Project Manual

U.S. Department of Energy Solar Decathlon 2013

SCI-Arc/Caltech

DALE

2013-08-22

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U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

U.S. DEPARTMENT OF ENERGY
NREL NATIONAL RENEWABLE ENERGY LABORATORY
GREAT PARK

Contents

Summary of Changes

Significant changes to the project manual that have occurred between submissions have been outlined below. The Construction Drawings should also be reviewed for relevant revisions.

2-14-2013 Revision

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

- We have removed one of the three modules making the total number of housing modules two. This reduced our total square footage to 622 sq.ft. as well as reduced the amount of MEP connections between modules to simplify the system and reduce costs.
- Our landscape and foundation designs have been modified. Our deck and landscape now exist strictly between the rails in order to reduce materials and costs as well as to focus jury and visitor attention on that interstitial space. Our foundation is no longer a series of individual piers but rather a continuous grade-beam footing that has been designed with both rapid assembly and timely removal in mind.
- Our canopy and PV integration have been modified and now appear geometrically more rectangular. Each canopy is installed on a series of drawer sliders allowing the canopies to telescope ten feet in both directions. So to summarize, there are two housing modules that move in the East/West direction on rails, and each module has its own canopy that telescopes in the East/West direction on large scale telescoping drawer sliders. As a result of these changes we have revised our safety system and information, as well as our tour and jury schedule in order for movement to occur around the competition schedule. This was done to gain energy and performance benefits.
- Our module delivery and operations strategy has been adjusted to meet our design changes. We are now using a more standard drop-deck transport with crane and spreader bar configuration. We plan to spend the first 3 full days of assembly building our foundation and landscape and then crane the two modules onto the rails around day 4.
- Our MEP systems have changed to respond to the design changes. The amount of plumbing and electrical cable reels was reduced due to the removal of a module from the design. The majority of the MEP system, with the exception of some of the sprinkler system and some electrical, has been focused to the East module, which is the mechanical and plumbing core. The HVAC system is only installed in this module with vents located at what is the center of the house when it is fully closed. We have sourced the appropriate electrical cable and hose types based on the unique requirements of our mobile system and have designed a typical maintenance schedule to be included in our larger narrative.
- Solar Thermal has been added to the South elevation of the East/core module, and is tied directly into our plumbing system. In order to maintain a level of symmetry in terms of design, we have designed in similar looking features on the South elevation of the West module (a hammock) and the North elevations of both modules (a deck to our mechanical room and a removable Thule rack for bike and surfboard storage.

4-5-2013 Revision
The Project Manual has been updated from the previous issue. Revisions include:

- Added hose reel specs.
- Added outdoor cable information.
- Added Plumbing Sheets.
- Added Instructions/Manuals for Macerator.
- Added Instructions/Manuals for D380 Inverter.
- Added hose reel specs as well as a water maintenance schedule to sheets E-603 and P-602.

5-8-2013 Revision
The Project Manual has been updated from the previous issue. Revisions include:

- Updated E601, E602 to correct indoor grounding wire size error and subpanel breaker rating to reflect NEC 705.12.
- Updated breaker information in Project Manual to include the 75 A breakers for the subpanel, rather than 100 A.

8-22-2013 Revision
The Project Manual has been updated from the previous issue. Revisions include:

- Added tour reconfiguration schedule to Summary of Reconfigurable Features
- Added Engineering Analysis Results and Discussion
- Added info on safety equipment
- Added info on motors
- Added info on motor controllers
- Updated PV Equipment – using Hanwha and Tigo equipment
- Updated Mechanical Equipment – using Mitsubishi equipment
- Replaced cable and hose reels with cable carriers
- Updated smart devices
- Added lights
- Updated bathroom fixtures
- Updated pipes – now using CPVC pipes from Lubrizol
- Updated flexible hoses
- Removed West panelboard
- Updated electrical plans reflecting changes
- Updated main panelboard
- Updated insulation
- Added structural platforms to house on north and south

Rules Compliance Checklist

RULE	RULE DESCRIPTION	LOCATION DESCRIPTION	LOCATION
Rule 4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	O-101
Rule 4-2	Construction Equipment	Specifications for heavy machinery	O-101
Rule 4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	S-401, XC-201
Rule 4-4	Impact within the Solar Envelope	Drawing(s) showing the location, contact area, and bearing pressure of every component resting directly within the solar envelope	G-101
Rule 4-5	Generators	Specifications for generators (including sound rating)	O-101
Rule 4-6	Spill Containment	Drawing(s) showing the locations of all equipment, containers, and pipes that will contain liquids at any point during the event	H-101
Rule 4-6	Spill Containment	Specifications for all equipment, containers, and pipes that will contain fluids at any point during the event	H-101
Rule 4-7	Lot Conditions	Calculations showing that the structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	STAMPED CALCS (ATTACHED)
Rule 4-7	Lot Conditions	Drawing(s) showing shimming methods and materials to be used if 18 in. (45.7 cm) of vertical elevation change exists on the lot	XC-201
Rule 5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	G-101
Rule 5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	N/A
Rule 6-1	Structural Design Approval	List of, or marking on, all drawing and project manual sheets that will be stamped by the qualified, licensed design professional in the stamped structural submission; the stamped submission shall consist entirely of sheets that also appear in the drawings and project manual	STAMPED CALCS (ATTACHED)

Rule 6-2	Finished Square Footage	Drawing(s) showing all information needed by the rules officials to measure the finished square footage electronically	G-101, A-100
Rule 6-2	Finished Square Footage	Drawing(s) showing all movable components that may increase the finished square footage if operated during contest week	A-100
Rule 6-3	Entrance and Exit Routes	Drawing(s) showing the accessible public tour route	G-101
Rule 7-1	Placement	Drawing(s) showing the location of all vegetation and, if applicable, the movement of vegetation designed as part of an integrated mobile system	XC-101
Rule 7-2	Watering Restrictions	Drawing(s) showing the layout and operation of greywater irrigation systems	N/A
Rule 8-1	PV Technology Limitations	Specifications for photovoltaic components	E-102
Rule 8-3	Batteries	Drawing(s) showing the location(s) and quantity of all primary and secondary batteries and stand-alone, PV-powered devices	N/A
Rule 8-3	Batteries	Specifications for all primary and secondary batteries and stand-alone, PV-powered devices	N/A
Rule 8-4	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	N/A
Rule 8-4	Desiccant Systems	Specifications for desiccant system components	N/A
Rule 8-5	Village Grid	Completed interconnection application form	(ATTACHED)
Rule 8-5	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-102
Rule 8-5	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-603
Rule 8-5	Village Grid	One-line electrical diagram	E-601
Rule 8-5	Village Grid	Calculation of service/feeder net computed load per NEC 220	E-603
Rule 8-5	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	G-101
Rule 8-5	Village Grid	Elevation(s) showing the meter housing, main utility disconnect, and other service	A-403

		equipment	
Rule 9-1	Container Locations	Drawing(s) showing the location of all liquid containers relative to the finished square footage	A-100
Rule 9-1	Container Locations	Drawing(s) demonstrating that the primary supply water tank(s) is fully shaded from direct solar radiation between 9 a.m. and 5 p.m. PDT or between 8 a.m. and 4 p.m. solar time on October 1	A-100
Rule 9-2	Team-Provided Liquids	Quantity, specifications , and delivery date(s) of all team-provided liquids for irrigation, thermal mass, hydronic system pressure testing, and thermodynamic system operation	N/A
Rule 9-3	Greywater Reuse	Drawing(s) showing the layout and operation of greywater reuse systems	N/A
Rule 9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	N/A
Rule 9-6	Thermal Mass	Drawing(s) showing the locations of liquid-based thermal mass systems	N/A
Rule 9-6	Thermal Mass	Specifications for components of liquid-based thermal mass systems	N/A
Rule 9-7	Greywater Heat Recovery	Drawing(s) showing the layout and operation of greywater heat recovery systems	N/A
Rule 9-8	Water Delivery	Drawing(s) showing the complete sequence of water delivery and distribution events	O-102
Rule 9-8	Water Delivery	Specifications for the containers to which water will be delivered	O-102, P-104
Rule 9-9	Water Removal	Drawing(s) showing the complete sequence of water consolidation and removal events	O-102
Rule 9-9	Water Removal	Specifications for the containers from which water will be removed	O-102, P-104
Rule 11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	G-101

Stamped Structural Calculations

Please See Appendix A for Stamped Structural Calculations.

Detailed Water Budget

FUNCTION	WATER USE (GALLONS)	CALCULATIONS		NOTES
		GAL	EVENTS	
Hot Water Draws	240	15	16	
Water Vaporization	6	1	6	
Dishwasher	24	6	4	
Clothes Washer	105	15	7	
Vegetation	20	20	1	
Fire Protection	50	50	1	
Thermal Storage Tanks	0	0	0	
Testing	0			
Initial Systems Fill	10	10	1	
Solar Thermal Collectors	25			
Aesthetic Purpose	185			185 gal. poured Directly Into Outdoor Water Feature
Radiant Flooring	0			
Safety Factor	320			
WATER REQUIRED	**985**	gallons		

Executive Summary

DALE, the Dynamic Augmented Living Environment, welcomes the Solar Decathlon 2103 to sunny southern California. Inspired by the region's wonderful climate, dramatic geography, and adventurous lifestyle, SCI-Arc/Caltech's net zero, rail-mounted, active dwelling system carries the architectural tradition of the adobe, bungalow, and Case Study Houses into the twenty-first century. Demonstrating advances in programmatic flexibility, climatic tuning, and size variability – made possible by its unique capability for multi-scale/axis movement – DALE sits lightly but lives large, requiring less space and no net energy consumption to match the unsustainably bloated lifestyle claims of the current investment-driven, supersized housing trends.

DALE is the product of needing a home that is designed to speak to the uniqueness of southern California: a home that is as active as the people who reside in it. Its design takes the residential outdoor connection from visible to tangible and allows the inhabitants the flexibility to configure it to fit their daily needs. DALE is comprised of two modules that work as well in unison as they do individually. These modules come together for conditioning and security purposes when needed but are designed to multiply inhabitable square footage and take advantage of southern California's ideal climate conditions. Varying configurations allow for the experience of multiple microclimates through drought-tolerant California native landscapes. DALE is an innovative, net-zero energy, solar powered home that will change the way homeowners interact with their environment.

DALE is a dynamic living environment running exclusively on solar power gathered through integrated photovoltaic panels on a performative second skin. This second skin rack telescopes on the same axis as the houses movement, creating a collection configurations that benefit the user both in terms of comfort and energy. The 5.5 kW system works in tandem with an evacuated tube solar thermal collection system for water heating that will ensure a net-zero outcome without sacrificing user comfort or expectations. DALE's flexibility allows the home to react to climate changes and optimize comfort level through passive systems that reduce its energy footprint. The electrical system relies on the use of day lighting and incorporates the use of energy efficient LED lighting, appliances, and electronics. A sophisticated home monitoring and control system meters every aspect of electricity and water consumption in real time and allows the home and users to regulate their behavior.

DALE learns from two classic California precedents: the super-sized suburban tract home and the compact, sufficient bungalow; amending one and expanding on the other to become a sweet new southern California typology. At 600 square feet it is a micro house with an unprecedented flexible interior that results in the program of a house three times the size. Suspended movable partitions in one module give the occupants two bedrooms, a living room, an office, or an open space for entertaining, while the other module provides a generous kitchen, sand-room, separate bathroom, and a mechanical room where the real energy-efficient magic happens. Couple this interior flexibility with the home's movement, and the options are nearly unlimited.

Summary of Unlisted Electrical Components

To our knowledge, there are no unlisted electrical components in the present design.

Summary of Reconfigurable Features

House Modules:

DALE is divided into two modules, both of which are situated on a rail system. This allows the house to exist as one connected whole or as separate segments capable of positioning themselves at different locations – across the long axis of the site – depending on the desired configuration or on the varying energy requirements of the house. This reconfigurable feature is supported by a user controlled, motorized end truck system complete with thermal seals and safety sensors between modules. All plumbing and electrical connections are housed in a durable, flexible cable carrier system that runs below the landscape grade at the north end of the site.

Interior Walls:

The West module contains two detachable moving partitions that allow the user to redeem multiple compartmentalized spaces from one larger space. Within each side of each partition is an integrated program surface, where different amenities unfold to accommodate different configurations. This flexible system allows DALE to perform like a house twice its size, all the while providing a comfortable one bedroom house layout when the partitions are in their default position.

Sliding Canopy:

Both the East and West modules of DALE are equipped with highly performative solar sliders that act as a sleeve on each unit. In their default positions, these second skin/canopies hug the modules on three surfaces; the top and the North and South short elevations. These components are installed on 2-way telescoping sliders, allowing them to extend one whole modules length in either direction, creating yet more potential in the variety of spaces in and around DALE, as well as adjusting shade at different times of the day, and on different days of the year. Hanwha photovoltaic panels are attached to the top of the sliders, thus creating comfortable amounts of shade while still allowing subtle rays of California sunshine to spill through. The housing modules can roll apart while the canopy sliders stay in place, creating an enclosed mid-yard and embracing the benign West-coast climate. Additionally, the sliders can move with the sun throughout the day to prevent solar thermal heat gain at the interior spaces. This feature compliments DALE's choreographic design, where residents benefit from the efficiency of a micro-home as well as the unprecedented flexibility of a purely dynamic housing typology.

Reconfigurations During Tour Hours

The team intends to showcase the motion of the home at various times during the day. To reduce tour interruptions, these movements will only take place at the opening and closing of the house and once during the middle of the day.

Morning: Open Modules

Modules start in closed configuration. Modules are then moved apart while watched by team members, temporary ramps are placed and secured, and then tours begin.

Afternoon: Reconfigure Modules

At about 2:25pm the tour line will be halted, and the last tour will exit the house. Team members will remove the temporary ramps. Team members will check to ensure that the area around the modules is clear, and another team member will control the modules to move. After the modules are moved back and forth, they will return to one of the tour configurations. Team members will them restore the temporary ramps, and continue tours. The entire process is expected to take 10 mins, and no more than 15 mins.

Evening; Close Modules

At the end of tours or at the end of a movie/dinner night, the house modules will be closed. Team members will watch the area to ensure it is clear during this process.

Movement Schedule:

	Open Modules	Reconfigure Modules	Close Modules
Day 11	11:00am	2:30pm	7:00pm
Day 12	11:00am	2:30pm	11:00pm
Day 13	11:00am	2:30pm	7:00pm
Day 14	11:00am	2:30pm	7:00pm
Day 18	11:00am	2:30pm	7:00pm
Day 19	11:00am	2:30pm	11:00pm
Day 20	11:00am	2:30pm	11:00pm
Day 21	11:00am	2:30pm	Disassembly

Interconnection Application Form

SCICAL – LOT 101

PV Systems

Module Manufacturer	Short Description of Array	DC Rating of Array (sum of the DC ratings)
Hanwha	West Array	3040 W
Hanwha	East Array	3040 W

Total DC power of all arrays is _____6.1_____ kW (in tenths)

Inverters

Inverter Manufacturer	Model Number	Voltage	Rating (kVA or KW)	Quantity
SMA America	SB6000US	240	6 kW	1

Total AC power of all inverters is _____6____ kVA or kW (in whole numbers)

Required Information

	Location
One-Line Electrical Schematic	E-601
Calculations of service/feeder net computed load and neutral load (NEC 220)	E-603
Plan view of the lot showing the house, decks, ramps, tour paths, the service point, and the distribution panel or load center	G-102

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

Energy Analysis Results and Discussion

I. Executive Summary

The typical southern California home consumes 40% less electricity than the typical American home (Figure 1), in part because California homeowners can take advantage of our state's mild climate to reduce HVAC use, but also because state legislature has taught us to be more energy-conscious. Building on the systems we designed for CHIP in the 2011 Solar Decathlon, the 2013 SCI-Arc/Caltech team has designed DALE to take southern California's green living practices a step further.

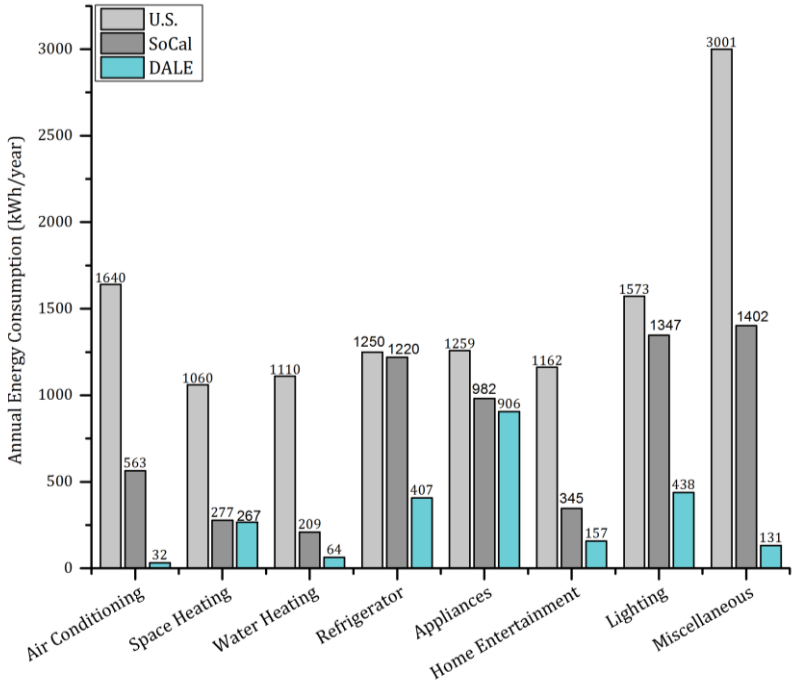


Figure 1 Comparison of average annual energy consumption by typical American homes,[1] typical southern California homes,[2] and DALE. Home entertainment includes televisions, set-top boxes, video game consoles, desktop and laptop computers, monitors, speakers, printers, networking equipment, and uninterruptible power supplies. Miscellaneous includes small electric devices, heating elements, and motors (not electric vehicles).

The following report describes in detail the analysis and simulations we performed to determine our necessary energy production and the engineering strategies we used to minimize our energy consumption.

[1] U.S. Energy Information Administration, 2009
[2] California Energy Commission, 2009-2010

II. Electrical Systems

Since we attribute CHIP's success in the Energy Balance Contest in 2011 to a thorough energy analysis using historical weather data and modeling software and a carefully planned energy budget, we approached DALE's electrical systems in a similar manner.

A. Solar photovoltaic array

To earn full points in the Energy Balance Contest, DALE's solar photovoltaic (PV) array must generate all of the energy consumed by the home during the ten-day competition. After estimating the power use of every energy sink in the home to calculate the total energy consumption, we used a combination of modeling and simulation, field-testing, and product research to design our PV array. The resulting system is optimized to produce enough energy meet the Solar Decathlon's net-zero contest requirements in 95% of historical early-October weather conditions in Irvine, CA, while requiring a minimum of panels.

Since the competition will be held in southern California's dry, arid climate this year, we wanted to test the effect of that climate on solar panels. We suspected that these conditions could lead to a significant accumulation of dirt and debris on the panels; this soiling would block incoming light, possibly resulting in costly pre-photovoltaic losses in energy production. We conducted field-testing on solar panels that were left outside to accumulate soiling for eight months and found that panels mounted at an angle saw a smaller decrease in energy production than panels that were flat (Figure 2.1). We thus concluded that tilting our array would be a passive, low-maintenance means of reducing the effects of soiling.

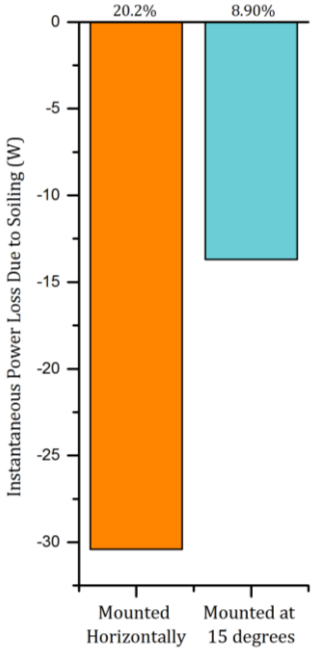


Figure 2.1 Decrease in energy production due to soiling accumulated over eight months on flat panels and panels tilted by 15°.

Given that a panel's energy production is proportional to light intensity, which depends on the angle of incidence, tilting our array to the south provides the additional benefit of increasing the amount of direct sunlight hitting the panels. We used NREL's System Advisor Model (SAM) to determine that PV arrays should be tilted to the latitude of their location in order to optimize annual energy production (Figure 5.1). Our array would therefore perform best over the course of the entire year if we mounted it at a 33.7° angle toward the south. The competition is held in October, however, and the optimal southern tilt for the month of October is 45°. In either case, such a steep angle poses several problems: DALE's small roof would cause issues with shading and we have a strict 18 foot height limit for the competition. Given these constraints, we decided that

mounting our PV array at a 15° angle would best maximize direct sunlight and reduce the effects of soiling while preventing the array from shading itself and keeing the house under the height limit.

In order to properly size our tilted PV array, we compiled a rough, high-level energy budget to estimate the average daily energy consumption of the home. We then used SAM 2012.11.30 and a year of typical weather data to simulate the hourly energy production of the given array. To ensure that our array could perform as needed in any weather conditions, not just those of a typical year, we ran the simulation with 30 years' worth of data from Weather Analytics for the El Toro Marine base, located in Irvine, California (1982-2011). In addition, we compared the SAM results for CHIP's array in Washington, D.C., with the 2011 competition data and the SAM results for Caltech's Wilson array during the second half of 2011 with actual production data (Figure 2.2) to gauge the accuracy of our simulations and adjust them accordingly. We found that SAM typically overestimates the energy production of an array by 5-10%.

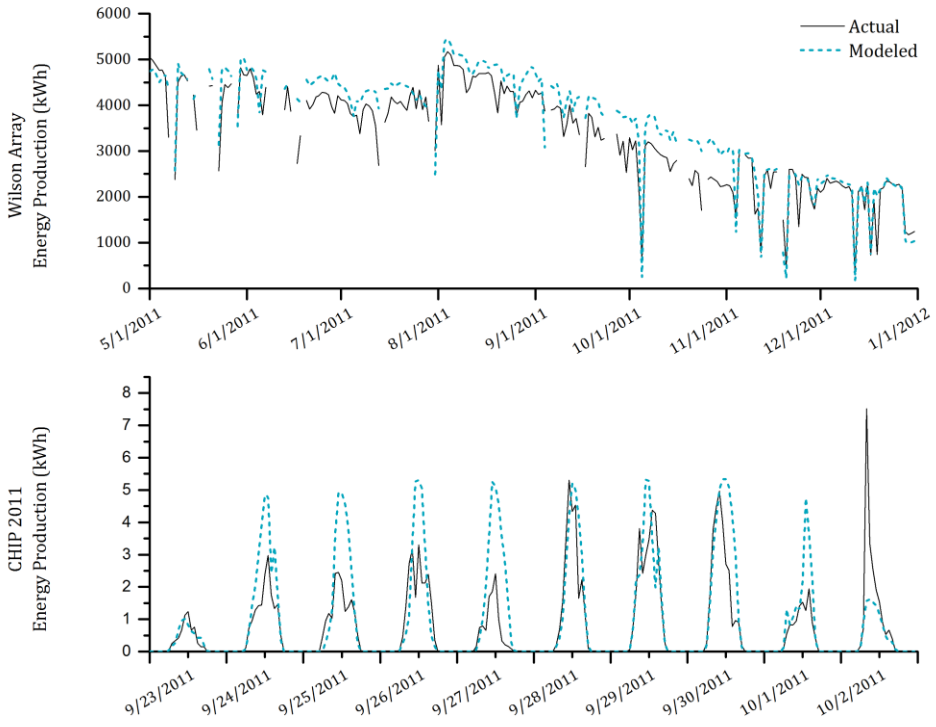


Figure 2.2 SAM predictions vs. actual energy production (a) CHIP array, September – October 2011 (b) Caltech's Wilson array, May 2011 – December 2011. Soiling effects were taken into account for the Wilson array, which had been washed at the end of July

After accounting for a margin of error in our energy budget and SAM results, we simulated the energy production for various array sizes and configurations (Table 2.1). We determined that a 32-panel, 5.5kW array mounted at a 15° angle would be net-zero over the course of a ten-day period in Irvine in early October approximately 95% of the time for our 23.1 kWh/day target.

Number of Panels	Southern Tilt (degrees)						
	0	5	10	15	20	25	30
24	10%	11%	14%	16%	18%	19%	20%
26	37%	46%	53%	59%	64%	67%	68%
28	67%	75%	81%	84%	86%	87%	87%
30	87%	90%	92%	94%	94%	95%	95%
32	93%	95%	96%	**97%**	97%	98%	98%
34	97%	98%	98%	99%	99%	99%	100%
36	98%	99%	100%	100%	100%	100%	100%

Table 2.1 Corrected SAM predictions for the likelihood of achieving net-zero during the competition with an array of Y panels mounted at X degrees.

In addition to minimizing pre-photovoltaic losses, we have attempted to reduce losses inherent to the solar panels themselves. PV cells are designed to capture as much sunlight as possible, which causes the panels to heat up drastically; this process increases current output but decreases voltage and overall power. We positioned the tilted PV array on DALE's canopies to take advantage of their ability to move and thereby reconfigure the array to maximize system efficiency throughout the day.

During our field-testing, we analyzed the effects of different air mass heights underneath the PV array. Since the array is mounted on mobile canopies, the panels can be located either one foot above the modules or ten feet above the ground (when the canopies are fully cantilevered). Thermal convection currents coupled with natural air currents produce different effects at these different heights: due to a wind-tunneling effect, airflow around the panels is greater when they are positioned above the house, keeping the panels cooler and resulting in a 2-4% greater efficiency than when the panels are ten feet above the ground.

Thus, the homeowner can optimize system performance by configuring the panels above the house in the early morning and late evening, when the effects of the air currents are greatest. During the day, the canopies can be moved to the inside of the modules to create a shaded area that will keep the space cooler and reduce the energy consumption of the HVAC system. In this way, positioning the PV array on the movable canopies allows us to optimally configure DALE for different environmental conditions while simultaneously increasing energy production.

Additionally, each panel is connected to a Tigo module maximizer, which regulates the output current of each PV module and helps boost energy production. Since the panels in each string of a PV system are wired in series, the current of each string is limited by the lowest current produced – one underperforming panel decreases the energy production of every panel in the string. Tigo module maximizers prevent this current capping by using impedance-matching technology to identify and deactivate underperforming panels.

B. Overview of energy production and consumption

Since we sized our array to be net-zero during October, it would actually produce more energy than the typical inhabitants consume over the course of an entire year in Los Angeles, CA.

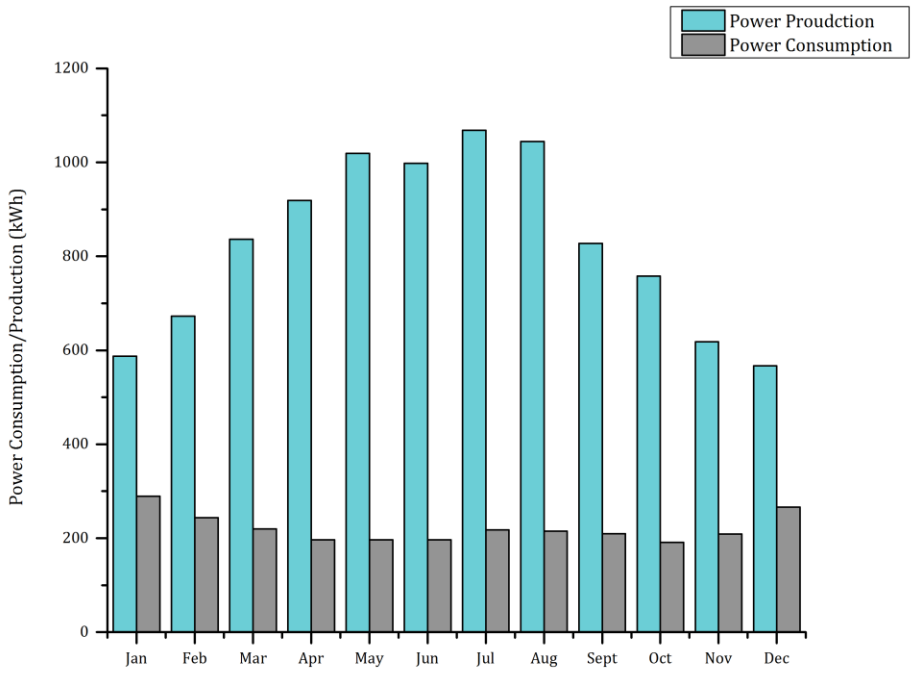


Figure 2.3 DALE's monthly energy production and consumption in Los Angeles, CA. Energy production simulated using SAM; energy consumption based on Energy Star usage estimates.

According to SAM simulations, our 5.5 kW array should generate an average of 23.1 kWh per day during the competition. When we adjust this value to correct for SAM's overestimates, we find a more realistic value of 21.0 kWh per day during the competition. To leave ourselves a margin of error, we have budgeted a total of just under 20 kWh per day for the contests. (Figure 2.4).

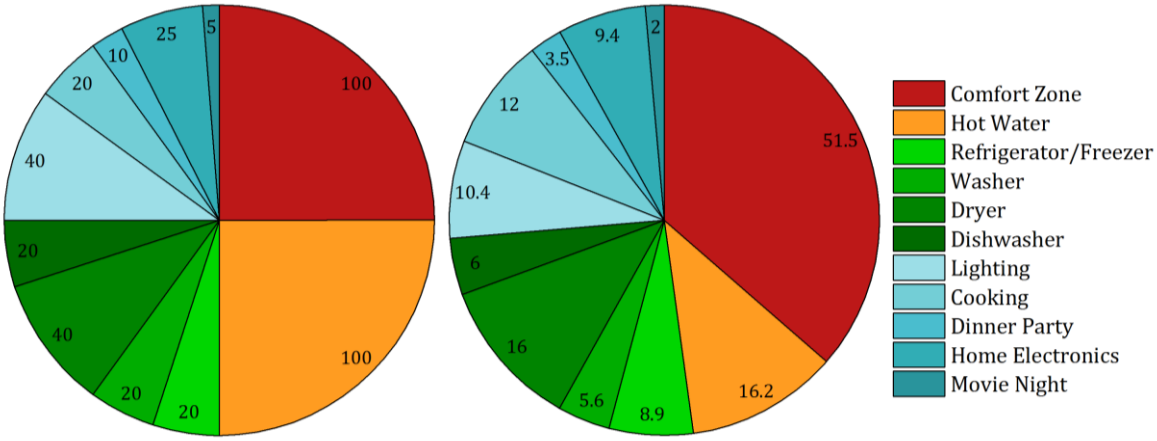


Figure 2.4 Comparison of energy and point allocations by contest
(a) Maximum possible points (b) Budgeted energy usage for competition.

Our strategy during the competition is based on an analysis of how many points we could earn in each contest and how much energy we would have to use in order to earn those points (Table 2.2). If we are running low on energy, we should stop conditioning the home and not participate and in the cooking contest. If we are running very low on energy, we should use as much energy as we need to maximize our points in the other contests: we would actually earn more points by participating in the other contests than we would lose by not being net-zero.

Table 2.2 Points earned per kWh of energy used.

Contest	Points/kWh
Hot Water	6.2
Lighting	3.8
Washer	3.6
Dishwasher	3.3
Dinner Party	2.9
Home Electronics	2.7
Movie Night	2.5
Dryer	2.5
Refrigerator/Freezer	2.2
Energy Contest	**2.0**
Comfort Zone	**1.9**
Cooking	**1.7**

C. Home electronics, lighting, and appliances

To choose home electronics for DALE, we performed a cost-benefit analysis on a variety of products to find the ones that are least expensive and most efficient. We began by eliminating products that are not readily compatible with Control4 (our home control system) and those that have poor customer reviews (fewer than three stars). Then, using typical retail prices and converting manufacturer-specified maximum power consumptions to kWh, we calculated the average cost and average use cost for each type of device and the monetary and energy cost scores for each product. By selecting the products with the lowest total cost scores among each type of device, we have managed to stay within both our monetary budget and our energy budget for the competition.

We performed a similar cost-benefit analysis on a variety of light fixtures to find an appropriate balance between cost, energy efficiency, illuminance, and color temperature. We also took into consideration customer reviews (to ensure quality), product longevity (to reduce maintenance costs), and thermal output (to limit HVAC demand). In addition, after consulting with lighting experts, we decided to only use light fixtures with a color rendering index (CRI) greater than 80; this allows the homeowners to experience natural-looking light in the evenings and at night, complementing the natural light they enjoy during the day thanks to DALE's large windows.

Due to budgetary constraints, we had fewer options for our home appliances. Whenever possible, however, we chose appliances that exceed Energy Star requirements for energy and water consumption to keep DALE resource-efficient. For example, our dishwasher uses just 3.5 gallons of water per cycle.[1]

[1] Energy Star certification requires ≤ 4.25 gallons/cycle

III. Mechanical Systems

Unlike the typical energy-efficient home, which relies solely on static systems to save energy, DALE utilizes static systems as well as a dynamic mechanical system that embodies our team's ingenuity and showcases a variety of energy-saving innovations.

A. Module and canopy movement system

Southern California has an agreeable climate that begs homeowners to open their doors and windows and enjoy the pleasant weather. DALE takes this practice a step further by letting homeowners open up the entire house without sacrificing their privacy or shade. Our module and canopy movement system comprises a variety of hardware and software and is responsible for correctly positioning the modules and canopies according to user input while keeping the inhabitants and their belongings safe (please refer to sheet T-101 in the drawing set).

