+Pittsburgh+Corning+ProVantage+Vertical+Spacer#.
      Ug0dkMrgpqM

I. Pittsburgh Corning ProVantage 15lb. Grout Mix
   1. Model number: 114006
   2. See distributor’s specifications for further information:
      http://www.homedepot.com/p/Pittsburgh-Corning-ProVantage-15-lb-Grout-Mix-
      114006/100542568?keyword=Pittsburgh+Corning+ProVantage+15+lb.+Grout+Mix#.
      Ug0eg8rgpqM

J. Pittsburgh Corning Premiere Perimeter Channels for Premiere Glass Blocks
   1. Model number: 120919
   2. Material: PVC
   3. See distributor’s specifications for further information:
      http://www.homedepot.com/p/Pittsburgh-Corning-Premiere-Perimeter-Channels-for-
      Premiere-Glass-Blocks-4-Pack-
      120919/100318670?keyword=Pittsburgh+Corning+Premiere+Perimeter+Channels+for-
      Premiere#.Ug0fdcrgpqM

K. Pittsburgh Corning ProVantage Horizontal Spacers
   1. Model number: 124005
2. Material: PVC

3. See distributor’s specifications for further information:
   
   http://www.homedepot.com/p/Pittsburgh-Corning-ProVantage-Horizontal-Spacers-4-Pack-124005/100577242#.Ug0fysrgpqM

L. Pittsburgh Corning Glass Block Sealant

1. Model number: 102133

2. See distributor’s specifications for further information:
   
   http://www.homedepot.com/p/Pittsburgh-Corning-Glass-Block-Sealant-4-Pack-102133/100318675#.Uq0gFMrgpqM

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s instructions

   END OF SECTION 08 53 13
SECTION 09 29 00

Drywall

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the drywall used in Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Gold Bond by National Gypsum

2001 Rexford Road
Charlotte, North Carolina 28211
Phone: 704.365.7300
Website: http://nationalgypsum.com/index.htm

2.2 Products

A. Gold Bond 5/8" Drywall Panel

1. Model Number: GB99500800
2. Made with Type X, fire-resistant gypsum core
3. See manufacturer’s specifications for further information:

http://www.lowes.com/pd_11737-272-
GB99500800_0___?productId=3009508&Ntt=11737&pl=1&currentURL=%3FNtt%3D
11737&facetInfo=

B. Gold Bond 1/2" Drywall Panel

1. Model Number: GB00090800
2. See manufacturer’s specifications for further information:
PART 3 – EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer’s instructions.

END OF SECTION 09 29 00
SECTION 09 64 00
Wood Flooring

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the wood flooring.

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Plyboo by Smith & Fong Company

475 Sixth Street
San Francisco, CA 94103
Phone: 866.835.9859
Website: www.plyboo.com

B. Kelly-Moore Paint Company Inc.

987 Commercial St.
San Carlos, CA 94070
Phone: 1.888.677.2468
Website: www.kellymoore.com

2.2 PRODUCTS

A. Plyboo Unfinished Flat Grain Bamboo Flooring

1. Model Number: FL-5872UN-NAUF/FSC

2. Material: 100% bamboo

3. Dimensions: 5/8” x 3 5/8” x 72”

4. Hardness:

    a. ASTM D1037, Janka Ball Hardness Test
b. 1800 lb.

5. Finish Rating
   a. ASTM D4060, CS17 wheel, taber abrasion and ASTM D3359 adhesion
   b. 23500 rotations, 4B adhesion rating

6. See Manufacturer’s Specifications for Further Information:
   http://www.plyboo.com/products/plyboo-flat-grain-bamboo-flooring

B. Kelly Moore Alkyd QD Sanding Sealer
   1. Model: 2164 EZ SAND
   2. Resin type: Alkyd
   3. Color range: Clear
   4. Finish: Semi-Gloss, MPI gloss level 5
   5. VOC: <540 grams per liter
   6. See Manufacturer’s Specifications for Further Information:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation
   1. Install according to manufacturer’s recommendations

END OF SECTION 09 64 00
SECTION 09 65 15

Baseboard

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the baseboard

1.2 SUBMITTALS

A. Product Data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Plyboo by Smith & Fong Company

475 Sixth Street
San Francisco, CA 94103
Phone: 866.835.9859
Website: www.plyboo.com

2.2 PRODUCTS

A. Plyboo Base Shoe

1. Model number: QRD-100PN

2. Location: Kitchen

3. Finish: Prefinished, Natural

4. Dimensions: 7/16" x 3/4" x 72"

5. Features:

   a. See manufacturer's specifications for further information:


PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's recommendations
END OF SECTION 09 65 15
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the tile used in Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire Clay Tile

   495 West Julian Street
   San Jose, CA 95110
   Phone: 408.275.1182
   Website: www.fireclaytile.com

2.2 Products

A. Quickship Recycled Ceramic Tile

   1. Finish: Horizon
   2. 6”x6”
   3. 70% recycled materials (including post-consumer waste)
   4. Made in California

END OF SECTION 09 65 19
SECTION 09 74 10
Tile Wall Coverings

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the tile used in Radiant House

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Fire Clay Tile

495 West Julian Street
San Jose, CA 95110
Phone: 408.275.1182
Website: www.fireclaytile.com

B. Jeffrey Court

620 Parkridge Avenue
Norco, CA 92860
Phone: 951.340.3383
Website: www.jeffreycourt.com

2.2 Products

A. Quickship Recycled Ceramic Tile

1. Fire Clay
2. Location: Bathroom
3. Finish: Horizon
4. 6”x6”
5. 70% recycled materials (including post-consumer waste)
6. Made in California

B. Yukon Cliff Brick 10-1/2” x 11-3/4” glass and travertine mosaic wall tile
   1. Jeffrey Court
   2. Location: Kitchen
   3. Smooth unglazed surface of glass combination with stone

   END OF SECTION 09 74 10
SECTION 10 28 00
Toilet, Bath, and Laundry Accessories

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the toilets, showers, and laundry accessories.

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Kohler Kitchen and Bath Plumbing Fixtures

Kohler Co.

444 Highland Drive
Kohler, WI 53044
Phone: 920.457.4441
Website: http://www.us.kohler.com/us/

2.2 PRODUCTS

A. Kohler Purist Horizontal Toilet Tissue Holder

1. Model Number: K-14377-CP

2. Location: Bathroom

3. Finish: Polished Chrome

4. Features:

   a. Pivoting holder makes changing toilet tissue quick and simple

   b. Premium mental construction for durability

   c. Kohler Finished resist corrosion and tarnish

B. Kohler Purist 24” Single Towel Bar

1. Model Number: K-14436-CP
2. Location: Bathroom  
3. Finish: Polished Chrome  
4. Features:  
   a. Solid Brass Configuration  
   b. KOHLER finishes resist corrosion and tarnish  

C. Kohler Purist 32” Grab Bar  
1. Model Number: K-11894-S  
2. Location: Bathroom  
3. Finish: Polished Stainless Steel  
4. Features:  
   a. Metal construction  
   b. See manufacturer’s specifications for further information:  

PART 3 - EXECUTION  

3.1 INSTALLATION  

A. Tools Required: an adjustable wrench, pliers, sealant tape, wax seal, level, hammer,  
tape measure, pencil, screw driver, drill.  

B. Install fixtures in accordance with manufacturer’s recommendations.  

1. Bathroom toilet:  

2. Toilet tissue holder:  

3. Towel bar:  

4. Toilet seat:
PART 1 – GENERAL

1.5 SUMMARY

B. This section includes the back awning and awning structure

1.6 SECTION REQUIREMENTS

B. Product data

PART 2 – PRODUCTS

2.3 MANUFACTURERS

A. Trivantage

1831 North Park Ave
Glen Raven, NC 27217
Phone: 800.786.1876
Website: www.trivantage.com

2.4 DEVICES

H. Trivantage AwnTex 160 #EF5 awning fabric

1. Item number: 863400
2. Dimensions: 60” 36x16
3. Color: Winter Wheat
4. See manufacturer’s specifications for further information:

I. Gatorshield steel awning structure

1. Dimensions: 2” square
2. Gauge: 16
3. See manufacturer’s specifications for further information:


PART 3 – INSTALLATION

3.1 INSTALLATION

B. Install according to manufacturer’s instructions

END OF SECTION 10 73 13
SECTION 11 31 13
Residential Kitchen Appliances

PART 1 - GENERAL

1.1 SUMMARY
   A. This section includes the residential kitchen appliances

1.2 SUBMITTALS
   A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Bosch Design Center
      17911 Von Karman, Suite 100
      Irvine, CA 92614
      Phone: 1.800.944.2904
      Website: http://www.bosch-home.com/us/
   B. Sun Frost Refrigerator Systems
      Sun Frost
      P.O. Box 1101
      Arcata, CA 95518
      Phone: 707.822.9095
      Website: http://www.sunfrost.com/index.html

2.2 PRODUCTS
   A. Bosch 30" Single Wall Oven
      1. Model Number: HBL3350UC
      2. Location: Kitchen
      3. Capacity: 4.7 Cubic Feet
      4. Material: 300 Series - Stainless Steel
5. See manufacturer’s specifications for further information:


B. Bosch 24” Bar Handle Dishwasher

1. Model number: SHX2AR55UC
2. Location: Kitchen
4. Material: Ascenta Series – Stainless Steel
5. See manufacturer’s specifications for further information:


C. Sun Frost Refrigerator and Freezer

1. Model number: RF12
2. Location: Kitchen
3. Single Compressor Refrigerator and Freezer with a Passive (No Fans) Cooling System
4. ENERGY STAR® Qualified Model
5. See manufacturer’s specifications for further information:

http://www.sunfrost.com/refrigerator_specs.html

D. Bosch Induction Stove Cooktop

1. Model Number: NIT5065UC
2. Location: Kitchen
3. Finish: Black top with Front and back Stainless Steel Strips
4. Features:
   a. 30” Induction Cooktop
   b. 4 Cooktop Burners
c. 11” Heating Element with Powerful 3600W

d. Touch Control

e. Direct Cooking Level Surface

f. Built-In-Timers

g. Fast Heat Mode Boils Water Twice as Fast as Conventional Electric

5. See manufacturer’s specifications for further information:


E. Bosch 30” Downdraft Ventilation

1. Model Number: DHD3014UC

2. Location: Kitchen

3. Finish: Stainless Steel

4. Features:

   a. 31” x 3 ¾”

   b. 600 CFM Blower Options (Sold Separately)

   c. Duct Blower Left, Right, or Straight Down

5. See manufacturer’s specifications for further information:


F. Bosch 600 CFM Internal Blower

1. Model Number: DHG601DUC

2. Location: Kitchen

3. Finish: Stainless Steel

4. Features:

   a. 15 1/8” x 14 3/8” x 6 ¾”

   b. Ducted Operating Mode
c. Internal Blowers are installed under the countertop with the downdraft

5. See manufacturer’s specifications for further information:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation Requirements

1. Kitchen Oven
   a. Watts: 5,800 W
   b. Current: 30; 25 A
   c. Volts: 240/208 V
   d. Frequency: 60 Hz
   e. Plug Type: Fixed Connection, No Plug
   f. Energy Source: Electric

2. Kitchen Dishwasher
   a. Watts: 1,400 W
   b. Current: 12 A
   c. Volts: 120 V
   d. Frequency: 160 Hz
   e. Tub Type: Tall Tub
   f. Plug Type: Fixed Connection

3. Kitchen Fridge/Freezer: N/A

4. Kitchen Induction Stove Cooktop
   a. Watts: 7,200W
   b. Current: 40A
c. Volts: 208-240V
d. Frequency: 60 Hz
e. Energy Source-Electric
f. No Plug Required

5. Kitchen Stove Hood
   a. Watts: 580W
   b. Volts: 110V
c. Frequency: 60 Hz
d. Requires a 120V-3 Prong Plug

B. Install products in accordance with manufacturer’s recommendations via instructions provided with unit.

1. Kitchen Oven: N/A
2. Kitchen Dishwasher: N/A
3. Kitchen Fridge/Freezer: N/A
4. Kitchen Induction Stove Cooktop: N/A
5. Kitchen Stove Hood: N/A

END OF SECTION 11 31 13
SECTION 11 31 23
Residential Laundry Appliances

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the residential laundry appliances.

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Bosch Design Center

17911 Von Karman, Suite 100
Irvine, CA 92614
Phone: 1.800.944.2904
Website: http://www.bosch-home.com/us/

3.2 PRODUCTS

A. Bosch 24" Compact Vented Dryer

1. Model Number: WTV76100US

2. Location: Closet

3. Capacity: 3.9 Cubic Feet

4. Finish: Axxis - White

5. Features:

   a. Moisture Sensor-Controlled Automatic Drying Programs Prevents Wasted Energy and Over drying

   b. 110 CFM High Air Flow

   c. 4 Temperature Settings

   d. See manufacturer’s specifications for further information:
B. 24” Compact Washer

1. Model Number: WAS20160UC
2. Location: Closet
3. Capacity: 2.2 Cubic Feet
4. Finish: Axxis - White
5. Features:
   a. Energy Star® Qualified
   b. Exceed Energy Star Requirements by up to 63%
   c. Internal Water Heater Heats Water Quickly and Efficiently
   d. Wash Up to 17.6 lbs.
   e. See manufacturer’s specifications for further information:


PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation Requirements:

1. Washer:
   a. Current: 10 A
   b. Volts: 120 V
   c. Energy Source: Electric

2. Dryer:
   a. Current: 30 A
   b. Volts: 240 V
   c. Energy Source: Electric

END OF SECTION 11 31 23
SECTION 11 52 00
Audio-Visual Equipment

PART 1 - GENERAL

1.1 SUMMARY
B. This section includes the audio-visual equipment

1.2 SUBMITTALS
B. Product Data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
B. Samsung

85 Challenger Road
Ridgefield Park, NJ 07660
Phone: 1.800.726.7864
Website: www.samsung.com

Available at:
1. Best Buy
2. Target

C. Sanus

6436 City West Parkway
Eden Prairie, MN 55344
Phone: 651.484.7988
Website: www.sanus.com

Available at:
1. Best Buy

2.2 PRODUCTS
A. Samsung 46” LED Smart HDTV
1. Model number: UN46EH5300
2. Resolution: 1080p
3. TV Type: LED flat-panel
4. Screen refresh rate: 60 Hz
5. Features:
   a. See distributor’s specifications for further information:
      
      http://www.bestbuy.com/site/46%22+Class++LED++1080p++60Hz+-
      +Smart+-
      +HDTV/5372883.p?id=1218637213786&skuId=5372883&st=samsung#tab=
      overview

B. Samsung Wi-Fi Blu Ray Player

1. Model number: BD-E5400/ZA
2. Resolution: HD – 1080p
3. Features:
   a. See distributor’s specifications for further information:
      
      http://www.target.com/p/samsung-wifi-blu-ray-player-black-bd-e5400-za/-/A-
      14291344#prodSlot=medium_1_2&term=samsung+blu-ray+player

C. Sanus Full Motion Wall Mount for 32”-47” Flat-Panel TV

1. Model number: VMF220-B1
2. Dimensions: 19 1/2” x 21 1/4” x 3 7/8”
3. Weight: 24.9 lbs.
4. Mount type: Full Motion
5. Features:
   a. See distributor’s specifications for further information:
      
      http://www.bestbuy.com/site/Full-Motion+Wall+Mount+for+Most+32%22+-
      +47%22+Flat-Panel+TVs+-
PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s recommendations

END OF SECTION 11 52 00
SECTION 12 32 13
Manufactured Wood-Veneer-Faced Casework

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the wood casework.