Module and canopy movement begins with the command center, where a touchscreen panel with an intuitive user interface (UI) feeds high-level commands to a programmable logic controller (PLC) located in the mechanical room. Using this touchscreen panel, the homeowner can select one of several preset module and canopy configurations, enter a new configuration manually, or program an additional configuration for the PLC to remember. The PLC checks this input for validity (Table 5.2), computes the necessary module and canopy moves and the order in which they should occur (Figure 5.2), and activates the safety equipment.

The homeowner can also use the command center's UI to operate the motorized louvers located on both sides of the canopies. Each set of louvers is independently controlled by pressing and holding a touchscreen button until the desired configuration is reached. With so many degrees of freedom, DALE's inhabitants are able to enjoy an energy-efficient, fully customizable, indoor/outdoor lifestyle.

To make these moves possible, each module is equipped with a variable-frequency drive (VFD) that gradually accelerates and decelerates a pair of one-horsepower end trucks, wheeled motors typically used in gantry cranes (Figure 3.1). This ramping provides two distinct advantages over single-speed operation: smoother starts and stops and less mechanical stress on the motors and modules. In addition, we chose end trucks that are rated for loads much heavier than the modules so they can better handle dynamic loading inside the house. Finally, the modules themselves protect the end trucks from the environment, further reducing maintenance and repair costs for this system. In the unlikely event that power is lost while the home is opened, the end trucks are equipped with a manual brake override to allow the inhabitants to manually close the home.

The modules can move along the entirety of the track's 54 foot length; the maximum separation between the modules is approximately 34 feet. The maximum separation between the modules during the competition, when we are limited by our solar envelope, is nearly the same at 32 feet.

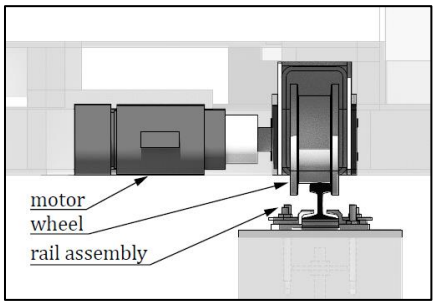


Figure 3.1 Cutaway view of module with end truck wheel and track.

To make canopy movement possible, a three-stage, ball-based linear telescopic slide system made of stainless steel is attached to the roof support structure of each module (Figure 3.2). Movement during the first and second stages is accomplished by means of a spur gear articulating with a horizontal gear rack. Movement during the third stage is accomplished by means of a tensioned chain running along the sliding rails that is fixed at one point. As with module movement, a VFD gradually accelerates and decelerates a pair of half-horsepower motors equipped with speed reducers and provides the same reduction in maintenance and repair costs for this system. Each canopy slides parallel to the track and can cantilever approximately 10 feet from center in either direction.

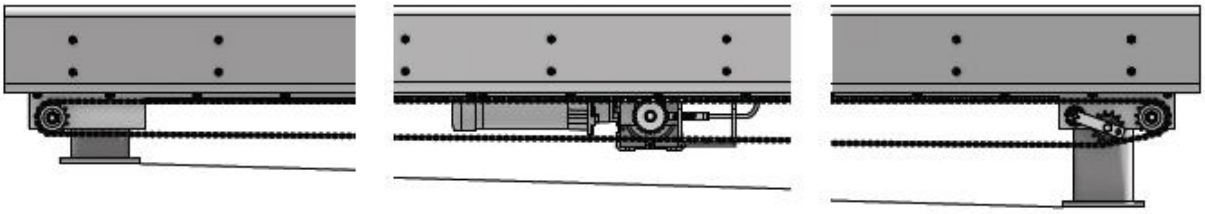


Figure 3.2 Linear telescopic slide system for canopy movement.

Having two independently moving modules makes plumbing and electrical wiring difficult since the municipal water supply line and local microgrid are stationary. To accommodate the lines that run between these fixed points and the core module, a durable cable carrier mounted underneath the mechanical room guides flexible cables and hoses along the length of the rails. A second cable carrier mounted underneath each module accommodates the lines that run between them. As with the end trucks, we chose weather-resistant cable carriers and positioned them underneath the modules to protect the lines as much as possible from the environment, thereby reducing maintenance and repair costs. Having canopies that can move in two directions relative to the modules also makes wiring difficult, so we once again chose to use cable carriers. In addition to the solar photovoltaic panels mounted on top of the canopies, small motors for the louvers and various safety sensors are located on the canopies and also necessitate wires running from each module to its canopy.

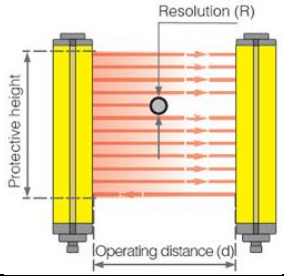
The PLC uses input from two laser distance sensors to calculate the position of each module relative to the end of the rails, while a third laser distance sensor provides the distance between the

modules as a check. A cost-efficient makeshift encoder comprised of a sprocket and a proximity sensor is attached to each canopy motor; as the motor turns, the teeth of the sprocket spin past the proximity sensor, triggering a pulse. The PLC counts these pulses to calculate the position of each canopy relative its module. A limit switch located at the end of each rail prevents the modules from driving off the rails.

A second pair of limit switches ensures that the modules continue to move together until the gaskets mounted along the perimeters of the opening form an air- and water-tight seal between the modules. We tested the gaskets to determine the minimum compression needed to form an air- and water-tight seal; the limit switches require this amount of compression plus a margin of error. The gaskets have a manufacturer-reported R-value > 11.5, are fire retardant, and provide acoustic dampening.

To keep DALE's inhabitants and their belongings safe during module and canopy movement – and to limit potential liability should damage occur – we have carefully implemented a risk management strategy. We began by identifying the hazards associated with careful operation of our module and canopy movement system and compiling an initial set of safety sensors that address these hazards. We then closely analyzed the coverage of these safety sensors, looked for ways that they could be defeated, and compiled a more robust set of safety sensors. Finally, we consulted with an expert in the field of factory safety to gain a new perspective on our system and to learn about additional safety devices and practices.

The resulting risk management strategy comprises two types of safety measures: preventative and reactive (Table 3.1). Preventative safety measures are used to keep people and objects out of harm's way, while reactive safety measures are used to stop module and canopy movement in the unlikely event that contact is made. Together, these measures balance safety and cost considerations, offering excellent protection without becoming overly complicated or breaking the bank.

Preventative Safety Measures		
Light Curtain		A transmitter on one side of the module emits horizontal beams of low-level visible light and a receiver on the other side of the module senses them. Emergency braking is triggered if one or more beams are interrupted.
Area Access Control Sensor	Like a miniature light curtain, a transmitter on one side of the module emits a single horizontal beam of low-level visible light and a receiver on the other side of the module senses it. Emergency braking is triggered if the beam is interrupted.	

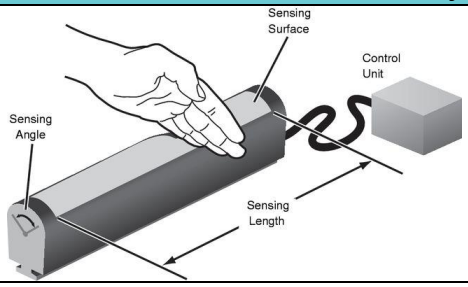
Reactive Safety Measures		
Sensing Edge		A pressure-sensitive rubber profile lines the vertical canopy edges and multi-use platforms (solar thermal collector, bike rack, hammock, stairs to mechanical room). Emergency braking is triggered on contact.

Table 3.1 DALE's preventative and reactive safety measures.

Consider the following scenarios:

- A homeowner parks close to the track and later decides to open DALE to spend a pleasant evening in the mid-yard. The canopy or multi-use platforms on the nearest module might hit the vehicle, possibly causing costly damage to the vehicle, the canopy or appendage, or both. While this scenario cannot be easily prevented by the movement system, our reactive safety measures limit the amount of damage that can occur by stopping all movement as soon as contact is made.
- A homeowner enjoys a picnic between the modules and forgets to move the table before closing DALE. One of the modules might hit the table, possibly pushing it over and causing a small amount of damage to the table, module, or both. While this scenario is unlikely to result in any real harm, it is a nuisance that our light curtains can easily prevent.
- A homeowner wants to move DALE in order to experience a different landscape and is unaware that the family pet is sleeping directly in the path of module movement. The module could run into the animal, possibly causing severe injury or even death. While we hope that this is the rarest of scenarios, we have included area access control sensors as a secondary preventative safety measure in the unlikely event that our light curtains fail to detect a small person, animal, or object.

B. HVAC and DHW systems

We designed DALE's HVAC and DHW systems to be compatible with module and canopy movement while achieving the same level of functionality and efficiency as the corresponding systems in a more typical home. We addressed our movement concerns by placing the equipment for both systems on just one of the modules – thereby avoiding the complexities associated with flexible, non-standard piping metals – and by choosing units that are well-suited for smaller homes.

Our ductless HVAC system comprises a dual zone heat pump with a single outdoor unit and two indoor units. The outdoor unit is among the most efficient in its size class, rated at a cooling seasonal energy efficiency ratio (SEER) of 18 and a heating seasonal performance factor (HSPF) of 8.9 at 47°F and the indoor units are rated at 15 SEER and 9.6 HSPF.[1] The heat pump cools/heats the refrigerant, R-410a, into a liquid/gaseous form and sends it to the two indoor units, which then drive air cooled/heated by the refrigerant piping into the house.

Since HVAC system size is such an important factor in energy efficiency, we sized our HVAC system to suit its typical load. Given that the majority of the work done by our HVAC system is correcting small temperature swings that are barely outside the desired indoor climate range, we looked for a smaller system that could handle these common loads efficiently. We also wanted our system to be strong enough to handle any larger cooling/heating loads adequately, so we chose ceiling units that can drive air in four directions. This ensures that our indoor units can quickly condition the entire home – no matter how the interior is configured – and keep DALE's occupants comfortable no matter where they are.

To keep the home conditioned while closed, DALE has fireproof floor, ceiling, and wall insulation that also dampens sound (Table 3.2). Our air exchange ventilator helps maintain proper indoor air quality in accordance with California's Title 24.

Surface	R value
Floor	24
Walls	23
Windows/Glass Walls	3
Roof	30

Table 3.2 DALE's insulation.

DALE can be opened and closed at any time, so it is possible that the weather might sour while DALE is open. With this in mind, we designed our HVAC system to be capable of handling any inclement weather it might encounter. The system can take a worst-case load and condition the closed space to a comfortable target temperature in less than 30 minutes while still performing at least as efficiently as the typical green home HVAC system.

DALE's DHW system takes advantage of the cutting-edge heating technology in solar thermal energy collectors, which capture solar energy and convert it to thermal energy. We chose

[1] SEER and HSPF ratings as reported by manufacturer. Note that Energy Star does not currently certify ductless HVAC systems; Energy Star certification for split systems requires SEER ≥ 14.5 and HSPF ≥ 8.2 for air-source heat pumps and SEER ≥ 14.5 for central air conditions.

to use a solar thermal collector because its conversion of sunlight into domestic hot water perfectly complements our solar panels' conversion of sunlight into electricity.

When radiant energy from the sun hits the collector, it heats a transfer fluid contained in heat pipes at the center of the collector tubes. The heat pipe fluid evaporates into a gas that collects at the top of the tubes, where it transfers its thermal energy to the working fluid of a closed loop system flowing through the manifold of the collector. The heated working fluid is pumped through this loop to the heat exchanger of our hot water tank to heat water for domestic use. A backup electric water heater ensures that hot water is always available, even on cloudy days and in high-demand situations.

While solar thermal systems are typically located on the roof, we chose to mount ours on the southern wall of the core module to make room for a larger photovoltaic array on DALE's roof. Since our collector is in a more accessible location, we chose to use evacuated tubes, which are safe to touch because their exteriors do not heat up significantly. In addition, we chose to orient our solar thermal collector to maximize the amount of sunlight collected in the winter, since there are fewer hours of daylight during those months.

C. Movement and HVAC energy analysis

We performed an extensive analysis of historical southern California weather using ASHRAE Standard 55 equations, which numerically describe how hot or cold an average person would feel given seven parameters: air temperature, mean radiant temperature, relative humidity, wind speed, clothing level, activity level, and metabolic rate. ASHRAE equations also compute a predicted percentage displeased (PPD), representing what percentage of people will be unhappy in a given weather condition. Using these ASHRAE equations, we calculated the hourly PPD given 30 years of weather data for the El Toro Marine base near in Irvine, CA to determine when the house could be opened comfortably and how much energy could be saved by doing so.

Since the homeowners can change their clothing level and adjust shading and wind speed by reconfiguring the modules and canopies, we varied these parameters to generate boundary zone estimates for weather conditions in which 90% of people would be happy with the home open (PPD ≤ 10, Figure 3.3) and predict how often the home could be opened comfortably (Figure 3.4).

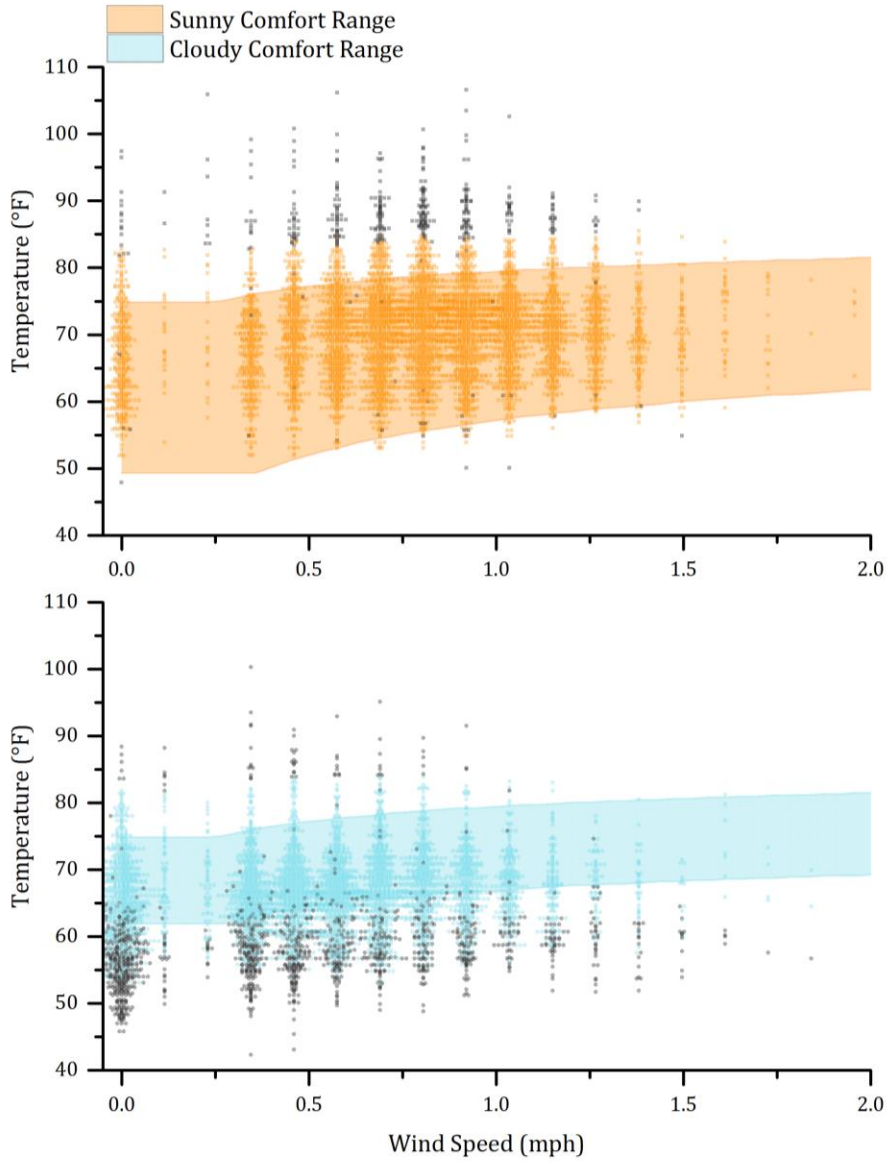


Figure 3.3 Comfort zones for sunny and cloudy days in southern California; actual data for 2009 – 2011 plotted. Orange and blue dots represent days/weather conditions for which at least 90% of people would have been comfortable outside. Some days/weather conditions outside of the boundaries were still comfortable due to other factors such as sunlight.

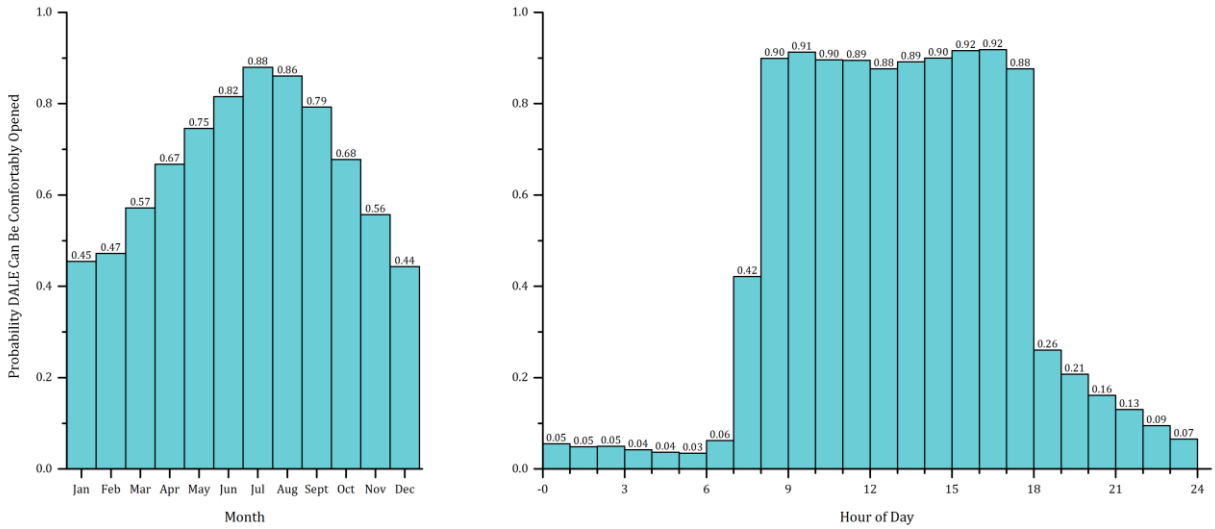


Figure 3.4 Likelihood that the home can be comfortably opened (a) during a given month of the year (b) during a given hour on a summer day.

We used Energy Pro to estimate how much energy would be consumed by DALE's HVAC system each hour to keep the inhabitants comfortable if the home was always closed. We then used hourly probabilities that the house could be comfortably opened to estimate how much energy would be consumed by DALE's HVAC system each month if the inhabitants opened the home strategically to help keep them comfortable (Figure 3.5). We assumed that the home would be closed at night from 10pm to 8am and anytime it was raining, and we considered a variety of homeowner habits:

- Works at home, opens the house during the day: 60% annual HVAC energy savings
- Works away from home from 9am to 5pm five days a week, leaves the house unconditioned during that time: 39% annual HVAC energy savings
- Works away from home from 9am to 5pm five days a week, chooses to condition the house during that time: 23% annual HVAC energy savings

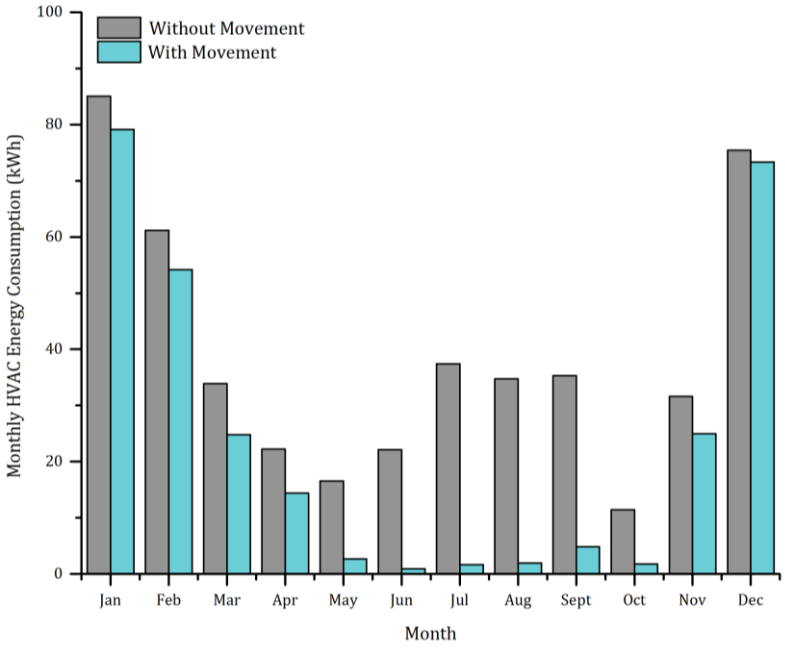


Figure 3.5 Comparison of monthly HVAC energy consumption with and without strategic module and canopy movement, assuming homeowner works away from home and leaves the house unconditioned from 9am to 5pm five days a week.

We have made DALE more energy-efficient and affordable by embracing an active mechanical systems approach. Although HVAC heat recovery systems do work, as we showed with CHIP in 2011, we purposefully chose not to implement such a system this year. With the competition being held in southern California's rather more seasonable climate, we concluded that any energy savings would be merely marginal and thus would not offset the cost of a heat recovery system.

A typical HVAC heat recovery system utilizes an additional heat exchanger in the refrigeration cycle to remove heat from the gas lines of the indoor units and preheat cold municipal water before it enters the water boiler. While the HVAC system is in cooling mode, heat recovery increases the efficiency of the system in two ways. First, it reduces the amount of heat that the outdoor unit has to expel in order to cool the incoming refrigerant. Second, it reduces the workload of the boiler by preheating the incoming water to 70-80°F (municipal water is a cool 50-60°F). Our HVAC heat recovery system in 2011 was capable of reducing the overall energy usage of CHIP's HVAC and DHW systems by up to 25% compared to the same systems without heat recovery and thus was a worthwhile endeavor.

Such a heat recovery system would not be as beneficial with DALE, however, for several reasons. First, DALE's HVAC system is already more efficient than CHIP's and has a higher cooling SEER, which means that the outdoor unit is already using less energy than CHIP's did and thus would realize smaller energy savings with a heat recovery system. Second, while CHIP utilized an air-to-water heat pump, DALE utilizes a solar thermal system to generate domestic hot water. The

passive heat exchange in DALE's solar thermal loop results in an equilibrium water temperature warmer than that of CHIP's passive heat recovery system. Finally, DALE's HVAC system is less likely to be used during periods of active cooling demand since the house is designed to be opened. Heat recovery systems only work when the house is being actively cooled, so DALE would only infrequently benefit from such a system; the extremely limited temperature gains would not offset the cost of customizing DALE's refrigeration loop.

IV. Home Control and Monitoring Systems

We designed DALE to boast a southern California philosophy – buy small, live large – and our home control and monitoring systems reflect this ideal.

A. Home control system

By integrating a Control4 system with a Honeywell HVAC control system, *DALE Control* frees homeowners from having to use multiple applications to control their appliances and HVAC system. The *DALE Control* application for tablets is intuitive, user-friendly, and easily programmable, allowing the homeowners to store their preferences.

Control4 is a well-known, smart home control system that is commonly used to wirelessly control home appliances. We used a Control4 system with CHIP in the 2011 Solar Decathlon and found it to be extremely reliable and time-saving, hence our decision to use Control4 again this year. *DALE Control* communicates with a Control4 box through a director application programming interface (API) to determine which devices are connected to DALE's Control4 server and thus can be controlled through our app.

CHIP's "big red button" was extremely popular in 2011, so *DALE Control* likewise has a single button that turns off all non-essential appliances, including lights and televisions. In addition to switching devices between their on and off states, *DALE Control* can be used to adjust specific device settings; for example, lights can be dimmed or brightened. *DALE Control* also has an automatic light mode in which the overall light level is fixed by the homeowner; light sensors measure the indoor and outdoor ambient light levels and the app adjusts the lights as needed.

DALE's HVAC system is controlled via a Honeywell Redlink thermostat, which can be controlled wirelessly from inside the house and monitored over the Internet. We chose to integrate the Redlink thermostat into the *DALE Control* app rather than use the separate app provided by Honeywell. This gives the homeowners greater control over the HVAC system without complicating the home control process by adding an entirely different user interface.

B. Monitoring system

DALE Control utilizes low-cost, real-time energy monitoring and easy-to-understand data visualization to help homeowners become more aware of how they are using energy and teach them how to run the home more efficiently.

We chose to use Chai Energy's technology to monitor DALE's energy consumption. Chai Energy was founded by Caltech alumni who built upon their experiences during the Solar Decathlon 2011 to start a successful business. Their monitoring system utilizes a router to send data from a whole-home smart meter to the cloud every six seconds. Chai Energy software then analyzes this

data, looking for spikes in energy consumption to determine which appliances are on and how much energy each of them is using.

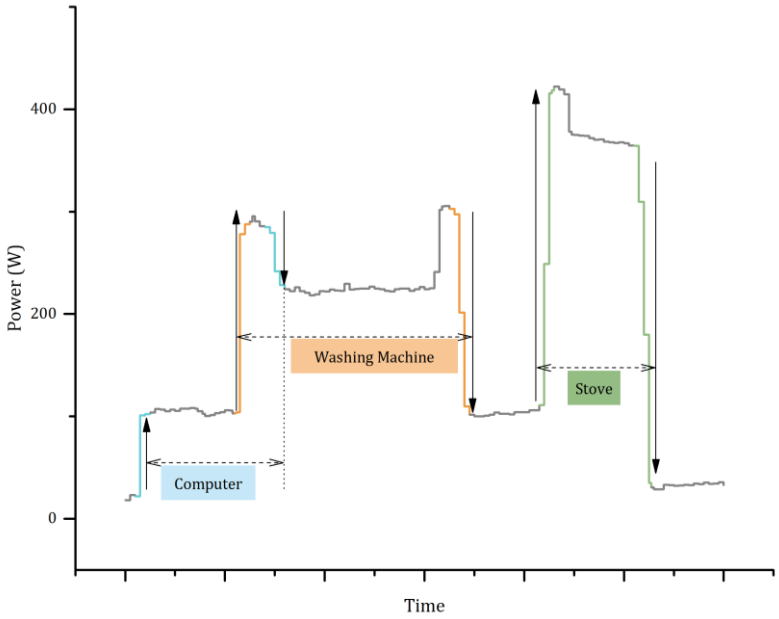


Figure 4.1 Chai Energy software uses algorithms and user feedback to identify spikes in total home energy consumption and attribute them to appliances and other energy sinks.

This clever technology offers several distinct advantages over more traditional monitoring systems. First, the Chai Energy system monitors total home energy consumption instead of monitoring at the circuit level; it is thus easier and less expensive to install because it requires very little hardware. The system also takes advantage of the increasing prevalence of smart meters to further lower installation costs. Finally, the Chai Energy system stores current and historical energy usage data for each appliance in an accessible database, allowing homeowners to see changes in their energy consumption over time.

The *DALE Control* app retrieves energy production data from the Tigo modules and energy consumption data analyzed by Chai Energy from their respective servers and creates an intuitive graphical display of the data. Overall energy production and consumption are plotted against time to show peak energy demands and peak PV array performance, and a pie chart shows the energy consumption of each appliance as calculated by Chai Energy. Together, these user-friendly graphs make the homeowners more aware of their net energy use and help them realize the importance of trying to save energy.

The *DALE Control* app does more than simply encourage homeowners to be more energy-efficient: it actively helps them develop green habits by offering suggestions and gentle reminders and by identifying potential problems with the house. For example, the app might alert the user if

the bathroom light has been on for several consecutive hours. If the PV array's energy production falls below some threshold, the app might inform the user that maintenance is required.

In addition, the *DALE Control* app has access to indoor/outdoor temperature and humidity data, which it uses to predict whether or not the occupants would be comfortable outside. Here, the app relies on ASHRAE Standard 55, which defines the range of thermal environmental conditions that are suitable to 90% of the population. We chose to use this standard because it accounts for a tremendous variety of factors, including sunlight, air speed, and clothing levels. The *DALE Control* app likewise takes these factors into consideration, and when it determines that 90% of the population would be comfortable outside, it will suggest that the occupants open up their home. If the homeowners act on the app's suggestion, they will save energy by not running the HVAC system and they will be able to enjoy a more spacious living environment.

We purposefully chose not to create a completely automated home control system. Instead, *DALE Control* provides homeowners with the tools they need to make informed decisions on how to run their home. By showing the occupants how they can save energy and money rather than just doing it for them, the *DALE Control* app helps people live a greener lifestyle that is better for their health and for the environment.

V. Methods and Results

A. Executive summary

Figure 1 Comparison of average annual energy consumption.
These data came from:

- US Energy Information Administration 2009 Residential Energy Consumption Survey CE4.1 (end-use consumption by fuel, total U.S. homes)
- California Energy Commission Updated California Energy Demand Forecast 2011-2022 Table B-6 (number of households by planning area, 2010)
- California Energy Commission Energy Almanac California Energy Consumption by End Use (BUGL, LADWP, PASD, SCE, and SDGE)

For each end use, we calculated: $\frac{electricity\ consumption\ per\ household}{number\ of\ households}$

Data rounded to nearest 10 kWh/yr

B. Electrical systems

Figure 2.1 Decrease in energy production due to soiling.
Four Hanwha panels – two that were flat and two that were mounted at a 15° angle – were allowed to accumulate soiling for eight months. On a sunny afternoon, we monitored their instantaneous energy production for ten minutes, cleaned them with a squeegee using dish soap and water, and then monitored their instantaneous energy production for another ten minutes (Table 5.1).

	Average energy production (W)	
	Soiled	Clean
Flat Panel 1	122.32	150.41
Flat Panel 2	118.95	151.82
Tilted Panel 1	140.14	153.02
Tilted Panel 2	141.59	156.08

Table 5.1 Average instantaneous energy production for soiled and clean panels. The panels produced similar amounts of energy while clean, thus the difference in energy production while soiled must be due to a difference in the amount of accumulated soiling related to the angle at which the panels were mounted.

Determination of optimal tilt.

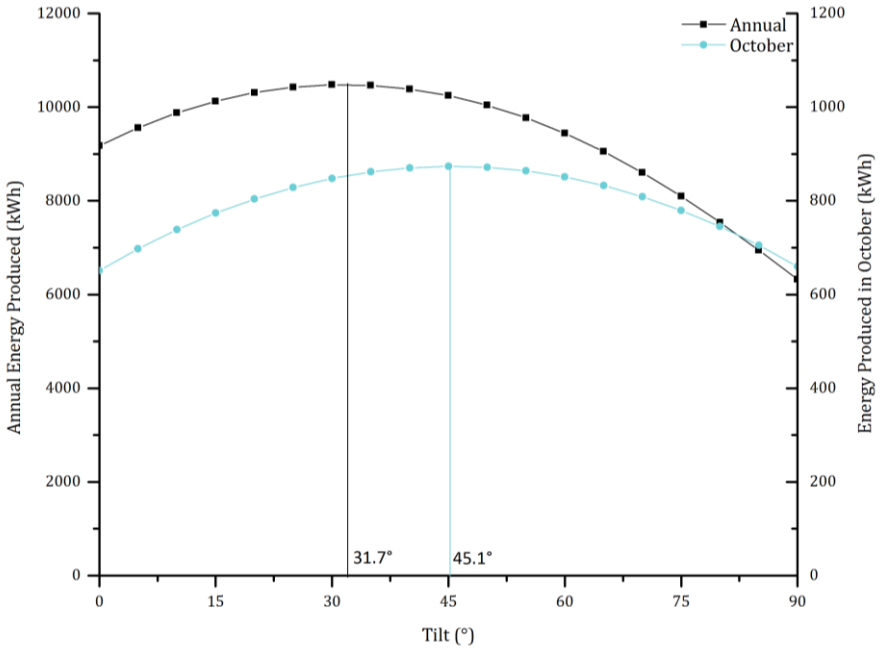


Figure 5.1 Energy production as a function of an array's southern tilt. Annual energy production (gray) is maximized when the array is tilted to its location's latitude; in Irvine, CA, this is 31.7°. Energy production in October (blue) is maximized when the array is tilted to 45.1°. Energy production simulated using SAM.

Home electronics cost-benefit analysis.
To convert manufacturer-specified maximum power consumptions to kWh, we made the following assumptions:

- The laptop, monitor, and television will each be powered on for 35 hours during the competition.
- The Blu-ray player, sound system, and projector will each be powered on for two hours during the competition.

To compute the use cost, monetary cost score, energy cost score, and total cost score, we used the following formulas:

$$use\ cost\ in\ \$ = power\ consumption\ in\ kWh * \$6/kWh$$

$$monetary\ cost\ score = \frac{(product\ cost - average\ cost)}{average\ cost}$$

$$energy\ cost\ score = \frac{(product\ use\ cost - average\ use\ cost)}{average\ use\ cost}$$

$$total\ cost\ score = monetary\ cost\ score + energy\ cost\ score$$

C. Mechanical systems

Module and canopy movement.

PLC check: canopy moves	Reason
WestM - 10ft < WestC < WestM + 10ft	The canopy can cantilever only 10 feet from the center in either direction.
EastM - 10ft < EastC < EastM + 10ft	The canopy can cantilever only 10 feet from the center in either direction.
WestC + 10ft ≤ EastC	The canopies cannot overlap.

PLC check: module moves	Reason
0ft ≤ WestM ≤ 54ft	The western module must be on the track.
0ft ≤ EastM ≤ 54ft	The eastern module must be on the track.
WestM + 10ft ≤ EastM	The modules cannot overlap.
WestM + 10ft = EastM OR WestM ≤ EastM - 15ft	The distance between the modules must be 0 feet (the house is closed) or greater than 5 feet (a small gap between the modules would be unsafe).

Note: The input position represents the distance between the western end of the track and the western edge of a particular module or canopy. The modules and canopies are 10 feet wide and the track is 54 feet long.

WestM position of western module
EastM position of eastern module
WestC position of western canopy
EastC position of eastern canopy

Table 5.2 Validity checks for input module and canopy configurations.

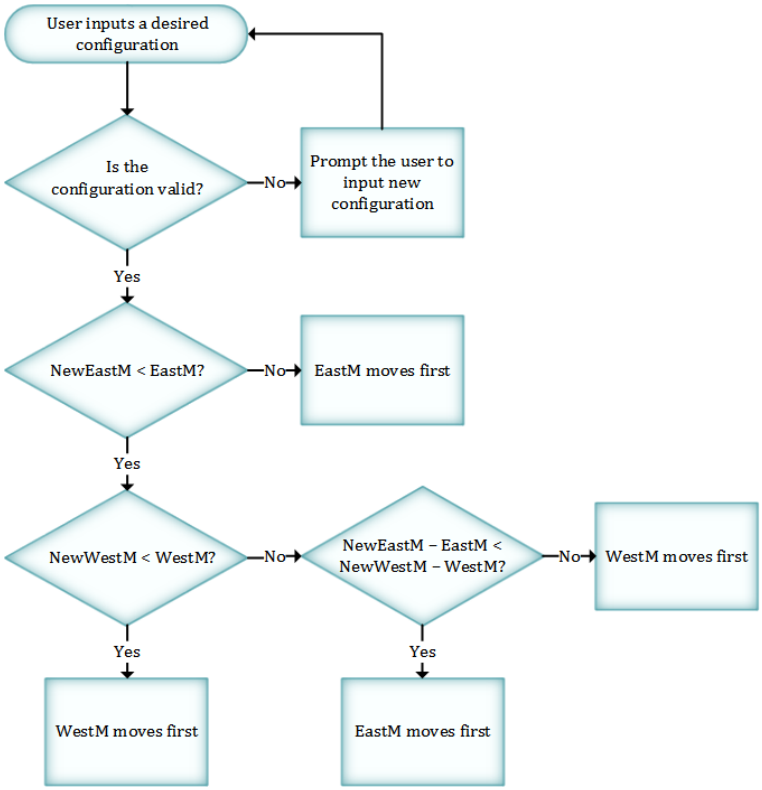


Figure 5.2 Flowchart used to determine the order of module movements.

Figures 3.3 – 3.5 Energy savings due to movement.
We set boundary zone estimates for weather conditions in which 90% of people would be happy with the home open (PPD ≤ 10).

To investigate the effect of shading on temperature, we conducted field-testing using thermocouples placed in the sun and in the shade. We found that shaded areas are significantly cooler than sunny areas during the day (Figure 5.3), and thus it was important for us to take shading into consideration when determining if a given weather condition fell within the 90% comfort zone.

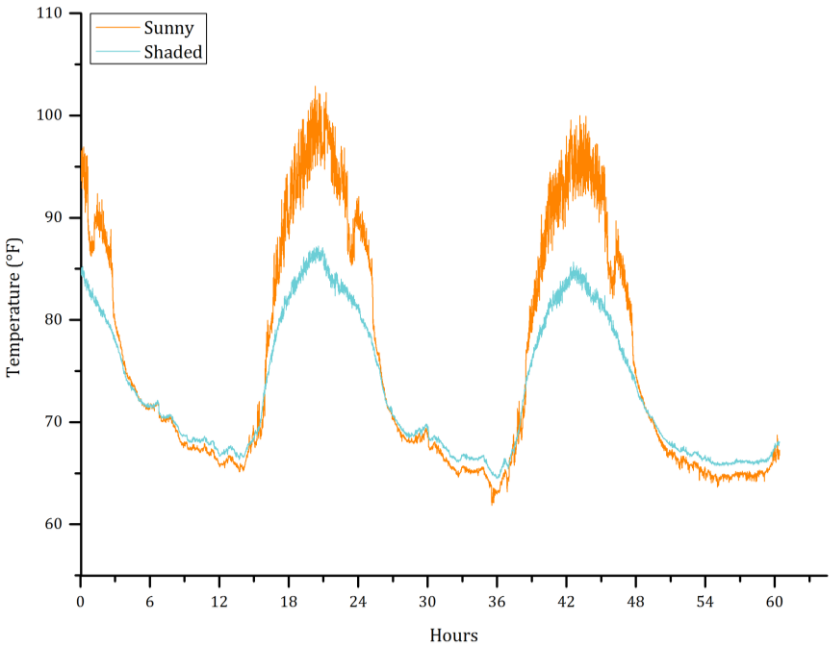


Figure 5.3 Temperature in the sun and shade. Data collected over 2.5 days; peaks occur around noon each day.

To set the comfort zone boundaries for a cloudy day, we used the following parameters:

- Relative humidity = 65% (approximate median for a cloudy day)
- Direct sunlight = 50 W/m^2 (approximate median for a very cloudy day)
- Diffuse sunlight = 200 W/m^2 (approximate median for a very cloudy day)

To set the comfort zone boundaries for a sunny day, we used the following parameters:

- Relative humidity = 52% (approximate median for a sunny day)
- Direct sunlight = 900 W/m^2 (approximate median for a very sunny day)
- Diffuse sunlight = 100 W/m^2 (approximate median for a very sunny day)

We then determined the coldest and warmest a person could feel given hourly weather conditions and the following parameters:

- Metabolic rate = 1.1 (normal adult)
- Activity level = 0 (sitting)

To determine the coldest a person could feel, we used the following parameters:

- Clothing level = 0.3 (shorts and a t-shirt)
- Wind speed = 0.75 * outdoor wind speed (the house is open and only partially blocks the wind)
- Mean radiant temperature = outdoor air temperature (the interior is completely shaded)

To determine the warmest a person could feel, we used the following parameters:

- Clothing level = 1 (sweater and jeans)
- Wind speed = 0.5 * outdoor wind speed (sunny), 0.25 * outdoor wind speed (cloudy)
- Mean radiant temperature > outdoor air temperature (the interior is not shaded; see *Thermal Comfort: Analysis and Applications in Environmental Engineering* by P. O. Fanger for the theory behind this calculation)

We computed the hourly PPD; if PPD ≤ 10 in the region bounded by the coldest and warmest a person could feel given that hour's weather conditions, the home could be opened comfortably. We then used our hourly yes/no values for 30 years to determine the probability that the homeowners would be comfortable with the house open during a given hour of the year.

Quantity Takeoff of Competition Prototype House

Please See Appendix B for the quantity takeoff.

Construction Specifications

DIVISION 03 – CONCRETE

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data, concrete mix designs, and submittals required by ACI 301.

B. Ready-Mixed Concrete Producer Qualifications: ASTM C 94/C 94M.

PART 2 - PRODUCTS

2.01 PEFORMANCE REQUIREMENTS

A. Comply with ACI 301, "Specification for Structural Concrete," and with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

2.02 MATERIALS

A. Plain Steel Wire: ASTM A 82, as drawn.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185, as drawn, flat sheet.

C. Portland Cement: ASTM C 150, Type I or II.

D. Fly Ash: ASTM C 618, Class C or F.

E. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

F. Silica Fume: ASTM C 1240, amorphous silica.

G. Aggregates: ASTM C 33, Class 3S, Class 3M, Class 1N, coarse aggregate or better, graded**,** with at least 10 years' satisfactory service in similar applications.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Maximum Aggregate Size for Concrete in Insulating Concrete Forms: 3/4 inch.

H. Air-Entraining Admixture: ASTM C 260.

I. Chemical Admixtures: ASTM C 494, water reducing, high-range water reducing, water reducing and accelerating, and water reducing and retarding. Do not use calcium chloride or admixtures containing calcium chloride.

J. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures.

1. Manufacturers: Quikrete

K. Synthetic Fiber: ASTM C 1116/C 1116M, Type III, polypropylene fibers, 1/2 to 1-1/2 inches long.

L. Vapor Retarder: Reinforced sheet, ASTM E 1745, Class A.

1. Products: Fortifiber Building Systems Group; Moistop Ultra 10.

M. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

N. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

O. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.03 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301.

B. Normal-Weight Concrete:

1. Minimum Compressive Strength: 4000 psi 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 5 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.

4. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of floor slabs to receive troweled finishes to exceed 3 percent.
5. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
6. For concrete exposed to deicing chemicals, limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; silica fume to 10 percent of portland cement by weight.

C. Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116.
1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 CONCRETING

A. Construct formwork according to ACI 301 and maintain tolerances and surface irregularities within ACI 347R limits of Class A, 1/8 inch for concrete exposed to view and Class B, 1/4 inch for other concrete surfaces.
B. Place vapor retarder on prepared subgrade, with joints lapped 6 inches and sealed.
C. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
D. Install construction, isolation, and contraction joints where indicated. Install full-depth joint-filler strips at isolation joints.
E. Place concrete in a continuous operation and consolidate using mechanical vibrating equipment.
F. Protect concrete from physical damage, premature drying, and reduced strength due to hot or cold weather during mixing, placing, and curing.
G. Formed Surface Finish: Smooth-formed finish for concrete exposed to view, coated, or covered by waterproofing or other direct-applied material; rough-formed finish elsewhere.
H. Slab Finishes: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces. Provide the following finishes:
1. Scratch finish for surfaces to receive mortar setting beds.
2. Float finish for surfaces to receive waterproofing, roofing, or other direct-applied material.
3. Troweled finish for floor surfaces and floors to receive floor coverings, paint, or other thin film-finish coatings.
4. Trowel and fine-broom finish for surfaces to receive thin-set tile.
5. Nonslip-broom finish to exterior concrete platforms, steps, and ramps.

I. Begin curing concrete slabs after finishing. Apply membrane-forming curing and sealing compound to concrete.
J. Owner will engage a testing agency to perform field tests and to submit test reports.
K. Protect concrete from damage. Repair and patch defective areas.

END OF SECTION 033000

DIVISION 05 – METALS

SECTION 051200 – STRUCTRUAL STEEL FRAMING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product data, statement of recycled content, shop drawings, welding procedure specifications (WPSs), mill test reports.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator.
   1. Use [LRFD; data are given at factored-load level] [ASD; data are given at service-load level].

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

2.02 STRUCTURAL STEEL

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] [50] <Insert number> percent.

B. W-Shapes: [ASTM A 992/A 992M] [ASTM A 572/A 572M, Grade 50 (345)].

C. Channels, Angles[, M] [, S]-Shapes: [ASTM A 36/A 36M] [ASTM A 572/A 572M, Grade 50 (345)].

D. Plate and Bar: [ASTM A 36/A 36M] [ASTM A 572/A 572M, Grade 50 (345)].

E. Cold-Formed Hollow Structural Sections: ASTM A 500, [Grade B], structural tubing.

F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

2.03 ACCESSORIES

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.

B. Anchor Rods: ASTM F 1554, Grade 36.
   1. Configuration: [Straight] [Hooked].
   2. Nuts: ASTM A 563 (ASTM A 563M) [heavy-]hex carbon steel.
   3. Plate Washers: ASTM A 36/A 36M carbon steel.
   4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.

C. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

D. Grout: ASTM C 1107, nonmetallic, shrinkage resistant, factory packaged.

2.04 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

B. Weld Connections: Comply with AWS D1.1/D1.1M[and AWS D1.8/D1.8M] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

C. Shop Priming: Prepare surfaces according to SSPC-SP 2, "Hand Tool Cleaning"; or SSPC-SP 3, "Power Tool Cleaning." Shop prime steel to a dry film thickness of at least 1.5 mils (0.038 mm). Do not prime surfaces to be embedded in concrete or mortar or to be field welded.

PART 3 - EXECUTION

3.01 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base [Bearing] [and] [Leveling] Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of base plate.
   3. [Snug-tighten] [Pretension] anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.

C. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

D. Do not use thermal cutting during erection[unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M].

E. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: [Snug tightened] [Pretensioned] [Slip critical].

F. Weld Connections: Comply with AWS D1.1/D1.1M[and AWS D1.8/D1.8M] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

END OF SECTION 051200

DIVISION 06 – WOOD, PLASTICS and COMPOSITES

SECTION 061533 – WOOD PATIO DECKING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: ICC-ES evaluation reports for wood-preservative treated wood, expansion anchors, metal framing anchors and decking fasteners.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Lumber: Provide dressed lumber, S4S, marked with grade stamp of inspection agency.

B. Certified Wood: Wood-based materials produced from tropical forests shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

2.02 TREATED MATERIALS

A. Preservative-Treated Boards and Dimension Lumber: AWPA U1; Use Category UC3b.
   1. Use treatment containing no arsenic or chromium.

B. Preservative-Treated Timber and Poles: AWPA U1; Use Category UC4a, waterborne preservative.
   1. Use treatment containing no arsenic or chromium.
   2. Treatment with CCA shall include post-treatment fixation process.

C. After treatment, redry boards, dimension lumber, timber, and poles to 19 percent maximum moisture content.

D. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

E. Provide preservative-treated materials for all exterior rough carpentry unless otherwise indicated on Drawings, and the following:
   1. Framing members less than 18 inches above grade.
   2. Sills and ledgers.
   3. Members in contact with masonry or concrete.
   4. Posts.
   5. Round wood poles.
   6. Decking.
   7. Stair treads.

2.03 LUMBER

A. Dimension Lumber:
   1. Maximum Moisture Content: [15 percent] [19 percent] [15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness] [19 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness].
   2. Deck[and Stair] Framing: [No. 1] [No. 2] [Construction or No. 2] [Construction, Stud, or No. 3]: [Hem-fir (north): NLGA;] [Southern pine: SPIB] [Douglas fir-larch: WCLIB, or WWPA;] [Spruce-pine-fir: NLGA;] [Douglas fir south: WWPA;] [Hem-fir: WCLIB, or WWPA;] [Douglas fir-larch (north): NLGA;] [or] [Spruce-pine-fir (south): NeLMA, WCLIB, or WWPA].
   3. Dimension Lumber Posts: [No. 2] [Construction or No. 2] [Construction, Stud, or No. 3]: [Hem-fir or hem-fir (north): NLGA, WCLIB, or WWPA;] [Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south: NLGA, WCLIB, or WWPA;] [or] [Mixed southern pine: SPIB].

4. Dimension Lumber Decking[and Stair Treads]: [No. 2] [Construction or No. 2]: [Hem-fir or hem-fir (north): NLGA, WCLIB, or WWPA;] [Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south: NLGA, WCLIB, or WWPA;] [or] [Mixed southern pine: SPIB].
5. Dimension Lumber Decking[and Stair Treads]: [No. 2] [Construction or No. 2] [Deck Heart or Construction Heart] [Deck Common or Construction Common] redwood; RIS.
6. Dimension Lumber Railing Members and Benches: [No. 1] [No. 2] [Construction or No. 2]: [Hem-fir or hem-fir (north): NLGA, WCLIB, or WWPA;] [Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south: NLGA, WCLIB, or WWPA;] [or] [Mixed southern pine: SPIB]. Provide material hand selected for freedom from characteristics, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.
7. Dimension Lumber Railing Members and Benches: [No. 1] [No. 2] [Construction or No. 2] [Heart B or Select Heart] redwood; RIS.

B. Boards:
1. Maximum Moisture Content: [15] [19] percent.
2. Board Decking: 1-1/4-inch- (32-mm-) thick, radius-edged decking of any of the following species and grades:
   a. Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south, WWPA, NLGA, or WCLIB.
   b. Hem-fir or Hem-fir (north), [Patio 1, Select Patio, or Select Dex] [Patio 2, Commercial Patio, or Commercial Dex]; WWPA, NLGA, or WCLIB.
   c. Southern pine, [Premium] [Standard]; SPIB.
3. Board Decking Heart B or Select Heart; RIS.
4. Stair Treads: 1-1/4-inch- (32-mm-) thick stepping with half-round or rounded-edge nosing and[any of] the following species and grades:
   a. Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
   b. Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
   c. Southern pine, [Edge Grain B & B stepping] [Near Rift B & B stepping] [B & B stepping]; SPIB.
5. Stair Treads: 1-1/4-inch- (32-mm-) thick stepping with half-round or rounded-edge nosing; redwood, [Heart Clear] [Heart B or Select Heart]; RIS.
6. Railing Boards: [Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA] [Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA] [or] [Southern pine, B & B finish; SPIB].
7. Railing Boards: Redwood, [Heart Clear] [Heart B or Select Heart]; RIS.
8. Boards for Benches: [Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA] [Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA] [or] [Southern pine, B & B finish; SPIB].
9. Boards for Benches: Redwood, [Heart Clear] [Heart B or Select Heart]; RIS.
10. Board Decking [Stair Treads] [and] [Boards for Benches]: Radius-edged S4S ipe boards, clear one face.

2.04 TIMBER AND POLES

A. Timbers 5-Inch Nominal (117-mm Actual) Size and Thicker: Provide [dressed timber (S4S)] [or] [timber that is rough sawn (Rgh)] unless otherwise indicated.
1. Maximum Moisture Content: [20] [23] <Insert number> percent.
2. Timber Posts: Balsam fir, Douglas fir-larch, Douglas fir-larch (north), eastern hemlock tamarack (north), hem-fir, southern pine, western hemlock, or western hemlock (north); [No. 1] [No. 2]; NeLMA, NLGA, SPIB, WCLIB, or WWPA.

3. Timber Posts: Alaska cedar; [No. 1] [No. 2]; WCLIB.
4. Timber Posts: Southern pine; [No. 1] [No. 2]; SPIB.

B. Round Wood Poles: Clean-peeled wood poles complying with ASTM D 3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.
1. Species: <Insert species required>.

2.05 MISCELLANEOUS PRODUCTS

A. Fasteners: Use [stainless steel] [fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or ASTM F 2329] unless otherwise indicated.
1. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
2. Power-Driven Fasteners: CABO NER-272.
3. Carbon-Steel Bolts: ASTM A 307 (ASTM F 568M) with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers all hot-dip zinc coated.

B. Postinstalled Anchors: Stainless-steel, [chemical] [or] [torque-controlled expansion] anchors with capability to sustain, without failure, a load equal to six times the load imposed as determined by testing per ASTM E 488.

C. Metal Framing Anchors: Structural capacity, type, and size indicated, made from [hot-dip galvanized steel complying with ASTM A 653/A 653M, G60 (Z180) coating] [hot-dip galvanized steel complying with ASTM A 653/A 653M, G185 (Z550) coating] [stainless steel complying with ASTM A 666, Type 304].
1. Manufacturers:
a. Simpson Strong-Tie Co., Inc.

D. Deck Splines: Plastic splines designed to fit in grooves routed into the sides of decking material and be fastened to deck framing with screws.[Splines are made from UV-resistant polypropylene.]
1. Products:
a. Blue Heron Enterprises, LLC.; Eb-Ty Hidden Deck-Fastener.

E. Deck Clips: Black-oxide-coated stainless-steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth.
1. Products:
a. Tiger Claw Inc.; Tiger Claw Hidden Deck Fasteners.

F. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from [epoxy powder-coated, hot-dip galvanized] [stainless] steel.
1. Products:
a. Grabber Deckmaster, a division of John Wagner Associates, Inc.; Deckmaster.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction" unless otherwise indicated.

C. 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. [Table 2304.9.1, "Fastening Schedule," in the IBC] [Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings].

D. Secure decking to framing with concealed decking fasteners.
E. Secure stair treads and risers by gluing and [nailing] [screwing] to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages[and finish with bullnose edge].
F. Railing Installation: Countersink fastener heads, fill flush, and sand filler.
    1. Fit balusters to railings, glue, and [nail] [screw] in place.
    2. Secure newel posts to stringers and risers with [through bolts] [lag screws] [countersunk-head wood screws and glue].
    3. Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts and glue.

END OF SECTION 061533

SECTION 061600 – SHEATHING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: ICC-ES evaluation reports for preservative-treated plywood.

PART 2 - PRODUCTS

2.01 WOOD PANEL PRODUCTS, GENERAL

A. Plywood: DOC PS 1.

B. Certified Wood: Wood-based materials shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

2.02 TREATED PLYWOOD

A. Preservative-Treated Plywood: AWPA U1; Use Category UC2.
   1. Use treatment containing no arsenic or chromium.
   2. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

B. Provide preservative-treated plywood for items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

C. Fire-Retardant-Treated Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Use Exterior type for exterior locations and where indicated.
   2. Use Interior Type A unless otherwise indicated.
   3. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F shall be not less than span ratings specified.
   4. Identify with appropriate classification marking of a testing and inspecting agency acceptable to authorities having jurisdiction.

D. Provide fire-retardant-treated plywood for items indicated on Drawings.

2.03 WALL SHEATHING

A. Plywood Wall Sheathing: Exterior, Structural I, Exposure 1 sheathing.

B. Plywood Roof Sheathing: Exterior, Structural 1, Exposure 1 sheathing.

C. Composite Nail Base Insulated Roof Sheathing: Polyisocyanurate foam with oriented strand board laminated to one face complying with ASTM C 1289, Type V.

2.04 SUBFLOORING AND UNDERLAYMENT

A. Combination Subfloor-Underlayment:
   1. Plywood Combination Subfloor-Underlayment: DOC PS 1, Exterior, Structural I, single-floor panels.

B. Subflooring:
   1. Plywood Subflooring: [Exterior, Structural I [Exterior] [Exposure 1, Structural I] [Exposure 1] single-floor panels or sheathing.
   2. Oriented-Strand-Board Subflooring: Exposure 1[, Structural I sheathing][single-floor panels or sheathing].

2.05 MISCELLANEOUS PRODUCTS

A. Fasteners: Size and type indicated.
   1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M of Type 304 stainless steel.
   2. Power-Driven Fasteners: CABO NER-272.

B. Sheathing Joint-and-Penetration Treatment Materials:

1. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant, recommended by tape and sheathing manufacturers for application indicated.
2. Sheathing Tape for Glass-Mat Gypsum Sheathing: Self-adhering, glass-fiber tape recommended by sheathing and tape manufacturers for application indicated.
3. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

C. Adhesives for Field Gluing Panels to Framing: APA AFG-01.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Securely attach to substrates, complying with the following:
1. CABO NER-272 for power-driven fasteners.
2. [Table 2304.9.1, "Fastening Schedule," in the IBC] [Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings].

B. Fastening Methods:
1. Combination Subfloor-Underlayment:
a. Nail to wood framing.
b. Screw to cold-formed metal framing.
2. Subflooring:
a. Nail to wood framing.
b. Screw to cold-formed metal framing.
3. Wall and Roof Sheathing:
a. Nail to wood framing.
b. Screw to cold-formed metal framing.

END OF SECTION 061600

SECTION 061713 – LAMINATED VENNER LUMBER

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data including specifications and installation instructions, ICC-ES evaluation reports the complete furnishings and installation of all Microllam® laminated veneer lumber (LVL) as shown on the drawings herein specified and necessary to complete the work.

B. Code Approvals: These products shall be designed and manufactured to the standards set forth in the ICC Evaluation Service, Inc. report ESR-1387.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Microllam® LVL shall be designed to fit the dimensions and loads indicated on the plans Comply with applicable requirements and recommendations of the following publications:

1. TPI 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
2. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
3. TPI BCSI, "Guide to Good Practice for Handling, Installing, Restraining & Bracing Metal Plate Connected Wood Trusses."

B. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

2.02 MATERIALS

A. Laminated Veneer Lumber: Materials shall comply with ICC ES ESR-1387.

B. Adhesives: Adhesives shall be of the waterproof type conforming to the requirements of ASTM D-2559.

C. Fasteners: Where beams are exposed to weather or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

D. Metal Framing Anchors: Provide framing anchors made from hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.

2.03 FABRICATION

A. Microllam® LVL shall be manufactured by Weyerhaeuser in a plant listed in the reports referred to above and under the supervision of an approved third-party inspection agency. It shall be manufactured in a continuous process with all grain parallel with the length of the members. All members are to be free of finger or scarf joints or mechanical connections in full-length members.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and brace beams according to TPI recommendations and as indicated. Install beams plumb, square, and true to line and securely fasten to supporting construction.

B. Anchor beams securely at bearing points; use metal beam or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchor.

C. Install and fasten permanent bracing during beam erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

1. Install bracing to comply with [Section 061000 "Rough Carpentry."] [Section 061053 "Miscellaneous Rough Carpentry."]
2. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.

D. Install LVL beams within installation tolerances in TPI 1.

E. Do not alter beams in field.

F. Remove LVL beams that are damaged or do not meet requirements and replace with beams that do meet requirements.

END OF SECTION 061753

SECTION 064100 – ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Shop Drawings.

B. Installer Qualifications: Fabricator of products.

C. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is completed, and HVAC system is operating.

PART 2 - PRODUCTS

2.01 ARCHITECTURAL CABINETS

A. Quality Standard: AWI, AWMAC, and WI's "Architectural Woodwork Standards."

B. Certified Wood: Wood-based materials shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

C. Plastic-Laminate Cabinets: Economy grade.

1. Type of Construction: Frameless.
2. Cabinet and Door and Drawer Front Interface Style: Flush overlay.
3. Laminate Cladding: Horizontal surfaces other than tops, Grade HGS; postformed surfaces, Grade HGP; vertical surfaces, Grade HGS; edges, Grade HGS PVC tape, PVC edge banding, 0.12 inch thick; semiexposed surfaces, Grade VGS thermoset decorative panels.
4. Drawer Sides and Backs: Thermoset decorative panels.
5. Drawer Bottoms: Thermoset decorative panels.

2.02 MATERIALS

A. Wood Moisture Content: 5 to 10 percent.

B. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.

C. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.

D. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

E. High-Pressure Decorative Laminate: NEMA LD 3.

1. Manufacturers:
   a. Formica Corporation.

2.03 CABINET HARDWARE AND ACCESSORY MATERIALS

A. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch thick metal, and as follows:

1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self-closing.

C. Wire Pulls: Back mounted, solid [metal] [plastic], [4 inches (100 mm) long, 5/16 inch (8 mm) in diameter] [5 inches (127 mm) long, 2-1/2 inches (63.5 mm) deep, and 5/16 inch (8 mm) in diameter].

D. Catches: [Magnetic catches, BHMA A156.9, B03141] [Push-in magnetic catches, BHMA A156.9, B03131] [Roller catches, BHMA A156.9, B03071] [Ball friction catches, BHMA A156.9, B03013].

E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081

F. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.

G. Drawer Slides: BHMA A156.9, B05091.

1. Box Drawer Slides: Grade 1HD-100.
2. Trash Bin Slides: Grade 1HD-100.

H. Drawer Locks: BHMA A156.11, E07041.

I. Exposed Hardware Finishes: Comply with BHMA A156.18 for BHMA code number indicated.
   1. Product: Atlas Homewares Tab Cabinet Pull 4-5/16”
      a. Finish; High Gloss White
      b. Quantity: 15

J. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated hardwood lumber, kiln dried to 15 percent moisture content.

2.04 FABRICATION

A. Complete fabrication to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

2.05 SHOP FINISHING OF WOOD CABINETS

A. Finishes: Same grades as items to be finished.

B. Finish cabinets at the fabrication shop; defer only final touch up until after installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

B. Install cabinets to comply with referenced quality standard for grade specified.

C. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Fasten with countersunk concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed nailing, countersunk and filled flush.

F. Cabinets: Install so doors and drawers are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation.
   1. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips.

END OF SECTION 064100

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

SECTION 072120 – THERMAL INSULATION

PART 1- GENERAL

1.1 Summary

A. This section covers thermal insulation

PART 2- PRODUCTS

2.1 Thermal batt insulation

A. Roxul Comfortbatt insulation

i. Manufacturer: Roxul

ii. Comfortbatt R30 - 24" Steel Stud

iii. Comfortbatt R24 - 24" Steel Stud

iv. Comfortbatt R23 - 16" Wood Stud

v. Fire resistant, non-combustible

vi. Chemically inert, non-corrosive

vii. http://www.roxul.com/products/building+envelope/roxul+comfortbatt

PART 3- EXECUTION

3.1 Install insulation following manufacturer instructions

A. Cut batts with serrated knife

B. Fill between studs

END OF SECTION 072120

SECTION 075000 – MEMBRANE ROOFING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Shop Drawings and ICC-ES evaluation reports for components of membrane roofing system.

B. Warranties: Manufacturer's standard or customized form, without monetary limitation, signed by membrane manufacturer agreeing to repair leaks due to defects in materials or workmanship for period of 10 years.

1.02 DEFINITIONS

A. Exterior unstructured vinyl siding: An architectural siding that provides weather protection and is wholly supported by the building to which it is attached.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide exterior fabric capable of withstanding the effects of gravity loads and the following loads and stresses within and under conditions indicated.
   1. Wind Loads:
      a. Uniform pressure of 18.6 lbs/sq. ft acting upward or downward.

B. Energy Performance: Initial Solar Reflectance not less than 0.70 and Thermal Emittance not less than 0.75 when tested according to CRRC-1.

C. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980.

D. Exterior Fire-Test Exposure: ASTM E 108, [Class A] [Class B] [Class C].

2.02 MATERIALS

A. PVC COATED POLYESTER:
   1. Manufacturers:
      a. NAIZIL INC.
   2. Product: High tenacity 1100 Dtex polyester PVC coated fabric, total weight 680 g/m 2. Self---extinguishing, ROTOFLUO W fluoridised mixed acrylic/resin lacquering.
   3. Weight: 24 ounce/yd2.
   4. Width: 98.5 inches.
   5. Color Fade Resistance: UV resistant. Most colors tested up to 1500 hrs in SAE 1960j fadeometer with minimal or no change. Fade resistant to most chemicals.
   6. Durability: Ten years,
   7. Mildew Resistance: Fabric will not support growth of mildew.
   8. Chemical Resistance: Highly resistant to acids, alkalis and solvents.
   9. Water Repellency: Excellent
   10. Oil Repellency: AATCC 118-1997 GRADE 5
   11. Bonding: can be heat sealed or sewn

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install substrate board with long joints continuous and perpendicular to roof slopes with end joints staggered. Tightly butt substrate boards together and fasten to wood joist

B. Install roofing membrane system according to roofing system manufacturer's written instructions, applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing," and as follows:

C. Maintain uniform side and staggered end laps. Bond and seal laps, leaving no voids.

END OF SECTION 075000

SECTION 079100 – PREFORMED JOINT SEALS

PART 1- GENERAL

1.1 Summary

A. Section Includes:

i. Seals for module gap

PART 2- PRODUCTS

A. QuickJoint

i. Manufacturer: EMSEAL JOINT SYSTEMS

ii. Self-Extinguising

iii. Fire-Retardant-acrylic-impregnated foam

iv. Material Cover: Silicone

v. Gap sizes: ½" to 6"

vi. R-value 5.696

PART 3- EXECUTION

3.1 Installation

A. Ducts shall be installed by a license contractor

B. Ducts prone to condensation shall be insulated to a minimum R-value of R8

C. Follow manufacturer instructions for attachment, support, and sealing

D. Installation shall comply with all applicable codes

E. Ducts shall be routed to reduce the number of bends where possible

END OF SECTION 079100

DIVISION 08 – OPENINGS

SECTION 083213 – SLIDING DOORS

PART 1- GENERAL

1.1 SUMMARY

A. Section includes:
   i. Sliding Metal Doors

B. Shop Drawings

Adobe Acrobat Document

   i. Double Click Icon:

C. Related sections
   i. Section 07270 (07 27 00) - Air Barriers: Water-resistant barrier.
   ii. Section 07920 (07 92 00) - Joint Sealants: Sealants and caulking.

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA)
B. American Society for Testing and Materials (ASTM)
C. Aluminum Association (AA)
D. National Wood Window & Door Association (NWWDA)

1.3 SYSTEM DESCRIPTION

A. General: In addition to requirements shown or specified, comply with:
   i. Applicable provisions of AAMA Windows and Sliding Glass Doors Manual for Design, materials fabrication and installation of component parts.

B. Design Requirements: Arcadia ULT-5820 Series (thermal/non-thermal) Multi-Sliding Doors.

C. Performance Requirements: This product is designed for applications only where AAMA/NWWDA ratings for air, water penetration and structural performance is not required.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility
   i. Obtain entrances, storefronts, ribbon walls, window walls, curtain walls, window systems and finish through one source from a single manufacturer.