1.2 SUBMITTALS
A. Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Northern Contours
   1355 Mendota Heights Rd.
   Suite 100
   St. Paul, MN 55120
   Phone: 651.695.1698
   Website: www.northerncontours.com

2.2 PRODUCTS
A. Northern Contour Custom Cabinets
   1. Spectrum Series Metro
   2. Location: Kitchen
   3. Material: Quartered Black Walnut
   4. Core: 3/4”
   5. Features:
      a. See manufacturer’s specifications for further information:
         http://www.northerncontours.com/Products/Detail/SPEMET
PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation

1. Install according to manufacturer’s instructions

END OF SECTION 12 32 13
SECTION 12 36 40
Stone Countertops

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the stone countertops used in Radiant House.

1.2 SUBMITTALS

A. Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ECO by Cosentino

Cosentino USA
13124 Trinity Street
Stafford, TX
Phone: 800-268-6837
Website: ecobycosentino.com/usa/

2.2 Products

A. ECO by Cosentino

1. Finish: Polar Cap

2. Features:
   a. 20 mm thick
   b. 75% of recycled materials
   c. 25% of natural stones ecological resin
   d. 94% of water used in manufacturing process is re-used

END OF SECTION 12 36 40
SECTION 21 05 19
Fire Suppression System Meters & Gauges

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the meters and gauges that will be used in Radiant House’s fire suppression system

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. NNI Inc.

N & N International
667 N.W. 118th Street
Miami, FL 33168-2540
Phone: 305-687-3330
Website: [http://nni.8m.com/index.html](http://nni.8m.com/index.html)

B. Badger Meter

4545 W Brown Deer Rd.
Milwaukee, WI 53223
Phone: 414.355.0400
Website: [www.badgermeter.com](http://www.badgermeter.com)

2.2 PRODUCTS

A. NNI Inc. System Sensor 2WTA-B

1. Electrical: 2-wire 8.5-35V 50uA (130uA alarm), 14-22 AWG wires.

2. Physical: 4-inch-square back box with paster ring directly mounted to ceiling.
3. See manufacturer’s specifications for further information:
   http://nni.8m.com/smoke_alarm_i3.html

B. Badger Meter Recordall FireSeries Meter FSMA 3”
   1. Size: 3”
   2. GPM: 6 to 550
   3. See manufacturer’s specifications for further information:

PART 3 – EXECUTION

3.1 INSTALLATION

   A. Install according to manufacturer’s instructions

   B. Install according to:
      1. Compliance with IRC (International Residential Code)
      2. Compliance with IFC (International Fire Code)

END OF SECTION 21 05 19
SECTION 21 10 00
Water-Based Fire Suppression Systems

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes water-based fire suppression systems

1.2 SECTION REQUIREMENTS
A. Submittals:
   1. Product performance requirements
   2. Product data for pipe and fittings
   3. Product data for sprinklers

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Hydraulically design sprinkler systems according to NFPA 13D.
B. Comply with NFPA 13D and NFPA 70.
C. UL-listed and -labeled and FM-approved pipe and fittings.

2.2 PRODUCTS – PIPE AND FITTINGS
A. CPVC Plastic Pipe
   1. ASTM F 442
   2. UL 1821
   3. Rating: 175-psig
   4. Approvals:
      a. UL
      b. FM
      c. C-UL
      d. NSF
      e. LPCB
f. MEA

g. City of Menlo Park Fire Department

5. Include "Listed" and "CPVC Sprinkler Pipe" marks on pipe.

B. Copper Tube

1. Drawn temper

C. CPVC Plastic Pipe Fittings

1. ASTM F 438 for NPS 3/4 to NPS 3
2. ASTM F 439 for NPS 2
3. UL listed
4. Rating: 175-psig
5. Include "Listed" and "CPVC Sprinkler Fitting" marks on fittings
6. Various types of adapters available to meet metallic fittings
7. All female pip thread adapters to have brass inserts for durability
8. Grooved adapters connect directly to grooved end valves and metallic pipe, with flexible grooved end couplings

2.3 PRODUCTS – SPRINKLERS

A. Automatic sprinklers:

1. Manufacturer:

   Tyco Fire Products
   PO Box 2806
   Lubbock, TX 79408-2806
   Phone: 714.993.6111
   Website: www.tyco-fire.com

2. Tyco Rapid Response Series LFII Residential Flat Plate Concealed Pendant Sprinkler
   a. Model number: TY3596
b. Features:
   i. K-Factor: 4.9K
   ii. Fast-response
   iii. Certified under UL 1626, for Residential Systems
   iv. Certified under UL 1767, for Rapid Response Enabled Systems
   v. Maximum working pressure: 175 psi
   vi. Discharge coefficient: 4.9 GPM/psi1/2
   vii. Temperature Rating: 160° F (Sprinkler), 139°F (Cover Plate)
   viii. Vertical Adjustment/Orifice: 1/2 inch
   ix. Spacing Requirements: Min 8 feet, not to exceed length of coverage area

c. Components and Composition:
   i. Body: Brass
   ii. Cap: Bronze
   iii. Saddle: Brass
   iv. Sealing Assembly: Beryllium Nickel w/Teflon
   v. Soldered Link Halves: Nickel
   vi. Lever: Bronze
   vii. Compression Screw: Brass
   viii. Deflector: Copper or Brass
   ix. Guide Pin Housings: Bronze
   x. Guide Pins: Stainless Steel or Bronze
   xi. Support Cup: Stainless Steel
   xii. Cover Plate: Copper
   xiii. Retainer Cover Plate: Bronze
   xiv. Ejection Spring: Stainless Steel
B. Sprinkler Types and Categories: Nominal 1/2-inch orifice for NFPA 13D standard temperature classification rating unless otherwise indicated or required by application.

C. Sprinkler types include the following:
   1. Upright, pendent, and sidewall sprinklers.
   2. Extended coverage sprinklers.
   3. Quick-response sprinklers.
   4. Pendent and sidewall, dry-type sprinklers.

D. Sprinkler Guards: Wire-cage type, including fastening device.

E. Sprinkler Cabinets: Finished steel cabinet and hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench, suitable for wall mounting

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING
   A. Connect sprinkler piping to external tank for service entrance to building
   B. Install shutoff valve, check valve, pressure gage, and drain at connection to water service

3.2 PIPING INSTALLATION
   C. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve
   D. Install sprinkler zone control valves, test assemblies, and drain headers adjacent to standpipes
   E. Install ball drip valves to drain piping between fire department connections and check valves
   F. Drain to floor drain or outside building
   G. Install alarm devices in piping systems and connect to fire-alarm system
   H. Protect piping from earthquake damage as required by NFPA 13D
   I. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe
J. Install gages to permit removal, and install where they will not be subject to freezing

K. Install fire-protection service valves supervised-open, located to control sources of water supply except from fire department connections

L. Where there is more than one control valve, provide permanently marked identification signs indicating portion of system controlled by each valve

M. Install check valve in each water supply connection

N. Install backflow preventers in potable-water supply sources

O. Install alarm check valves for proper direction of flow, including bypass check valve and retard chamber drain line connection

3.3 PIPING

P. Install shutoff valve, check valve, pressure gage, drain, and other accessories indicated at connection to water service piping

3.4 TESTING

Q. Flush, test, and inspect sprinkler piping systems according to NFPA 13D

END OF SECTION 21 10 00
SECTION 21 30 00
Fire Pumps

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the pumps used in the water based fire suppression system

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 778 for motor-operated water pumps.

2.2 MANUFACTURERS

A. Talco Fire Systems

6040 NE 112th Ave.

Portland, OR 97220

Phone: 800 878 8055

http://www.talcofire.com/index.html

2.3 Products

A. Talco LSF-150SP


2. Impeller: Plastic.

3. Impeller Material: ASTM B 584, cast bronze or stainless steel.

4. Shaft and Shaft Sleeve: Steel shaft with copper-alloy shaft sleeve or cast iron.
5. Seal: Mechanical; with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.

6. Motor:
   a. 1.5 horsepower electric
   b. 230 Volt, 10.9 Amp
   c. Single Phase

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

B. Motor Sizes: Minimum size as indicated.

C. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 262913 "Enclosed Controllers."

2.5 CONTROLS

A. Timers: Electric, for control of minimum run time of pump.
   1. Type: Programmable, clock with manual override on-off switch.

B. Switches: Electric for changing pump settings.
   1. HOA Toggle switch (Hand, Off, Auto)
   2. 40/60 Pressure switch

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping so weight of piping is not supported by pump volute.

D. Install electrical connections for power, controls, and devices.
E. Suspend in-line pumps independent from piping. Use continuous-thread hanger rods and vibration isolation hangers. Fabricate brackets or supports as required for pumps.

F. Install vertical in-line pumps on concrete bases.

G. Connect piping with valves that are at least the same size as piping connecting to pumps.

H. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

I. Install shutoff valve and strainer on suction side of pumps.

J. Install non-slam check valve and throttling valve on discharge side of pumps.

K. Install thermostats in hot-water return piping.

L. Install pressure gages on suction and discharge of each pump. Install at integral pressure gauge tappings where provided.

END OF SECTION 21 30 00
SECTION 22 05 00
Common Work Results for Plumbing

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes common work results for plumbing

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Uponor

5925 148th Street West
Apple Valley, MN 55124
Phone: 800.321.4739
Website: http://www.uponor-usa.com/

2.2 PRODUCTS

A. Uponor plastic bend support

1. Model number: A5250500

B. Uponor tube talon

1. Sizes:
   a. 1/2"
   b. 5/8"
   c. 3/4"
   d. 1"

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install piping according to manufacturer’s instructions
1. Install piping free of sags and bends
2. Install fittings for changes in direction and branch connections
3. Install sleeves for pipes passing through walls and concrete floors and roof slabs
4. Install unions at final connection to each piece of equipment

B. Install general equipment according to safety standards and to manufacturer’s instructions
   1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated
   2. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated
   3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations
   4. Install equipment to allow right of way for piping installed at required slope

C. Install bases, supports, and anchorages according to seismic codes and to manufacturer’s instructions
   1. Construct concrete bases of dimensions indicated, but not less than 100 mm larger in both directions than supported unit
   2. Install dowel rods on 450-mm centers around the full perimeter of the base to connect concrete base to concrete floor
   3. Place and secure anchorage devices

D. Install hangers and supports in accordance with MSS SP-69 and MSS SP-89
   1. Install building attachments within concrete or to structural steel
   2. Install hangers and supports to allow controlled thermal and seismic movement of piping systems
3. Install hangers and supports to piping live and dead loading and stresses from movement will not be transferred to connected equipment

E. For horizontal piping hangers and supports, install the following types:

1. Pipe hangers: MSS Type 5
   1. For suspension of pipes DN 15 to DN 100 to allow off-center closure for hanger installation before pipe erection

2. Pipe hangers: MSS Type 10
   a. For suspension of non-insulated stationary pipes DN 15 to DN 50

F. For vertical piping clamps, install the following types:

1. Extension pipe or riser clamps: MSS Type 8
   a. For support of pipe risers DN 20 to DN 500

2. Carbon or alloy steel riser camps: MSS Type 42
   a. For support of pipe risers DN 20 to DN 500

G. Comply with the PHCC National Standard Plumbing Code and manufacturer’s recommendations

END OF SECTION 22 05 00
SECTION 22 05 19

Meter and Gauges for Water-Based Piping

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes meters and gauges for plumbing piping

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Badger Meter

   4545 W Brown Deer Rd.
   Milwaukee, WI 53223
   Phone: 414.355.0400
   Website: www.badgermeter.com

2.2 PRODUCTS

A. Badger E-Series water meter

   1. Size: 5/8” (15 mm)
   2. Maximum pressure: 175 PSI
   3. Maximum flow: 25 gpm
   4. Measured temperature range: 34 – 140 F
   5. See manufacturer’s specifications for further information:


PART 3 - EXECUTION

A. General: Comply with owner’s manual and the PHCC National Standard Plumbing

   Code and manufacturer’s recommendations.

END OF SECTION 22 05 19
SECTION 22 05 23
General-Duty Valves for Water-Based Piping

PART 1 – GENERAL

1.1 SUMMARY

   A. This section includes plumbing valves

1.2 SUBMITTALS

   A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

   A. Homewerks Worldwide, LLC.
       500 Bond Street
       Lincolnshire, Illinois 60069
       Phone: 224.543.1500
       Website: http://www.homewerksww.com/

   B. Honeywell
       101 Columbia Road
       Mailstop – M6/LM
       Norristown, NJ 07962
       Phone: 1.877.841.2840
       Website: https://honeywell.com/Pages/Home.aspx

   C. Matco-Norca
       PO Box 27 Route 22
       Brewster, New York 10509
       Phone: 845.278.7570
       Website: http://www.matco-norca.com/

   D. Belimo
2.2 PRODUCTS

A. Brass Full-Port Ball Valve
   1. Model: VBVFPSB5B
   2. Location: Mechanical Room
   3. Material: Brass
   4. Dimensions [L x W x H]: 2.25" x 5.5" x 3.25"
   5. Weight: 1.2 lb
   6. Valve inlet diameter: 1"
   7. Valve outlet diameter: 1"
   8. Rating: 200 psi
   9. Minimum working temperature: 40 F
   10. Maximum working temperature: 180 F

B. Sweat Union Mixing Valve
   1. Model: AM102-US-1
   2. Location: Mechanical Room
   3. Material: Nickel plated Brass
   4. Valve inlet diameter: 1” threaded
   5. Valve outlet diameter: 1” threaded
   6. Max pressure: 150 psi
   7. Minimum working temperature: 70 F
   8. Maximum working temperature: 145 F

C. Bronze In-Line Check Valve
1. Model: 525C05
2. Location: Mechanical Room
3. Material: Bronze
4. Valve inlet diameter: 1”
5. Valve outlet diameter: 1”

D. Belimo Mixing Valve
   1. Model: B317+LRB24-SR-T
   2. Location: Mechanical Room
   3. Valve diameter: 3/4”

PART 3 – EXECUTION

3.1 INSTALLATION
   A. Install according to manufacturer’s instructions

END OF SECTION 22 05 23
SECTION 22 07 00

Plumbing Insulation

PART 1 – GENERAL

1.1 SUMMARY
   A. This section includes the plumbing insulation

1.2 SUBMITTALS
   A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS
   A. SharkBite
      2727 Paces Ferry Rd. SE
      Suite 1750, Building Two
      Atlanta, GA 30339
      Phone: 1.877.700.4242
      Website: www.sharkbite.com

2.2 PRODUCTS
   A. SharkBite PEX pipe with insulation
      1. Model number: U860I100
      2. Inside diameter: 1/2"
      3. Outside diameter: 3/4"
      4. See manufacturer's specifications for further information:
         http://www.homedepot.com/h_d1/N-5yc1v/R-203316941/h_d2/ProductDisplay?catalogId=10053&langId=-1&keyword=pex+insulation&storeId=10051#US03-oZvZ8E

PART 3 – EXECUTION

3.1 INSTALLATION
A. Install around PEX piping ensuring a snug fit

END OF SECTION 22 07 00
SECTION 22 11 13
Facility Water Distribution Piping

PART 1 – GENERAL

1.1 SUMMARY
A. This section includes facility water distribution piping, the non-radiant portion of hydronic piping for the radiant system

1.2 SUBMITTALS
A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS
A. Genova Products

7034 East Court St.
Box 309
Davison, MI 48423-0309
Phone: 810.744.4500
Website: www.genovaproducts.com

2.2 PRODUCTS
A. Copper piping for hydronic use

1. Sizes:
   a. 1/2"
   b. 3/4"
   c. 1"
   d. 1 1/4"

2. Type: L

B. Genova Products DWV CC ABS pipe

1. Dimensions: 2"x10"
C. Genova Products ABS coupling
   1. Model number: 80120
   2. Diameter: 2”

D. Genova Products sanitary street ABS elbow
   1. Model number: 82926
   2. Diameter: 2”

E. Genova Products ABS sanitary tee
   1. Model number: 81120
   2. Diameter: 2”

F. Genova Products ABS vent cap
   1. Diameter: 2”

G. Genova Products ABS wye
   1. Model number: 81020
   2. Diameter: 2”

H. Genova Products ABS pipe
   1. Dimensions: 2”x10”

1.3 ACCESSORIES

A. NPT fittings
   1. Diameter: less than or equal to 1 1/2”
   2. ANSI B16.22 & B16.18

PART 3 – EXECUTION

3.1 INSTALLATION

A. Copper pipe installation
   1. All water and glycol systems with operating temperatures of 40°F to 210°F: Install Type L, drawn copper tubing with wrought copper fittings and solder joints for 1.5” and smaller, above ground, within building
2. Install air vents at high points in the system, heat transfer coils, and elsewhere as required for system air venting

B. ABS pipe installation

1. Comply with requirements in Division 22 Section “Common Work Results for Plumbing” for basic piping installation requirements.

2. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 22 Section “Common Work Results for Plumbing” for wall penetration systems.

3. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

4. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

5. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

6. Building Sanitary Drain: 2 percent downward in direction of flow for piping DN 80 and smaller; 1 percent downward in direction of flow for piping DN 100 and larger


8. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

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

END OF SECTION 22 11 13
SECTION 22 11 16
Domestic Water Piping

PART 1 – GENERAL

1.1 SUMMARY
A. This section includes domestic water piping

1.2 SUBMITTALS
A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS
A. Uponor
   5925 148th Street West
   Apple Valley, MN 55124
   Phone: 800.321.4739
   Website: http://www.uponor-usa.com/

B. SharkBite
   2727 Paces Ferry Rd. SE
   Suite 1750, Building Two
   Atlanta, GA 30339
   Phone: 1.877.700.4242
   Website: www.sharkbite.com

C. BrassCraft Manufacturing Company
   39600 Orchard Hill Place
   Novi, MI 48375-6000
   Phone: 248.305.6000
   Website: www.brasscraft.com

D. Nibco
2.2 PRODUCTS

A. Nibco Manifold

1. MSC part #: 75924340
2. Manufacturer part #: PX01120
3. Location (in house): Mechanical room
4. Inlet size: 3/4"
5. Outlet size: 1/2"
6. Features:
   a. 6 outlet ports
7. See distributor’s specifications for further information:
   http://www.mscdirect.com/product/75924340

B. Uponor PEX piping

1. SKU: F1040500
2. Diameters:
   a. 1/2"
   b. 3/4"
   c. 1"
3. Complies with:
   a. DIN4726
   b. ASTM F877
   c. NSF
4. See distributor’s specifications for further information:

   http://www.pexsupply.com/Wirsbo-Uponor-F1040500-1-2-AQUAPEX-100-ft-coil-
   2173000-p

C. SharkBite rings

1. Model number: 23103CP25

2. Diameters:
   
   a. 3/8”
   
   b. 1”
   
   c. 2”
   
   d. 4”

3. See manufacturer’s specifications for further information:

   http://www.homedepot.com/h_d1/N-5yc1v/R-
   202032916/h_d2/ProductDisplay?catalogId=10053&langId=-
   1&keyword=PEX+rings&storeId=10051#.US1DQIZvZ8E

D. SharkBite tees

1. Model number: UC326LFA
   
   a. Size: 1/2”

2. Model number: UC374A
   
   a. Size: 1”

3. See manufacturer's specifications for further information:

   d=-

   1&catalogId=10053&keyword=pex+tees&Ns=None&Ntpr=1&Ntpc=1&selectedCa
   tgry=Search+All

PART 3 – EXECUTION

3.1 INSTALLATION
A. Install Wirsbo AQUAPEX tubing in accordance with the tubing manufacturer’s recommendations and as indicated in the installation handbook

B. Do not install PEX tubing within 6 inches [152 mm] of gas appliance vents or within 12 inches [305 mm] of any recessed light fixtures

C. Do not solder within 18 inches [457 mm] of PEX tubing in the same waterline

D. Make sweat connections prior to making PEX connections

E. Do not expose PEX tubing to direct sunlight for more than 30 days

F. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer

G. Protect PEX tubing with sleeves where abrasion may occur

H. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail

I. Comply with requirements in Division 22 Section “General-Duty Valves for Plumbing Piping” for general-duty metal valves.

J. Comply with requirements in Division 22 Section “Domestic Water Piping Specialties” for balancing valves, drain valves, backflow preventers, and vacuum breakers

3.2 INSPECTION AND CLEANING

A. Inspect and test piping systems as follows:

1. Fill domestic water piping

2. Check components to determine that they are not air bound and that piping is full of water

3. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired

B. Clean and disinfect potable domestic water piping by filling system with water/chlorine solution with at least 50 mg/L of chlorine

C. Isolate with valves and allow to stand for 24 hours
D. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time

END OF SECTION 22 11 16
SECTION 22 11 23
Water Pumps

PART 1 – GENERAL

1.1 SUMMARY
A. This section includes domestic water and greywater pumps

1.2 SUBMITTALS
A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS
A. Grundfos Pumps Corporation
   17100 W. 118th Terrace
   Olathe, Kansas 66061
   Phone: 913.227.3400
   Website: http://us.grundfos.com/

B. Ace Pump Corporation
   1650 Channel Ave.
   Memphis, TN 38113
   Phone: 901.948.8514
   Website: http://www.acepumps.com/

2.2 PRODUCTS
A. Grundfos Alpha 15-55F
   1. Model Number: 59896877
   2. Description: Cast iron with terminal box
   3. 1 x 115V, 60 Hz
   4. See manufacturer’s specifications for further information:

B. Grundfos MQ3-35 Pressure Boosting Pump

1. Model Number: 96860172
2. 115V
3. See manufacturer's specifications for further information:

C. Grundfos UPS15-58FC 3-Speed Circulator Pump

1. Model Number: 59896341
2. 115V, 1/25 HP
3. See manufacturer's specifications for further information:

D. Grundfos UP15-29SU Circulator Pump

1. Model Number: 4VZJ6
2. 115 V, 1/12 HP
3. See manufacturer's specifications for further information:
rgCFUFyQgodZxwAjQ&cm_mmc=PPC:%20Google%20Catalog-_
Pumps%3EHot%20Water%20Circulating%20Pumps-%
Grundfos%3EHot%20Water%20Circulating%20Pumps%3EPhrase-%
UP15-29SU&ef_id=UgpdWwAAAS4EYer0:20130813162251:s

E. Water Ace R5V Sump Pump

1. Model Number: 27496D500
2. 1 1/4” – 1 1/2” discharge

3. 115v

4. See manufacturer’s specifications for further information:

PART 3 – EXECUTION

3.1 INSTALLATION

A. Comply with HI 1.4

B. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings, and accessories

C. Support pumps and piping so weight of piping is not supported by pump volute.

D. Install electrical connections for power, controls, and devices

E. Suspend in-line pumps independent from piping. Use continuous-thread hanger rods and vibration isolation hangers

F. Fabricate brackets or supports as required for pumps

G. Install vertical in-line pumps on concrete bases

H. Connect piping with valves that are at least the same size as piping connecting to pumps

I. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles

J. Install shutoff valve and strainer on suction side of pumps

K. Install non-slam check valve and throttling valve on discharge side of pumps

L. Install thermostats in hot-water return piping

M. Install pressure gauges on suction and discharge of each pump. Install at integral pressure gauge tappings where provided

END OF SECTION 22 11 23
SECTION 22 12 00
Facility Potable-Water Storage Tanks

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes facility potable-water storage tanks

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Loomis Tank Center

2610 Ramada Drive
Paso Robles, CA 93446
Phone: 805.239.2279
Website: www.loomistank.com

2.2 PRODUCTS

A. Loomis Tank custom fabricated potable-water storage tank

1. Capacity: 1500 gal.

2. Model Number: LNW1500W

3. Material: polyethylene

4. Features:
   a. Single-chamber
   b. Molded
   c. HDPE or PE construction
   d. 95in D X 58 in H
   e. Top Fitting: 1.5” D and 16.5” D
   f. Bottom Fitting: 2” D
5. See manufacturer’s specifications for further information:

http://shop.loomistank.com/product/1003201.1008797.1008800.0.0/LNW1500W//NW_1

500_WTR_95D_X_58H

2.3 ACCESSORIES

A. PEX pipes and fittings

1. See Section 22 11 16

B. Cleanouts

1. ASME A112.36.2M, with round, flanged, cast-iron housing; and secured, scoriated, medium-duty loading class, cast-iron cover

2. Includes cast-iron ferrule and countersunk brass cleanout plug

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install potable-water storage tanks level

B. Install polyethylene potable-water storage tanks according to guidelines

1. Accessibility, ease of maintenance, and removal should be taken into consideration when installing tanks

2. Adequately support all pipes and valves

3. Do not apply excess weight on water tanks

4. Tanks are not designed for storage of fluid in vacuum conditions or higher pressure above atmospheric

5. Use caution when handling all tanks

C. Fill potable-water storage tank with water

END OF SECTION 22 12 00
SECTION 22 13 00
Facility Sanitary Sewage and Vent Piping

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes facility sanitary sewage and vent piping

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Genova Products

7034 East Court Street
Box 309
Davison, MI 48423-0309
Phone: 810.744.4500
Website: www.genovaproducts.com

2.2 PRODUCTS

A. Genova Products ABS p-trap

1. Product number: various

2. Size: various"

B. PVC Plastic and ABS Pipe and Fittings:

1. ASTM D 2665,

2. Plain ends with PVC socket-type.

3. Diameter 1 1/2" and 2"

PART 3 – EXECUTION

3.1 INSTALLATION
A. Comply with requirements in Division 22 Section “Common Work Results for Plumbing” for basic piping installation requirements

B. Install wall penetration system at each pipe penetration through foundation wall

C. Make installation watertight

D. Comply with requirements in Division 22 Section “Common Work Results for Plumbing” for wall penetration systems

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends

F. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical

G. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe

H. Straight tees, elbows, and crosses may be used on vent lines

I. Do not change direction of flow more than 90 degrees

J. Use proper size of standard increasers and reducers if pipes of different sizes are connected

K. Reducing size of drainage piping in direction of flow is prohibited

L. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping DN 80 and smaller; 1 percent downward in direction of flow for piping DN 100 and larger

   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow

   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack

M. Install PVC soil and waste drainage and vent piping according to ASTM D 2665

N. Install underground PVC soil and waste drainage piping according to ASTM D 2321
O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction

P. Comply with requirements in Division 22 Section “Common Work Results for Plumbing” for basic piping joint construction

END OF SECTION 22 13 00
SECTION 22 13 53
Facility Greywater Tanks

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the waste water tanks used for bathroom and kitchen shower and sink water

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 SEPTIC TANKS

A. Polyethylene Greywater Tanks: Two single-chamber, molded, HDPE or PE construction; fabricated for greywater tank application.


2. See http://www.ryanherco.com/ for fabricator

2.2 SIPHONS

A. Automatic Siphons: Manufactured siphon assembly of molded HDPE trap, pipe, and bell, with PVC vent piping and stainless-steel bolts.

1. Unit Size: min. 4 inches diameter.

2.3 DISTRIBUTION PIPES AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D 2751, SDR 35, for solvent-cement or elastomeric gasket joints.


PART 3 - EXECUTION

3.1 GREYWATER TANK INSTALLATION

A. Install greywater tanks level
B. Install polyethylene greywater tanks according to guidelines.

C. Fill septic tank with water.

END OF SECTION 22 13 53
SECTION 22 41 16
Residential Lavatories and Sinks

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the sinks for the Bathroom and Kitchen

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Kohler Kitchen and Bath Plumbing Fixtures

Kohler Co.