B. Provide test reports from AAMA accredited laboratories certifying the performances as specifies in 1.3.

1.5 WARRANTY

A. Warranted against failure and/or deterioration of metals due to manufacturing process for a period of one (1) year providing the product was installed in accordance to Arcadia's installation instructions and maintained in accordance with Arcadia's operations manual

PART 2- PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   i. Arcadia, Inc., 3225 East Washington BLVD., Vernon, CA. Telephone 323/269-7300, FAX 323/269-7390

B. Acceptable Products:
   i. Arcadia Inc., Series ULT-5820 (thermal/non-thermal) Multi-slide door.

2.2 MATERIALS

A. Windows & doors fabricated from aluminum extrusions of 6063-T5 alloy and temper with a minimum wall thickness of 0.090" for the door frame sill member and a minimum of
0.072" for all other members including frame, panel and optional horizontal muntins. The aluminum shall be free of defects which impair strength and appearance.
B. Component parts and accessories shall be of aluminum alloy, stainless steel or non-metallic materials which will neither deteriorate nor promote corrosion.
C. Thermal break barrier (optional) shall provide a continuous uninterrupted thermal separation around the entire perimeter of the panel only which shall consist of a two-part, chemically
curing, high-strength urethane.
D. Sill shall have a full-length nylon track cap.
E. Panel members shall have a minimum of 5/8" glass penetration into the aluminum.
F. Operable panel shall be equipped with two adjustable steel tandem ball bearing rollers (all stainless steel tandem rollers and housings optional).
G. Locking device Adams-Rite maximum security lock MS+1850 with stainless steel hook bolt standard. Multi-slider doors & windows including all pocket windows can be supplied with
locking flush pulls and an Adams-Rite MS+1847 stainless steel mortise lock-optional.
H. Operating panels shall have an extruded 3/4" diameter – 8" O.C. aluminum wire pull handle set in either clear or black architect finish – other colors available.
I. Operating panels shall contain a bottom rail vinyl sweep.
J. Horizontal members shall have two contact points incorporating silicone treated woven pile with mylar center fins. All vertical members shall have four contact points of silicone treated woven pile with mylar center fins. All shall be held in integral extruded slots and secured to prevent movement or loss while operating sash.
K. Fixed and/or sliding panels shall be constructed to allow for either factory or field glazing. Panel glazing shall be accomplished using a "marine" style reusable, wraparound
black flexible PVC or EPDM material per commercial standard CS23060 without the need for separate glazing beads or putty style bedding compounds. The glazing channel shall be provided with the unit for either 1" insulating glass or 3/16" or 1/4" single glazing.
L. All assembly and installation screws shall be 18-8 or 410 stainless steel.
M. Screen made of extruded aluminum frame and screened with 18 x 16 fiber mesh.

2.3 FINISH

A. Finish all exposed areas of aluminum and components as indicated (excluding hardware):
   i. Clear Anodized Class I (215 R1-0.4-0.7 mils thick) meeting AAMA 611.89
   ii. (or) Dark Bronze Anodized Class 1 (0.7 mils thick) meeting AAMA 611.89
   iii. (or) Standard finish is White baked on enamel-Duracron paint PPG UC-UC-42737 meeting AAMA 2603-98
   iv. (or0 Standard finish is Quaker Bronze baked on enamel-Duracron paint PPG UC-88426 meeting AAMA 2603-98.
   v. (or) Custom colors in a baked-on enamel or Duranar finish are also available – AAMA 2604.98 and AAMA 2605.98 subject to minimum square footage requirements.

2.4 FABRICATION

A. Primary frame must be a minimum of 2" deep per panel required.

B. Frame sections interlock together to form any number of repetitious sections, each capable of accommodating a panel.
C. Each frame corner joint shall be secured with two stainless steel screws.
D. D. Profile of the fixed jamb and the latching jamb shall include two weatherstripped pockets to receive the fixed and latching stiles.
E. Fixed and sliding panels shall have a nominal 1-1/2" depth and shall have overlapped joints of the mortise type to provide extra strength and interlocking mechanically fastened hairline joints.
F. Interlocks and latching stiles shall be heavy gauge tubular sections assuring precise alignment and to resist twisting under load conditions.

PART 3- EXECUTION

3.1 EXAMINATIONS

A. Examine conditions and verify substrate conditions are acceptable for product installation.

3.2 INSTALLATION

A. Install in accordance with approved shop drawings and manufacturers installation instructions.

3.3 FIELD QUALITY CONTROL

A. Contractor's responsibility to make all necessary final adjustments to attain normal operation of each door and its mechanical hardware.

END OF SECTION 083213

DIVISION 09 – FINISHES

SECTION 093000 – TILING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data and Samples.

B. Obtain tile of each type and color or finish from same production run for each contiguous area.

C. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.[Comply with requirements in ANSI A137.1 for labeling ceramic tile packages.]

PART 2 - PRODUCTS

2.01 CERAMIC TILE

A. Ceramic tile that complies with Standard grade requirements in ANSI A137.1, "Specifications for Ceramic Tile."

B. Tile Type: Glazed, square-edged quarry tile.

1. Manufacturers:
    a. Daltile; Division of Dal-Tile International Inc.
2. Face Size: 6 by 3 inches
3. Thickness: 3/8”.
4. Wearing Surface: Nonabrasive, smooth.
5. Finish: clear glaze.
6. Color and Pattern: white subway running bond pattern.
7. Grout Color: white.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile
    a. Base: Coved.
    b. Wainscot Cap: Surface bullnose.

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

1. Products:
    a. USG Corporation; DUROCK Cement Board.

D. Fiber-Cement Underlayment: ASTM C 1288, 1/2 inch thick.

1. Products:[One of the following:]
    a. CertainTeed Corp.; FiberCement Underlayment.

E. Low-Emitting Materials: Adhesives and fluid-applied waterproofing membranes shall have a VOC content of 65 g/L or less.

F. Low-Emitting Materials: Adhesives and fluid-applied waterproofing membranes shall comply with Green Seal's GS-36 and with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. Waterproofing Membranes for Thin-Set Installations: ANSI A118.10, [fabric-faced chlorinated polyethylene, PVC, or polyethylene sheet product] [fabric-reinforced modified bituminous product] [fabric-reinforced liquid-latex or elastomeric polymer product] [unreinforced liquid-latex or elastomeric polymer product] [urethane waterproofing and adhesive].

H. Setting and Grouting Materials: Comply with material standards in ANSI's "Specifications for the Installation of Ceramic Tile" that apply to materials and methods indicated.

1. Thin-Set Mortar Type: Latex-portland cement.
    a. Manufacturers:
        1) MAPEI Corporation.
2. Thin-Set Mortar Type for Wood Subfloors: EGP latex-portland cement.

a. Manufacturers:
1) MAPEI Corporation.

3. Water-Cleanable, Tile-Setting Epoxy:
a. Manufacturers:
1) MAPEI Corporation.

4. Grout Type: Standard cement
a. Manufacturers:
1) MAPEI Corporation.

5. Grout Type: Polymer modified
a. Manufacturers:
1) MAPEI Corporation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
1. For installations indicated below, follow procedures in ANSI's "Specifications for the Installation of Ceramic Tile" for providing 95 percent mortar coverage.
a. Exterior tile floors.
b. Tile floors in wet areas.
c. Tile swimming pool decks.
d. Tile floors in laundries.
e. Tile floors composed of tiles 8 by 8 inches or larger.
f. Tile floors composed of rib-backed tiles.

B. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

C. Lay tile in grid pattern unless otherwise indicated. Align joints where adjoining tiles on floor, base, walls, and trim are the same size.

D. Install cementitious backer units and fiber-cement underlayment and treat joints according to ANSI A108.11.

E. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

F. Install waterproofing to comply with ANSI A108.13.

G. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

H. Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).

I. Apply sealer to cleaned stone tile flooring according to sealer manufacturer's written instructions.

J. Interior Floor Tile Installation Method(s):
1. Over Waterproof Membranes on Concrete Subfloors: [TCA F121 (cement mortar bed)] [TCA F122 (thin-set mortar)].
2. Over Wood Subfloors: thin-set mortar bonded on cementitious backer units or fiber cement underlayment

3. Over Waterproof Membranes on Wood Subfloors: TCA F121 (cement mortar bed).

K. Interior Wall Tile Installation Method(s):

1. Bathtub Wall Installations, Wood Studs or Furring: TCA B413 with thin-set mortar thin-set mortar on water-resistant gypsum board

END OF SECTION 093000

SECTION 096500 – RESILIENT FLOORING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data and Samples.

B. Extra Materials:

1. Resilient Floor Tile: Deliver to Owner one box for every 36 Square feet, 17 boxes or fraction thereof, of each type and color of resilient floor tile installed.

PART 2 - PRODUCTS

2.01 VINYL COMPOSITION FLOOR TILE

A. Products:

1. Armstrong World Industries, Inc.; Natural living D2404.

B. Color and Pattern: Black Walnut.

C. ASTM F 1066, Class 3 (surface-pattern tile).

D. Fire-Test Response: Critical radiant flux classification of Class I, not less than 0.45 W/sq. cm per ASTM E 648.

E. Wearing Surface: Smooth

F. Thickness: 0.125 inch

G. Size: 4 by 36 inches

2.02 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement- or blended hydraulic cement-based formulation provided or approved by flooring manufacturer for applications indicated.

B. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

C. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.

1. Low-Emitting Materials: Adhesives shall have a VOC content of [50] [60] g/L or less.

2. Low-Emitting Materials: Adhesives shall comply with Green Seal's GS-36 and with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.

1. Low-Emitting Materials: Chemical-bonding compound shall have a VOC content of 510 g/L or less.

2. Low-Emitting Materials: Chemical-bonding compound shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.

F. Integral-Flash-Cove-Base Accessories: 1-inch radius cove strip and square metal, vinyl, or rubber cap; both provided or approved by floor covering manufacturer.

1. Provide metal inside and outside corners and end stops.

G. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Prepare concrete substrates according to ASTM F 710. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

B. Unroll sheet floor coverings and allow them to stabilize before cutting and fitting.
C. Maintain uniformity of resilient sheet flooring direction, and match edges for color shading at seams.
D. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in substrates.
E. Lay out tiles so tile widths at opposite edges of room are equal and are at least one-half of a tile.
F. Match tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged. Lay tiles [with grain running in one direction] [in basket-weave pattern with grain direction alternating in adjacent tiles] [in patterns indicated].
G. Adhesively install resilient wall base and accessories.
H. Install wall base in maximum lengths possible. Apply to walls, columns, pilasters, casework, and other permanent fixtures in rooms or areas where base is required.
I. Install stair-tread-nose filler to nosing substrates that do not conform to tread contours.
J. Install reducer strips at edges of floor coverings that would otherwise be exposed.
    1. Install metal corners and end stops.
K. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor covering before applying liquid floor polish.
    1. Apply two coat(s).

END OF SECTION 096500

SECTION 099000 – PAINTING AND COATING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals:
   1. Product Data. Include printout of MPI's "MPI Approved Products List" with product highlighted.
   2. Samples.

B. Mockups: Full-coat finish Sample of each type of coating, color, and substrate, applied where directed.

PART 2 - PRODUCTS

2.01 PAINT

A. Manufacturers:
   1. Dunn-Edwards Corporation.

B. MPI Standards: Provide materials that comply with MPI standards indicated and listed in its "MPI Approved Products List."
   1. Exterior Painting Materials:
      a. Primer, Latex: MPI #6.
      b. Primer, Alkyd: MPI #5.
      c. Latex, Exterior Flat (Gloss Level 1): MPI #10.
      d. Latex, Exterior Low Sheen (Gloss Level 3-4): MPI #15.
      e. Latex, Exterior Semigloss (Gloss Level 5): MPI #11.
      f. Latex, Exterior, Gloss (Gloss Level 6): MPI #119.
      g. Light Industrial Coating, Exterior, Water Based (Gloss Level 3): MPI #161.
      h. Light Industrial Coating, Exterior, Water Based, Semigloss (Gloss Level 5): MPI #163.
      i. Light Industrial Coating, Exterior, Water Based, Gloss (Gloss Level 6): MPI #164.
      j. Alkyd, Exterior Flat (Gloss Level 1): MPI #8.
      k. Alkyd, Exterior, Semigloss (Gloss Level 5): MPI #94.
      l. Alkyd, Exterior Gloss (Gloss Level 6): MPI #9.
      m. Alkyd, Quick Dry, Semigloss (Gloss Level 5): MPI #81.
      n. Alkyd, Quick Dry, Gloss (Gloss Level 7): MPI #96.
      o. Floor Paint, Latex, Low Gloss (Maximum Gloss Level 3): MPI #60.
      p. Floor Enamel, Alkyd, Gloss (Gloss Level 6): MPI #27.
   2. Interior Painting Materials:
      a. Primer Sealer, Latex: MPI #50.
      b. Primer, Latex, for Interior Wood: MPI #39.
      c. Latex, Interior, Flat, (Gloss Level 1): MPI #53.
      d. Latex, Interior, (Gloss Level 2): MPI #44.
      e. Latex, Interior, (Gloss Level 4): MPI #43.
      f. Latex, Interior, Semigloss, (Gloss Level 5): MPI #54.
   3. Staining and Clear Finishing Materials:
      a. Wood Filler Paste: MPI #91.
      b. Primer, Latex for Exterior Wood: MPI #6.
      c. Primer, Alkyd for Exterior Wood: MPI #5.
      d. Primer, Oil for Exterior Wood: MPI #7.
      e. Preservative, for Exterior Wood: MPI #37.
      f. Stain, for Exterior Wood Decks: MPI #33.
      g. Stain, Semitransparent, for Interior Wood: MPI #90.
      h. Varnish, Water Based, Clear, Satin (Gloss Level 4): MPI #128.

i. Danish Oil: MPI #92.

4. High-Performance Coating Materials:
   a. Block Filler, Latex: MPI #4.
   b. Block Filler, Epoxy: MPI #116.
   c. Primer Sealer, Latex: MPI #50.
   d. Primer, Zinc-Rich, Epoxy: MPI #20.
   e. Primer, Epoxy, Anticorrosive: MPI #101.
   f. Polyurethane, Two-Component, Pigmented, Gloss (Gloss Level 6): MPI #72.

C. Material Compatibility: Provide materials that are compatible with one another and with substrates.
   1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

D. Use interior paints and coatings that comply with the following limits for VOC content:
   1. Flat Paints and Coatings: [50] <Insert value> g/L.
   2. Nonflat Paints, Coatings: [150] <Insert value> g/L.
   3. Dry-Fog Coatings: [400] <Insert value> g/L.
   4. Primers, Sealers, and Undercoaters: [200] <Insert value> g/L.
   5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: [250] <Insert value> g/L.
   6. Zinc-Rich Industrial Maintenance Primers: [340] <Insert value> g/L.
   7. Pretreatment Wash Primers: [420] <Insert value> g/L.
   8. Clear Wood Finishes, Varnishes: [350] <Insert value> g/L.
   9. Clear Wood Finishes, Lacquers: [550] <Insert value> g/L.
   10. Floor Coatings: [100] <Insert value> g/L.
   11. Shellacs, Clear: [730] <Insert value> g/L.
   12. Shellacs, Pigmented: [550] <Insert value> g/L.
   13. Stains: [250] <Insert value> g/L.

E. Colors: As [selected] [scheduled].

PART 3 - EXECUTION

3.01 PREPARATION

A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, lighting fixtures, and similar items that are not to be painted. Mask items that cannot be removed. Reinstall items in each area after painting is complete.

C. Clean and prepare surfaces in an area before beginning painting in that area. Schedule painting so cleaning operations will not damage newly painted surfaces.

3.02 APPLICATION

A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Paint exposed surfaces, new and existing, unless otherwise indicated.
   1. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
   2. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Paint the back side of access panels.
   4. Color-code mechanical piping in accessible ceiling spaces.
   5. Do not paint prefinished items, items with an integral finish, operating parts, and labels unless otherwise indicated.

C. Apply paints according to manufacturer's written instructions.

1. Use brushes only for exterior painting and where the use of other applicators is not practical.
2. Use rollers for finish coat on interior walls and ceilings.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
1. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

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

3.03 EXTERIOR PAINT APPLICATION SCHEDULE

A. Concrete, Nontraffic Surfaces:
1. Flat Latex: Two coats over primer: MPI EXT 3.1A.
2. Flat Latex: Two coats over alkali-resistant primer: MPI EXT 3.1K.

B. Steel:
1. Semigloss Water-Based, Light-Industrial Coating: Two coats over alkyd anticorrosive primer.

C. Wood: Including wood trim, wood-based panel products.
1. Flat Latex: Two coats over latex primer: MPI EXT 6.3L.

3.04 INTERIOR PAINT APPLICATION SCHEDULE

A. Concrete, Nontraffic Surfaces:
1. Flat Latex: Two coats: MPI INT 3.1E.
2. Flat Latex: Two coats over primer/sealer: MPI INT 3.1A.

B. Steel:
1. Semigloss, Quick-Dry Enamel: Two coats over quick-drying alkyd metal primer: MPI INT 5.1A.

C. Galvanized Metal:
1. Flat Latex: Two coats over waterborne galvanized-metal primer: MPI INT 5.3J.

D. Wood: Including wood trim, door and wood-based panel products.
1. Semigloss Latex: Two coats over latex primer for wood: MPI INT 6.3T.

E. Gypsum Board:
1. Flat and Semigloss Latex: Two coats over latex primer/sealer: MPI INT 9.2A.

3.05 EXTERIOR STAIN AND CLEAR FINISH APPLICATION SCHEDULE

A. Wood, traffic surfaces, including wood decks and stairs.
1. Deck Stain over Wood Preservative: Two coats over preservative: MPI EXT 6.5D.
2. Deck Stain: Two coats: MPI EXT 6.5F.

3.06 INTERIOR STAIN AND CLEAR FINISH APPLICATION SCHEDULE

A. Wood substrates, nontraffic surfaces,
1. Semitransparent Stain: Two coats: MPI INT 6.1G
2. Semitransparent Stain: Two coats: MPI INT 6.3C.
3. Danish Oil: Two coats: MPI INT 6.3M.

3.07 EXTERIOR HIGH PERFORMANCE COATING APPLICATION SCHEDULE

A. Concrete, Nontraffic Surfaces:
1. Gloss Epoxy: Three] coats: MPI EXT 3.1D.

B. Concrete, Traffic Surfaces:
1. Epoxy Slip-Resistant Deck Coating: One coat: MPI EXT 3.2C.

C. Steel:
1. Gloss Polyurethane, Pigmented: Two coat(s) over gloss epoxy and epoxy anticorrosive primer: MPI EXT 5.1H.

2. Gloss Polyurethane, Pigmented: One coat over intermediate coat and epoxy primer recommended by topcoat manufacturer.
3. Gloss Polyurethane, Pigmented: Two coat(s) over gloss epoxy and zinc-rich epoxy primer: MPI EXT 5.1P.
4. Gloss Polyurethane, Pigmented: One coat over intermediate coat recommended by topcoat manufacturer and zinc-rich epoxy primer.

D. Galvanized Metal:
1. Gloss Polyurethane, Pigmented: [One] [Two] coat(s) over epoxy anticorrosive primer: MPI EXT 5.3L.
2. Gloss Polyurethane, Pigmented: [One] [Two] coat(s) over epoxy primer recommended by topcoat manufacturer.

E. Wood:
1. Gloss Polyurethane, Pigmented: Two coats: MPI EXT 6.3H.

3.08 INTERIOR HIGH PERFORMANCE COATING APPLICATION SCHEDULE

A. Concrete, Nontraffic Surfaces:
1. Gloss Epoxy: Two coats: MPI INT 3.1F.
2. Gloss Epoxy-Modified Latex: Two coats: MPI INT 3.1G.

B. Concrete, Traffic Surfaces:
1. Gloss Epoxy: Two coats: MPI INT 3.2C.
2. Gloss Polyurethane, Pigmented: Two coat(s) over gloss epoxy: MPI INT 3.2D.
3. Gloss Polyurethane, Pigmented Two coat(s) over epoxy primer recommended by topcoat manufacturer.

C. Steel:
1. Gloss Epoxy: [One] [Two] coat(s) over anticorrosive epoxy primer: MPI INT 5.1L.
2. Gloss Epoxy: [One] [Two] coat(s) over epoxy primer recommended by topcoat manufacturer.
3. Epoxy-Modified Latex: Two coats over primer recommended by topcoat manufacturer.
4. Gloss Polyurethane, Pigmented: [One] [Two] coat(s) over anticorrosive epoxy primer: MPI INT 5.1F.
5. Gloss Polyurethane, Pigmented: Two coats over epoxy primer recommended by topcoat manufacturer.

D. Galvanized Metal:
1. Gloss Epoxy: Two coat(s) over anticorrosive epoxy primer: MPI INT 5.3D.
2. Gloss Epoxy: Two coat(s) over epoxy primer recommended by topcoat manufacturer.
3. Gloss Polyurethane, Pigmented: Two coats over epoxy primer recommended by topcoat manufacturer.

E. Wood:
1. Gloss Epoxy: Two coats: MPI INT 6.3L.
2. Gloss Polyurethane, Pigmented: Three coats: MPI INT 6.3E.

F. Gypsum Board:
1. Gloss Epoxy: Two coat(s) over latex primer sealer: MPI INT 9.2E.
2. Gloss Epoxy-Modified Latex: Two coats over latex primer sealer: MPI INT 9.2F.

END OF SECTION 099000

DIVISION 10 – SPECIALTIES

SECTION 102226 – OPERABLE PARTITIONS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Related Sections 064100

B. Submittals: Product Data, Shop Drawings, and Samples.

PART 2 - PRODUCTS

2.01 OPERABLE PANEL PARTITION: SHEET XB101

A. Manufacturers:

1. Unistrut.
    a. Product: Wheel Trolley P2950
    b. Quantity: 8
2. Unistrut.
    a. Product: Channel P5000
    b. Quantity: 60 LF

B. Partition Operation and Configuration: Manually operated, individual panels.

C. 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.

D. Surface-Burning Characteristics: Provide finishes with flame-spread and smoke-developed indexes not more than [25] [75] [200] and 450, respectively, per ASTM E 84.

E. Panel Weight: 2000 LBS maximum.

F. Panel Thickness: 3'X 8'Cabinet

G. Panel Edges: Cap trimmed

H. Panel Face Finish: Formica.

1. Total Weight: 500lbs.
2. Color and Pattern: White.

I. > per ASTM E 90 and ASTM E 413.

J. Suspension System: Steel trolley-system carriers and aluminum track. Limit track deflection to 0.10 inch between supports.

K. Safety Features:

PART 3 - EXECUTION

3.01 INSTALLATION

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Install operable panel partitions to comply with ASTM E 557 after other finishing operations, including painting, had been completed.

C. Adjust operable panel partitions to operate smoothly, without warping or binding. Lubricate hardware, and other moving parts.

END OF SECTION 102226

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.01 TOILET AND BATH ACCESSORIES

A. Manufacturers
   1. Kohler Inc.

B. Toilet Tissue Dispenser: SHEET P102
   1. Product: K-14444-BN.
   2. Type: Single-roll dispenser.
   3. Mounting: Vertically mounted.
   4. Material: Brushed Nickel
   5. Operation: Non-control delivery with standard spindle.
   6. Capacity: Designed for 4-1/2- or 5-inch diameter-core tissue rolls.

C. Towel Bar: SHEET P102:
   1. Product: Kohler K-14436-BN
   2. Description: 3/4-inch- square tube with circular end brackets.
   3. Mounting: Flanges with concealed fasteners.
   4. Length: 24 inches.
   5. Material and Finish: Brushed Nickel

D. Towel Bar: SHEET P102:
   1. Product: Kohler K-14435-BN
   2. Description: 3/4-inch- square tube with circular end brackets.
   3. Mounting: Flanges with concealed fasteners.
   4. Length: 18 inches.
   5. Material and Finish: Brushed Nickel

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install accessories using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items. Remove temporary labels and protective coatings.

END OF SECTION 102800

SECTION 107114 – METAL SUN SHADE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Modular, shop fabricated, metal sun shades to mount on exterior canopy frame.

B. Related Sections:

1. Section 107313 - AWNINGS

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:

1. ASTM A36 - Structural Steel.
2. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
3. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.

1.3 SUBMITTALS

A. Provide in accordance with Section 01 33 00 - Submittal Procedures:

1. Product data for sun shade components and finish.
2. Shop drawings showing layout, dimensions, spacing of components, and anchorage and installation details.
3. Calculations for support system.
4. Sample: [10 by 10 inches] [254 by 254 mm] minimum size sample of sun shade panel illustrating design, fabrication workmanship, and selected color coating.
5. Copy of warranty specified in Paragraph 1.5 for review by Architect.

1.4 QUALITY ASSURANCE

A. Design structural support framing components for sun shades under direct supervision of professional structural engineer.

B. Installer qualifications: Approved by manufacturer for installation sun of shade system.

1.5 WARRANTY

A. Provide in accordance with Section 01 77 00 - Closeout Procedures:

1. 20 years warranty for factory finish against cracking, peeling, and blistering under normal use.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Apollo Roof opening system

B. Requests to use equivalent products of other manufacturers shall be submitted in accordance with Section 01 63 00 - Product Substitution Procedures.

2.2 MATERIALS

A. Extruded aluminum: ASTM B221, Alloy 6063, Temper T-6.

B. Sheet aluminum: ASTM B209 6063, Temper T-6.

2.3 SUN SHADE SYSTEM

A. Aluminum sun shades consisting of modular framed panels with louvered infill and outriggers for mounting on canopy frame; Sun Shades as manufactured by Apollo Roof Systems.

1. Panel size: 126 by 126 inches aluminum frame with louvered infill panel as indicated on Drawings and approved shop drawings.

i. Quantity: 4

B. Sun shade panel: Modular infill panel

2. Panel size: 57 by 126 inches insert panel as indicated on Drawings and approved shop drawings.

i. Quantity: 26

3. Panel infill: Perforated Aluminum Panel.

a. Incident angle of sun shade: N/A

C. Support system: Provide outriggers or other means for support of sun shade panel fabricated from same material as panel. System shall be designed to resist applicable dead, live, wind, and seismic loads.
   1. Type: Straight projecting outriggers.
   2. Construction: Welded fabrication consisting of attachment plate, double support angles, and tapered plate extension as detailed and dimensioned on Drawings and approved shop drawings.
   3. Size: As required to provide sufficient structural support of panels.

D. Fasteners: Stainless steel bolts, studs, and other types of size and spacing as recommended by manufacturer for specific condition and detailed on approved shop drawings.

2.4 FACTORY FINISH

A. Sun shade panels, outriggers, and other components shall receive electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.
   1. Minimum hardness measured in accordance with ASTM D3363: 2H.
   2. Direct impact resistance tested in accordance with ASTM D2794: Withstand 160 inch-pounds.
   3. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95 degrees F and 95 percent relative humidity and after 1000 hours less than [3/16 inch] [5 mm] undercutting.
   4. Weatherability tested in accordance with ASTM D822: No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted at 45 degrees.

B. Color: Silver with weather resistant clear coating

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to fabrication, field verify required dimensions.

B. Coordinate sun shade installation with provision of canopy frame structure to ensure proper structural support is provided, attachment of sun shades is compatible with substrate, and weathertightness of exterior envelop is maintained.

3.2 INSTALLATION

A. Install sun shades in accordance with manufacturer's installation instructions and approved shop drawings.

B. Insulate dissimilar metals to prevent electrolysis with bituminous paint or non-absorptive gasket to prevent contact.

C. Allow for thermal expansion and contraction of metal components.

D. Install shade panels plumb, level, free from distortion, and aligned with building elements and adjacent shade panels.

E. Do not installed bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.

F. Attach shade panels to outriggers with appropriate fasteners for secure, permanent installation.

G. After installation, touch-up damaged finish with paint supplied by manufacturer and matching original coating.

END OF SECTION 107114

SECTION 107313 – AWNINGS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data, Shop Drawings, and Samples.

B. Verify dimensions by field measurements before fabrication and indicate on Shop Drawings.

PART 2 - PRODUCTS

2.01 AWNINGS

A. Performance Requirements: Provide awnings capable of withstanding design loads indicated.

B. Aluminum Frames: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
   1. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M).
   2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
   3. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M.
   4. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M).
   5. Aluminum Finish: Mill.

C. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Corrosion-resistant, weather-resistant, nonstaining materials. Where exposed to view, provide finish and color as selected.
   1. Expansion Anchors: Stainless steel anchors able to sustain six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete.

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 BALL BEARING SLIDER

A. Manufacturer
   1. Barnes Engineering Company
      a. Product: HD3B2
      b. Quantity: 10

B. Manufacturer
   1. Unistrut:
      a. Product: Wheel trolley P2750
      b. Quantity: 8

C. Manufacturer
   1. Unistrut:
      a. Product: Channel P1000
      b. Quantity: 40 LF

2.03 CANOPY DRIVE MOTORS

A. Manufacturer
   1. Baldor
      a. Product: VEM3538
      b. FL Amps 1.54/.77
      c. 60 Hz
      d. 1745 rpm
      e. 0.5 hp
      f. Quantity: 2
      g. http://www.baldor.com/products/specs.asp?1=1&page=1&catalogonly=1&catalog=VEM3538&product=AC+Motors&family=General+Purpose%7Cvw_ACMotors

_GeneralPurpose&phase=3&rpm=1400-1800&voltage=230%2F460&hp=0%2E5&winding=35WGQ186&rating=40CMB-CONT

B. Manufacturer
   1. BOSTON GEAR
      a. Product: Model # F710-15-B4-G
      b. Quantity: 2

2.04 AWNING FABRICATION

A. Frames: Preassemble awning frames in the shop to greatest extent possible.
   1. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
   2. Form exposed work true to line and level with accurate angles and straight edges.
   3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Provide weep holes where water may accumulate.
   4. Weld corners and connections continuously. At exposed corners and connections, finish exposed welds and surfaces smooth and blended.

B. Colors of Metal and Plastic Components Exposed to View: As indicated by manufacturer's.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install awnings securely connected to supports, free of rack, and in proper relation to adjacent construction.

B. Install awnings after other finishing operations, including joint sealing and painting, have been completed.

C. Slip fit frame connections accurately together to form hairline joints.

D. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

E. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

F. Galvanized Surfaces: Clean field welds, connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 107313

SECTION 107400 – MANUFACTURED EXTERIOR SPECIALTIES

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Variable- and single-frequency drives accelerate and decelerate pairs of motors to move the modules and canopies.

B. Submittals

i. http://ab.com/catalogs/

PART 2- PRODUCTS

2.1 Single-Phase Drives

A. Allen-Bradley single-phase drive

i. Allen-Bradley 1PH 240 VAC single-phase drives (50/60 Hz)

a Catalog number: 22F-A2P5N103
b Certification: UL508C, EN 50178
c Environment: IP20, -10 to 50 °C
d Voltage tolerance: 200 to 240 V ± 10%
e Input frequency tolerance: 48 to 63 Hz
f Carrier frequency: 2 to 10 kHz
g Output frequency: 0 to 400 Hz
h Frequency accuracy
(i) Digital input: within 0.05% of set output frequency
(ii) Analog input: within 0.5% of maximum output frequency
i Speed regulation: open loop with slip compensation
j Stop modes: ramp, coast, DC brake, ramp-to-hold, S curve
k Output HP: 0.5
l Output kW: 0.4
m Output current: 2.5 A

2.2 Three-Phase Drives

A. Rockwell Automation three-phase drive

i. PowerFlex 4M

a	Catalog Number:	22F-RF010-AL
b	Input Voltage	240 V
c	Single Phase	
d	Power	0.75 kW
e	Rating	1.0 hp
f	Current	10 A
g	Control output voltage	0-10 V
h	Control output amperage	4-20 mA
i	Efficiency	97.5%
j	UL508 C Listed	
k	CSA 22.2 Listed	
l	Frequency Accuracy	+/- 0.05%
m	Stop Modes:	Multiple, including ramp, coast, DC break, S curve
n	http://literature.rockwellautomation.com/idc/groups/literature/documents/td/22f-td001_-en-p.pdf	

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 107400

DIVISION 11 – EQUIPMENT

SECTION 113100 – RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Allowances: See Section 012000 "Price and Payment Procedures" for appliance allowances.

B. Submittals: Product Data.

PART 2 - PRODUCTS

2.01 RESIDENTIAL APPLIANCES

A. Regulatory Requirements: Comply with the following:

1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.

B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with [the U.S. Architectural & Transportation Barriers Compliance Board's Accessibility Guidelines] [ICC A117.1].

C. Electric Cooktop: 30-inch, built-in cooktop with four burner elements.

1. Manufacturers:
   a. BOSCH Home Appliances.
2. Product: NET8054UC
3. Color: black and stainless steel.

D. Electric Wall Oven: Built-in, single electric, self-cleaning wall oven with broiler unit.

1. Manufacturers:
   a. BOSCH Home Appliances.
2. Product: HBL8450UC
3. Color: stainless steel.

E. Exhaust Hood: 20-inch, downdraft exhaust hood with variable-speed two-speed fan.

1. Manufacturers:
   a. BSH Home Appliances Corporation (Gaggenau).
2. Product: VL431-707
3. Color: Stainless Steel
4. Fan Control: Hood-mounted switch, with separate light switch.
5. Weatherproof floor cap with backdraft damper and rodent-proof screening.

F. Refrigerator/Freezer: Freestanding, frost-free cycle-defrost, two-door refrigerator with bottom-mounted freezer, ABS thermoplastic-copolymer interior cabinet liners.

1. Manufacturers:
   a. LIEBHERR.
2. Product: HC1001
3. Color: custom panel.
4. Fresh Food Compartment Volume: 7.1 cu. ft.
5. Freezer Compartment Volume: 2.4 cu. Ft.
6. Shelf Area: four adjustable glass shelves.
7. Energy Performance: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

G. Dishwasher: Built-in, undercounter, automatic dishwasher drawer, sized to fit in 24-inch base cabinet, nine wash cycles with hot-air and heat-off drying cycles, porcelain-enamel tub and molded-plastic door liner, nylon-coated sliding dish racks.

1. Manufacturers:
   a. Fisher & Paykel.ffa

2. Product: Model DD36ST12
3. Color: custom panel.
4. Energy Performance: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

H. Clothes Washer: Freestanding, automatic clothes washer with 2.2-cu. ft. capacity stainless-steel tub and eight [8] wash cycles including regular, delicate, and permanent press; 1200 maximum RPM reversible motor.
1. Manufacturers:
   a. BOSCH Home Appliances.
2. Product:WAS24460UC
3. Color: white.
4. Energy Performance: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

I. Electric Clothes Dryer: Freestanding, front-loading clothes dryer, 3.9-cu. ft. capacity with stainless-steel interior.
1. Manufacturers:
   a. BOSCH Home Appliances.
2. Product: WTE86300US
3. Color: white.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Built-in Appliances: Securely anchor to supporting cabinetry or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

B. Freestanding Appliances: Place in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

C. Test each item of residential appliances to verify proper operation. Make necessary adjustments.

D. Verify that accessories required have been furnished and installed.

END OF SECTION 113100

SECTION 115213 – PROJECTION SCREENS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Coordinate layout and installation with ceiling construction.

PART 2 - PRODUCTS

2.01 PROJECTION SCREENS

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. Surface-Mounted Electrically Operated Screens: UL-labeled units consisting of case, screen, motor, controls, mounting accessories, and other components. Provide units with three-position switch infrared remote control, no ceiling closure, and end-mounted motor.

1. Manufacturer:
    a. FAVI ENTERTAINMENT
2. Product: FAVI 16:9/120-Inch Electric Projector Screen (HD-120)

C. Screen Material: Mildew- and flame-resistant fabric with a matte silver, silver lenticular, pearlescent, or high-gain matte neutral viewing surface with a peak gain of at least 1.3 and half-gain angle of at least 40 degrees

1. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
2. Flame Resistance: Passes NFPA 701.
3. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
4. Size of Viewing Surface: 105” x 60”

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install projection screens where indicated, securely anchored to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.

B. Test projection screens to verify proper operation. Make necessary adjustments.

END OF SECTION 115213

DIVISION 12 – FURNISHINGS

SECTION 123623 – PLASTIC COUNTERTOPS

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Shop Drawings, Samples showing the full range of colors, textures, and patterns available for each type of finish.

B. Fabricator Qualifications: Certified participant in AWI's Quality Certification Program Licensee of WI's Certified Compliance Program.

C. Installer Qualifications: Fabricator of products.

D. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet work is completed, and HVAC system is operating.

PART 2 - PRODUCTS

2.01 PLASTIC-LAMINATE COUNTERTOPS

A. Quality Standard: AWI, AWMAC, and WI's "Architectural Woodwork Standards."

B. Certified Wood: Wood-based materials shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

C. Plastic-Laminate Countertops: Premium grade.

1. Laminate Grade: HGS for flat countertops, HGP for post-formed countertops.
2. Grain Direction: Parallel to cabinet fronts.
3. Edge Treatment: Same as laminate cladding on horizontal surfaces.

2.02 MATERIALS

A. Wood Moisture Content: 5 to 10 percent.

B. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.

C. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.

D. Softwood Plywood: DOC PS 1.

E. High-Pressure Decorative Laminate: NEMA LD 3.

1. Manufacturers
   a. Formica Corporation.

2.03 FABRICATION

A. Complete fabrication to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

B. Install countertops to comply with referenced quality standard for grade specified.

C. Install countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor countertops securely to base units. Seal space between backsplash and wall.

END OF SECTION 123623

DIVISION 21 – FIRE PROTECTION

SECTION 210500 – FIRE PREVENTON EQUIPMENT

PART 1- GENERAL

1.1 Summary

A. This section includes submittals on fire prevention equipment

PART 2- Products

2.1 Sprinkler Head

A. Tyco Concealed Pendent

i. Tyco TY2596
ii. Maximum Coverage Area 12 x 12 ft
iii. Minimum Flow 13 GPM
iv. Minimum Pressure 7 PSI
v. Minimum Spacing 8 FT
vi. Temperature Rating: 160 F with 139 F Cover Plate
vii. K-Factor 4.9 GPM/Psi
viii. Quantity 8
ix. http://tyco-fire.com/TD_TFP/TFP/TFP442_07_2012.pdf

2.2 Hose Material

A. BlazeMaster Pipe and Fittings

i. Manufacturer: Lubrizol
ii. Material: CPVC
iii. Max Pressure 175 psi
iv. Max Temp 150F
v. Service Life 50 years
vi. Pipe Size 1”
vii. http://www.lubrizol.com/CPVC/Products/BlazeMaster/Single-Family-Fire-Sprinkler-Systems.html

PART 3- EXECUTION

3.1 Installation

END OF SECTION 210500

DIVISION 22 – PLUMBING

SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1- GENERAL

1.1 Summary

A. This section includes plumbing equipment related to movement of structures

B. Please Observe Section 260529 HANGARS AND SUPPORTS FOR ELECTRICAL

i. Cable Carriers are Dual-Use for Hose and Wire Cable

END OF SECTION 220519

SECTION 221116 – DOMESTIC WATER PIPING

PART 1- GENERAL

1.1 Summary

A. This section includes submittals on domestic water piping

PART 2- Products

2.1 Pipe Material

A. 1/2“ FlowGuard Gold CPVC
   i. Company: Lubrizol
   ii. Manufacturer: Charlotte Pipe
   iii. Material: CPVC
   iv. Max Pressure 400 psi
   v. Max Temp 230°F
   vi. Dimensions
      a Outside diameter: 0.625”
      b Wall thickness: 0.068”
      c Copper-tube-size: 1/2”
   vii. Fittings: FlowGuard Gold CPVC solvent weld fittings
   viii. http://www.lubrizol.com/CPVC/Products/FlowGuard/FlowGuard-Gold-Pipe-Fittings.html

B. 3/4“ FlowGuard Gold CPVC
   i. Company: Lubrizol
   ii. Manufacturer: Charlotte Pipe
   iii. Material: CPVC
   iv. Max Pressure 400 psi
   v. Max Temp 230°F
   vi. Dimensions
      a Outside diameter: 0.875”
      b Wall thickness: 0.080”
      c Copper-tube-size: 3/4”
   vii. Fittings: FlowGuard Gold CPVC solvent weld fittings
   viii. http://www.lubrizol.com/CPVC/Products/FlowGuard/FlowGuard-Gold-Pipe-Fittings.html

C. 1“ FlowGuard Gold CPVC
   i. Company: Lubrizol
   ii. Manufacturer: Charlotte Pipe
   iii. Material: CPVC
   iv. Max Pressure 400 psi
   v. Max Temp 230°F
   vi. Dimensions
      a Outside diameter: 1.125”
      b Wall thickness: 0.102”
      c Copper-tube-size: 1”
   vii. Fittings: FlowGuard Gold CPVC solvent weld fittings
   viii. http://www.lubrizol.com/CPVC/Products/FlowGuard/FlowGuard-Gold-Pipe-Fittings.html

PART 3- EXECUTION

3.1 Follow manufacturer’s directions.

END OF SECTION 221116

SECTION 221117 – FLEXIBLE HOSES

PART 1- GENERAL

1.1 Summary

A. This section contains information on the flexible reels

1.2 Submittals:

A. Product Information

PART 2- PRODUCTS

2.1 POTABLE WATER FLEXIBLE HOSES

A. Ace Hose and Rubber Company

i. Part 4082-06/3025-AB-Nex
ii. PVC Potable Water Hose
iii. NSF 51 Certified
iv. Black
v. 1" Diameter
vi. Max working Pressure: 125 psi for 1" ID hose @70F
vii. Website: http://acehose.com/mcart/index.cgi?code=3&cat=16

2.2 SANITARY WASTE DISPOSAL HOSES

A. Ace Hose and Rubber Water Hose

i. Part 4082-06/3025-AB-Nex
ii. PVC Potable Water Hose
iii. NSF 51 Certified
iv. Black
v. 1" Diameter
vi. Max working Pressure: 100 psi for 1" ID hose @70F
vii. Website: http://acehose.com/mcart/index.cgi?code=3&cat=16

2.3 FIRE SPRINKLER

A. Ace Hose and Rubber Company

i. Part 4082-06/3025-AB-Nex
ii. PVC Potable Water Hose
iii. NSF 51 Certified
iv. Black
v. 1" Diameter
vi. Max working Pressure: 125 psi for 1" ID hose @70F
vii. Website: http://acehose.com/mcart/index.cgi?code=3&cat=16

PART 3- EXECUTION

3.1 Installation

A. Install with strain relief as needed
B. Follow manufacturer installation instructions
C. Ensure proper fitting attachment

END OF SECTION 221117

SECTION 221123 – DOMESTIC WATER PACKAGED BOOSTER PUMPS

Part 1 – GENERAL

1.1 Summary

A. Section includes:

1. Booster pump for the entire water distribution system

1.2 Related Sections

1. 223330.13 – Residential Small-Capacity Electric Domestic Water Heaters

1.3 Section Requirements

A. Submittals

1. Product Data

Part 2 – PRODUCTS

A. Domestic Water booster pump

1. Grundfos MQ3-45 Flow based pressure boosting system

a. Product Requirements

i. UL listed

b. Product Specifications

i. System pressure — Max 109 psi
ii. Inlet pressure — Max 44 psi
iii. Suction lift — Max 26 ft (8m)
iv. Liquid Temperature — 32 F to 95 F
v. Main Voltage — 120V, 60Hz
vi. Voltage tolerances: –10% / +6%
vii. Sound pressure level — <55dB
viii. Flow rate at 75 feet head — 4 GPM
ix. Price: $475 (http://www.freshwatersystems.com/p-4439-grundfos-mq3-45-230v-1-hp-pressure-booster-pump-96860207.aspx?affiliateid=10050&qid=0&utm_source=Googlebase&utm_medium=Feed&utm_campaign=Product&utm_term=MQ3-45-2)

c. Manufacturer Information and Product Link

i. Manufacturer: Groundfos
ii. Link: http://noteswww.grundfos.com/web/HOMEus.NSF/Webopslag/PAVA-5CHJE7

Part 3 – EXECUTION

3.1 Installation

A. Follow manufacturer's installation instructions

END OF SECTION 221123

SECTION 221223 – WATER STORAGE TANKS

PART 4- GENERAL

4.1 Summary

A. This section covers info in the water storage tanks

PART 5- PRODUCTS

5.1 Storage Tank

A. 800 Gallon Fresh Water Bladder Tank

i. Manufacturer: Go-to tanks
ii. Size: 8' 8" x 10' x 16"
iii. Used to store potable water
iv. 4" PVC fill fitting at top
v. 1 ½" PVC Flange Fitting with PVC Ball Valve
vi. Ground Tarp Included
vii. XR3 FDA/NSF-61 Approved Materials
viii. 47 lbs
ix. http://www.gototanks.com/951-008002.aspx

5.2 Wastewater Tank

A. 800 Gallon Fresh Water Bladder Tank

i. Manufacturer: Go-to tanks
ii. Size: 8' 8" x 10' x 16"
iii. Used to store potable water
iv. 4" PVC fill fitting at top
v. 1 ½" PVC Flange Fitting with PVC Ball Valve
vi. Ground Tarp Included
vii. XR3 FDA/NSF-61 Approved Materials
viii. 47 lbs
ix. http://www.gototanks.com/951-008002.aspx

PART 6- EXECUTION

6.1 Install tanks following manufactur instructions

6.2 Ensure access to filling hole

6.3 Ensure that pvc outlet pipe is properly connected

END OF SECION 221223

SECTION 221300 – FACILITY SANITARY SEWERAGE

PART 1- GENERAL

1.1 Summary

A. This section contains specifications for the macerator unit

PART 2- PRODUCTS

2.1 Macerator

A. SFA Sanigrind pro

i. Manufacturer: Saniflo
ii. Model 38724.0
iii. 120 V Macerator Pump
iv. Dimensions 10 ½" x 8" x 20 5/16"
v. Capacity 30 gpm
vi. Power 1 HP
vii. Anti-siphon backflow prevention
viii. Requires 15 A dedicated circuit
ix. Current 9.0 A
x. Power 600 W
xi. Duty Cycle 2.5 gpm, 10 foot lift, 1 hour on, 45 mins off
xii. Vent 1 ½" Port
xiii. http://www.saniflo.com/upload/products/45/240732-manual_sanigrind-pro.pdf

2.2 Sump Pump

A. Little Giant Sump/Effluent pump

i. Manufacturer: Little Giant
ii. Model Number: 6EN-CIA-SFS
iii. http://www.little-giantpump.com/little_giant_pump_506630.htm
iv. 1/3 hp PSC motor with thermal overload protection
v. Cast Iron pump housing
vi. Stainless Steel screws, bolts, and handle
vii. Mechanical seals
viii. Vortex Impellor
ix. Passes ½ Spherical Solids
x. 1 ½" FNPT Discharge
xi. Integral snap action float switch: on level 7" – 10", off level 2" – 5"
xii. Fully submersible
xiii. 115 V
xiv. 6 A
xv. 30 GPM at 15' head

B. Sump Pump Basin

i. Manufacturer: Topp Industries
ii. The Sump Box System
iii. 11 gallon capacity
iv. 12" x 16" x 14"
v. Weight: 7 lbs
vi. Wall Thickness: 3/16"
vii. 1 1/2" "spin weld" inlet
viii. Discharge size options: 1 1/2" or 1 1/4"

2.3 Laundry Pump

A.

PART 3- EXECUTION

3.1 Installation

A. Follow Manufacturer Instructions
B. Install dedicated 15 A circuit for macerators

END OF SECTION 221300

SECTION 223300 – DOMESTIC ELECTRIC HOT WATER HEATERS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. 76 gal insulated tank for heating and holding hot water. Tank will provide hot water for living needs and for heating the house. Primary heating from heat exchange loop connected to solar thermal system with backup heating provided by integrated electric water heater.

B. Submittals

i. http://s3.pexsupply.com/product_files/SUNX-Overview.pdf

PART 2- PRODUCTS

2.1 Hot Water Tank

A. 76 Gallon AO Smith Hot Water Tank

i. Model No SUNX-80

ii. Specification:

a *Water Volume* 76 gal

b *Booster heater* 4.5 kW

c *Working Pressure* 150 psi

iii. Piping Connections:

a *Water inlet H/E Diameter* 3/4" (F) BSP

b *Water outlet H/E Diameter* 3/4" (F) BSP

c *Heat Exchanger in Diameter* 1" (F) NPT

d *Heat Exchanger out Diameter* 1" (F) NPT

iv. Power Supply

a *V/PH/Hz* 240/1/60

v. Tank Material:

a *Material outside casing* Glass Tank Coating

b *Heating Element* Low-watt density Copper

c *Insulation* 2 in non-CFC foam insulation

vi. Unit Data:

a *Dimensions (HxDiam)* 63-1/4” x 24”

b *Shipping weight* 257 lbs

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow manufacturer specified instructions

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals:
   1. Product Data for each type of plumbing fixture, including trim, fittings, accessories, appliances, appurtenances, equipment, and supports.
   2. Documentation indicating flow and water consumption requirements.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

B. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

2.02 WATER CLOSET: SHEET P102

A. Vitreous-China Water Closet: Compact elongated siphon-jet type, floor-mounted outlet with one-piece bowl and tank, flushometer valve.
   1. Manufacturers:
      a. Kohler Co.
   2. Product: Reve K-3797-0
      a. Color: white

2.03 FLUSHOMETERS: SHEET P102

A. Flushometer Valve: Brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker. Polished, chrome-plated, exposed metal parts. Consumption: Dual-flush .8 gal./flush or 1.6 gal./flush.
   1. Manufacturers:
      a. Kohler Co.

2.04 LAVATORY: SHEET P102

A. Vitreous-China Lavatory: Counter mounting, H 7-7/16”x L 23-5/8”x W 18-5/16”
   1. Manufacturers:
      a. Kohler Co.
   2. Product: K-5027-8-0
      a. Color: white

B. ME A112.18.1; solid brass Retain option in "Manufacturers" Subparagraph below to limit manufacturers to those listed.
   1. Manufacturers:
      a. Kohler Co.
   2. Product: K-14406-4-BN
      a. Color: brushed nickel
   3. Type: Widespread faucet with low lever handles and gooseneck spout.
   4. Finish: brushed nickel
   5. Handle(s): Dual lever.
   6. Maximum Flow Rate: 1.5 gpm.

C. Drain: Pop up with NPS 1-1/4 tailpiece, included with faucet.

D. Trap: plastic tubular fittings with slip-joint inlet and wall flange.

E. Supply and Drain Insulation: Soft-plastic covering; removable at stops.

F. Fixture Support: Concealed arm.

2.05 SHOWER: SHEET P102

A. Center drain shower stall with integrated high-dome ceiling, H 90" x L 36" x W 36-1/2"
   1. Manufacturers:
      a. Kohler Co.
   2. Product: Sonata K-1689-0
      a. Color: white

B. Sonata accessory kit (grab bar and shelf kit), L 16" x W 3-1/2"
   1. Manufacturers:
      a. Kohler Co.
   2. Product: Sonata K-9459-BN
      a. Color: brushed nickel

C. Mixing-Valve Faucet and Miscellaneous Fittings: Single-lever, thermostatic and pressure-balance antiscald-type faucet; maximum 2.5-gpm (0.16-L/s) flow rate.
   1. Manufacturers:
      a. Kohler Co.
   2. Product: K-T14422-4-BN
      a. Color: brushed nickel
   3. pop-up waste and overflow; shower diverter valve; shower head, arm, and flange; and ball, gate, or globe valves on supplies if check stops are not included with faucet.
   4. Body Material: Solid brass.
   5. Finish: brushed nickel.
   6. Shower Arm, Flow-Control Fitting: 1-1/2 gpm

2.06 SINK: SHEET P102

A. Stainless Sink: Undercounter type, 18-gauge thick, one bowl(s).
   1. Manufacturers:
      a. Kohler Co.
   2. Product: Iron/Tones K-6585-0
      a. Finish: white

B. Bowl:
   1. Dimensions: H 8-1/4" x L 24-1/4" x W 18-3/4"
   2. Drain(s): 3-1/2-inch removable, stainless-steel crumb cup with tubular stainless-steel tailpiece] outlet for disposer.
   3. Drain location: Centered in bowl.

C. Faucet: [**Solid brass**] [**Solid-brass underbody and brass cover plate**] [**Nonmetal (plastic) underbody and plastic or brass cover plate**].[**Maximum** 2.5-gpm (0.16-L/s) **flow rate.**]
   1. Manufacturers:
      a. Kohler Co.
   2. Product: K-7505-BN
   3. Type: Purist with pull-out spout.
   4. Finish: brushed nickel.
   5. Handle(s): Single lever.
   6. Spout: Integral with body Swing aerator 1.8-gpm.

PART 3 - EXECUTION

3.01 INSTALLATIONS

A. Install fitting insulation kits on fixtures for people with disabilities.

B. Install fixtures with flanges and gasket seals.

C. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
D. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
E. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
F. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
G. Fasten wall-mounted fittings to reinforcement built into walls.
H. Fasten counter-mounting plumbing fixtures to casework.
I. Secure supplies to supports or substrate within pipe space behind fixture.
J. Set shower receptors and mop basins in leveling bed of cement grout.
K. Install individual supply inlets, supply stops, supply risers, and tubular brass traps with cleanouts at fixture.
L. Install water-supply stop valves in accessible locations.
M. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes unless otherwise indicated.
N. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.
O. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install [**in sink deck**] [**on countertop at sink**] <**Insert location**>. Connect inlet hose to dishwasher and outlet hose to disposer.
P. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.
Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.
R. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.
S. Install piping connections between plumbing fixtures and piping systems and plumbing equipment. Install insulation on supplies and drains of fixtures for people with disabilities.
T. Ground equipment.

END OF SECTION 224000

DIVISION 23 – HVAC

SECTION 233100 – HVAC DUCTS AND CASINGS

PART 1- GENERAL

1.1 Summary

A. Section Includes:

i. Ducting for ventilation and exhaust systems

1.2 Submittals:

A. Product Data

1.3 Related Sections:

A. 23 80 00 Decentralized HVAC Equipment

PART 2- PRODUCTS

2.1 Metal Ducts

A. Ducts will be used for the range hood, AEV, and bathroom fan

B. Sizes

i. 4” diameter circular for bathroom ceiling fan

ii. 5” diameter circular for air exchange ventilator

PART 3- EXECUTION

3.1 Installation

A. Ducts shall be installed by a license contractor

B. Ducts prone to condensation shall be insulated to a minimum R-value of R8

C. Follow manufacturer instructions for attachment, support, and sealing

D. Installation shall comply with all applicable codes

E. Ducts shall be routed to reduce the number of bends where possible

END OF SECTION 233100

SECTION 233200 – AIR EXCHANGE VENTILATOR

PART 1- GENERAL

1.1 Summary

A. Section Includes:

i. Air exchanger for whole house ventilation.

1.2 Submittals:

A. Product Sheet: http://fantech.net/download/412123-aev-spec

1.3 Related Sections:

A. 23 80 00 Decentralized HVAC Equipment

PART 2- PRODUCTS

2.1 Fantech Air Exchanger

A. Model Number: AEV 1000

B. Specifications

i. Speeds (CFM): 25/63/87

ii. Power (V/Hz/Phase): 120/60/1

iii. Max Amps: 0.7

iv. Max inlet temp: 140° F

v. Dimensions (H x W x D): 14” x 12-1/2” x 18-3/16”

PART 3- EXECUTION

3.1 Installation

A. Mounted vertically

B. Follow outdoor exhaust/inlet placement requirements

C. Install as specified by manufacturer

END OF SECTION 233200

SECTION 233423 –VENTILATORS

PART 1- GENERAL

1.1 Summary

A. Section Includes:

i. Exhaust fans

1.2 Submittals:

A. Product Data: http://shop.panasonic.com//docs/misc/2012/appliance/FV-08VRL1_Submittal_Sheet.pdf

PART 2- PRODUCTS

A. Bathroom Ventilation Fans

i. Manufacturer: Panasonic
ii. Model: FV-08VRL1 WhisperRecessed
iii. Light: 18 W, GU24
iv. Power Consumption: 20.5 W
v. Duct Diameter: 4”
vi. Voltage: 120 V
vii. UL Listed for Tub/Shower Enclosure when on GFCI Circuit and enclosed in insulated ceiling

PART 3- EXECUTION

3.1 Installation

A. Ducts shall be installed by a license contractor

B. Follow Manufacturer Instructions

END SECTION 233423

SECTION 235601 – SOLAR THERMAL PUMP STATION

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. Pump station for circulating working fluid through collector to DHW solar kit and back.

B. Submittals

i. http://solarusmfg.com/downloads/Pump_Station.pdf

PART 2- PRODUCTS

2.1 Pump Station

A. Solar Thermal Pump Station

i. Model No: Wilo Solar pump STAR S 21 U 15 130 PR 3

ii. Technical Features:

a Fluid Type: Water, Glycol solution (50% max glycol)

b Safety Valve Calibration: 60 psi

c Connection: 3/4" NPT

d Operating Temperature Range: 14-230° F

e Max Ambient Temp: 104° F

f Max Operative Pressure: 145 psi

g Insulated Shell Conductibility: 0.041 W/mK

h Dimensions (LxWxD): 16.5" x 10.25" x 7"

i Center to center connection distance: 5.12 in

j Power supply: 115V - 60Hz

k Protection level: NEMA 2

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 235601

SECTION 235613.01 – HEATING, SOLAR, VACUUM TUBE COLLECTORS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. Solar Thermal Collector made evacuated tubes with heat pipe cores. The panel collects sunlight to heat a working fluid in the manifold pumped to circulate through the hot water tank to heat water.

B. Submittals

i. http://solarusmfg.com/downloads/solarus_30.pdf

PART 2- PRODUCTS

2.1 Solar Thermal Collector

A. Solar US Evacuated Tube Collector

i. Solarus 30

ii. Model No: SolarUS SL-30

iii. Dimensions:

a Overall Length (in/mm): 76.2/1935

b Overall Depth (in/mm): 5.7/145

c Overall Width (in/mm): 90.2/2290

d Absorber Area (ft^2/m^2): 26.22/2.436

e Net Weight: 216 lbs/98 kg

f Volume (Manifold): 0.46 gal/1740 mL

iv. Performance:

a Efficiency (η0G): 74.4%

b Peak Power Output: 1917 W/hr/6541 BTU

v. Tilt: 75° down from horizontal

vi. Flow Rates:

a Max: 2.11 gpm/8 Lpm

b Recommended: 0.8 gpm/3 Lpm

c Max tubes in series: 150

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 235613.01

SECTION 236333 – HEAT PUMP REFRIGERANT CONDENSERS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. Outdoor heat pump split system.

B. Submittals

i. http://usa.mylinkdrive.com/categories/3/product_types/5/series/42/models/66/products/show/874.html

PART 2- PRODUCTS

2.1 Outdoor Condensor Unit

A. Mitsubishi Electric Heat Pump

i. Model No MXZ-2B20NA-1
ii. Heating Capacity 22,000 Btu/h
iii. Heating Input Power 2.62 kW
iv. Cooling Capacity 20,000 Btu/h
v. Cooling Input Power 2.19 kW
vi. HSPF 8.9
vii. SEER 18
viii. Operating Range
a Cooling Temp. (Min/Max) 14/115°F (-10/46°C)
b Heating Temp. (Min/Max) 6/75°F (-14/24°C)
ix. Compressor
a DC INVERTER-driven Twin Rotary
x. Power Supply
a V/PH/Hz 208-230/1/60
b Minimum Circuit Amps (MCA) 15.0 Amps
c Maximum Overcurrent Protection (MOP) 20.0 Amps
xi. Refrigerant & Piping:
a Refrigerant Type/Charge R-410A/5,15
b Liquid Piping 1/4”
c Gas Piping 3/8”
d Max Pipe Length(total) 164 ft
e Vertical Limit 49 ft
xii. Unit Data:
a Dimensions (HxWxD) 27-15/16” x 33-1/16” x 13”
b Weight 130 lbs

PART 3- EXECUTION

3.1 INSTALLATION

A. Installation shall be designed and completed by trained contractors

END OF SECTION 236333

SECTION 238219 – INDOOR HEAT PUMP UNITS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. Ductless indoor unit heats/cools air over the refrigeration piping from the outdoor unit.

B. Submittals

i. http://usa.mylinkdrive.com/categories/3/product_types/5/series/48/models/56/products/show/401.html

PART 2- PRODUCTS

2.1 Indoor Unit

A. Mitsubishi Electric Ceiling-recessed Cassette Ductless Heat Pump

i. SLZ-KA09NA

ii. Cooling Performance:

a Nominal Capacity 8,400 Btu/h
b Capacity Range 3,100-10,900 Btu/h
c Total Input 700 W
d Energy Efficiency SEER 15
e Sensible Heat Factor 0.84

iii. Heating Performance:

a Nominal Capacity 10,900 Btu/h
b Capacity Range 3,100-14,100 Btu/h
c Total Input 930 W
d HSPF (Region IV) 9.6

iv. Airflow Rate:

a Cooling DRY 280-320-350 CFM
b Cooling WET 250-290-320 CFM
c Heating WET 250-290-320 CFM
d External Static Pressure: 0.02-0.06-0.14-0.20 In. WG (5-15-35-50 Pa)
e Sound Pressure Level: 29-32-38 dB(A)

v. Electrical Data:

a *Power supply* 208-230V / 1PH / 60Hz
b Min. Circuit Amps (MCA) 1 AMP

vi. Physical Data:

a Dimension (H x W x D) 9-1/4"x22-7/16"x22-7/16"
b Grill (H x W x D) 13/16”x25-5/8”x25-5/8”
c *Weight* 36 lbs

vii. Connection type

a Gas Line 3/8”
b Liquid Line 1/4"
c Field Drain Pipe (OD) 1-1/4”

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 238219

DIVISION 25 – INTEGRATED AUTOMATION AND CONTROL

SECTION 251400 – MICROPROCESSOR-BASED CONTROL UNIT

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. This section includes information on the Control4 Controller, which is used to receive and send messages between the UI and the house.

B. Submittals

a Product link: http://www.control4.com/files/products/data-sheets/Control4-HC-300-Datasheet.pdf

PART 2- PRODUCTS

2.1 Control Equipment

A. Control4 Controller

i. Home Controller HC-300

a Specifications

(i) Model Number: C4-HC300C-E-B
(ii) Remote: SR-250 Included
(iii) Video Outputs: Component (SD/HD), Composite, SVideo
(iv) Line-Level Audio Outputs: 2RCA
(v) Analog Audio Inputs: 1 RCA
(vi) Num. IR Outputs (Individual Device Control): 6
(vii) Num. IR Blaster (Multiple Device Control): 1
(viii) Num. IR Inputs: 1
(ix) Voltage: 100-240 VAC
(x) Amps: 0.26 A
(xi) Hertz: 50-60 Hz
(xii) Dimensions: 2.8” x 12” x 7.25’ (71mm x 305mm x 184mm)
(xiii) Weight: 5.2 lbs (2.35kg)

b Manufacturer Info

(i) Manufacturer: Control4 Corporation

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow all manufacturer specifications

END OF SECTION 251400

SECTION 253489 – MITSUBISHI WIRELESS THERMOSTAT

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. This section includes information on the Mitsubishi Wireless Thermostats used to control the HVAC system of the house

B. Submittals

a Product link: http://www.mitsubishipro.com/media/448725/mhk1kit.pdf

PART 2- PRODUCTS

2.1 Control Equipment

A. Mitsubishi Wireless Remote Controller

i. Model Number: MRCH1

a Operation Modes: Cool/Drying/Auto/Heat/Fan Only

b Temperature Setting Range 50– 87°F

c Fan Speed Setting Hi/Mid-2/Mid-1/Low/Auto

d Power Supply: 2 AA batteries

e Dimensions: 5-3/16” x 1-1/2” x 3-9/16”

B. Mitsubishi Wireless Receiver

i. Model Number: MFH1

a Receives commands from remote and relays them to the units

b Dimensions: 3-1/4” x 1-5/16” x 6-7/16”

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow all manufacturer specifications

END OF SECTION 253489

DIVISION 26 – ELECTRICAL

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1- GENERAL

1.1 Related Documents
- A. Solar Decathlon 2013 Building Code
- B. Solar Decathlon 2013 Rules
- C. Drawings and General Provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, apply to this section and to all following sections within Division 26

1.2 Summary
- A. Section Includes
  - i. Electrical equipment installation
  - ii. Common electrical installation requirements

1.3 Section Requirements
- A. The following specifications apply to all Division 26 Sections as a set of minimum requirements.
  - i. Compliance with the following codes:
    - a Solar Decathlon 2013 Building Code
    - b International Building Code 2012
    - c International Residential Code 2012
    - d National Electric Code 2012
  - ii. Compliance with local rules and regulations

1.4 Submittals
- i. Product data sheets
- ii. Manufacturer installation instructions

PART 2- PRODUCTS

2.1 26 05 19: Low Voltage Electrical Conductors and Cables
2.2 26 05 26: Grounding and Bonding for Electrical Systems
2.3 26 05 33: Raceway and Boxes for Electrical Systems
2.4 26 05 53: Identification for Electrical Systems
2.5 26 05 83: Wiring Connectors

PART 3- EXECUTION

3.1 INSTALLATION
- A. Perform all electrical work in compliance with applicable safety regulations
- B. All safety equipment required for compliance shall be provided by the Contractor

3.2 Quality Assurance
- A. All work and materials shall be specified in accordance with the requirements and codes listed above and all applicable local regulations applicable to the structure's final location.