444 Highland Drive
Kohler, WI 53044
Phone: 920.457.4441
Website: http://www.us.kohler.com/us/

2.2 PRODUCTS

A. 23" semi-pedestal bathroom sink with single faucet hole and shroud

1. Model Number: K-5150-1-0

2. Location: Bathroom

3. Features:

   a. Finish: White and Polished Chrome


   c. Single Faucet Hole

   d. Deep, V shape basin

   e. Coordinates with other products in Reve Suite
4. See manufacturer’s specifications for further information:

http://www.us.kohler.com/us/R%C3%A4ve%28%29-semi-pedestal-bathroom-sink-with-single-faucet-hole-and-shroud/productDetail/Wall-mount-Sinks/427399.htm?brandId=651438&skuid=405496&categoryId=651434&hash=id%3Dfilters%26startIndex%3D20%26scrollTop%3D0

B. Escale Bathroom Sink Overflow Caps

1. Model Number: K-4061-CP
2. Location: Bathroom
3. Features:
   a. Finish: Polished Chrome
   b. Overflow cap attractively conceals drain while still allowing water to exit the sink
4. See manufacturer’s specifications for further information:


C. Pair 3/8” NPT angle supplies with stop, cross handle and annealed vertical tube

1. Model Number: K-7605-P-CP
2. Location: Bathroom
3. Features:
   a. Finish: Polished Chrome
   b. Pair of angle supplies with stop
   c. Annealed vertical tube
   d. 3/8” NPT
   e. Four-arm handle
4. See manufacturer’s specifications for further information:

D. Kohler Bathroom Sink Grid Drain with Overflow

1. Model Number: K-7129-A-CP
2. Location: Bathroom
3. Features
   a. Finish: Polished Chrome
   b. Solid brass construction ensures durability and reliability
   c. Kohler finished resist corrosion and tarnishing
   d. For use in overflow applications
4. See manufacturer’s specifications for further information:

E. Kohler Lawnfield Under-Mounted Large/Medium Double Bow

1. Model Number: K-5841-4U-FE
2. Location: Kitchen
3. Features
   a. Finish: Frost
   c. KOHLER cast iron
   d. Drop-in or under-mount installation
4. See manufacturer’s specifications for further information:

F. Kohler Duostrainer Manual sink strainer with tailpiece

1. Model Number: K-8801-VS
2. Location: Kitchen
3. Features
   a. Finish: Vibrant Stainless
   b. Fits sinks with standard 3-1/2” or 4” outlet
   c. 1-1/2” connection and 4” tailpiece
4. See manufacturer’s specifications for further information:
   

G. Saile one-piece elongated with dual flush technology

1. Model Number: K-3564-0
2. Location: Bathroom
3. Features
   a. Finish: White
   b. One-piece toilets integrate the tank and bowl into a seamless, easy-to-clean design
   c. Compact elongated bowl offers added comfort while occupying the same space as a round-front bowl
   d. Top-mounted 2 button flush offers a choice of 0.8 or 1.6 gpf
   e. Saile Quiet-Close seat with Quick-Release functionality allows seat to close quietly and quickly unlatch from the toilet for easy removal and convenient cleaning
4. See manufacturer’s specifications for further information:
   

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all items with manufacturer’s recommendations.

1. Kohler Bathroom Sink and Accessories

2. Kohler Kitchen Sink and Accessories

3. Kohler Lavatory

END OF SECTION 22 41 16
SECTION 22 41 23
Residential Showers

PART 1 GENERAL

1.1 SUMMARY

A. This section includes the necessary parts for the residential shower

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Kohler Kitchen and Bath Plumbing Fixtures

MAAX Bath Inc.,
160 St. Joseph Blvd
Lachine, QC H8S2L3
Phone: 800.328.2531
Website: http://www.maax.com/en/main%20navigation/contact/contact%20us.aspx

2.2 PRODUCTS

A. Maax Evidence 6034 M Wall-Mount Shower Base

1. Model Number: 105738-R-000-001-103

2. Location: Bathroom

3. Features:

a. Finish: White Base

b. Dimensions: W: 60" D: 34" H:3 ¼"

c. See manufacturer’s product description for optional accessories:


4. See manufacturer’s specifications for further information:

B. Maax Evidence Walk-In Enclosure Right

1. Model Number: 137346-900-084-002
2. Location: Bathroom
3. Features:
   a. Finish: Chrome Clear
   b. Glass Enclosure Only
   c. Wall mount installation – 3 stationary glass panels
   d. Made with thick 8mm clear safety glass
   e. Dimensions: W: 60" D: 36" H: 84" Opening 23"
4. See Manufacturer’s Product Description for Optional Accessories:
   [Link to Optional Accessories]

C. Maax Evidence Wood Drip-Tray Accessory

1. Model Number: 10024772-185
2. Location: Bathroom
3. Features
   a. Finish: Teak
   b. Only Available for the 60 x 34" Evidence Shower Base
   c. Material composed of strong birch wood which is heat-treated to resist water
   e. See Manufacturer’s Product Description for Optional Accessories:
      [Link to Optional Accessories]

D. Kohler Forte Essentials Performance Shower Package

1. Model Number: K-10827-4-CP
2. Location: Bathroom
3. Features
   a. Finish: Polished Chrome
   b. Hand shower, Showerhead, Shower arm with Diverter, Shower Hose, Slidebar Kit, Rite-Temp Valve Trim
   c. Single lever handle provides on/off activation and temperature setting
   d. 2.5 gallons per minute flow rate from the showerhead and hand shower
   e. See manufacturer’s Specifications for Further Information

4. See manufacturer’s specifications for further information:

E. Kohler Rite-Temp ½” Pressure-Balancing Valve with PEX Expansion Connections
   1. Model Number: K-304-UX-NA
   2. Location: Bathroom
   3. Features
      a. Brass valve bodies
      b. High-temperature limit setting for added safety
      c. Mixing valve from “cold” to “hot”
      d. Rite-Temp pressure balancing diaphragm design valve
   4. See manufacturer’s specifications for further information:

F. Kohler Round Shower Drain
   1. Model Number: K-9132-CP
   2. Location: Bathroom
   3. Features
      a. Finish: Polished Chrome
b. Intended for installations with 2” caulk connection

c. Perforated strainer

4. See manufacturer’s specifications for further information:


PART 3 - EXECUTION

3.1 INSTALLATION

A. Tools Required: Electric drill, 1/4” ceramic drill bit, File and utility knife, Cutting pliers, Measuring tape, Pencil, Screwdriver, Level, Safety glasses, 1/8” and 5/32” Allen keys, Square, and Hack saw

B. Install all items in accordance with manufacturer’s recommendations.

1. Maax Shower Base and Accessories

   http://menards.inserts2online.com/main/store/20090519001/items/media/Plumbing/Maax/Install_Instruct/install_EVm-Pnls1of2.pdf

2. Kohler Shower Accessories:


END OF SECTION 22 41 23
SECTION 22 41 39
Residential Faucets, Supplies, and Trim

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the necessary parts for the bathroom faucet

1.2 SUBMITTALS
A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Kohler Kitchen and Bath Plumbing Fixtures
   Kohler Co.
   444 Highland Drive
   Kohler, WI 53044
   Phone: 920.457.4441
   Website: www.us.kohler.com/us/

2.2 PRODUCTS
A. Purist Tall Single-Hole Bathroom Sink Faucet with Straight Lever Handle
   1. Model Number: K-14404-4A-CP
   2. Location: Bathroom
   3. Features:
      a. Finish: Polished Chrome
      b. Dimensions: L: 6/14" W: 2-1/4" H: 12"
      c. Single Faucet Hole
      d. Solid brass construction for durability and reliability
      e. Single-control operation allows faucet to be turned on and off at any temperature setting
f. High temperature limit stop allows comfortable maximum temperature preset

g. 6-1/4” spout

h. WaterSense-labeled faucet – uses at least 30% less water than the standard faucets

4. See manufacturer’s specifications for further information:


PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install all items in accordance with manufacturer’s recommendations.

      1. Kohler Faucet


END OF SECTION 22 41 39
SECTION 22 80 08
Domestic Hot Water Tanks

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes specifications for the domestic hot water tank

1.2 SUBMITTALS
A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURER
A. Daikin Industries
   1645 Wallace Dr., Suite 110
   Carrollton, TX 75006
   Phone: 972.245.1510
   Website: www.daikin.com

B. American Solartechnics
   P.O. Box 882
   Searsport, ME 04974
   Phone: 888.866.8970
   Website: http://americansolartechnics.com/index.html

2.2 PRODUCTS
A. Domestic hot water tank
   1. Model number: EKHWS050BA3VJU
   2. Location: Mechanical room
   3. Dimensions: [Height X Diameter]: 45-3/8" x 22-7/8"
   4. Capacity: 50 gal
   5. Weight: 99.2 lbs.
B. Softank Heat Storage Tank

1. Dimensions: [Height X Diameter]: 48” x 46”
2. Capacity: 200 gal
3. See manufacturer's specifications for more information:
   http://americansolartechnics.com/softank.html

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendation

END OF SECTION 22 80 08
SECTION 22 81 81

Phase Change Material

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes phase change material that will be used to store thermal energy from Radiant House’s solar thermal panel

1.2 RELATED SECTIONS

A. 22 80 08 Domestic Hot Water Tanks

1.3 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. Pure Temp

151 Chesire Lane, Suite 400
Plymouth, MN 55441
Phone: 952.941.0306
Website: http://puretemp.com/index.html

2.2 PRODUCTS

A. Pure Temp 48 and Pure Temp 53 Vegetable Based Phase Change Material

1. Non-toxic, renewable, and biodegradable PCM

2. See manufacturer’s specifications for further information:

   http://puretemp.com/technology.html

PART 3 – EXECUTION

3.1 INSTALLATION

A. The phase change material will be installed in coils in the Softank domestic water tank.

END OF SECTION 22 81 81
SECTION 23 09 13
Sensors and Transmitters

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes sensors and transmitters

1.2 SECTION REQUIREMENTS

A. Product data

PART 2 – PRODUCTS

2.5 MANUFACTURERS

B. Davis Instruments

3465 Diablo Ave
Hayward, CA 94545
Phone: 800.678.3669
Website: www.davisnet.com

C. Campbell Scientific

815 West 1800 North
Logan, UT 84321
Phone: 435.227.9090
Website: www.cambellsci.com

D. Viasala

6980 Santa Teresa Blvd
San Jose, CA 95119
Phone: 408.578.3670
Website: www.viasala.com

2.6 PRODUCTS

A. Davis Instruments 6450 Solar Radiation Sensor
1. SKU: 6450

2. See distributor’s specifications for further information:
   http://www.rainmanweather.com/site/products/6450-Solar-Radiation-Sensor

B. Campbell Scientific R.M. Young Wind Sentry Set

   1. Model number: 03002

   2. See manufacturer’s specifications for further information:

C. Viasala HMP60 Humidity and Temperature Probe for Volume Applications

   1. See manufacturer’s specifications for further information:

PART 3 – INSTALLATION

3.1 INSTALLATION

   C. Install according to manufacturer’s instructions

END OF SECTION 23 09 13
SECTION 23 23 23
Refrigerant

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the refrigerant used in the heat pump and compressor for the Messana system

1.2 RELATED SECTIONS

A. Section 23 81 43 Air to Water Heat Pump

1.3 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Homewerks Worldwide, LLC.
   500 Bond Street
   Lincolnshire, Illinois 60069
   Phone: 224-543-1500
   Website: http://www.homewerksww.com/

2.2 PRODUCTS

A. R-410a Refrigerant
   1. Model: R-410a
   2. Location: Mechanical Room & Outside Enclosure (Used in Heat Pump & Compressor)
   3. Product specs:
      a. Density: 67.87 lb/ft³ (@ 68°F)
      b. Melting Point: -247°F
      c. Boiling Point: -55.3°F
PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s recommendations.

END OF SECTION 23 23 23
SECTION 23 31 00
HVAC Ducts and Casings

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes specifications for all ducting elbows, joints, and casings

1.2 SUBMITTALS
A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. O.C. McDonald Co
   1150 W San Carlos St
   San Jose, CA 95126
   Phone: 408-295-2182
   http://www.ocmcdonald.com/

B. Acosta Sheet Metal Manufacturing Company, Inc.
   930 Remillard Ct
   San Jose, CA 95122
   Phone: 408-275-6370
   http://www.acostamfg.com/

2.2 PRODUCTS
A. O.C. McDonald 10x4, 7x4, 12x3, 5x4 Rectangular Straight Ducting
   1. Location: Mechanical Room/Hallway/Great Room
   2. Material: 24 Gauge Galvanized Steel - Snaplock Seam

B. O.C. McDonald 4x7, 4x5, 5x4 Rectangular Elbow Ducting
   1. Location: Mechanical Room/Hallway/Great Room
   2. Material: 24 Gauge Galvanized Steel - Snaplock Seam
C. Acosta 5” Round Spiral Pipe
   1. Location: Mechanical Room
   2. Material: Prime G-90

D. Acosta 4” Round Wire Flex Duct
   1. Location: Hallway/Bedroom
   2. Material: wireflex
   3. Insulation: R value - 4.2

E. Acosta 90 Degree Elbow
   1. Location: Mechanical Room
   2. Material: Prime G-90

F. Acosta F-13 90 Degree Angle Boot
   1. Location: Bedroom
   2. Material: Prime G-90
   3. Dimensions: 4” Diameter to 12” x 3.5”

PART 3 - EXECUTION
3.1 INSTALLATION

A. Installation Requirements:
   1. Install according to manufacturer’s specifications.
SECTION 23 37 13
Diffusers, Registers, and Grilles

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes specifications for all diffusers, registers, and grilles

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. The Reggio Register Co.
   31 Jytek Road
   Leominster, MA 01453
   Phone: 1.800.880.3090
   Website: http://www.reggioregister.com/

2.2 PRODUCTS

A. Reggio Register Metal Grill Square Design
   1. Model Number: G412 no holes
   2. Inside Dimensions: 10” x 2⅛”
   3. Outside Dimensions: 12” x 3½”

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendation

END OF SECTION 23 31 00
SECTION 23 56 13
Solar Thermal Collectors

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the flat plate solar thermal collectors

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Free Hot Water

2146 Bering Drive
San Jose, CA 95131
Phone: 408.432.9900
Website: http://www.freehotwater.com/

2.2 PRODUCTS

B. 4’ x 10’ 8000 Series Flat Collector

1. Dimensions: 120’ X 48” X
2. Glazed Large Flat Panel
3. See manufacturer’s specifications for further information:

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer’s instructions

END OF SECTION 23 56 13
SECTION 23 72 15
Heat Recovery Ventilator (HRV)

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the HRV, part of the Messana Radiant Heating and Cooling system

1.2 SUBMITTALS

A. Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Messana Air-Ray Conditioning LLC

    2224 Albert Ln
    Capitola, CA 95010
    Phone: 1.855.729.6244
    Website: www.raymagic.com

2.2 PRODUCTS

A. Messana Air-Magic RR250 HRV

    1. Part number: AM1687
    2. 110V, 60Hz
    3. Blower: 120 cfm
    4. Dimensions: 20 1/2” x 10” x 28”
    5. Weight: 55 lbs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer’s instructions

END OF SECTION 11 31 13
SECTION 23 83 16
Radiant-Heating Hydronic Piping

PART 1 – GENERAL

1.1 SUMMARY
A. This section includes specifications for the radiant heating panels used throughout the house

1.2 SUBMITTALS
A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURER
A. Messana Air-Ray Conditioning LLC
   2224 Albert LN
   Capitola, CA 95010
   Phone: 855-729-6244
   Website: www.raymagic.com

2.2 PRODUCT
A. Ray Magic Panel
   1. Model: Standard
   2. Location: In ceiling throughout house
   3. Dimensions [L x W x H]: 8’ x 4’ x 2”
   4. Weight (dry): 2.63 lbs./ft³
   5. Radiant Tubing: PEOC Dowtex
      a. Diameter: 7/16” o.d. – 5/16” i.d.
      b. Spacing: 2 5/8”
      c. 61 ft. per circuit (two circuits per panel with 0.12 gal of water each)
   6. Heat Output:
a. Typical: 32.5 Btu/h/ft²
b. Max: 78.7 Btu/h/ft²

7. Cooling Output:
   a. Typical: 24.7 Btu/h/ft²
   b. Max: 38.4 Btu/h/ft²

B. Manifold
   1. Model: Standard
   2. Location: Mechanical Room
   3. Product Specs:
      a. Dimensions [L x W x D]: 8” x 2” x 8”
      b. Inlet Port Size: 1” or 1-1/4”
      c. Outlet Port Size: 5/8”
      d. Flow Rate: Max of 0.4 GPM

PART 3 – EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s recommendation

END OF SECTION 23 83 16
SECTION 23 83 33
Air to Water Heat Pump

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes specifications for the HVAC system in the house

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. Daikin Industries

1645 Wallace Dr., Suite 110
Carrollton, TX 75006
Phone: 972.245.1510
Fax: 972.245.1038
Website: www.daikin.com

2.2 PRODUCTS

A. Daikin Altherma split type heat pump outdoor unit

1. Model number: ERLQ018BAVJU

2. Product Specs:
   a. Dimensions [H x W x D]: 28 9/10" x 32 1/2" x 11 8/10"
   b. Weight (gross): 134 lbs.
   c. EER [efficiency]: 10.41
   d. Nominal heating capacity: 19,620 Btu/hr.
   e. Nominal cooling capacity: 24,570 Btu/hr.