END OF SECTION 260500

SECTION 260519 – LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES

PART 1- GENERAL

1.1 Summary

A. This section covers all conductors and cables used in the house. Refer to Construction Drawings for locations of products

1.2 Related Sections

A. Section 26 05 00: Common Work Results for Electrical

1.3 Submittals

A. Product Data Sheets

PART 2- PRODUCTS

2.1 Interior Cables

A. NM-B 3-conductor and 4-conductor solid cables
   i. Manufacturer: Southwire
   ii. Insulation Type: NM-B
   iii. Insulation Voltage Rating: 600 V
   iv. Wire type: Solid Copper
   v. Wire colors:
      a Phase 1: Black
      b Phase 2: Red
      c Neutral: White
      d Ground: Bare

B. NM-B 3-conductor and 4-conductor stranded cables
   i. Manufacturer: Southwire
   ii. Insulation Type: NM-B
   iii. Insulation Voltage Rating: 600 V
   iv. Wire type: Stranded Copper
   v. Wire colors:
      a Phase 1: Black
      b Phase 2: Red
      c Neutral: White
      d Ground: Bare

2.2 Outdoor Cables

A. SOOW
   i. Manufacturer: Southwire
   ii. Maximum Voltage: 600 V
   iii. Wire color: Black
   iv. Usage: Outdoors
   v. http://www.southwire.com/products/viper-type-soow.htm

PART 3- EXECUTION

3.1 Wiring Requirements

A. Verify that raceway work is completed

B. Verify that no further mechanical work is likely do damage cables

3.2 Installation

A. NM-B Solid Cables
   i. Use conductor size AWG 12 for lighting and receptacle branch circuits rated 15-20 A
   ii. Use conductor size AWG-10 for circuits rated up to 30 A
   iii. Pull all conductors through raceway at the same time
   iv. Use suitable wire pulling equipment

v. Support cables using plastic-protected cable fasteners
vi. Protect cables installed through studs with nail plates

B. NM-B Stranded Cables
i. Use conductor size AWG-8 for circuits up to 40 A
ii. Use conductor size AWG-6 for circuits up to 55 A
iii. Use conductor size AWG-2/0 for service entrance cable
iv. Pull all conductors through raceway at the same time
v. Use suitable wire pulling equipment
vi. Support cables using plastic-protected cable fasteners
vii. Protect cables installed through studs with nail plates

C. SOOW Stranded Cables
i. Use conductor size AWG-10, 12
ii. Use conductor size AWG-8 for Ground
iii. Tie cables to PV mounting frame or structure using clips or UV-rated cable ties
iv. Connect to junction boxes via approved watertight connectors
v. Follow Manufacturer Specifications

END OF SECTION 26 05 19

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. This section covers electrical bonding and grounding.

ii. Related Sections:

a 262416: Panelboards

B. Submittals

PART 2- PRODUCTS

2.1 Grounding Electrodes

A. Grounding Rod

i. Product to be determined based on ground penetration decisions by the Organizers

ii. Quantity to be determined based on Organizers Building Code Requirements

2.2 Electrode Fittings

A. Direct Burial Ground Clamp

i. Product to be determined based on grounding rod system

ii. Quantity to be determined based on grounding rod system

PART 3- EXECUTION

3.1 General

A. Install in accordance with NEC

B. Install in locations as shown in Construction Drawings

C. All metallic equipment, including building structure, ductwork, metallic raceways, junction boxes, and other conductive equipment shall be grounded

3.2 Installation

A. Grounding Rod system shall be connected to the central panelboard by means of an uninsulated wire of minimum 4 AWG

B. Grounding Rod and Clamp must be installed where they will not pose a tripping or falling hazard

END OF SECTION 260526

SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1- GENERAL

1.1 Summary

A. This section includes electric equipment related to movement of structures

PART 2- PRODUCTS

2.1 Cable Carriers

A. GORTRAC TS-110 Cable Carrier
   i. Outside-Inside Cable Carrier
      a 99 links
      b Outside Dimensions
         (i) 5” Width x 3.24” Height
      c Inside Dimensions
         (i) 3.91” Width x 2.22” Height
      d Link Length 4.06”
      e Bend Radius 10.98”
   ii. Inter-Module Cable Carrier
      a 176 links
      b Outside Dimensions
         (i) 3” Width x 3.24” Height
      c Inside Dimensions
         (i) 2.89” Width x 2.22” Height
      d Link Length 4.06”
      e Bend Radius 10.98”

B. GORTRAC N3-8D Cable Carrier
   i. Canopy Cable Carriers
      a 119 links
      b Outside Dimensions
         (i) 2.95” Width x 1.38” Height
      c Inside Dimensions
         (i) 2.48” Width x 0.91” Height
      d Link Length 4.06”
      e Bend Radius 10.98

PART 3- EXECUTION

3.1 INSTALLATION

A. Installation shall be designed and completed by trained contractors
B. Remove all sharp edges prior to installing cables
C. On-site, attach carriers with wires pre-loaded
D. Ensure that hoses and cables can fit in the bend radius

END OF SECTION 260529

SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

- A. Summary
  - i. This section covers electrical boxes and raceways for wires
  - ii. Related Sections
    - a 26 05 19: Low-Voltage Electrical Conductors and Cables
- B. Submittals
  - i. Product Data Sheets

PART 2- PRODUCTS (example is for water systems)

2.1 Metallic boxes

- A. Ceiling Boxes
  - i. Manufacturer: Raco or Equivalent
  - ii. Size:
    - a 4” square 2 -1/8” deep
    - b 4” octagon 2-1/8” deep
  - iii. Website:
- B. Wall Boxes
  - i. Manufacturer: Raco or Equivalent
  - ii. Size:
    - a 4” x 2-1/8” rectangle 2-1/8” deep
    - b 4” square 2-1/8” deep
  - iii. Website:

2.2 Nonconducting boxes

2.3 Faceplates and Rings

- A. Faceplates
  - i. Approved plastic faceplates shall be used as appropriate for outlets and switches
  - ii. Website:

2.4 Raceway

- A. Metallic conduit
- B. Flexible armored cable
- C. Liquidtight flexible conduit

2.5 Cable Carriers

- A. Gortrac KN Series Cable Carriers
  - i. Manufacturer: A&A Manufacturing
  - ii. Sizes: various
  - iii. Website: http://www.gortrac.com/carriers/cable-hose-carriers/nylatrac/nylatrac-open-style-standard-plastic-carriers/kn-series

PART 3- EXECUTION

3.1 INSTALLATION

- A. Follow Manufacturer Specifications
- B. Installation shall be performed by qualified team member or licensed electrician

END OF SECTION 260533

SECTION 260913 – ELECTRICAL POWER MONITORING AND CONTROL

Part 1 - GENERAL

1.1 Summary

A. This section includes information on the monitoring equipment. These include the:

1. Powerhouse Dynamics eMonitor 4-24 Energy Monitor

Part 2 - PRODUCTS

2.1 Products

A. Energy Consumption Monitor

1. Product Description and/or Specifications

i. Power Needs: 120 VAC, 60 Hz

ii. Operating Temperature: 14 - 140°F

iii. Operating Humidity: 5 - 95%, non-condensing

iv. Circuits able to Monitor: 24

v. Circuit Needs: 120VAC/15A breaker

vi. Communication Protocols: eLink Wireless 2.4 GHz between circuit probes and Gateway, RS485 link protocol to xPod, WiFi 802.11 and TCP-IP via Ethernet to computer

vii. Dimensions: 7” x 2.5” x 1.875” (eMonitor), 3.75” x 1.875” x .875” (xPod), 5.25” x 3.25” x 1.5” (Gateway)

viii. Weight: 4 oz (eMonitor), 2 oz (xPod), 6 oz (Gateway)

2. Manufacturer Information and Product Link

i. Manufacturer: Powerhouse Dynamics

ii. Model: 4 - 24

iii. Product Specifications: http://www.smarthome.com/90422/Powerhouse-Dynamics-eMonitor4-24-Intelligent-Residential-Power-Usage-Monitor/p.aspx

iv. Manufacturer Website: http://www.powerhousedynamics.com/residential-energy-efficiency/electricity-monitor-features-circuit-level-monitoring/

END SECTION 260913

SECTION 262616 – PANELBOARDS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. Panelboards/Circuit breaker panels provide electrical connectivity for the house

B. Submittals

i. http://products.schneider-electric.us/products-services/product-detail/?event=productDetail&countryCode=us&partNumber=HOM42M225RB

PART 2- PRODUCTS

2.1 150 A Panelboard

A. Manufacturer: Schenider Electric

i. Model: HOM24M225RB
ii. Ampere Rating 225 A
iii. Bus Material Tim-Plated Aluminum
iv. Enclosure Type Outdoor/Rainproof
v. Enclosure Rating NEMA 3R
vi. Maximum Single-Pole Circuits 42
vii. Short Circuit Rating 22 kA
viii. Phase 1-Phase
ix. Dimensions 39.37 in H x 14.75 in W x 4.52 in D
x. Voltage Rating 120/240 V

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

B. Products to be installed by a licensed electrician.

END OF SECTION 262616

SECTION 262726 – WIRING DEVICES

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Summary

i. These switches and dimmers receive commands from the Control4 Controller and turn home electronics on and off.

B. Submittals

i. Product Link: http://www.control4.com/files/products/data-sheets/Control4-120V-Lighting.pdf

PART 2- PRODUCTS

2.1 Switches

A. Outlet Switch

i. Control4 Outlet Switch

a Specifications

(i) Power requirements: 120 VAC +/- 10%; 60/50 Hz
(ii) Power Consumption: 1.4W (LEDs Off), 1.7W (LEDs On)
(iii) Maximum One Gang Load (Total across both outlets)
1. Incandescent/Tungsten/Halogen: 600W
2. Fluorescent: 7.2
3. Compact Fluorescent: 7.2
4. Electronic Low Voltage: 7.2 A
5. Magnetic Low Voltage: 1000VA
6. Motor: 1/3 HP (7.2 FLA)
7. Control Communications: ZigBee (802.15.4)
(iv) Operational Temperature: 0°C- 40°C
(v) Humidity: 5%-95% (non-condensing)
(vi) Storage Temperature: -20°C - 70°C
(vii) Dimensions: 4.5” x 2.6” x 1.6” (115mm x 67mm x 42mm)
(viii) Weight: 8.0 oz (227 g)

b Manufacturer Info

(i) Manufacturer: Control4 Corporation

2.2 Dimmers

A. Outlet Dimmer

i. Control4 Outlet Dimmer

a Specifications

(i) Power requirements: 120 VAC +/- 10%; 60/50 Hz
(ii) Power Consumption: 350 mW
(iii) Maximum One Gang Load
1. Incandescent/Tungsten/Halogen: N/A
2. Fluorescent: 1000W electronic ballast
3. Compact Fluorescent: 1000VA
4. Electronic Low Voltage: 1000VA
5. Magnetic Low Voltage: 1000VA
6. Control Communications: ZigBee (802.15.4)
(iv) Operational Temperature: 0°C- 40°C
(v) Humidity: 5%-95% (non-condensing)
(vi) Storage Temperature: -20°C - 70°C
(vii) Dimensions: 4.5” x 2.75” x 1.6” (117mm x 70mm x 41mm)
(viii) Weight: 4.9 oz (139 g)

b Manufacturer Info

(i) Manufacturer: Control4 Corporation

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow all manufacturer specifications

END OF SECTION 262726

SECTION 262800 – LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

- A. Summary
  - i. This section contains circuit breaker specifications
- B. Submittals
  - i. Manufacturer Information

PART 2- PRODUCTS (example is for water systems)

2.1 Circuit Breakers

- A. Square D HOM Line Circuit Breakers
  - i. AFCI Breakers
    - a HOM115AFI
      - (i) Amperage: 15 A
      - (ii) Poles: 1
      - (iii) AFCI Protection
  - ii. GFCI Breakers
    - a HOM115GFI
      - (i) Amperage: 15 A
      - (ii) Poles: 1
      - (iii) GFCI Protection
    - b HOM120GFI
      - (i) Amperage: 20 A
      - (ii) Poles: 1
      - (iii) GFCI Protection
  - iii. Standard Breakers
    - a HOM115
      - (i) Amperage: 15 A
      - (ii) Poles: 1
    - b HOM215
      - (i) Amperage: 15 A
      - (ii) Poles: 2
    - c HOM230
      - (i) Amperage: 30 A
      - (ii) Poles: 2
    - d HOM240
      - (i) Amperage: 40 A
      - (ii) Poles: 2
    - e HOM240
      - (i) Amperage: 50 A
      - (ii) Poles: 2
  - iv. Panel Breakers
    - a QOM2150VH
      - (i) Amperage 150 A
      - (ii) Poles 2

PART 3- EXECUTION

3.1 Installation

- A. Follow Manufacturer Specifications
- B. Installation shall be performed by qualified team member or licensed electrician

END OF SECTION 262800

SECTION 263100 – SOLAR PHOTOVOLTAICS

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. This section contains information on the solar array, including:
   i. Hanwha monocrystalline modules
   ii. SMA America inverter
   iii. Tigo module maximizer hubs

B. Submittals
   i. http://www.hanwha-solarone.com
   ii. http://www.sma-america.com/en_US.html
   iii. http://www.tigoenergy.com
   iv. {Shop Drawings}
   v. {Manuf. Instructions}

PART 2- PRODUCTS

2.1 Photovoltaic modules

A. Hanwha photovoltaic modules
   i. Hanwha monocrystalline modules
      a Catalog number: SF160-24-1M190
      b Certification: IEC 61215
      c Power: 137 W (max at normal cell operating temperature)
      d Open circuit voltage: 41.2 V
      e Short circuit current: 4.68 A
      f Voltage and current at maximum power: 32.2 V, 4.26 A
      g Module efficiency: 13.4%
      h Cell efficiency: 17.2%
      i System voltage: 1,000 V (max)
      j Series fuse fating: 10 A
      k Environment: IP65, -40 to 85 °C

2.2 Grid-Tied Inverters

A. SMA America grid-tied inverters
   i. SMA America Sunny Boy 6000 US
      a Catalog number: SB6000US
      b Max. recommended PV power: 7500 W
      c Max. DC power: 6350 W
      d Max. DC voltage: 600 V
      e MPP voltage range: 250 to 480 V
      f Max. input current: 25 A, 20 A per string
      g MPP trackers: 1
      h Fused strings per MPP tracker: 4
      i Max. AC nominal power: 6000 W
      j Max output current: 29 A
      k Efficiency: 96.9% (max)
      l Electronics proection rating: NEMA 3R
      m Certification: UL1741

2.3 Module Maximizers

A. Tigo Energy module maximizers
   i. Tigo Energy module maximizer
      a Catalog number: MM-ES50
      b Maximum power: 350 W
      c Maximum input DC voltage: 52 V

d Voltage at maximum power: 16 to 48 V
e Maximum input current: 10 A
f Maximum output power: 350 W
g Maximum continuous output current: 9.5 A
h Environment: IP65, -30 to 70 °C
i Certification: UL1741

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 263100

SECTION 265000 – LIGHTING

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data for each luminaire, including lamps.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fixtures, Emergency Lighting Units, Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Exterior Luminaires: Comply with UL 1598 and listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

D. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

E. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2.03 LAMPS

A. Recessed Can Lights

1. Elite Lighting 4” Can
    a. Manufacturer: Elite Lighting
    b. Wattage: 10W
    c. Dimming: Yes
    d. Voltage: 120 V
    e. Housing: LED4IC-AT
    f. Insulation: Yes, can Contact
2. PAR16 GU10 Task Light
    a. Manufacturer: Philips
    b. Yes

B. Outdoor Strip Lights

1. American Lighting LED Rope Light Kit
    a. Model: 120-TL60-30-WW
    b. Color: White
    c. Dimensions: ¼” x 3/8” x 360 in.
    d. Waterproof
    e. Wattage 37 W

C. Deck Recessed Lights

1. Solar LED Recessed Deck Dock Patio Light
    a. Manufacturer: Reusable Revolution
    b. Model: SRroundwhite1
    c. Color: White
    d. Dimensions: 4.75” diameter x 2” x 3” diameter base
    e. Waterproof
    f. Battery: 900 mAh

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate ceiling-mounted luminaires with ceiling construction, mechanical work, and security and fire-prevention features mounted in ceiling space and on ceiling.

B. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

C. Comply with NFPA 70 for minimum fixture supports.

D. Seismic Protection: Luminaire attachments to building walls and ceilings shall comply with seismic criteria in Section 260500 "Common Work Results for Electrical."

E. Adjust aimable lighting fixtures to provide required light intensities.

END OF SECTION 265000

DIVISION 27 – COMMUNICATIONS

SECTION 272200 – DATA COMMUNICATIONS HARDWARE

Part 1 - GENERAL

1.1 Summary

A. This section includes information on the control equipment. These include the:

1. Google Nexus 7

Part 2 - PRODUCTS

2.1 Products

A. Tablets

1. Google Nexus 7

a. Product Description and/or specifications

i. 7" 1280x800 (216ppi) screen
ii. 198.5 x 120 x 10.45 mm dimension
iii. 32 GB hard drive
iv. 340 g
v. 1.2 MP front-facing camera
vi. Wi-Fi 802.11 b/g/n
vii. bluetooth
viii. 1GB ram
ix. NVIDIA Tegra 3 quad-core processor
x. 4,325 mAh battery
xi. Accelerometer
xii. GPS
xiii. Gyroscope
xiv. Microphone
xv. Magnetometer

Part 3- EXECUTION

2.2 Installation

A. Comply with all manufacturers' written recommendations and specifications

END OF SECTION 272200

SECTION 274116 – INTEGRATED AUDIO-VISUAL SYSTEMS AND EQUIPMENT

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. The home entertainment system will contain TV, audio system, projector, projector screen, computer, and monitor. It will be used to entertain guests indoors and outdoors.

B. Submittals

i. TV: Samsung UN32EH5000

ii. Blu-Ray player: LG BP220
Audio system: Panasonic SC-BTT190 Blu-Ray Home Theater System
Projector: Acer H5360
Projector screen: FAVI HD150
Computer: Lenovo H330 (77805RU)
Monitor: Viewsonic VX2250WM

iii. {Shop drawings}

iv. Follow all manufacturer instructions.

PART 2- PRODUCTS

2.1 TV/blue-ray/audio system

A. TV
Brand: Samsung
Model: UN40EH5300
Type: LED-LCD (LED backlighting)
Screen size: 40-inch
Resolution: 1080p HD
Refresh rate: 60 Hz
Other: Built-in wifi, Smart Hub

B. Blue-ray
Brand: LG
Model: BP220
Features: Smart TV, Smart phone app
Connectivity: Wired Internet, DMP (DLNA), SIMPLINK
Other: HDMI 1.4

C. Audio
Brand: Panasonic
Model: SC-BTT190
Output: 1000W
Connectivity: Smart phone, VIERA Connect™, Wireless LAN, DLNA (DMP&DMR), BD-Live™
Other: HMDI

2.2 Projector system:

A. Projector
Brand: Acer
Model: H5360
Brightness: 2500 lumen
Throw distance: min – 3.2ft, max – 33.4ft
Max power consumption: 224W
Resolution: 1080HD
Other: 3D
Connectors: HDMI, DVI, VGA

B. Projector screen
Brand: FAVI

Model: HD-150
Size: 150-inch
Aspect Ratio: 16:9/HD
Viewing Area: 131-inch x 74-inch

2.3 Computer and monitor system

A. Computer

Brand: Lenovo
Model: H520s - 57310716
CPU: 2nd generation Intel Core i3-2130 Processor (3.40GHz)
RAM: 4GB
Hard drive: 1TB 7200 rpm
Graphics: Intel HD Graphics 2000

B. Monitor

Brand: Viewsonic
Model: VX2250WM
Resolution: 1080p
Type: LED backlighting
Connectivity: VGA, power

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 274116

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

SECTION 281600 – SAFETY MEASURES

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. When a person or other object comes in contact with one or more safety edges, the sensor(s) will trigger a full and immediate stop of module and canopy movement. When a person or other object interrupts the beams of a light curtain, the sensor will trigger a full and immediate stop of module and canopy movement. When a person or other object interrupts the beam of an area access control sensor, the sensor will trigger a full and immediate stop of module and canopy movement. Safety limit switches mute the signal from a light curtain when it is interrupted by the home. Safety relays and safety edge controllers send status inputs to a programmable logic controller and are hard-wired to the module motors.

B. Submittals

i. http://www.ab.com/catalogs

ii. {Shop Drawings}

iii. {Manuf. Instructions}

PART 2- PRODUCTS

2.1 Safety Edges

A. Allen-Bradley sensitive edge system

i. Allen-Bradley Safedge 0118S

a Catalog number: 440F-E0118S10

b Safety rating: IEC/EN 60204-1

c Environment: IP65, -5 to 55 °C

d Bend radius: 19.6 in (min)

e Power supply: 4 VDC (from control unit)

f Wire size: 18 AWG

g Cushion factor: 0.15 in

h Length: 32.8 ft

i Profile: 0.63 in

j Mounting rail

(i) Catalog number: 440F-R1212

(ii) Material: aluminum

(iii) Length: 6.5 ft

k Connector and cable

(i) Catalog number: 440F-A1185

l Mini profile resistor

(i) Catalog number: 440F-A1186

m Mini profile closing cap

(i) Catalog number: 440F-A1318

2.2 Safety Edge Controllers

A. Allen-Bradley sensitive edge controller

i. Allen-Bradley Safedge controller

a Catalog number: 440F-C252D

b Safety rating: EN 954-1

c Environment: IP65, -10 to 55 °C

d Response time: 13 ms (max)

e Contacts

(i) Safety: 2 NO

(ii) Auxiliary: 1 NC

2.3 Light Curtains

A. Allen-Bradley safety light curtain

i. Allen-Bradley Guardmaster Type 4 POC GuardShield Standard

a Catalog number: 440L-P4K0320YD
b Protected height: 12.6 in
c Number of beams: 16
d Resolution: 1.18 in
e Safety rating: IEC/EN 61496 Parts 1 & 2
f Operating voltage: 24 VDC (max)
g Power: 0.4 A max (no load)
h Response time: 20 to 25 ms
i Wavelength: 870 nm
j Environment: IP65, -10 to 55 °C
k Cordset

(i) Transmitter

1. Catalog number: 889D-F4AC-10
2. 22 AWG

(ii) Receiver

1. Catalog number: 889D-F8AB-10
2. 24 AWG

2.4 Area Access Control Sensors

A. Allen-Bradley area access control sensor

i. Allen-Bradley area access control single beam – emitter

a Catalog number: 440L-T4F2070-Q
b Safety rating: IEC/EN 61496 Parts 1 & 2
c Input power: 24 VDC ±20%
d Power consumption: 8 W (max, 24 VDC)
e Outputs: 2 NO relays
f Response time: < 22 ms
g Beam diameter: 23 mm
h Scanning range: 0.5 to 20 m
i Wavelength: 950 nm
j Environment: IP67, -25 to 55 °C

ii. Allen-Bradley area access control single beam – receiver

a Catalog number: 440L-R4F0020-Q
b Safety rating: IEC/EN 61496 Parts 1 & 2
c Input power: 24 VDC ±20%
d Power consumption: 8 W (max, 24 VDC)
e Outputs: 2 NO relays
f Response time: < 22 ms
g Beam diameter: 23 mm
h Scanning range: 0.5 to 20 m
i Environment: IP67, -25 to 55 °C

2.5 Safety Limit Switches

A. Allen-Bradley safety limit switch

i. Allen-Bradley compact safety limit switch

a Catalog number: 440P-ARPS11C
b Safety rating: UL, CE, marked for all applicable directives
c Outputs

(i) Safety contact: 1 NC, snap acting
(ii) Auxiliary contact: 1 NO, snap acting
d Actuation speed: 250 mm/s (max), 100 mm/min (min)
e Actuation frequency: 6,000 operations/hour (max)
f Mechanical life: 10,000,000 operations
g Environment: IP 66/67, 2 to 70 °C

2.6 Safety Relays
A. Allen-Bradley safety relay
i. Allen-Bradley muting module safety relay
a Catalog number: 440R-P23071
b Safety rating: IEC/EN 61496 Parts 1 & 2
c Input power: 24 VDC ±20%
d Power consumption: 0.4 A max (no load)
e Outputs
(i) Safety: 2 OSSD, 0.5 A
(ii) Auxiliary: 0.5 A
f Response time: 20 ms

PART 3- EXECUTION

3.1 INSTALLATION
A. Follow Manufacturer Specifications

END OF SECTION 281600

SECTION 281601 – POSITIONING EQUIPMENT

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. Retroreflective laser distance sensors measure the distance between the modules and the distance between each module and the end of the track. Limit switches prevent the modules from driving off the ends of the track and ensure that the modules continue to close until an air- and water-tight seal forms between the modules.

B. Submittals

i. http://ab.com/catalogs/

ii. {Shop Drawings}

iii. {Manuf. Instructions}

PART 2- PRODUCTS

2.1 Laser Distance Sensors

A. Allen-Bradley photoelectric sensor

i. Allen-Bradley laser measurement photoelectric sensor

a Catalog number: 45LMS-U8LGC3-D4

b Sensing mode: retroreflective

c Light source: Class 1 laser (visible red 660 nm)

d Sensing distance: 0.2 to 50 m

e Spot size: < 50mm at a distance of 50 m

f Precision: accurate to ± 25 mm

g Environment: IP65, -30 to 50 °C

h Outputs: one discrete (NPN/PNP), one analog (4 to 20 mA)

i Mounting bracket

(i) Catalog number: 45LMS-BKT1

j Cordset

(i) DC Micro quick disconnect, 22 AWG

k Reflector target

(i) Dimensions: 40.5 x 60 mm

2.2 Limit Switches

A. Allen-Bradley limit switch

i. Allen-Bradley compact limit switch (top push cross roller)

a Catalog number: 802B-CSAD1XSXD4

b Torque/force to operate: 11.77 N (max)

c Travel to operate contacts: 1.8 mm (max)

d Maximum travel: 5 mm

e Maximum travel to reset contacts: 0.2 mm

f Output type: standard

2.3 Proximity Sensors

A. Allen-Bradley proximity sensor

i. Allen-Bradley 2W proximity switch

a Catalog number: 872C-D3NE12-D4

b Environment: IP67, -25 to 70 °C

c Barrel Diameter: 12 mm

d Sensing Distance: 3 mm

e Load current: < 100 mA

f Leakage current: < 0.9 mA

g Operating voltage: 10 to 30 VDC

h Voltage drop: ±6 V

PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 281601

SECTION 281602 – COMMAND CENTER EQUIPMENT

PART 1- GENERAL

1.1 SECTION REQUIREMENTS

A. A programmable logic controller with a touchscreen user interface and manual trigger allow the homeowners to input a desired module and canopy configuration.

B. Submittals

i. http://ab.com/catalogs/

ii. {Shop Drawings}

iii. {Manuf. Instructions}

PART 2- PRODUCTS

2.1 Programmable Logic Controllers (PLCs)

A. Allen-Bradley PLC

i. Allen-Bradley MicroLogix 1400 PLC

a Catalog number: 1766-L32BWA

b Environment: -20 to 60 °C

c Line voltage: 120/240 VAC

d Memory

(i) 10 kB user program

(ii) 10 kB user data

(iii) Battery-backed RAM

e Inputs: 12 (fast 24 VDC), 8 (normal 24 VDC)

f Outputs: 12 relay

2.2 PLC Input/Output Modules

A. Allen-Bradley input module

i. Allen-Bradley four-channel analog input module

a Catalog number: 1762-IF4

b Environment: -20 to 65 °C

c Inputs: four differential (bipolar)

d Analog ranges

(i) Voltage: ±10 V

(ii) Current: 4 to 20 mA

ii. Allen-Bradley 16 point digital input module

a Catalog number: 1762-IQ16

b Environment: -20 to 65 °C

c Inputs: 16 (eight points/group)

d Operating voltage range: 10 to 26.4 VDC

e Maximum on-state current: 12 mA at 30 VDC

f Maximum off-state current: 1.5 mA at 5 VDC

B. Allen-Bradley output module

i. Allen-Bradley 16 point digital output module

a Catalog number: 1762-OW16

b Environment: -20 to 65 °C

c Outputs: 16 (eight points/group)

d Operating voltage range: 5 to 265 VAC, 5 to 125 VDC

e Maximum continuous current per output: 2.5 A

f Maximum off-state leakage current: 0 mA

2.3 User Interface Panels

A. Allen-Bradley touchscreen user interface panels

i. Allen-Bradley PanelView graphic terminal

a Catalog number: 2711C-T6T
b Display type: color transmissive TFT active matrix LCD
c Display size: 5.7 in
d Resolution: 320 x 240
e Backlight: white LED lifetime 40,000 hours (min)
f Touchscreen type: analog resistive
g Actuation rating: 1,000,000 presses
h Communication ports: RS-232 (DH-485), RS-232 (DF1), RS485, Ethernet
i Programming port: USB device port or Ethernet port
j Input voltage range: 18 to 30 VDC (24 VDC nom)
k Power consumption: 10 W (max, 0.42 A at 24 VDC)
l Environment: IP 65, 0 to 50 °C
m Certification: c-UL-us, CE marked, C-Tick

2.4 Power Supplies
A. Allen-Bradley power supply
i. Allen-Bradley 480 W power supply
a Catalog number: 1606-XLS480E
b Output wattage and voltage: 480 W, 24 to 28 VDC
c Input voltage: 100 to 240 VAC or 110 to 150 VDC
d Rated input current
(i) 4.6 A at 100 VAC
(ii) 2.5 A at 240 VAC
e Output current
(i) 20 A at 24 V
(ii) 17 A at 28 V
f Safety rating: IEC/EN 60950, EN 50178

2.5 Emergency Stop Buttons
A. Allen-Bradley emergency stop button
i. Allen-Bradley metal mushroom push button
a Catalog number: 800FM-MT34
b Trigger action: twist to release
c Color: red
d Size: 30 mm diameter
e Environment: IP 65/66, -25 to 70 °C
f Mechanical durability: 300,000 cycles
g Operating force: 9 N (typical)
h Certifications: UR/UL, CSA, CCC, CE
i Metal latch
(i) Catalog number: 800F-ALM
(ii) Mechanical durability: 10,000,000 cycles
(iii) Certifications: UR/UL, CSA, CCC, CE
j Contact blocks
(i) Catalog numbers: 800F-X01, 800F-X10

2.6 Unmanaged switches
A. Allen-Bradley unmanaged switch
i. Allen-Bradley Stratix 2000
a Catalog number: 1783-US05T
b Inrush current: 2.2 A (max)
c Power supply voltage: 24 VDC (10 to 35 VDC)
d Isolation voltage: 30 V (continuous)

e Power consumption: 4 W (max, 400 mA at 10 VDC)
f Ethernet connections: category 5 cable (ISO/IEC 24702)
g DC power connections: 16 to 14 AWG
h Environment: open-style enclosure, 0 to 60 °C
i Certification: UL Listed Industrial Control Equipment
j Copper ports per module: 5

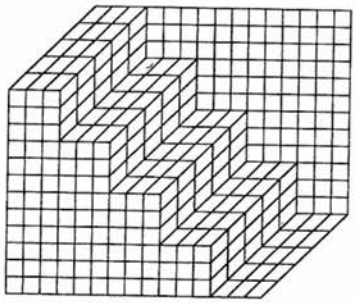
PART 3- EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer Specifications

END OF SECTION 281602

Appendix B: Quantity Takeoff



Buro Happold

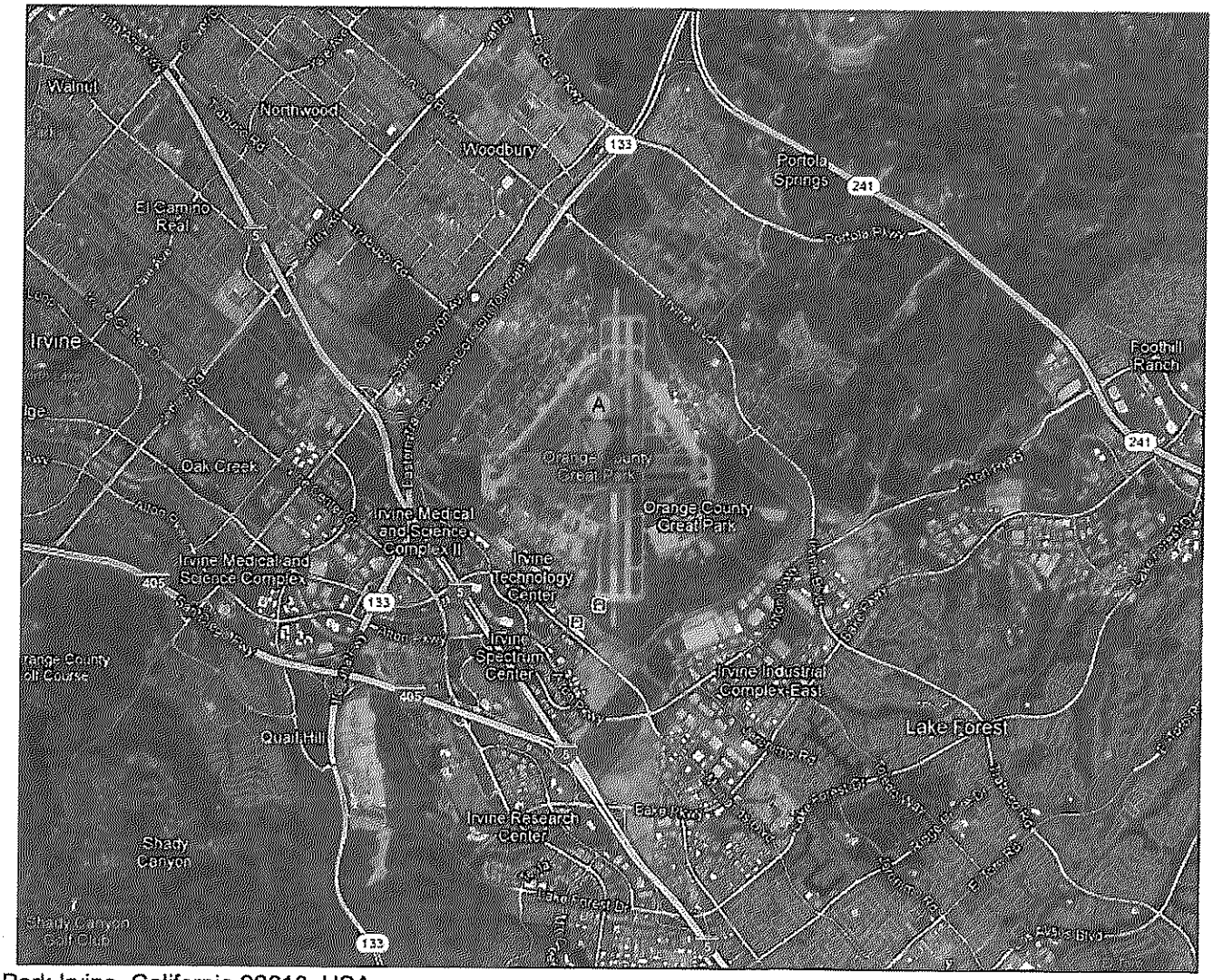
Sci-Arc Solar Decathlon

Structural Calculations (Construction Documents Phase)
Project #: 3102BD
November 9, 2012

2-12-2013

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: SITE MAP		AUTHOR/DATE:
			CHECKED BY/DATE:

SITE MAP:



Great Park Irvine, California 92618, USA

Latitude: N 33.672917
N 33° 40' 22.5"

Longitude: W 117.73172
W 117° 43' 54.2"

GENERAL DESIGN CRITERIA

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: GENREAL DESIGN CRITERIA		AUTHOR/DATE:
			CHECKED BY/DATE:

GENERAL DESIGN CRITERIA:

Structural Design is based on the California Building Code, 2010 Edition, City of Irvine Building Ordinances and Amendments, ASCE (American Society of Civil Engineers), ACI (American Concrete Institute), AISC (American Institute of Steel Construction), AITC (American Institute of Timber Construction), and NDS (National Design Standards) for wood construction.