A. Daikin Altherma Hydrobox indoor unit

1. Model number: EKHBX030BA3VJU
2. Product Specs:
   a. Dimensions [H x W x D]: 36 5/16” x 19 3/4” x 14 7/32”
   b. Weight (gross): 130 lbs.

PART 3 – EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s recommendation

   END OF SECTION 23 83 33
SECTION 23 84 16

Dehumidifier

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the radiant dehumidifier used in the Radiant House.

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Messana Air-Ray Conditioning LLC

2224 Albert Ln
Capitola, CA
Phone: 855.729.6244
Website: www.raymagic.com

2.2 PRODUCTS

A. Ray Magic Panel

1. Model Number: HI 250
2. Location: TBD
3. Dimensions [L x W x H]: 25.59” x 19.84” x 9.8”
4. Weight: 63.93 lbs.
5. Thermal Specifications
   a. Condensed Humidity: 6.34 gallons/day
   b. Refrigeration Power Consumption: 800 W
   c. Air Flow: 367.86 CFM
   d. Static Pressure Available:
      i. Maximum: 0.0201 feet of head
ii. Medium: 0.0184 feet of head
iii. Minimum: 0.0100 feet of head

e. Water Flow Rate: 63.40 gallons/hour

f. Water Circuit Head Loss: 1.6728 feet of head

g. Refrigerant Gas R134a: 0.4189 lbs.

h. Sound Power Level: 41 dB(A)

i. Sound Pressure Level: 33 dB(A)

6. Electrical Specifications

   a. Rated Power Consumption: 290 W

   b. Max. Power Consumption (Compressor + Speed 3): 320 W

   c. Rated Amps. Absorbed: 1.7 A

   d. Max. Amps. Absorbed: 1.9 A

   e. Production Rating: IP 44

   f. Power Supply: 230 Vac / 1 + N Ph / 50 Hz

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install in accordance with manufacturer’s recommendations.

END OF SECTION 23 84 16
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes information regarding the data logger and its adjacent systems, including the monitoring network and automation devices that will be in direct communication with the central processor.

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. Jameco ValuePro

1355 Shoreway Road
Belmont, CA 94002
Phone: 1.800.831.4242
Website: https://www.jameco.com

B. Cable To Go

3555 Kettering Blvd
Moraine, OH 45439
Phone: 1.800.506.9607
Website: http://www.cablestogo.com/

2.2 PRODUCTS

A. Cat 5e Ethernet Cable

1. Model Description: Jacketed, braided Cat 5e cable

2. See manufacturer's specifications for further information:
https://www.jameco.com/webapp/wcs/stores/servlet/Product_10001_10001_644615_-1

B. Copper Cable (Black)
   1. Model Description: Solid copper 22AWG insulated wire
   2. See manufacturer’s specifications for further information:
      https://www.jameco.com/webapp/wcs/stores/servlet/Product_10001_10001_36792_-1

C. Copper Cable (Red)
   1. Model Description: Solid copper 22AWG insulated wire
   2. See manufacturer’s specifications for further information:
      https://www.jameco.com/webapp/wcs/stores/servlet/Product_10001_10001_36856_-1

D. RJ45 Plug
   1. Model Description: Modular Plug for Cat 5 RJ45 – 100pk.
   2. See manufacturer’s specifications for further information:

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendations

END OF SECTION 25 13 10
SECTION 25 13 20
Integrated Automation Control & Monitoring Network

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes information regarding the control system and its adjacent systems, including the monitoring network and automation devices that will be in direct communication with the central processor.

1.2 SUBMITTALS

A. Product data

PART 2 – Products

2.1 MANUFACTURERS

A. Arduino

   Calle Huelva 2 - Ed.Villapalma
   18690 Almunecar (GR) - Spain
   Website: http://arduino.cc/en/

B. Marvel via Alco Service and Supply Co.

   11578 K-Tel Dr.
   Minnetonka, MN 55343
   Phone: 800.328.6019
   Website: www.alcosupply.com

C. RollerTrol

   Website: www.rollertrol.com

D. Autoslide Pty Ltd

   3/413 Victoria St
   Wetherill Park, NSW 2164 Australia
   Phone: 1.866.967.3669
Website: www.autoslide.com

E. Jameco Electronics
   1355 Shoreway Rd
   Belmont, CA
   Phone: 1.800.831.4242
   Website: www.jameco.com

F. Cables To Go (C2G)
   3555 Kettering Blvd
   Moraine, OH 45439
   Phone: 800.506.9607
   Website: www.cablestogo.com

G. Raspberry Pi
   Website: www.raspberrypi.org

H. Cisco
   170 West Tasman Dr.
   San Jose, CA 95134
   Phone: 1.800.553.6387
   Website: www.cisco.com

2.2 PRODUCTS

A. Arduino UNO
   1. Arduino Store Code: A000066
   2. Microcontroller: ATmega328
   3. Operating voltage: 5V
   4. Input voltage: 7-12V
   5. Flash memory: 32 KB
   6. Clock speed: 16 MHz
7. See manufacturer’s specifications for further information:
   http://www.arduino.cc/en/Main/ArduinoBoardUno

B. Arduino MEGA

1. Arduino Store Code: A000067
2. Microcontroller: ATmega2560
3. Operating voltage: 5V
4. Input voltage: 7-12V
5. Flash memory: 256 KB
6. Clock speed: 16 MHz
7. See manufacturer’s specifications for further information:
   http://arduino.cc/en/Main/ArduinoBoardMega2560

C. Marvel Power Window System

1. Model number: 4290
2. See distributor’s specifications for further information:
   http://www.alcosupply.com/products/marvel-power-window-system-129.cfm

D. RollerTrol Tubular Motor

1. Reference number: TMDC-12-25-15-28-NR
2. Operating voltage: 12V DC
3. See manufacturer’s specifications for further information:

E. Autoslide Sliding Door Motor

1. See manufacturer’s specifications for further information: http://www.autoslide.com

F. Jameco Cat 5e Ethernet Cable

1. Manufacturer number: 10X5-804TH-100VP
2. See manufacturer’s specifications for further information:
   https://www.jameco.com/Jameco/Products/ProdDS/644615.pdf
G. Jameco Wire Hook-up Solid 22 AWG (Black)
   1. Manufacturer number: 9313-0-R
   2. See manufacturer’s specifications for further information:
      https://www.jameco.com/Jameco/Products/ProdDS/36792.pdf

H. Jameco Wire Hook-up Solid 22 AWG (Red)
   1. Manufacturer number: 9313-2-R
   2. See manufacturer’s specifications for further information:
      https://www.jameco.com/Jameco/Products/ProdDS/36856.pdf

I. C2G Cat5 Modular Plug for Round Stranded Cable
   1. Model number: 11381
   2. Plug type: RJ45
   3. See distributor’s specifications for further information:

J. Raspberry Pi Assembled Board
   1. Manufacturer part number: RASPBERRY-MODB-512M
   2. See distributor’s specifications for further information:
      http://www.newark.com/raspberry-pi/raspbrry-modb-512m/model-b-assembled-board-only/dp/43W5302

K. Cisco Small Business Desktop Switch
   1. Series: 100
   2. Model number: SF100D-16-NA
   3. Ports: 16
   4. See distributor’s specifications for further information:
      http://www.newegg.com/Product/Product.aspx?Item=N82E16833150148&Tpk=sf-100d-16

PART 3 – INSTALLATION
3.1 INSTALLATION

A. Install according to manufacturer's instructions

END OF SECTION 25 13 20
SECTION 26 05 19
Low-Voltage Power Connectors & Conductors

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes specifications for low-voltage power connectors & conductors

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Belden

401 Pennsylvania Parkway, #200

Indianapolis, IN 46280

Phone: 510.438.9071

Website: http://www.belden.com/

2.2 PRODUCTS

A. Belden AWG #20 gage

1. 4 Conductor stranded

2. Shielded gray copper

3. CMR 75C

4. See manufacturer’s specifications for further information:


PART 3 - EXECUTION

3.1 INSTALLATION

A. Maybe be used for both exposed and concealed work in normal dry locations at

   temperatures not exceeding 90°C.
B. Primarily used in residential wiring as branch circuits for outlets, switches, and other
loads.
C. Copper conductors are annealed copper.
D. Stranded conductors are compressed stranded.

END OF SECTION 26 05 19
SECTION 26 05 20
Controls Wiring

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the wiring for the control systems

1.2 SUBMITTALS
A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Southwire
   9199 Cleveland Ave.
   Suite 100
   Rancho Cucamonga, CA 91730
   Phone: 919.989.2888
   Website: www.southwire.com
   Available at:
   1. Home Depot
B. GE
   3135 Easton Turnpike
   Fairfield, CT 06828
   Phone: 203.373.2211
   Website: www.ge.com
   Available at:
   1. Home Depot
C. Aurum Cables via Amazon.com

2.2 PRODUCTS
A. Southwire 22-4 CL3R Shielded Security Cable
   1. Model Number: 56910544
   2. Rating: 300 Volts
   3. Length: 500’
   4. Features:
      a. PVC jacket with flame-retardant PVC insulation
      b. Solid bare copper conductors
      c. UL listed
      d. See distributor’s specifications for further information:

B. Southwire 24/4 CAT5e Riser Cable
   1. Model Number: 56917945
   2. Length: 500’
   3. Features:
      a. Low-smoke PVC jacket
      b. 24-gauge cord
      c. Soft annealed copper conductors
      d. See distributor’s specifications for further information:
         http://www.homedepot.com/p/Southwire-500-ft-24-4-CAT5e-Riser-Cable-Gray-56917945/202316244#.UgrSeVfqpqN

C. GE 14-Gauge Speaker Wire
   1. Model Number: 87649
   2. Length: 100’
   3. Features:
      a. Extra-thick PVC insulation
b. See distributor’s specifications for further information:

http://www.homedepot.com/p/GE-100-ft-14-Gauge-Speaker-wire-clear-style-87649/202788268#.UgrTA1fgpqN

D. GE RG-6 Coaxial Cable

1. Model Number: 73287
2. Length: 100’
3. Features:
   a. F-connectors on each end for easy screw-on installation
   b. See distributor’s specifications for further information:

http://www.homedepot.com/p/GE-100-ft-RG-6-Coaxial-Cable-White-73287/202698864#.UgrTaFfgpqN

E. Aurum Ultra Series High Speed HDMI Extension Cable

1. Amazon Standard Identification Number: B009EAGMW2
2. Length: 35’
3. Features:
   a. 1080 audio return channel
   b. 24k gold-plated connectors with braided thick 26 AWG cable core
   c. ROHS compliant
   d. See distributor’s specifications for further information:

http://www.amazon.com/gp/product/B009EAGMW2/ref=oh_details_o05_s00_i01?ie=UTF8&psc=1

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendations

END OF SECTION 26 05 20
SECTION 26 05 26
Grounding and Bonding for Electrical Systems

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the grounding and bonding for electrical systems

1.2 SUBMITTALS

A. Product Data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Burndy

47 e Industrial Park Drive
Manchester, NH 03109
Phone: 800.346.4175
Website: www.burndy.com

B. Southwire

9199 Cleveland Ave.
Suite 100
Rancho Cucamonga, CA 91730
Phone: 919.989.2888
Website: www.southwire.com

Available at:

1. Home Depot

2.2 PRODUCTS

A. Burndy WEEB-Lug

1. Catalog: WEEB-LUG-8.0

2. Item number: 30020111
3. Dimensions: 1.6” x 0.87” x 0.47”

4. Features:
   a. See manufacturer’s specifications for further information:
      

B. Burndy WEEB DPF
   1. Material: 304 stainless steel
   2. Features:
      a. ETL listed to UL 467
      b. UL recognized to Subject Standard 2703
      c. Outdoor rated
      d. See manufacturer’s specifications for further information:
         

C. Southwire 6 Solid Bare Copper
   1. Model number: 10638502
   2. Rating: 600 volts
   3. Gauge: 6
   4. Length: 315 ft.
   5. Features:
      a. 1-UL listed
      b. See distributor’s specifications for further information:
         
         http://www.homedepot.com/p/Southwire-315-ft-6-Solid-BareCopper-Cable-
         10638502/202316341#.UgukhfpgqN

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendations

END OF SECTION 26 05 26
PART 1 - GENERAL

1.1 SUMMARY
A. This section includes specifications for the electrical housings, including raceways, conduits, boxes, and meter housing

1.2 SUBMITTALS
A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Allied Tube and Conduit available via Home Depot
   Website: http://www.allieddeg.us/

B. Southwire
   9199 Cleveland Ave.
   Suite 100
   Rancho Cucamonga, CA 91730
   Phone: 919.989.2888
   Website: www.southwire.com
   Available at: Home Depot

C. Thomas & Betts
   8155 T&B Boulevard
   Memphis, TN 38125
   Phone: 901.252.5000
   Website: http://www.tnb.com/pub/

D. Greenfield Industries, Inc.
   99 Doxsee Drive
Freeport, NY 11520-4782
Phone: 516.623.9230
Website: http://www.greenfieldny.com/

E. Halex
23901 Aurora Road
Cleveland, OH 44146
Phone: 1.800.749.3261
Website: http://www.halexco.com/

F. RACO
3902 West Sample Street
South Bend, IN 46619
Phone: 1.800.722.6437
Website: http://www.hubbell-raco.com/default.aspx

2.2 PERFORMANCE REQUIREMENTS
A. Comply with NFPA 70, “National Electrical Code.”

2.2 PRODUCTS
A. Allied 3/4” Electrical Metallic Tubing Conduit
   1. Model Number: 873044
   2. Material: Galvanized steel
   3. See manufacturer's specifications for further information:

B. Southwire 3/4’ Liquidtight Flexible Metal Conduit (LFMC)
   1. Titan – Type UL Conduit
   2. See manufacturer's specifications for further information:
http://www.southwire.com/products/TitanTypeUL.htm

C. Thomas & Betts REDDOT 17 cubic in 1-Gang Old Work Metal. Electrical Box
   1. Model Number: 72239
   2. UL listed and approved for outdoor use
   3. See manufacturer's specifications for further information:
      http://www.lowes.com/ProductDisplay?partNumber=72239-53911-S105E-RL&langId=-1&storeId=10151&productId=3419602&catalogId=10051&cmRelshp=req&rel=nofollow&w&cid=PDIO1

D. Greenfield 1-Gang Weatherproof Electrical Box
   1. Model Number: CBPS
   2. Internet Model Number: 202188604
   3. See manufacturer's specifications for further information:
      http://www.homedepot.com/p/Greenfield-1-Gang-Weatherproof-Electrical-Box-Blank-Cover-Gray-CBPS/202188604?MERCH=REC-NavPLPHorizontal1-1-NA-202188604-N#.Uf_ef5KG14c

E. Thomas & Betts Carlon 1-Gang 21 cubic in. Adjustable Electrical Box
   1. Model Number: B121ADJ
   2. See manufacturer's specifications for further information:

F. Thomas & Betts Carlon 2-Gang 34 cubic in. Adjustable Switch and Outlet Box
   1. Model Number: B234ADJC
   2. Internet Model Number: 100315472
   3. See manufacturer's specifications for further information:
G. Thomas & Betts Carlon 1-Gang 18 cubic in. Zip Switch and Outlet Box

1. Model Number: B118A
2. Internet Model Number: 100404124
3. See manufacturer’s specifications for further information:

   Switch-and-Outlet-Box-Case-of-100-B118A/100404124?N=2dq#.Ugu9Y1dAeUJ

H. RACO 1- Gang 6 cubic in. Round Ceiling Pan

1. Model Number: 8293
2. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/Raco-1-Gang-6-0-cu-in-Round-Ceiling-Pan-
   8293/100574367#.Ugu911dAeUJ

2.3 ACCESSORIES

A. Thomas & Betts Superstrut 3/4” Conduit Clamp

1. Model Number: Z703 3/4EG-25
2. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/Superstrut-3-4-in-Conduit-Clamp-Z703-3-4EG-
   25/202077399#.Ugu0WldAeUJ

B. Thomas & Betts Superstrut 1-5/8” Metal Framing Channel

1. Model Number: ZB14HS10PG
2. See manufacturer’s specifications for further information:

   http://www.homedepot.com/p/Superstrut-1-5-8-in-x-10-ft-Metal-Framing-Channel-
   ZB14HS10PG/100183826#.Ugu1FidAeUJ

C. Halex 3/4” Type LB Threaded Aluminum Conduit Body

1. Model Number: 58607
2. See manufacturer’s specifications for further information:

http://www.homedepot.com/p/Halex-3-4-in-Type-LB-Threaded-Aluminum-Conduit-Body-58607/100146504#.Ugu1dVdAeUJ

D. Raco 3/4” Steel EMT Set-Screw Connector

1. Model Number: 2003B5

2. See manufacturer’s specifications for further information:


PART 3 - EXECUTION

3.1 INSTALLATION

A. Install outdoor raceways according to:

1. Exposed or Concealed: IMC.

2. Underground, Single Run: RNC.

3. Connection to Vibrating Equipment: LFMC.

4. Boxes and Enclosures: Metallic, NEMA 250, Type 3R or Type 4.

B. Install indoor raceways according to:

1. Exposed or Concealed: EMT.

2. Connection to Vibrating Equipment: FMC; in wet or damp locations, use LFMC.

3. Damp or Wet Locations: IMC.

4. Boxes and Enclosures: Metallic, NEMA 250, Type 1, unless otherwise indicated.

C. Install raceways and conduits according to manufacturer’s instructions

1. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

2. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.
3. Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 1-inch- (25-mm-) thick concrete cover.

4. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

5. Space raceways laterally to prevent voids in concrete.

6. Install conduit larger than 1-inch (27-mm) trade size, parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.

7. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.

8. Raceways Embedded in Slabs:
   a. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

9. Install pull wires in empty raceways.

10. Connect motors and equipment subject to vibration, noise transmission, or movement with a 72-inch (1830-mm) maximum length of flexible conduit.

11. Install raceways and cables concealed within finished walls, ceilings, and floors unless otherwise indicated.

12. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

13. Installation of Hangers and Supports:
a. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in this article.
b. Separate dissimilar metals and metal products from contact with wood or cementitious materials, by painting each metal surface in area of contact with a bituminous coating or by other permanent separation.
14. Raceway Support Methods: In addition to methods described in NECA 1, [EMT] [IMC] [and] [RMC] may be supported by openings through structure members, as permitted in NFPA 70.
15. Multiple Raceways or Cables: Install on trapeze-type supports fabricated with steel slotted channel.
16. Strength of Support[ and Seismic-Restraint] Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static[ and seismic] loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
17. 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:
a. To Wood: Fasten with lag screws or through bolts.
b. To New Concrete: Bolt to concrete inserts.
c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
d. To Existing Concrete: Expansion anchor fasteners.
e. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] [Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69]
18. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount on
slotted-channel racks attached to substrate.

END OF SECTION 26 05 33
SECTION 26 05 83
Wiring Connections

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the wiring connections

1.2 SUBMITTALS
A. Product Data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Shoals Technologies Group
   1400 Shoals Way
   Portland, TN 37148
   Phone: 615.451.1400
   Website: www.shoals.com

2.2 PERFORMANCE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application
B. Comply with NFPA-70

2.3 PRODUCTS
A. Shoals Interconnect System Y-Joints
   1. Model number: STG.ICY.10.12
   2. Maximum voltage: 1000V
   3. Maximum DC current: 20 (12AWG)/30A (10AWG, 8AWG)
   4. Certifications:
      a. UL9703 for 600V and 1000V systems
5. Features:
   a. Resistance welded joints
   b. See manufacturer’s specifications for further information:

PART 3 - EXECUTION

3.1 INSTALLATION

    A. Install in accordance with manufacturer’s recommendations

      END OF SECTION 26 05 83
SECTION 26 09 23
Lighting Control Devices

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the wall mounted switches and high-voltage relays for light control

1.2 SECTION REQUIREMENTS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. WattStopper

2800 De La Cruz Blvd.
Santa Clara, CA 95050
Phone: 408.988.5331
Website: http://www.wattstopper.com/

B. SainSmart

5251 West 16th Place, Suite 200
Leawood, Kansas 66211
Phone: 323.372.3043
Website: http://www.sainsmart.com/

2.2 PRODUCTS

A. WattStopper 0-10V Fluorescent Architectural Dimmer

1. Model Number: ADF-120277

2. See manufacturer’s specifications for further information:


B. SainSmart DC Controlled Relay Board
1. Model Number: 20-018-102

2. See manufacturer’s specifications for further information:


PART 3 – EXECUTION

3.1 INSTALLATION

   A. Install all products according to manufacturer’s instructions

   END OF SECTION 26 09 23
SECTION 26 24 16

Panelboards

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes panelboards

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric

   Phone: 888.778.2733

   Website: http://www.schneider-electric.com/site/home/index.cfm/us/

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in
   NFPA 70, by a qualified testing agency, and marked for intended location and
   application.

B. Comply with NEMA PB 1.

2.3 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush and Surface-mounted cabinets; NEMA
   250, Type 1.
   1. Hinged Front Cover: Entire front trim hinged to box and
      with standard door within hinged trim cover.

B. Incoming Mains Location: Side

C. Phase, Neutral, and Ground Buses: Tin-plated aluminum.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Tin-plated copper.
   2. Main and Neutral Lugs: Mechanical type.
   3. Ground Lugs and Bus Configured Terminators: Mechanical type.
E. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.


2.4 DISTRIBUTION PANELBOARDS

A. Mains: Circuit breaker

B. Branch Overcurrent Protective Devices: For circuit-breaker frame sizes 125 A and smaller: plug-in circuit breakers.

C. Main Service Panel

1. Service panel for connecting grid, PV array, and house sub-panels.

2. Schneider Electric NF3000G3, 200A mains breaker rating

3. See manufacturer’s specifications for further information:

   http://products.schneider-electric.us/products-services/products/lighting-control/powerlink/3000-level-system/3000-level-g3-controller/

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground- fault protection (6-mA trip).

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
C. Surge Breakers
   1. Protect house electric system from voltage spikes
   2. Schneider Electric
   3. See manufacturer's specifications for further information:
      http://ecatalog.squared.com/fulldetail.cfm?partnumber=QO2175SB

B. Arc Fault Breaker
   1. Schneider Electric QO120CAFIC
   2. See manufacturer's specifications for further information:
      http://ecatalog.squared.com/fulldetail.cfm?partnumber=QO120CAFIC

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Referenced NECA and NEMA standards in first paragraph below include similar
      requirements. See "Testing and Inspecting" Article in the Evaluations.
   B. Receive, inspect, handle, store and install panelboards and accessories according to
   C. NECA 407 and NEMA PB 1.1.
   D. Comply with mounting and anchoring requirements specified in Section 260500
      "Common Work Results for Electrical."
   E. Ensure that, whatever height is retained for top of trim in first paragraph below, the
      operating handle of top-most switch or circuit breaker, in on position, is not higher than
   F. 79 inches (2000 mm) above finished floor or grade.
   G. Mount top of trim 90 inches above finished floor unless otherwise indicated.
   H. Arrange conductors into groups; bundle and wrap with wire ties.
   I. Create a directory to indicate installed circuit loads and incorporating Owner's final
      room designations. Obtain approval before installing. Use a computer or typewriter to
      create directory.

END OF SECTION 26 24 16
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the electricity metering devices

B. Electrical components, devices, and accessories: listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric

North American Division

1415 Roselle Road

Palatine, IL 60067

Phone: 1.888.788.2733

Website: http://www.schneider-electric.com/site/home/index.cfm/ww/

2.2 PRODUCTS

A. Square D Meter Socket by Schneider Electric

1. Model Number: UTRS202B Meter Socket

2. See manufacturer’s specifications for further information:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Install equipment for utility company metering. 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.

END OF SECTION 26 27 13
SECTION 26 27 26
Wiring Devices

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the wiring devices

1.2 SUBMITTALS
A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS
A. Southwire
   9199 Cleveland Ave.
   Suite 100
   Rancho Cucamonga, CA 91730
   Phone: 919.989.2888
   Website: www.southwire.com
   Available at:
   1. Home Depot

B. Shoals Technologies Group
   1400 Shoals Way
   Portland, TN 37148
   Phone: 615.451.1400
   Website: www.shoals.com

C. Leviton Mfg. Company Inc.
   201 North Service Rd.
   Melville, NY 11747
   Phone: 1.800.323.8920
2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA-70

2.3 PRODUCTS

A. Southwire 14/2 BX/AC-90 Cable
   1. Model number: 61029323
   2. Length: 100 ft.
   3. Materials:
      a. Soft-drawn copper
      b. Moisture-resistant, flame retardant paper covering
      c. Exterior aluminum armor
   4. Certifications:
      a. UL listed
      b. CSA certified
   5. See distributor’s specifications for further information:
      http://www.homedepot.com/p/Southwire-14-2-X-100-ft-BX-AC-90-Cable-61029323/202819634#.Uquxf1fpgqM

B. Southwire 12/2 BX/AC-90 Cable
   1. Model number: 61023101
   2. Length: 250 ft.
   3. Rating: 600V
   4. Certifications:
      a. UL listed
b. CSA certified

5. See distributor’s specifications for further information:


C. Southwire 10/3 MC Stranded Electrical Cable

1. Model number: 69118805
2. Length: 125 ft.
3. Rating: 600V
4. Certifications:
   a. UL listed
5. See distributor’s specifications for further information:

http://www.homedepot.com/p/Southwire-10-3-X-125-ft-MC-Stranded-Electrical-Cable-69118805/202250422#.Ugu0H1fgpqM

D. Southwire 10/2 BX/AC-90 Cable

1. Model number: 61029805
2. Length: 125 ft.
3. Certifications:
   a. UL listed
   b. CSA certified
4. See distributor’s specifications for further information:


E. Southwire Black 6-3 Romex NM-B W/G Wire

1. Model number: 63950002
2. Length: 125 ft.
3. Rating: 600V
4. Certifications:
   a. 1-UL listed
   b. CSA certified

5. See distributor’s specifications for further information:
   http://www.homedepot.com/p/Southwire-125-ft-Black-6-3-Romex-NM-B-W-G-Wire-63950002/202316279#.Ugu1gVfgpqM

F. Shoals 2000V AWG 10 PV Wire

1. Ratings:
   a. UL listed as 2000V type PV
   b. UL listed as RHH?RHW-2
   c. 90C temperature rating
   d. UL subject 4703
   e. Meets the requirement of UL 854 for TYPE USE-2
   f. NEC Article 690 standards

2. See manufacturer's specifications for further information:

G. Leviton feed-through, tamper resistant AFCI receptacles

1. Model number: AFTR1-W (Arc Fault Circuit Interrupter receptacles)

2. Product specs:
   a. 125 V, 15A
   b. Complies with: NEMA WD 1, NEMA WD 6, Configuration 5-20R, and UL 498

3. See manufacturer's specifications for further information:
   http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber= AFTR1-W&section=55035&minisite=10251

H. Leviton duplex GFCI convenience receptacles
1. Model number: S7899-GY (Ground Fault Circuit Interrupter receptacles)

2. Product specs:
   a. 125 V, 15A
   b. straight blade, feed-through type
   c. Complies with: NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

3. See manufacturer’s specifications for further information:
   
   http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=S7899-GY&section=42318&minisite=10251

I. Leviton wall plates, finished areas

1. Model number: PJ26-W

2. Product specs:
   a. Smooth, high-impact thermoplastic fastened with metal screws having matching plate color
   b. Complies with CSA, UL524

3. See manufacturer’s specifications for further information:
   
   http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber= PJ26-W&section=42938&minisite=10251

J. Leviton wall plates, damp locations

1. Model number: 4992 (Raintight and Weather Resistant Wallplate)

2. Product specs:
   a. Thermoplastic with spring-loaded lift cover, and listed and labeled for us in wet locations
   b. Complies with CSA, UL524

3. See manufacturer’s specifications further information:
   
   http://www.leviton.com/OA_HTML/ProductDetail.jsp?partnumber=4992&section=429
PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Install devices and assemblies plumb, level, and square with building lines.

C. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

D. Install unshared neutral conductors on line and load side of dimmers.

E. Mount devices flush, with long dimension vertical, and grounding terminal of receptacles on top unless otherwise indicated. Group adjacent devices under single, multigang wall plates.

END OF SECTION 26 27 26
SECTION 26 28 16
Enclosed Switches and Circuit Breakers

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the enclosed switches and circuit breakers

1.2 SUBMITTALS
A. Product data

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Milbank

4801 Deramus
Kansas City, MO 64120
Phone: 877.483.5314
Website: www.milbankmfg.com

B. Eaton

1111 Superi Avenue
Cleveland, OH 44114
Phone: 216.523.5000
Website: www.eaton.com

2.2 PERFORMANCE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PRODUCTS
A. Milbank U3832 30A Fusible disconnect

1. Features:
a. 240 VAC
b. 30 amp
c. Power rating: 3 HP
d. NEMA 3R
e. UL listed
f. See manufacturer’s specifications for further information:
   http://www.milbankworks.com/catalogs/CO.pdf

B. Eaton Single-Phase Main Lug Loadcenter
1. Model number: BR3040L200
2. Features:
   a. Main ampere rating: 200
   b. Spaces: 30
   c. Circuits: 40
   d. 1 phase/3 wire
e. See manufacturer’s specifications for further information:
   http://www.eaton.com/ecm/groups/public/@pub/@electrical/documents/content/vol01_tab01.pdf

C. Eaton Circuit Breakers
1. Types:
   a. 15A single-pole
   b. 20A single-pole
   c. 30A double-pole
d. 20A double-pole
e. 15A double-pole
2. See manufacturer’s specifications for further information:

http://www.eaton.com/ecm/groups/public/@pub/@electrical/documents/content/vol01_tab01.pdf

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated

B. Install fuses in fusible devices

C. Comply with NECA 1

END OF SECTION 26 28 16
SECTION 26 31 00
Photovoltaic Collectors

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes photovoltaic collectors

1.2 SUBMITTALS

A. Product data

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Bosch

Robert-Bosch -Straße 1
99310 Arnstadt
Germany
Phone: 49.0.3628.664.0
Website: http://www.bosch-solarenergy.com/en/bosch_se_online/home_1.html

B. Tigo Energy

420 Blossom Hill Rd
Los Gatos, CA 95032
Phone: 408.402.0802
Website: http://www.tigoenergy.com/

C. Sunplanter


D. Silverback Solar

327 Coral Street
Santa Cruz, CA 95060
877.765.2759
Website: www.silverbacksolar.com

2.2 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 “National Electrical Code”

B. Meets UL 1703 requirements and the ASTM standards applied to photovoltaic panels

2.3 DEVICES

A. Modules

1. Manufacturer: Bosch

2. Mono-crystalline photovoltaic module for electricity generation

3. Bosch Solar Module c-Si M 60 NA42117 (255Wp)

4. See manufacturer’s specifications for further information:
   
   http://www.bosch-
   
   solarenergy.com/media/bosch_se_online/alle_pdfs/technische_dokumente_1/datenbl
   
   aetter/kristalline_module_/m_60_na42117/Bosch_Solar_Module_c_Si_M_60_NA421
   
   17_englisch_USA_US.pdf

B. Accessories

1. Module Maximizers

   a. Manufacturer: Tigo Energy

   b. Model number MM-ES50

   c. Maximizer to extract the maximum power from each solar module

   d. See manufacturer’s specifications for further information:

   http://www.tigoenergy.com/sites/default/files/attachments/mm_es_datasheet.pdf

2. Maximizer Management Unit

   a. Manufacturer: Tigo Energy

   b. Communicator between the Panel Maximizers and the inverter

   c. See manufacturer’s specifications for further information:

3. Energy Gateway
   a. Manufacturer: Tigo Energy
   b. Provides robust and scalable wireless communications with each optimizer.
      This solution provides clear, concise communication with the optimizers on the array.
   c. See manufacturer’s specifications for further information:
      http://www.tigoenergy.com/sites/default/files/attachments/gateway_datasheet_en_0.pdf

4. Roof Mounting
   a. Manufacturer: Sunplanter
   b. Aluminum rails act as roof support and as PV racking system
   c. Product sheets not disclosed: patent pending technology

5. Module Bonding Clips, Tek Screws, and WEEBS
   a. Manufacturer: Silverback Solar
   b. Aluminum clip attached to solar panel mounting rails fastened with self-drilling tek screws.
   c. See manufacturer’s specifications for further information:
      http://www.silverbacksolar.com/docs/silverback__WEEB.PDF

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Installation
      1. Install solar modules and maximizers in accordance with manufacturer’s written recommendations and reference drawings for location.
      2. Set modules level and true to line and anchor securely to Sunplanter rails to meet torque pressures required in manufacturer’s instructions.
3. Repair or replace any solar modules, mountings, or maximizers damaged during transportation or installation.

END OF SECTION 26 31 00
PART 1-GENERAL

1.1 SUMMARY

A. This section includes the generators used to power tools and lights for assembling and disassembling the house.

1.2 SUBMITTALS

A. Product data

PART 2 - PRODUCTS

2.1 GENERATOR REQUIREMENTS

A. Sound Rating: No more than 60 dB at 50 ft.

B. Must be UL listed.

C. Will not leak liquids onto the construction site.

2.2 GENERATOR ASSEMBLY

A. Honda Inverter Generator - EU6500iS

1. 389cc Gasoline Powered Engine

2. Run Time: 4.7 hours (rated load), 14 hours (¼ rated load)

3. Outputs:

   a. 20A 125V Duplex

   b. 30A 125V Locking Plug

   c. 30A 125/250V Locking Plug

4. Maximum Output: 6500 Watts (54.1A @ 120V / 27.1A @ 240V) F. Rated Output: 5500 Watts (45.8 @ 120V / 22.9A @ 240V)

5. Operating Noise: 60 dB(A) (rated load), 52 dB(A) (1/4 load) at 7m using the (A) scale
6. See manufacturer's specifications for further information:

http://powerequipment.honda.com/generators/models/eu6500is

PART 3-EXECUTION

3.1 INSTALLATION

A. Wheel outside to use as needed. Store when not in use.

B. Use caution while filling the generator in order to prevent spills.

C. Wear hearing protection when within 50 feet to prevent hearing loss.

END OF SECTION 26 32 13
SECTION 26 33 13
Batteries

PART 1 GENERAL

1.1 SUMMARY

A. This section includes batteries for smoke detector battery backup and for the television remote control

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Duracell

Berkshire Corporate Park
Bethel, CT 06801
Phone: 1.800.551.2355
Website: http://www.duracell.com/en-US/index.jsp

2.2 BATTERIES FOR SMOKE DETECTOR BATTERY BACK UP

A. Product: Duracell CopperTop 9 Volt

1. Classification: Alkaline


2.1 Anode: Manganese Dioxide

2.2 Electrolyte: Potassium Hydroxide

i. Designation: ANSI-1604A, IEC-6LR61
ii. Nominal Voltage: 9 Volts

2.3 BATTERIES FOR TELEVISION REMOTE CONTROL

A. Product: Duracell CopperTop AA

1. Classification: Alkaline

2. Chemical System:

a. Cathode: Zinc
b. Anode: Manganese Dioxide

c. Electrolyte: Potassium Hydroxide
   i. Designation: ANSI-15A, IEC-LR6
   ii. Nominal Voltage: 1.5 Volts

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install batteries in equipment according to the instruction manual.

   END OF SECTION 26 33 13
SECTION 26 50 00
Lighting

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the house lighting

1.2 SUBMITTALS

A. Product Data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Energy Savings Technology, LLC
   562 East Weddell Drive, Suite 7
   Sunnyvale, CA 94089
   Phone: 408.744.1602
   Website: www.est-es2.com

B. Broan-NuTone LLC
   926 W State St.
   Hartford, WI 53027
   Phone: 262.673.4340
   Website: www.nutone.com

C. Y Lighting LLC
   1850 Mt. Diablo Blvd
   Walnut Creek, CA 94596
   Phone: 866.428.9289
   Website: www.ylighting.com

D. Lamps Plus Inc.
   20250 Plummer St
E. Hampton Bay

Available at:

1. Home Depot

2.2 PRODUCTS

A. EST Lighting LED 2” Linear Down light

1. Model: M109 D

2. See manufacturer’s specifications for further information:

B. EST Lighting LED 2” Recessed Down light

1. Model: DL 2 BL

2. See manufacturer’s specifications for further information:

C. EST LED Pendant light

1. Model: P38


D. NuTone 70 CFM Fan/Light with Transparent Polymeric Lens and Resin Grille

1. Model number: 769RFT

2. Location: Bathroom

3. Material and finish:
   a. Housing: galvanized steel
   b. Grille: white polymeric
4. Motor: 115vAC, 60Hz, 1.1 amp

5. Electrical rating: 120V, 60Hz, 1.3A

6. See manufacturer’s specifications for further information:
   
   http://www.nutone.com/common/productDigitalAssethandler.ashx?id=fc258f95-2e43-45c1-8f82-77a10dddb7a8

E. Y Lighting Zenith Vanity Light
   
   1. Item number: OXY-ZENITH-VANITY
   
   2. Model: 2-5142
   
   3. Dimensions: 47.6” x 2.88” x 3.1”
   
   4. See manufacturer’s specifications for further information:
      
      http://www.ylighting.com/oxy-zenith.html

F. Lamps Plus Matte Silver Up and Down Wall Light
   
   1. Style number: R7830
   
   2. Dimensions: 6 3/4” x 2 1/2” x 3 3/4”
   
   3. See manufacturer’s specifications for further information:
      

G. Hampton Bay 12V Low Voltage LED 8 Piece Stainless Steel Deck Light Kit
   
   1. Model number: HD28101BS8
   
   2. Certifications:
      
      a. 1-UL listed
      b. CSA listed
   
   3. See distributor’s specifications for further information:
      

PART 3 - EXECUTION
3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendations

END OF SECTION 26 50 00
SECTION 26 50 01
Bathroom Exhaust Fan and Light

PART 1 – GENERAL

1.1 SUMMARY
A. This section includes the exhaust fan for the bathroom

1.2 SUBMITTALS
A. Product Data

PART 2 – PRODUCTS

2.1 MANUFACTURERS
A. NuTone

9825 Kenwood Rd., Ste. 301
Cincinnati, OH 45242
Phone: 1.888.336.3948
Website: www.nutone.com

2.2 PRODUCTS
A. NuTone 70 CFM Ceiling Exhaust Fan with Light

1. Model Number: QTN110LE
2. Location (in house): Bathroom
3. Dimensions [L x W x H]: 10.5” x 11.375” x 7.625”
4. Weight: 10.6 lbs.
5. Wattage: 18 W
6. See manufacturer’s specifications for further information:

2.3 ACCESSORIES
A. Broan Roof Vent Kit
   1. Model Number: RVK1A
   2. Weight: 3 lbs.
   3. See manufacturer's specifications for further information:
      http://www.homedepot.com/p/Broan-Roof-Vent-Kit-RVK1A/100344509#specifications

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install NuTone 70 CFM Ceiling Exhaust Fan with Light according to manufacturer’s instructions

END OF SECTION 26 50 01
SECTION 32 93 00

Plants

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the exterior plants

1.2 Submittals

A. Product data

PART 2 - PRODUCTS

2.1 PLANTING MATERIALS

A. Shrub, Grass, and Flower Species Used: Listed by common name, Latin name. Nursery grown with healthy root systems, healthy structure, and free of insects, eggs, larvae, defects, and disfigurement.

1. Deer Grass (*Muhlenbergia rigens*)
2. Windmill Palm (*Trachycarpus fortunei*)
3. Lavender (*Lavandula*)
4. Bush Monkey Flower (*Mimulus aurantiacus*)
5. Golden Goddess (*Bambusa multiplex*)
6. Rosemary (*Rosmarinus officinalis*)
7. Lion’s Tail (*Lenonotis leonurus*)
8. Scarlet Bugler (*Penstemon barbatus*)
9. Kangaroo Paws (*Anigozanthos bicolor*)
10. *Aloe Cameronii*
11. Bush Marigold (*Tagetes lemmonii*)
12. *Clysto Cactus Strausii*
13. *Aloe Striata*
14. Dyckia Fosterana Hybrid
15. Aloe Plicatillis
16. Aeonium Zorcoft

B. Tree Species Used: Listed by common name, Latin name, size (W x H). Nursery grown, with healthy root systems, well-shaped, fully branched, healthy, and free of insects, eggs, larvae, defects, and disfigurement.

1. Windmill Palm, *Trachycarpus Fortunei*, 1 ft / 10-15 ft (trunk width/ foliage width) x 30-60 ft (height)

C. Ground Covers Used: N/A – Install as desired in future

PART 3 - EXECUTION

3.1 PREPARATION

A. Planting Bed Establishment: Loosen subgrade to a depth of 6 inches. Remove stones sticks, roots, and rubbish. Spread planting soil mixture to a depth of 6 inches, but not less than required to meet finish grades. Work first layer into top of loosened subgrade.

B. Trees and Shrubs: Excavate pits with sides sloped inward and with bottom of excavation slightly raised at center to assist drainage. Excavate approximately three times as wide as ball diameter. Scarify sides of plant pit smeared or smoothed during excavation.

1. Set trees and shrubs plumb and in center of pit with top of ball flush with 1 inch adjacent finish grades.

2. Remove burlap and wire baskets from tops of balls and partially from sides, but do not remove from under balls. Carefully remove root balls from containers without damaging root ball or plant. Do not use planting stock if ball is cracked or broken before or during planting operation.

3. Place planting soil mix around ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water
thoroughly before placing remainder of backfill. Water again after placing and tamping final layer of planting soil mix.