LOADS:

- **Dead Load:** *(As required per calculations)*
- **Roof Live Load:** 20 psf
- **Floor Live Load:**
  Typical Floor: 50 psf *(Reducible per CBC Section 1607.9.1.1)*
  Decks used for Tour Staging and Egress: 100 psf *(Reducible per CBC Section 1607.9.1.1)*
- **Seismic:** Occupancy Category II; Site class D; Short period spectral response acceleration (S_S) 143.6%; 1.0 sec period spectral response acceleration (S_1) 50.7%; Long-period transition period (T_L) 8.0; Importance factor (I_E) 1.00;
- **Wind:** Basic wind speed 85 mph; Exposure category C; Importance factor (I_W) 1.0
- **Snow:** N/A

FOUNDATIONS:

- **Spread and Continuous Footings:** Designed for an allowable bearing pressure of 1,500 psf on paved surfaces.

MATERIALS:

CONCRETE:

- **Concrete:**
  Spread and Continuous Footings: Minimum compressive strength of 4,500 psi at 28 days.
  Slab on Grade: Minimum compressive strength of 4,500 psi at 28 days.
- **Cement:** Type V
- **Reinforcing:** ASTM A615, Grade 60 *(F_y = 60 ksi)*

STEEL:

- **W-Beams and W-Columns:** ASTM A992, Grade 50 *(F_y = 50 ksi)*
- **HSS-Beams and HSS-Columns (Rectangular):** ASTM A500, Grade B *(F_y = 46 ksi)*
- **Angles and Plates:** ASTM A36 *(F_y = 36 ksi)*
- **Bolt Connections:** ASTM A325 (Slip-Critical where occurs).
- **Anchor Bolts:** Standard: ASTM A307

WOOD:

- **Visually Graded Dimension Lumber (2" - 4" thick):** Douglas Fir-Larch No. 2 Grade.
- **Pre-Manufactured Lumber:** Truss Joists, a Weyerhaeuser Business or ICBO approved equal.
- **Connection Hardware:** Simpson Strong Tie or ICBO Approved Equal.
- **Shear Walls:** As per attached Shear Wall Schedule

WELDS:

- E70XX Electrode

INSPECTION:

- As required by governing municipality
- **Concrete:** Required verification and inspection per Table 1704.4
- **Steel:** Required verification and inspection per Table 1704.3
- **Quality Assurance:** Section 1705 for Seismic Resistance and 1706 for Wind Requirement

SHEAR WALL SCHEDULE:

SHEAR WALL SCHEDULE								
SHEAR WALL			SILL PLATE CONNECTION		HARDWARE CONNECTION		ALLOWABLE SHEAR	
MARK	NOMINAL PANEL THICKNESS	EDGE NAILING (E.N.)	SILL PLATE NAILING AT STEEL FLOOR MEMBER	SILL PLATE NAILING AT WOOD FLOOR	A35 OR LTP4	16dS	SEISMIC	WIND
<P6>	3/8 " PLYWOOD	10dN @ 6" O.C.	PDP @ 6" O/C	16dS @ 4" O.C.	16" O.C.	4" O.C.	340 PLF	476 PLF
<P4>	3/8 " PLYWOOD	10dN @ 4" O.C.	PDP @ 4" O/C	20dN @ 3" O.C.	10" O.C.	3" O.C.	510 PLF	714 PLF
<P3>	3/8 " PLYWOOD	10dN @ 3" O.C.	PDP @ 3" O/C	20dN @ 2" O.C.	8" O.C.	2" O.C.	665 PLF	931 PLF
<P2>	3/8 " PLYWOOD	10dN @ 2" O.C.	PDP @ 2" O/C	20dN @ 2" O.C.	6" O.C.		870 PLF	1218 PLF

NOTES:

1. 10dN = 10d COMMON NAIL (0.148" DIA.)
   20dN = 20d COMMON NAIL (0.192" DIA.)
   16dS = 16d SINKER NAIL (0.148" DIA.)
   PDP = HILTI X-U (0.157" DIA)
2. WALL SHEATHING SHALL BE STRUCTURAL I PLYWOOD WITH A SPAN RATING OF 32/16. ALL UNSUPPORTED EDGES SHALL BE BLOCKED WITH 12" O.C. FEILD NAILING.
3. ALL SILL PLATES SHALL BE 2x NOMINAL LUMBER AND TOP PLATE SHALL BE DOUBLE 2X NOMINAL LUMBER U.O.N.
4. WHERE HILTI X-U PDP'S ARE USED, FULL PENETRATION INTO THE STEEL MEMBER MUST BE ACHIEVED- INSTALL PER MFR SPECIFICATION
5. P4, P3, P2 AND DOUBLE-SIDED SHEAR WALLS SHALL REQUIRE THE FOLLOWING:
   A. NAILS SHALL BE STAGGERED AT ALL ADJOINING PANEL EDGES.
   B. 3x NOMINAL LUMBER SHALL BE USED AT ALL ADJOINING PANEL EDGES.
   C. SILL PLATE SHALL BE 3x NOMINAL LUMBER. 4x NOMINAL LUMBER MAY BE USED AT THE FOUNDATION ONLY.
6. FOR DOUBLE-SIDED SHEAR WALLS USE ONE-HALF THE SPACING SHOWN IN THE SCHEDULE FOR SILL PLATE CONNECTION AND HARDWARE CONNECTION
7. ALL SHEAR WALL LENGTHS NOTED ON PLAN ARE MINIMUM REQUIRED AND MAY BE INCREASED WITHOUT REVIEW.
8. ALLOWABLE SHEAR VALUES ARE BASED ON THE SPECIFIC GRAVITY OF THE FRAMING LUMBER NOT LESS THAN 0.50 AND STUDS ARE NOT SPACED MORE THAN 16" O.C.
9. MULTIPLE END POSTS SHALL BE STITCH NAILED TOGETHER WITH 16dS PER SHEAR WALL SCHEDULE.

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: DEAD LOADS		AUTHOR/DATE:
			CHECKED BY/DATE:

Roof Dead Loads (Typical Surface Load): Maximum

Solar Panels	4.0 psf
Attachment Steel and Fabric	4.0 psf
Waterproofing Membrane	1.5 psf
1/2" Roof Sheathing *(O.S.B. Allowance)*	1.7 psf
2x10 Douglas-Fir Floor Joists @ 16" o/c	2.8 psf
Insulation	0.5 psf
Mechanical/Electrical/Plumbing	3.0 psf
Sprinklers	2.0 psf
5/8" Gypsum Board	2.8 psf
Miscellaneous	1.7 psf
Total Dead Load	**24.0 psf**

Roof Dead Loads (Typical Surface Load): Minimum

Attachment Steel and Fabric	3.1 psf
Waterproofing Membrane	0.5 psf
1/2" Roof Sheathing	1.5 psf
2x10 Douglas-Fir Floor Joists @ 16" o/c	2.8 psf
Insulation	0.3 psf
5/8" Gypsum Board	2.8 psf
Total Dead Load	**11.0 psf**

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: DEAD LOADS		AUTHOR/DATE:
			CHECKED BY/DATE:

Floor Dead Loads (Typical Surface Load): Maximum

Floor Finish	5.0 psf
3/4" Floor Sheathing *(O.S.B. Allowance)*	2.5 psf
2x6 Douglas-Fir Floor Joists @ 16" o/c	1.7 psf
Insulation	0.5 psf
3/4" Floor Sheathing *(O.S.B. Allowance)*	2.5 psf
Miscellaneous	1.8 psf
Total Dead Load	**14.0 psf**

Floor Dead Loads (Typical Surface Load): Minimum

Floor Finish	2.7 psf
3/4" Floor Sheathing	2.3 psf
2x6 Douglas-Fir Floor Joists @ 16" o/c	1.7 psf
3/4" Floor Sheathing	2.3 psf
Total Dead Load	**9.0 psf**

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: DEAD LOADS		AUTHOR/DATE:
			CHECKED BY/DATE:

Wall Dead Loads (Typical Surface Load): Maximum

Attachment Steel and Fabric	4.0 psf
Waterproofing Membrane	2.5 psf
1/2" Wall Sheathing *(O.S.B. Allowance)*	1.7 psf
2x6 Douglas-Fir Floor Joists @ 16" o/c	1.7 psf
Insulation	0.5 psf
Mechanical/Electrical/Plumbing	1.0 psf
5/8" Gypsum Board	2.8 psf
Miscellaneous	1.8 psf
Total Dead Load	**16.0 psf**

Wall Dead Loads (Typical Surface Load): Minimum

Attachment Steel and Fabric	3.2 psf
Waterproofing Membrane	0.5 psf
1/2" Wall Sheathing	1.5 psf
2x6 Douglas-Fir Floor Joists @ 16" o/c	1.7 psf
Insulation	0.3 psf
5/8" Gypsum Board	2.8 psf
Total Dead Load	**10.0 psf**

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: DEAD LOADS		AUTHOR/DATE:
			CHECKED BY/DATE:

Line Loads To Exterior Frames:

Trib. Width: 4.50 ft <<< *Tributary width at all modules*

					Design Loads	
	DL *(psf)*	LL *(psf)*	DL *(plf)*	LL *(plf)*	DL *(plf)*	LL *(plf)*
Roof (Max):	24.0	20.0	108	90	110	90
Roof (Min):	11.0		50		50	
Floor (Max):	14.0	50.0	63	225	65	225
Floor (Min):	9.0		41		45	

Point Loads To Exterior Frames:

Wall Height: 9.5 ft <<< *Constant for all modules*

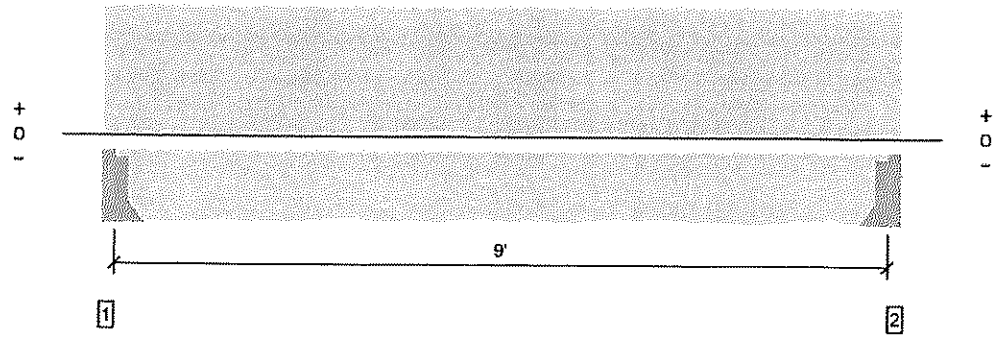
				Design Loads
	DL *(psf)*	DL *(plf)*	DL *(lbs)*	DL *(lbs)*
Wall (Max):	16.0	152	684	685
Wall (Min):	10.0	95	428	430

GRAVITY ANALYSIS AND DESIGN (MAIN STRUCTURAL SYSTEM)

FORTE® MEMBER REPORT *Level, Floor: Joist* **PASSED**

1 piece(s) 1 3/4" x 5 1/2" 1.9E Microllam® LVL @ 12" OC

Overall Length: 9' 7"



All Dimensions Are Horizontal; Drawing is Conceptual

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	288 @ 3 1/2"	1969	Passed (15%)	--	1.0 D + 1.0 L (All Spans)
Shear (lbs)	259 @ 9"	1829	Passed (14%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	648 @ 4' 9 1/2"	2211	Passed (29%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.126 @ 4' 9 1/2"	0.225	Passed (L/859)	--	1.0 D + 1.0 L (All Spans)
Total Load Defl. (in)	0.161 @ 4' 9 1/2"	0.300	Passed (L/671)	--	1.0 D + 1.0 L (All Spans)
TJ-Pro™ Rating	47	40	Passed	--	--

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

- Deflection criteria: LL (L/480) and TL (L/360).
- Bracing (Lu): All compression edges (top and bottom) must be braced at 9' o/c unless detailed otherwise. Proper attachment and positioning of lateral bracing is required to achieve member stability.
- A 4% increase in the moment capacity has been added to account for repetitive member usage.
- A structural analysis of the deck has not been performed.
- Deflection analysis is based on composite action with a single layer of 23/32" Weyerhaeuser Edge™ Panel (24" Span Rating) that is glued and nailed down.
- Additional considerations for the TJ-Pro™ Rating include: None

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Total	
1 - Hanger on 5 1/2" DF beam	3.50"	Hanger[1]	1.50"	67	240	307	See note [1]
2 - Hanger on 5 1/2" DF beam	3.50"	Hanger[1]	1.50"	67	240	307	See note [1]

- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- [1] See Connector grid below for additional information and/or requirements.

Connector: Simpson Strong-Tie Connectors						
Support	Model	Seat Length	Top Nails	Face Nails	Member Nails	Accessories
1 - Face Mount Hanger	Connector not found	N/A	N/A	N/A	N/A	
2 - Face Mount Hanger	Connector not found	N/A	N/A	N/A	N/A	

Loads	Location	Spacing	Dead (0.90)	Floor Live (1.00)	Comments
1 - Uniform(PSF)	0 to 9' 7"	12"	14.0	50.0	Residential - Living Areas

Weyerhaeuser Notes

Weyerhaeuser warrants that the sizing of its products will be in accordance with Weyerhaeuser product design criteria and published design values. Weyerhaeuser expressly disclaims any other warranties related to the software. Refer to current Weyerhaeuser literature for installation details. (www.woodbywy.com) Accessories (Rim Board, Blocking Panels and Squash Blocks) are not designed by this software. Use of this software is not intended to circumvent the need for a design professional as determined by the authority having jurisdiction. The designer of record, builder or framer is responsible to assure that this calculation is compatible with the overall project. Products manufactured at Weyerhaeuser facilities are third-party certified to sustainable forestry standards.

The product application, input design loads, dimensions and support information have been provided by Forte Software Operator

SUSTAINABLE FORESTRY INITIATIVE

Forte Software Operator	Job Notes
Frank Reppi BuroHappold (310) 945-4800 frank.reppi@burohappold.com	

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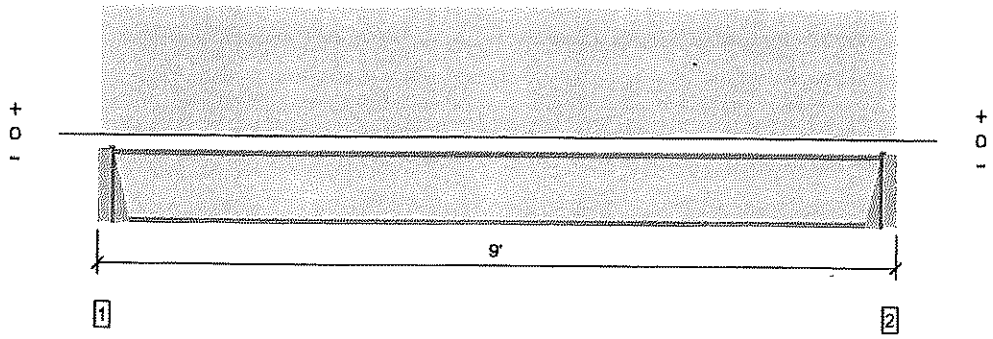
Forte v3.5, Design Engine: V5.5.3.2
3102BD-20120920-FAR-Floor Joists.4te

FORTE® MEMBER REPORT *Level, Roof: Joist* **PASSED**

1 piece(s) 16" TJI® 230 @ 24" OC

Overall Length: 9'



All Dimensions Are Horizontal; Drawing is Conceptual

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	370 @ 3 1/2"	1325	Passed (28%)	1.25	1.0 D + 1.0 Lr (All Spans)
Shear (lbs)	370 @ 3 1/2"	2738	Passed (14%)	1.25	1.0 D + 1.0 Lr (All Spans)
Moment (Ft-lbs)	779 @ 4' 6"	7138	Passed (11%)	1.25	1.0 D + 1.0 Lr (All Spans)
Live Load Defl. (in)	0.011 @ 4' 6"	0.281	Passed (L/999+)	--	1.0 D + 1.0 Lr (All Spans)
Total Load Defl. (in)	0.025 @ 4' 6"	0.421	Passed (L/999+)	--	1.0 D + 1.0 Lr (All Spans)

System : Roof
Member Type : Joist
Building Use : Residential
Building Code : IBC
Design Methodology : ASD
Member Pitch: 0/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Bracing (Lu): All compression edges (top and bottom) must be braced at 8' 5" o/c unless detailed otherwise. Proper attachment and positioning of lateral bracing is required to achieve member stability.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Roof Live	Total	
1 - Hanger on 16" DF beam	3.50"	Hanger[1]	1.75"	216	180	396	See note [1]
2 - Hanger on 16" DF beam	3.50"	Hanger[1]	1.75"	216	180	396	See note [1]

- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- [1] See Connector grid below for additional information and/or requirements.

Connector: Simpson Strong-Tie Connectors						
Support	Model	Seat Length	Top Nails	Face Nails	Member Nails	Accessories
1 - Top Mount Hanger	ITS2.37/16	2.00"	4-10d x 1-1/2	2-10d x 1-1/2	N/A	
2 - Top Mount Hanger	ITS2.37/16	2.00"	4-10d x 1-1/2	2-10d x 1-1/2	N/A	

Loads	Location	Spacing	Dead (0.90)	Roof Live (non-snow: 1.25)	Comments
1 - Uniform(PSF)	0 to 9'	24"	24.0	20.0	Roof

Weyerhaeuser Notes

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The product application, input design loads, dimensions and support information have been provided by Forte Software Operator

SUSTAINABLE FORESTRY INITIATIVE

Forte Software Operator	Job Notes
Frank Reppi BuroHappold (310) 945-4800 frank.reppi@burohappold.com	

10/24/2012 4:38:31 PM
Forte v3.5, Design Engine: V5.5.3.2
3102BD-20120920-FAR-Floor Joists.4te

Buro Happold

PROJECT: SOLAR DECATHLON | PROJECT #: 31.02320

DESCRIPTION: HANGER DESIGN.

PAGE #:

AUTHOR / DATE:

CHECKED BY / DATE:

FLOOR JOIST HANGER DESIGN:

REACTION FROM JOIST DESIGN = 288# (SEE FORE ANALYSES)

HU 1.81/5 = (1610# X .64)

FROM TABLES

REDUCTION FROM 160 TO 160 x 1.6 PER NDS

OK = 1030# > 288#

ROOF JOIST HANGER DESIGN:

REACTION FROM JOIST DESIGN. = 370# (SEE FORE ANALYSES)

WIND UPLIFT ON ROOF: (K_z = .85 @ 15' Exp C)

$q = (.00256)(.85)(1.0)(.85)(85 mph)^2(1.0)$

K_z K_{zt} K_d V I

$= 13.36$ psf

$p = (13.36 psf)(-.48 - .5)$

$= 31.4$ psf

Uplift (wind) $= (31.4 psf - 16 psf)(2')(9'/2)$ DL (min)

$= 185\# < 265\#$ ok

BA 2.37/16 = 2220# > 370# ok (FROM TABLES)

FACE MOUNT HANGERS – STRUCTURAL COMPOSITE LUMBER

SIMPSON Strong-Tie

These products are available with additional corrosion protection. Additional products on this page may also be available with this option, check with Simpson for details.

CODES: See page 12 for Code Reference Key Chart.

Actual Joist Size	Model No.	Ga	Dimensions W	Dimensions H	Dimensions R	Min/ Max	Fasteners Face	Fasteners Joist	Allowable Loads DF/SP Species Header Uplift (160)	DF/SP Floor (100)	DF/SP Snow (115)	DF/SP Roof (125)	SPF/HF Species Header Floor (100)	SPF/HF Snow (115)	SPF/HF Roof (125)	Code Ref.
1¾ x 5½	HU1.81/5	14	1 13/16	5 3/8	2½	Min	12-16d	4-10dx1½	575	1610	1850	2010	1390	1600	1740	170
			1 13/16	5 3/8	2½	Max	16-16d	6-10dx1½	865	2145	2465	2680	1855	2135	2320	
1¾ x 7¼	HU7	14	1 13/16	6 11/16	2½	Min	12-16d	4-10dx1½	575	1610	1850	2010	1390	1600	1740	I9, F8
			1 13/16	6 11/16	2½	Max	16-16d	8-10dx1½	1150	2145	2465	2680	1855	2135	2320	
1¾ x 9½	HUS1.81/10	16	1 13/16	8 7/8	3	—	30-16d	10-16d	3000	4900	5045	5145	4355	5010	5145	F23
	HU9	14	1 13/16	9 5/16	2½	Min	18-16d	6-10dx1½	865	2410	2775	3015	2090	2400	2610	I9, F8
			1 13/16	9 5/16	2½	Max	24-16d	10-10dx1½	1440	3215	3700	4020	2785	3200	3480	
	HUCQ1.81/9-SDS		1 13/16	9	3	—	8-SDS ¼"x1¾"	4-SDS ¼"x1¾"	1505	2000	2300	2500	1490	1655	1800	
1¾ x 11¼ - 11⅞	HUS1.81/10	16	1 13/16	8 7/8	3	—	30-16d	10-16d	3000	4900	5045	5145	4355	5010	5145	F23
	HU11	14	1 13/16	11 11/16	2½	Min	22-16d	6-10dx1½	865	2950	3390	3685	2550	2935	3190	170
			1 13/16	11 11/16	2½	Max	30-16d	10-10dx1½	1440	4020	4315	4405	3480	4000	4350	
	HUCQ1.81/11-SDS		1 13/16	11	3	—	10-SDS ¼"x1¾"	4-SDS ¼"x1¾"	1505	2500	2675	3125	1800	2070	2250	
1¾ x 14	HUS1.81/10	16	1 13/16	8 7/8	3	—	30-16d	10-16d	3000	4900	5045	5145	4355	5010	5145	F23
	U14		1 13/16	10¼	2	—	14-16d	6-10dx1½	865	1860	2140	2330	1610	1850	2010	
	HU14	14	1 13/16	13 11/16	2½	Min	28-16d	8-10dx1½	1150	3750	4110	4180	3250	3735	4060	I9, F8
			1 13/16	13 11/16	2½	Max	36-16d	14-10dx1½	2015	4540	4730	4855	4175	4730	4855	
	HUCQ1.81/11-SDS		1 13/16	11	3	—	10-SDS ¼"x1¾"	4-SDS ¼"x1¾"	1505	2500	2675	3125	1800	2070	2250	F23
2 11/16 x 9¼ - 9½	HU2.75/10/ HUC2.75/10	14	2¾	9	2½	Min	14-16d	6-10dx1½	865	1875	2155	2345	1625	1870	2030	I9, F8
			2¾	9	2½	Max	18-16d	10-10dx1½	1440	2410	2775	3015	2090	2400	2610	
	HGUS2.75/10	12	2¾	8 15/16	4	—	46-16d	16-16d	3630	7940	8220	8410	5980	6195	6335	F23
2 11/16 x 11¼ - 11⅞	HU2.75/12/ HUC2.75/12	14	2¾	10¾	2½	Min	16-16d	6-10dx1½	865	2145	2465	2680	1855	2135	2320	I9, F8
			2¾	10¾	2½	Max	22-16d	10-10dx1½	1440	2950	3390	3685	2550	2935	3190	
	HGUS2.75/12	12	2¾	10 15/16	4	—	56-16d	20-16d	4055	8410	8760	8995	6335	6600	6775	F23
2 11/16 x 14	HU2.75/14/ HUC2.75/14	14	2¾	13	2½	Min	18-16d	8-10dx1½	1150	2410	2775	3015	2090	2400	2610	I9, F8
			2¾	13	2½	Max	24-16d	14-10dx1½	2015	3215	3700	4020	2785	3200	3480	
	HGUS2.75/14	12	2¾	12 15/16	4	—	66-16d	22-16d	5380	8645	9030	9285	6510	6800	6995	F23
2 11/16 x 16	HU2.75/16/ HUC2.75/16	14	2¾	14 1/16	2½	Min	20-16d	8-10dx1½	1150	2680	3080	3350	2320	2670	2900	I9, F8
			2¾	14 1/16	2½	Max	26-16d	14-10dx1½	2015	3485	4005	4355	3015	3470	3770	
	HGUS2.75/14	12	2¾	12 15/16	4	—	66-16d	22-16d	5380	8645	9030	9285	6510	6800	6995	F23
3½ x 7¼	HU48/HUC48	14	3 9/16	6 13/16	2½	Min	10-16d	4-10d	725	1340	1540	1675	1160	1335	1365	I7, F6
			3 9/16	6 13/16	2½	Max	14-16d	6-10d	1085	1875	2155	2345	1625	1870	2030	
	HGUS46	12	3⅝	4 7/16	4	—	20-16d	8-16d	2325	3940	4535	4930	3410	3920	4260	IL14, F23
	HHUS48	14	3⅝	7⅛	3	—	22-16d	8-16d	2000	3885	4465	4885	3275	3765	4095	I9, F8
	HGUS48	12	3⅝	7 1/16	4	—	36-16d	12-16d	3220	6805	7830	7925	5890	6655	6655	IL14, F23
3½ x 9¼ - 9½	U410	16	3 9/16	8⅜	2	—	14-16d	6-10d	1065	1860	2140	2330	1610	1850	2010	I9, F8
	HUS410	14	3 9/16	8 15/16	2	—	8-16d	8-16d	2590	2010	2310	2510	1650	1900	2065	
	HU410/HUC410		3 9/16	8⅝	2½	Min	14-16d	6-10d	1085	1875	2155	2345	1625	1870	2030	
			3 9/16	8⅝	2½	Max	18-16d	10-10d	1810	2410	2775	3015	2090	2400	2610	
	HHUS410		3⅝	9	3	—	30-16d	10-16d	3430	5190	5900	5900	4385	5040	5480	
	HUCQ410-SDS		3 9/16	9	3	—	12-SDS ¼"x2½"	6-SDS ¼"x2½"	3155	4680	4955	4955	3370	3570	3570	F23
	HGUS48	12	3⅝	7 1/16	4	—	36-16d	12-16d	3220	6805	7830	7925	5890	6655	6655	IL14, F23
	HGUS410		3⅝	9 1/16	4	—	46-16d	16-16d	3630	8780	8940	8940	7365	7510	7510	
3½ x 11¼ - 11⅞	U410	16	3 9/16	8⅜	2	—	14-16d	6-10d	1065	1860	2140	2330	1610	1850	2010	I9, F8
	HUS412	14	3 9/16	10½	2	—	10-16d	10-16d	3240	2510	2885	3140	2065	2375	2580	
	HU412/HUC412		3 9/16	10 5/16	2½	Min	16-16d	6-10d	1085	2145	2465	2680	1855	2135	2320	
			3 9/16	10 5/16	2½	Max	22-16d	10-10d	1810	2950	3390	3685	2550	2935	3190	
	HHUS410		3⅝	9	3	—	30-16d	10-16d	3430	5190	5900	5900	4385	5040	5480	
	HUCQ412-SDS		3 9/16	11	3	—	14-SDS ¼"x2½"	6-SDS ¼"x2½"	3155	5460	5560	5560	3930	4005	4005	F23
	HGUS48	12	3⅝	7 1/16	4	—	36-16d	12-16d	3220	6805	7830	7925	5890	6655	6655	IL14, F23
	HGUS410		3⅝	9 1/16	4	—	46-16d	16-16d	3630	8780	8940	8940	7365	7510	7510	
	HGUS412		3⅝	10 1/16	4	—	56-16d	20-16d	4055	9155	9155	9155	7690	7690	7690	F23
3½ x 14	U414	16	3 9/16	10	2	—	16-16d	6-10d	1065	2130	2445	2660	1840	2115	2300	I9, F8
	HU416/HUC416	14	3 9/16	13⅝	2½	Min	20-16d	8-10d	1445	2680	3080	3350	2320	2670	2900	
			3 9/16	13⅝	2½	Max	26-16d	12-10d	2015	3485	4005	4355	3015	3470	3770	
	HHUS410		3⅝	9	3	—	30-16d	10-16d	3430	5190	5900	5900	4385	5040	5480	
	HGUS410	12	3⅝	9	4	—	46-16d	16-16d	3630	8780	8940	8940	7365	7510	7510	IL14, F23
	HGUS414		3⅝	12 1/16	4	—	66-16d	22-16d	5380	10015	10015	10015	7890	8185	8380	F23
	HUCQ412-SDS	14	3 9/16	11	3	—	14-SDS ¼"x2½"	6-SDS ¼"x2½"	3155	5460	5560	5560	3930	4005	4005	

1. 10d commons or 16d sinkers may be used instead of the specified 16d at 0.84 of the table load value.
2. 16d sinkers may be used instead of the specified 10d commons with no load reduction.
3. Uplift loads based on DF/SP lumber and have been increased 60% for wind or earthquake loading with no further increase allowed. For normal loading applications such as cantilever construction refer to Simpson Strong-Tie® Connector Selector™ software or conservatively divide the uplift load by 1.6. For SPF/HF, use 0.86 x DF/SP Uplift Load for products requiring nails and 0.72 x DF/SP Uplift Load for products requiring screws.
4. MIN nailing quantity and load values—fill all round holes; MAX nailing quantity and load values—fill all round and triangle holes.
5. Hangers sorted in order of recommended selection for best overall performance and installation value.
6. **NAILS:** 16d = 0.162" dia. x 3½" long, 10d = 0.148" dia. x 3" long, 10dx1½ = 0.148" dia. x 1½" long. See page 16-17 for other nail sizes and information.

Roof · Joist Hanger

TOP FLANGE HANGERS LBV/BA/B/HB *I-Joist & Structural Composite Lumber Hangers*

SIMPSON Strong-Tie®

This product is preferable to similar connectors because of a) easier installation, b) higher loads, c) lower installed cost, or a combination of these features.

The BA hanger is a cost effective hanger targeted at high capacity I-joists and common Structural Composite Lumber applications. A min/max joist nail option gives dual use of this hanger. Minimum values featuring positive angle nailing are targeted at I-joist without web stiffeners requirement and the maximum nailing generates higher loads to support structural composite lumber. The unique two level embossment provides added stiffness to the top flange.

The newly improved LBV, B and HB hangers offer wide versatility for I-joists and structural composite lumber. The enhanced load capacity widens the range of applications for these hangers. The LBV still features positive angle nailing and does not require the use of web stiffeners for standard non modified I-joist installations.

See Top Flange tables on pages 96 to 105. See Hanger Options on pages 181-183 for hanger modifications, which may result in reduced loads.

MATERIAL: See tables, pages 96 to 105.

FINISH: LBV, B, BA and HB—Galvanized; all saddle hangers and all welded sloped and special hangers—Simpson Strong-Tie® gray paint. LBV, B, BA and HB may be ordered hot-dip galvanized; specify HDG.

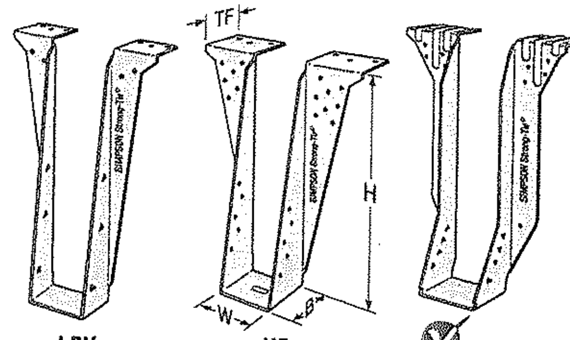
INSTALLATION: • Use all specified fasteners. See General Notes and nailer table.

- LBV, B, BA and HB may be used for weld-on applications. Weld size to match material thickness (*approximate thickness shown*). The minimum required weld to the top flanges is ⅛" x 2" fillet weld to each side of each top flange tab for 14 and 12 gauge and 3⁄16" x 2" fillet weld to each side of each top flange tab for 7 gauge and 10 gauge. Distribute the weld equally on both top flanges. Welding cancels the top and face nailing requirements. Consult the code for special considerations when welding galvanized steel. The area should be well-ventilated, see page 14 for weld information. Weld on applications produce the maximum allowable down load listed. For uplift loads refer to T-WELDUPLFT.
- LBV hangers do not require the use of web stiffeners for non-sloped or non-skewed applications.
- B and HB hangers require the use of web stiffeners. BA MIN nailing does not require web stiffeners. BA MAX nailing requires the use of web stiffeners.
- Ledgers must be evaluated for each application separately. Check TF dimension, nail length and nail location on ledger.
- Refer to technical bulletin T-SLOPEJST for information regarding load reductions on selected hangers which can be used without modification to support joists which have shallow slopes (≤¾:12).

OPTIONS: • LBV, B and HB

- Other widths are available; specify W dimension (*the minimum W dimension is 1 9⁄16"*).
- The coating on special B hangers will depend on the manufacturing process used. Check with your Simpson Strong-Tie representative for details. Hot-dip galvanized available: specify HDG.
- Refer to technical bulletin T-BSERIES for the complete line of LBV, BA, B and HB hangers, including models not shown here, their available modification combinations and their associated reduction factors.
- Modified hangers have reduced loads, see Hanger Options, pages 181-183.

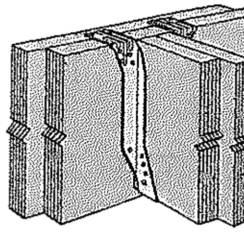
CODES: See page 12 for Code Reference Key Chart.