4. Prune, thin, and shape trees and shrubs after planting.
   i. Ground Cover, Grasses, and Flowers:

5. Dig holes large enough to allow root spread, obeying directions written on plant label for spacing and arrangement.

6. Plant stock working soil around roots and leaving a slight saucer around plants to hold water. Obey grower and other directions on soil type and amendments needed/watering patterns needed, and amend soil/watering patterns accordingly

7. Water after planting. Do not cover plant crowns with wet soil.

8. Fertilize and feed plants according to directions as needed

C. Edgings: Install edgings and anchor with stakes driven below top elevation of edging.

3.2 MAINTENANCE

A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings.
   Spray or treat as required to keep trees and shrubs free of insects and disease. Install support stakes to combat the effects of high wind and/or inclement weather
   1. Maintain trees and shrubs until established, but not less than six months.

B. Ground, Grass, and Flower Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.
   1. Maintain ground covers and plants until established, but not less than six months.

END OF SECTION 32 93 00
SECTION 41 20 00
Crane and Hoists

PART 1 - GENERAL

1.1 SUMMARY

A. This specification includes the requirements, terms of use, and product data of a mobile crane used to unload and load the modules of the house for the competition.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Terex

106 12th Street SE
Waverly, IA 50677
Phone: +1 877 794 5284
Fax: +1 855 891 3089

2.2 MODEL

A. T-340-1 Truck Crane

B. See manufactures specifications at:
http://www.terex.com/main.php?obj=prod&action=VIEW&id=d65db72ae72987e738c2ee4044594260&nav=prod&cid=487c16c8ff14 5d0843f57512eafb8592

2.3 GENERAL NOTES

A. Rated loads as shown on Lift Charts pertain to this machine as originally manufactures and equipment. Modifications to the machine or use of optional equipment other than that specified can result in reduction of Capacity.

B. Construction equipment can be hazardous if improperly operated or maintained. Operation and maintenance of this machine shall be in compliance with the information in the operator’s Parts and Safety Manuals supplied with this machine. If these manuals are missing, order replacements from the manufacture through your distributor.
C. These warnings do not constitute all of the operating conditions for the crane. The operator and job site supervision must read the operators manual, CIMA safety manual, and applicable OSHA regulations. And ASME safety standards for cranes.

D. This crane and its load ratings are in accordance with per crane and shovel association, standard no. 4 SAE crane load stability test code J765A, SAE method of test for crane structure J1603 and applicable safety code for cones, derricks and hoists, ASME/ANSI b30.5

2.4 CAPACITIES

A. Maximum Lifting Capacity: 40 t (36.36 mt)

B. Maximum Boom Length: 30 - 94 ft (9.23 - 28.49 m)

C. Elevation Degree (min to max.): -4 to 77 degrees

D. Standard Jib Length: 32-49 ft (9.75-14.86m)

E. Optional Jib Length: 32 ft (9.75m)

F. Maximum Tip Height with Jib:147 ft (44.81m)

G. Drive/Steer: 6X4X2

H. Engine Model: Cummins ISC 300

I. Horsepower: 300 hp ( 224 kW)

J. Max Speed: 60 mph (96 km/h)

K. Max Gradeability: 56%

L. Overall Length: 26 ft 4 in (8.03m)

M. Overall Width: 8 ft (2.46m)

N. Overall Height: 10 ft 8.75 in (3.27m)

O. Lightest Gross Vehicle Weight: (minimum counterweight) 47,101 lb. (21,365 kg.)

P. Gross Vehicle Weight Typical Equipment: (maximum counterweight) 57,275 lbs. (25,979 kg)

PART 3-EXECUTION
3.1 SETUP

A. Crane load ratings are based on the crane being leveled and standing on a firm, uniform supporting surface.

B. Crane load ratings on outriggers are based on all outrigger beams being fully extended or in the case of partial extension ratings mechanically pinned in the appropriate position, and the tires free of the supporting surface.

C. Crane load ratings on tires depend on appropriate inflation pressure and the tire conditions. Caution must be exercised when increasing air pressures in tires. Consult Operator’s Manual for precautions.

D. Use of jibs, lattice–type boom extensions, or fourth section pullouts extended is not permitted for pick and carry operations.

E. Consult appropriate section of the Operator’s and Service Manual for more exact description of hoist line reeving.

F. The use of more parts of line than required by the load may result in having insufficient rope to allow the hook block to reach the ground.

G. Properly maintained wire rope is essential for safe crane operation. Consult Operator’s Manual for proper maintenance and inspection requirements.

H. When spin-resistant wire rope is used, the allowable rope loading shall be the breaking strength divided by five (5), unless otherwise specified by the wire rope manufacturer.

I. Do not elevate the boom above 60°unless the boom is positioned in-line with the crane’s chassis or the outriggers are extended. Failure to observe this warning may result in loss of stability.

3.2 – OPERATION

A. Crane load ratings must not be exceeded. Do not attempt to top the crane to determine allowable loads.
B. When either radius or boom length, or both, are between listed values, the smaller of the two listed load ratings shall be used.

C. Do not operate at longer radii than those listed on the applicable load rating chart (cross hatched areas shown on range diagrams).

D. The boom angles shown on the Capacity Chart give an approximation of the operating radius for a specified boom length. The boom angle, before loading, should be greater to account for boom deflection. It may be necessary to retract the boom if maximum boom angle is insufficient to maintain rated radius.

E. Power telescoping boom sections must be extended equally.

F. Rated loads include the weight of hook block, slings, and auxiliary lifting devices. Their weights shall be subtracted from the listed rated load to obtain the net load that can be lifted. When lifting over the jib the weight of any hook block, slings, and auxiliary lifting devices at the boom head must be added to the load. When jibs are erected but unused add two (2) times the weight of any hook block, slings, and auxiliary lifting devices at the jib head to the load.

G. Rated loads do not exceed 85% on outriggers or 75% on tires, of the tipping load as determined by SAE Crane Stability Test Code J765a. Structural strength ratings in chart are indicated with an asterisk (*).

H. Rated loads are based on freely suspended loads. No attempt shall be made to drag a load horizontally on the ground in any direction.

I. The user shall operate at reduced ratings to allow for adverse job conditions, such as: Soft or uneven ground, out of level conditions, high winds, side loads, pendulum action, jerking or sudden stopping of loads, hazardous conditions, experience of personnel, two machine lifts, traveling with loads, electric wires, etc., (side pull on boom or jib is hazardous). Derating of the cranes lifting capacity is required when wind speed exceeds 20 MPH. the center of the lifted load must never be allowed to move more than 3* feet
off the center line of the base boom section due to the effects of wind, inertia, or any combination of the two. Use 2 feet off the center line of the base boom for a two section boom, 3 feet for a three section boom, or 4 feet for a four section boom.”

J. The maximum load which can be telescoped is not definable, because of variations in loadings and crane maintenance, but it is permissible to attempt retraction and extension if load ratings are not exceeded.

K. Load ratings are dependent upon the crane being maintained according to manufacturer’s specifications.

L. It is recommended that load handling devices, including hooks, and hook blocks, be kept away from boom head at all times.

M. 360°capacities apply only to machines equipped with a front outrigger jack and all five (5) out- rigger jacks properly set. If the front (5th) outrigger jack is not properly set, the work area is restricted to the over side and over rear areas as shown on the Crane Working Positions diagram. Use the 360°load ratings in the overside work areas.

N. Do not lift with outrigger beams positioned between the fully extended and intermediate (pinned) positions.

O. Truck Cranes not equipped with equalizing (bogie) beams between the rear axles may not be used for lifting “on tires”. Truck Cranes equipped with equalizing beams and rear air suspension should “dump” the air before lifting “on tires”.

3.3 SPECIAL RESTRICTIONS

1. Crane may not leave access road when on the National Mall. Crane is not allowed to travel on any of the grass on the mall.

2. Crane must wait aside the National mall for Solar Decathlon Operations Director to approve site access.

END OF SECTION 41 20 00
PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the terms of use, requirements, and product data for a boom lift to be used during the assembly and disassembly of the house.

1.2 STANDARDS OF COMPLIANCE

A. ANSI A92.5
B. CSA B354.4
C. CE Compliance
D. AS 1418.10

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Genie

2.2 PRODUCTS

A. Z-34/22 DC

1. Measurements

a. Working Height Maximum: 40.5 ft
b. Platform Height Maximum: 34.5 ft
c. Horizontal reach Maximum: 22.25 ft
d. Up and Over Clearance: 14.9 ft
e. Platform Length: 2.5 ft
f. Platform Width: 4.5 ft
g. Height – Stowed: 6.5 ft
h. Length – Stowed: 18.5 ft
i. Storage Height: 7.5 ft
j. Storage Length: 13.5 ft
k. Wheelbase: 6 ft
l. Ground clearance – center: 6 in

2. Productivity
   a. Lift Capacity: 500 lbs.
   b. Platform Rotation: 180 Degrees
   c. Vertical Jib Rotation: 139 Degrees
   d. Drive Speed – Stowed: 4 mph
   e. Drive Speed-Raised: .68 mph
   f. Gradeability stowed: 30%
   g. Turning Radius- Inside: 5ft 9 in
   h. Turning Radius-Outside: 13 ft 1 in
   i. Controls: 24V DC proportional
   j. Drive: 2WD
   k. Jib: 4 ft boom
   l. Tires: Air Filled

3. Power
   a. Power source: 48V DC (eight 6V batteries 315 Ah capacity)
   b. Auxiliary Power Unit: 24V DC
   c. Hydraulic Tank Capacity: 4 gal

4. Weight
   a. 11,000 lbs.

PART 3 - EXECUTION

3.1 Safety and Implementation

   A. All operators must comply with all safety standards and regulations set forth for by the Solar Decathlon.
B. All operators must be certified to operate equipment and carry certification card at all times during operation.

C. Boom lift must only travel on pads provided to protect the grass of the National Mall.

END OF SECTION 41 23 23
PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the terms of use, requirements, and product data for the fork
lifts needed for assembly and disassembly of the house.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gradall
B. Toyota

2.2 PRODUCTS

A. 534D10-45 Telescopic Forklift

1. Dimensions
   a. Length to fork face: 19.7 ft
   b. Width Over Tires: 8.2 ft
   c. Overall Height: 7.7 ft
   d. Wheelbase: 11.2 ft
   e. Ground Clearance: 19.3 ft
   f. Turning Radius Outside Tires: 14.6 ft

2. Lift
   a. Max Lift Height: 45 ft
   b. Max Forward Reach: 31.5 ft
   c. Max Lift Capacity: 10000 lb
   d. Max Load at Max Reach: 3000 lb

3. Engine
   a. Power: 114 hp
b. Torque: 2500 rpm

c. Displacement: 274.6 cu in

d. Cylinders: 4

4. Operational

a. Weight: 25300 lb

b. Fuel Capacity: 38 gal

c. Hydraulic System Fluid Capacity: 40 gal

d. Operating Voltage: 12V

e. Alternator Supplied Amperage: 65 A

f. Drawbar Pull: 21000 lb

g. Tire Size: 14x24-12PR

h. Max Speed: 19 mph

5. Manufacturer specifications for Gradall Forklift can be found at:


B. 8FGU15 Internal Combustion Pneumatic Warehouse Forklift

1. Performance

a. 2007 EPA/CARB certified engine with closed loop 3-way catalytic muffler system

b. Toyota 136 cu. in., 4-cylinder, OHV gasoline engine (4Y-ECS)

c. Toyota 152 cu. in., 4-cylinder, OHV diesel engine (1DZ-II)

d. Electronic fuel injection (gasoline only)

e. UL “G” gasoline engine

f. UL “D” diesel engine

g. One-way automatic fork leveling

h. Independent brake & inching pedals
i. Integrated monitoring system – includes
  i. Digital hour meter display
  ii. Engine coolant temperature gauge
  iii. Fuel gauge (gasoline only)
  iv. Check engine light
  v. Sedimentor warning light (diesel only)
  vi. Glow indicator light (diesel only)
  vii. Engine oil pressure warning light
  viii. Battery charge warning light
  ix. OPSS activation light
  x. SAS/OPSS warning light
  xi. 2-stage limited free lift mast (V)
  xii. Adjustable headlights with guards
  xiii. Foot-activated parking brake
  xiv. Alternator with built-in regulator
  xv. Transistorized ignition assembly
  xvi. Automatic transmission with oil cooler
  xvii. Full floating powertrain
  xviii. Hydraulic valve lifters
  xix. Integrated head light and turn signal lever
  xx. Electric shift control
  xxi. Durability
j. Control Area Network (CAN-bus) communication
k. Fully-stamped steel side panels
l. Moisture resistant electric connectors
m. High cooling capacity radiator with fan shroud
n. Low maintenance battery
o. Large capacity engine cooling fan
p. 7” cyclone air cleaner with high positioned external air-intake (6” diameter on 8FGCU15.18.S20)
q. Plate iron front fenders
r. Anti-restart ignition key switch
s. Stamped steel engine hood
t. Fully-sealed air-intake system
u. Self-adjusting brakes
i. Load and Capacities
   A. Load Capacity: 3000 lb
   B. Engine HP/rpm: 51/2570
   C. Max Travel Speed: 11.5 mph
   D. Maximum Lift Speed Full Load (f.p.m.): 131
   E. Maximum Gradeability Full Load (%): 45
   F. Basic Tight Angle Stack (in): 92.1
   G. Turning Radius: 76 in
   H. Dimensions
2. Width: 42.1 in
3. Length: 87.8 in
4. Height: 81.9 in
5. Manufacturer specifications for Toyota Pneumatic Forklift can be found at: http://www.directindustry.com/prod/toyota-industrial-equipment/electric-forklift-truck-14115-27200.html

PART 3 - EXECUTION

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

B. All operators must be certified to operate equipment and carry certification card at all times during operation.

C. Forklifts must only travel on protective pads provided to protect the grass of the National Mall.

END OF SECTION 41 62 23
SECTION 48 19 16

Electrical Power Generation Inverters

PART 1 – GENERAL

1.1 SUBMITTALS

A. Product Data

1.2 RELATED SECTIONS

A. Section 26 31 00 – Photovoltaic Collectors

PART 2 – PRODUCTS

2.1 PRODUCT PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70, “National Electrical Code”

2.2 DEVICES

A. Inverter

1. SMA Sunny Boy 8000TL-US

2. DC to AC transformer-less grid-tie inverter for up to a 8000 watt photovoltaic array.

3. See manufacturer’s specifications for further information:

   http://files.sma.de/dl/10707/SUNNYBOY6-11TLUS-DUS122510W.pdf

PART 3 – EXECUTION

3.1 EXECUTION

A. Installation

1. Measure service entrance conductors to confirm AC service at the site.

2. Install in accordance with manufacturer’s recommendations.

END OF SECTION 48 19 16