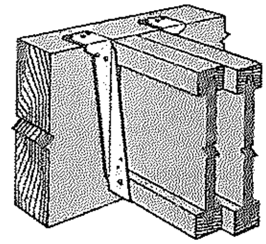
LBV

HB *(B Similar)*

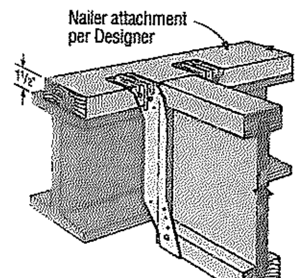
BA U.S. Patent 7,334,372



BA Installed LVL to LVL Max Nailing

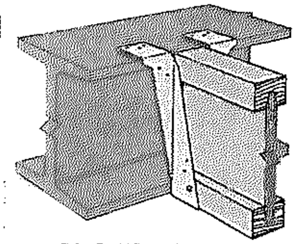


Typical Double LBV Hanger Installation



BA installed 2X nailer on steel beam minimum nailing

LBV features positive angle nailing, no web stiffeners are required



BA, B, HB and LBV are acceptable for weld-on applications (*LBV shown*). See Installation Information.

Model No.	Nailer	Top Flange Nailing	Uplift[1] (160)	Allowable Loads DF/SP	Allowable Loads SPF/HF
LBV	2x	10-10dx1½	265	2280	2085
	2-2x	10-10d	265	1955	1530
	3x	10-16dx2½	265	2490	—
	4x	10-16d	255	2590	—
BA	2x	10-10dx1½	265	2220	1755
	2-2x	14-10d	265	2695	2235
	3x	14-16dx2½	265	3230	—
	4x	14-16d	265	3300	—
B	2-2x	14-10d	710	3615	2770
	3x	14-16dx2½	825	3725	—
	4x	14-16d	825	3800	—
HB	4x	22-16d	1550	5500	—

NAILER TABLE

The table indicates the maximum allowable loads for LBV, BA, B and HB hangers used on wood nailers. Nailers are wood members attached to the top of a steel I-beam, concrete or masonry wall.

1. Uplift values are for DF/SP members only. LBV and BA hangers resist more uplift when web stiffeners are used. Refer to technical bulletin T-NAILERUPLFT for additional information (*see page 191 for details*).
2. See page 184 for reductions on modified hangers on nailers.
3. B hangers require 6-10dx1½ joist nails to achieve published loads. For joist members 2½" or wider, 16dx2½" joist nails should be installed for additional uplift loads on the 3x and 4x nailer applications of 970 lbs. and 1010 lbs. respectively.

NAILS: 16d = 0.162" dia. x 3½" long, 16dx2½ = 0.162" dia. x 2½" long, 10d = 0.148" dia. x 3" long, 10dx1½ = 0.148" dia. x 1½" long. See page 16-17 for other nail sizes and information.

B SERIES WITH VARIOUS HEADER APPLICATIONS

Model Series	Fasteners Top	Fasteners Face	Fasteners Joist	Uplift[3] (160)	LVL[8]	PSL	LSL	DF/SP[2]	SPF/HF	I-Joist[9] DF/SCL	I-Joist[9] SPF/HF	Code Ref.
LBV (Min)	6-10dx1½	4-10dx1½	2-10dx1½	265	2295	2610	2270	1790	1835	1495	1340	I1, F21
	6-10d	4-10d	2-10dx1½	265	2295	2610	2645	2310	2060	—	—	
	6-16d	4-16d	2-10dx1½	265	2910	2885	3190	2460	2060	—	—	
LBV (Max)	6-10dx1½	4-10dx1½	6-10dx1½	635	2295	2610	2270	1790	1835	1495	1350	
	6-10d	4-10d	6-10dx1½	785	2295	2610	2645	2310	2060	—	—	
	6-16d	4-16d	6-10dx1½	895	2910	2885	3190	2460	2060	—	—	
BA (Min)	6-10dx1½	10-10dx1½	2-10dx1½	—	—	—	—	—	—	1495	1495	
	6-10d	10-10d	2-10dx1½	265	3230	3630	4005	3080	2425	—	—	
	6-16d	10-16d	2-10dx1½	265	4015	3705	4005	3435	2665	—	—	
BA (Max)	6-10d	10-10d	8-10dx1½	1170	3555	3630	4120	3625	2465	—	—	
	6-16d	10-16d	8-10dx1½	1170	4715	4320	4500	3800	2665	—	—	
B[2]	6-10d	8-10d	6-10dx1½	990	3575	3195	3640	3625	2190	—	—	
	6-16d	8-16d	6-16dx2½	1010	4135	3355	4500	3800	2650	—	—	
HB[2]	6-16d	16-16d	10-16dx2½	2610	5815	5640	6395	5650	3820	—	—	

(Allowable Loads Header Type: Uplift through I-Joist columns.)

1. This table assumes joists with Fc⊥ = 750 psi. For other joists, check that bearing and joist nails are adequate.
2. Loads for B's and HB's assume a joist width of 2½" or greater.
3. Uplift loads are based on DF/SP lumber and have been increased 60% for wind or earthquake loading with no further increase allowed. For normal loading applications such as cantilever construction refer to Simpson Strong-Tie® Connector Selector™ software or conservatively divide the uplift load by 1.6. For SPF/HF use 0.86 x DF/SP uplift load.
4. Loads may not be increased for short term loading.
5. Web stiffeners required when more than two joist nails are used.
6. SCL (*structural composite lumber*) is LVL (*laminated veneer lumber*), LSL (*laminated strand lumber*), and Parallam® PSL.
7. Code values are based on DF/SP header species.
8. Applies to LVL headers made primarily from Douglas Fir or Southern Pine. For LVL made primarily from Spruce-Pine-Fir or similar less dense veneers, use the values found in the SPF/HF column.
9. DF I-joists include flanges made from solid sawn Douglas Fir, LVL made primarily of Douglas Fir/Southern Pine, or LSL. For flanges with thicknesses from 1 5⁄16 to 1⅜, use 0.85 of the I-joist header load. For flanges with thicknesses from 1⅛ to 1¼, use 0.75 of the I-joist header load.

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Buro Happold

PROJECT: SOLAR DECATHLON | PROJECT #: 3102B

DESCRIPTION: W/AM STUD DESIGN

PAGE #:

AUTHOR / DATE:

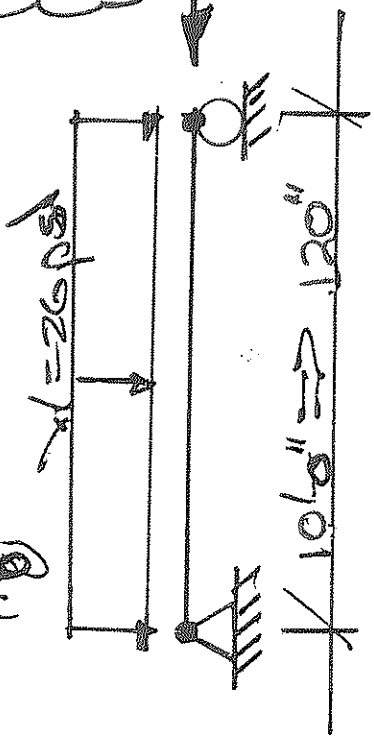
CHECKED BY / DATE:

W/AM STUD DESIGN: 2x6

(Non-bearing)

* USE DOUGLAS FIR LARCH #2

* WALLS ARE NON-BEARING SO ONLY WIND BENDING COMBOS.



WIND: (K2=.85 OVERHANG)

$q = (.00256)(.85)(1.0)(.85)(80^2)(1.0)$
$= 13.36$ psf ✓

$p = (13.36\text{ psf})(1.4 - .55)$
$= 26$ psf ✓

$\text{Moment}(w) = (26\text{ psf})(16"/12)(10')^2/8$
$= 433$ #-ft ✓

$\text{Shear}(w) = (26\text{ psf})(16"/12)(10'/2)$
$= 173$ # ✓

$f_b = (1.6)(1.3)(900\text{ psi})$
$= 1872$ psi ✓

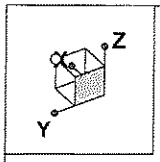
$F_b = (433\text{ #-ft})(12)/7.563$
$= 687$ psi < 1872 psi ok ✓

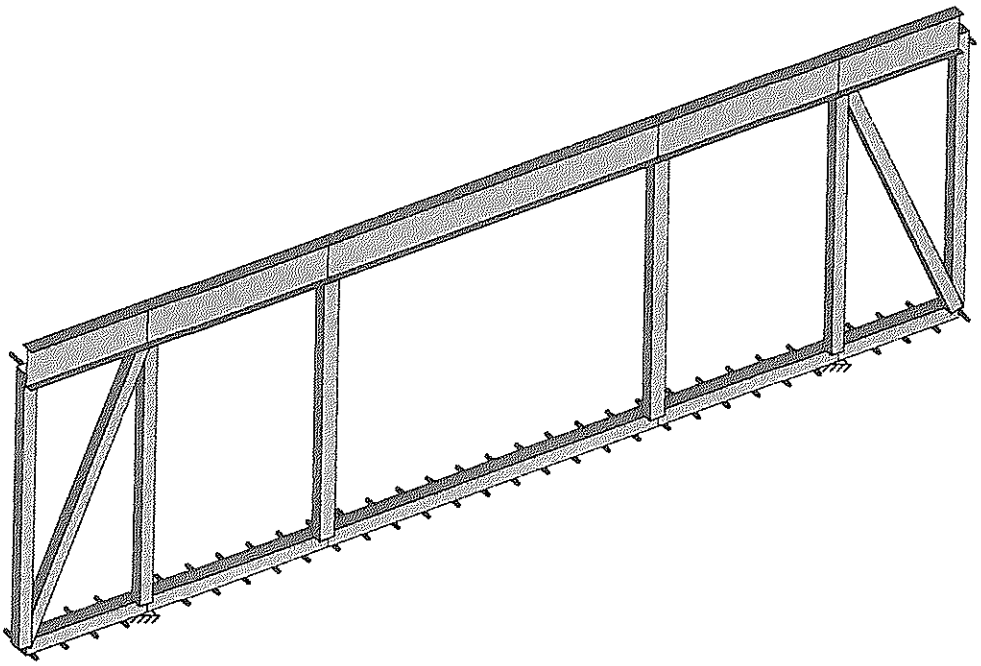
$f_v = (180\text{ psi})(1.6)$
$= 288$ psi ok ✓

$F_v = (1.5)(173\text{ #})/8.25$
$= 31.5$ psi < 288 psi ✓

Deflection:
$\Delta = (96\text{ psf})(16/12)(5)(10')^4(12)^3/(384)(1.6E6\text{ psi})(20.80)$
$= .234$ in $\Rightarrow$ L/512 ok ✓

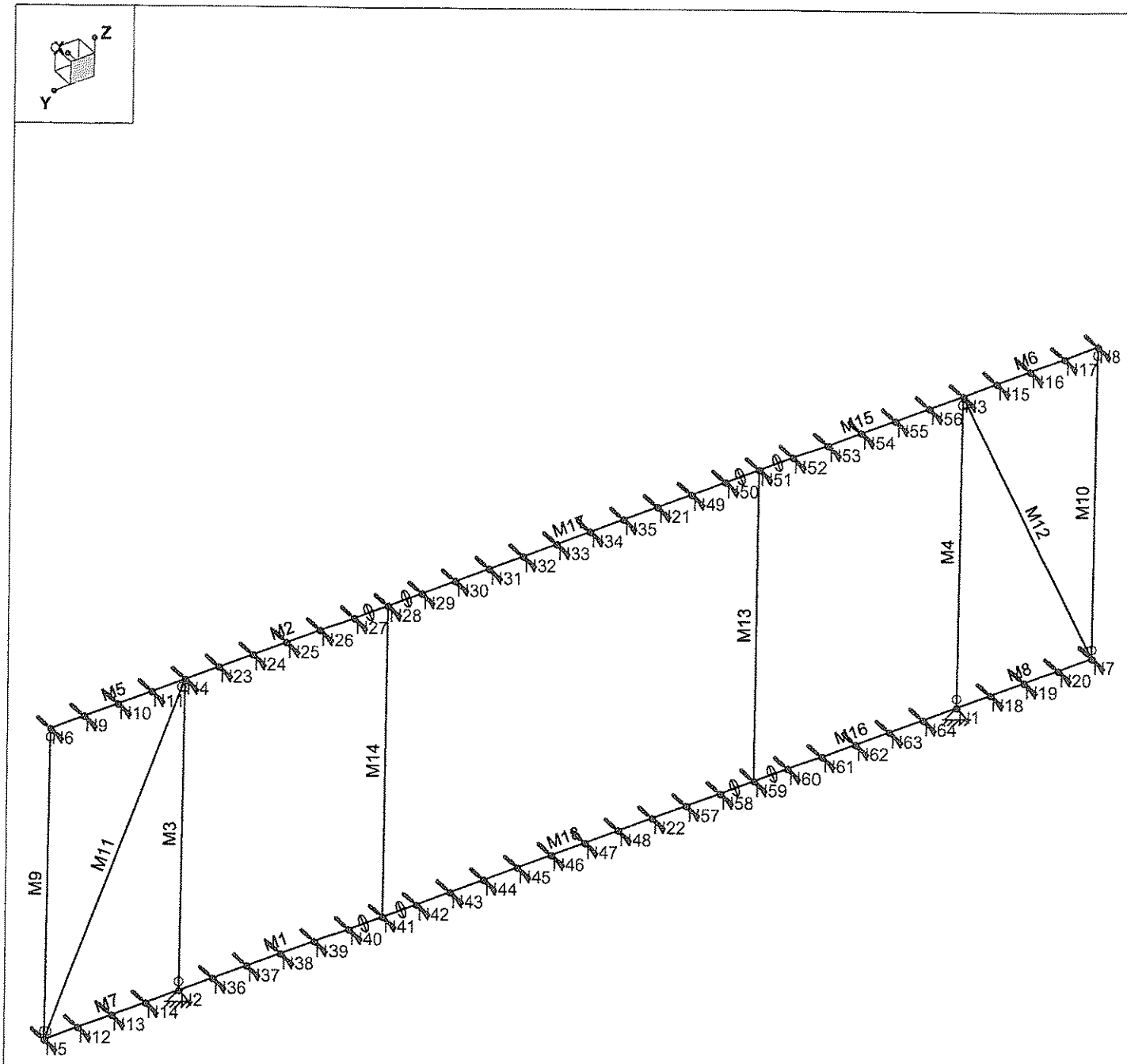
(2x6 NFL #2 @ 16" o/c is ok)





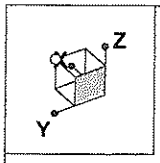
Solution: Envelope

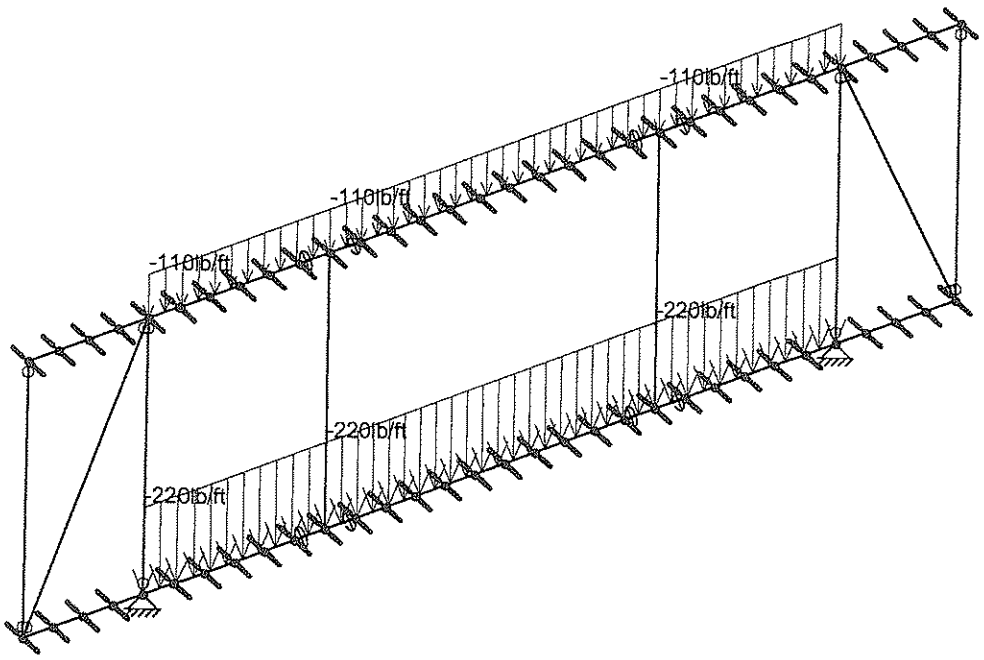
		SK - 1
		Feb 4, 2013 at 10:40 AM
		3102BD-20120930-FAR-Risa Anal...



Solution: Envelope

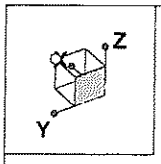
		SK - 16
		Feb 4, 2013 at 10:46 AM
		3102BD-20120930-FAR-Risa Anal...

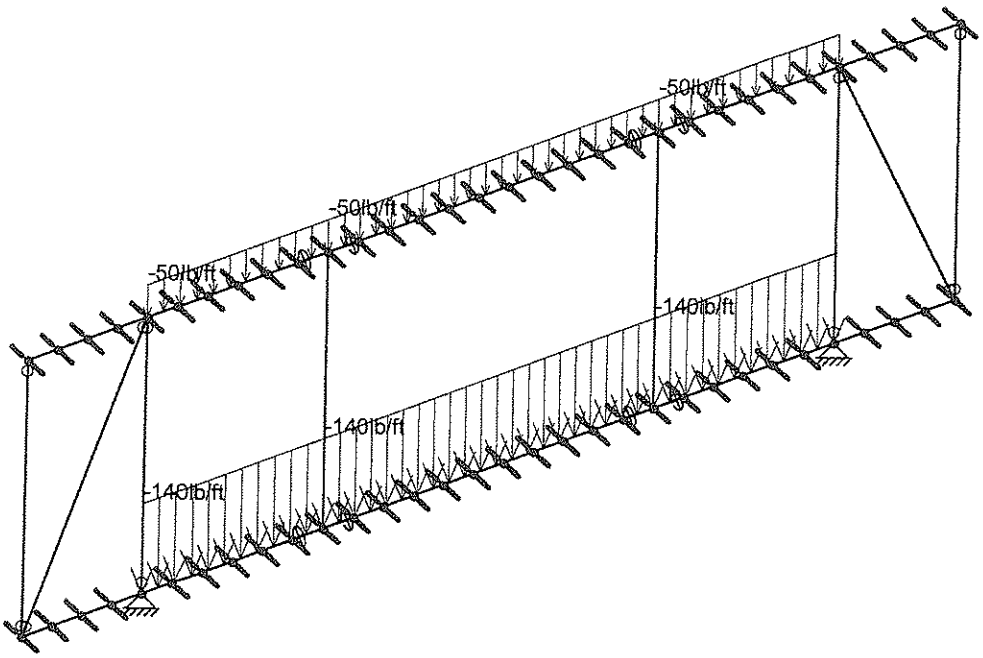




Loads: BLC 2, DL (Max - Center)
Solution: Envelope

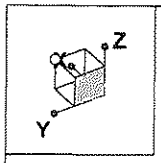
		SK - 3
		Feb 4, 2013 at 10:41 AM
		3102BD-20120930-FAR-Risa Anal...

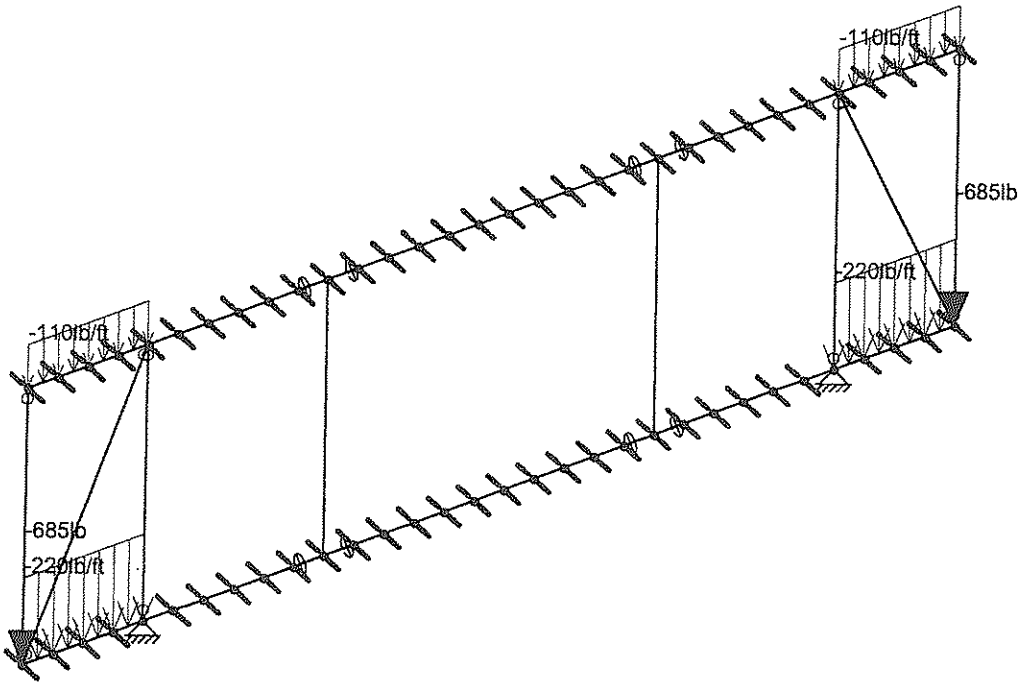




Loads: BLC 3, DL (Min - Center)
Solution: Envelope

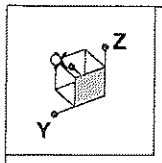
		SK - 4
		Feb 4, 2013 at 10:41 AM
		3102BD-20120930-FAR-Risa Anal...

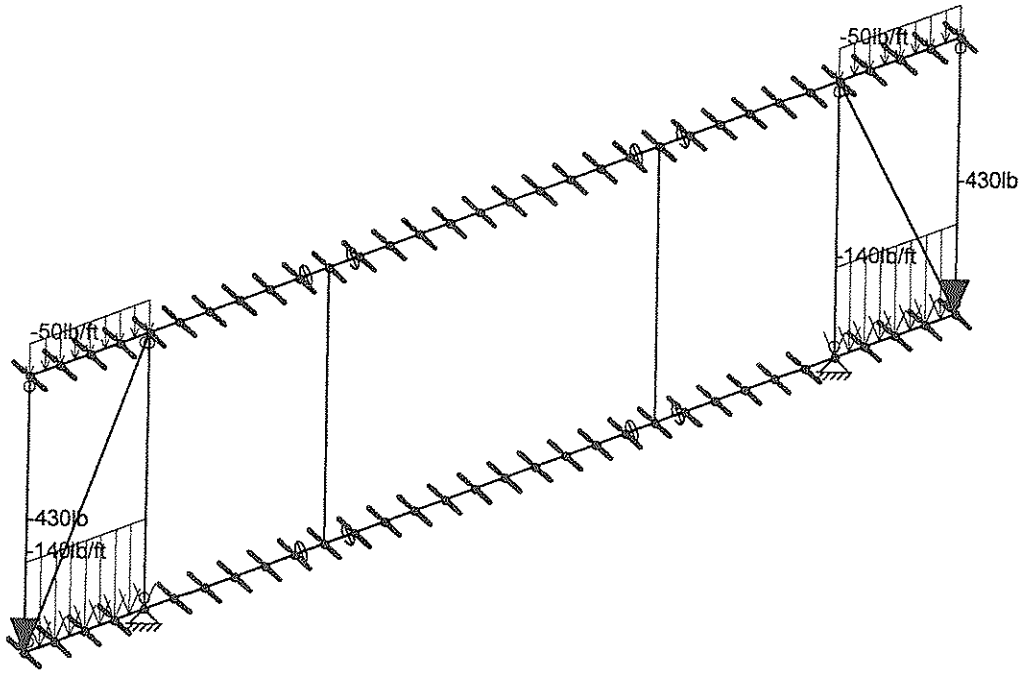




Loads: BLC 4, DL (Max - Cantilever)
Solution: Envelope

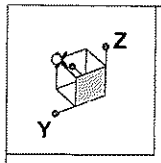
		SK - 5
		Feb 4, 2013 at 10:41 AM
		3102BD-20120930-FAR-Risa Anal...

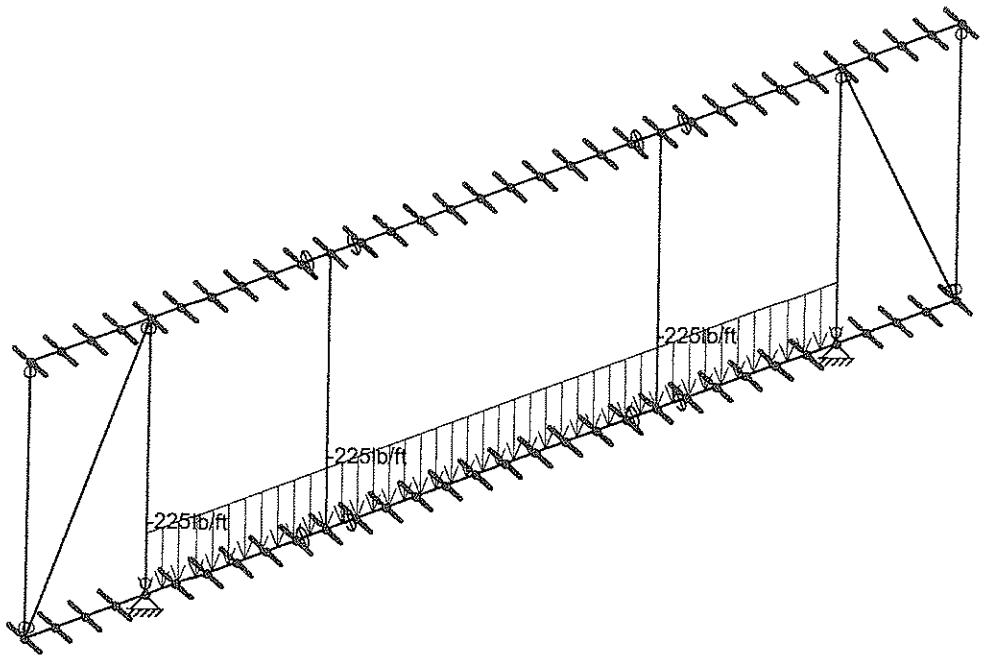




Loads: BLC 5, DL (Min - Cantilever)
Solution: Envelope

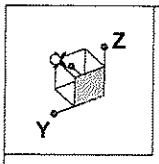
		SK - 6
		Feb 4, 2013 at 10:41 AM
		3102BD-20120930-FAR-Risa Anal...

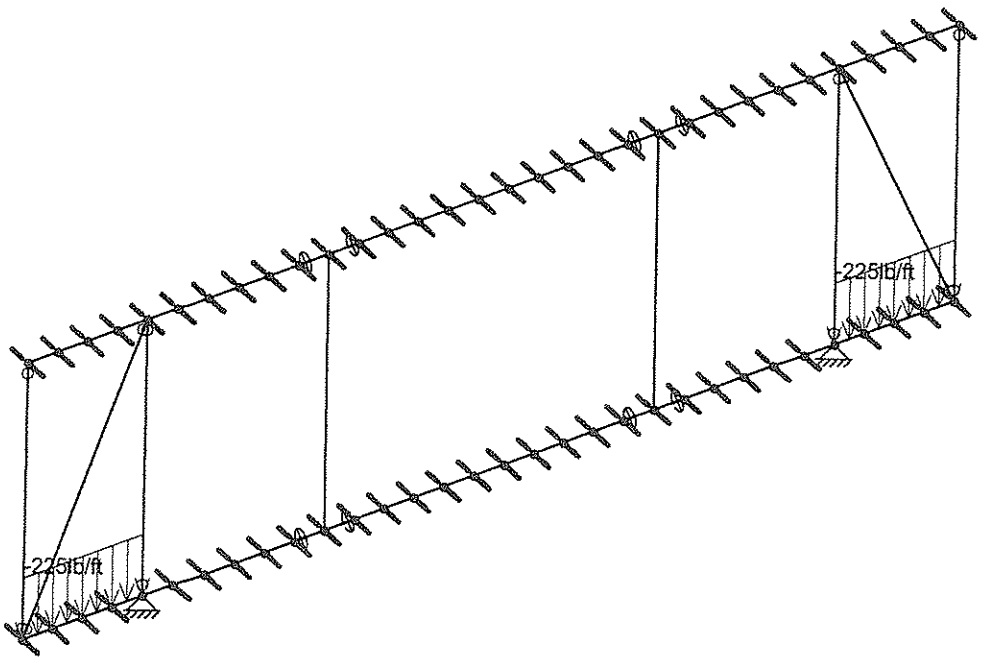




Loads: BLC 6, LL (Center)
Solution: Envelope

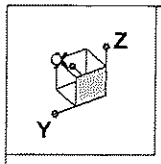
		SK - 7
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

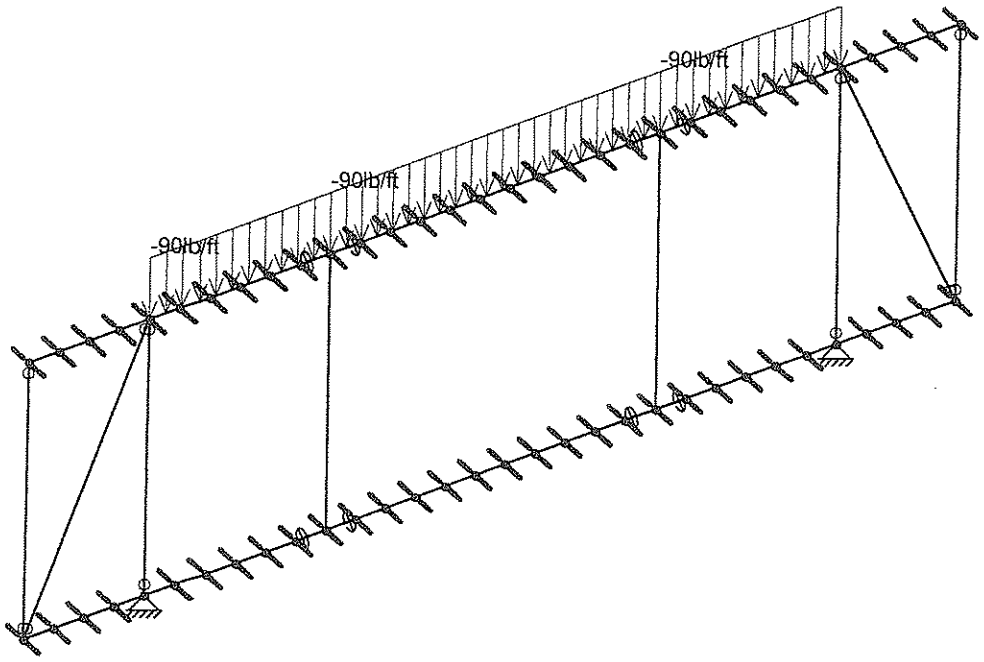




Loads: BLC 7, LL (Cantilever)
Solution: Envelope

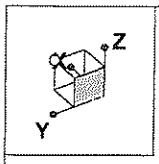
		SK - 8
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

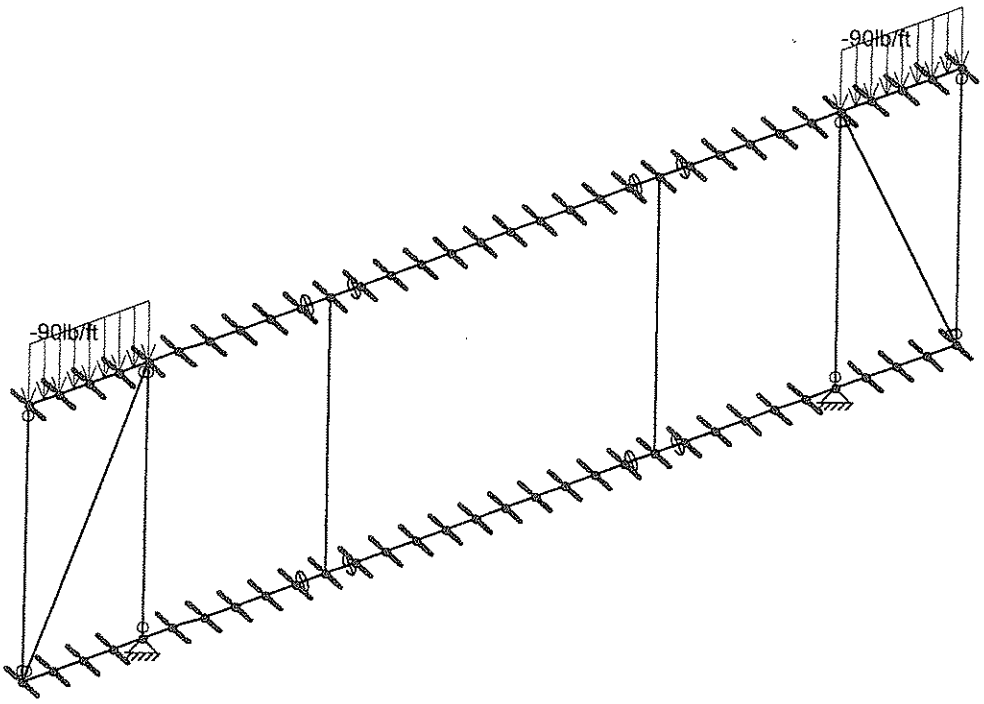




Loads: BLC 8, Lr (Center)
Solution: Envelope

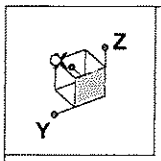
		SK - 9
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

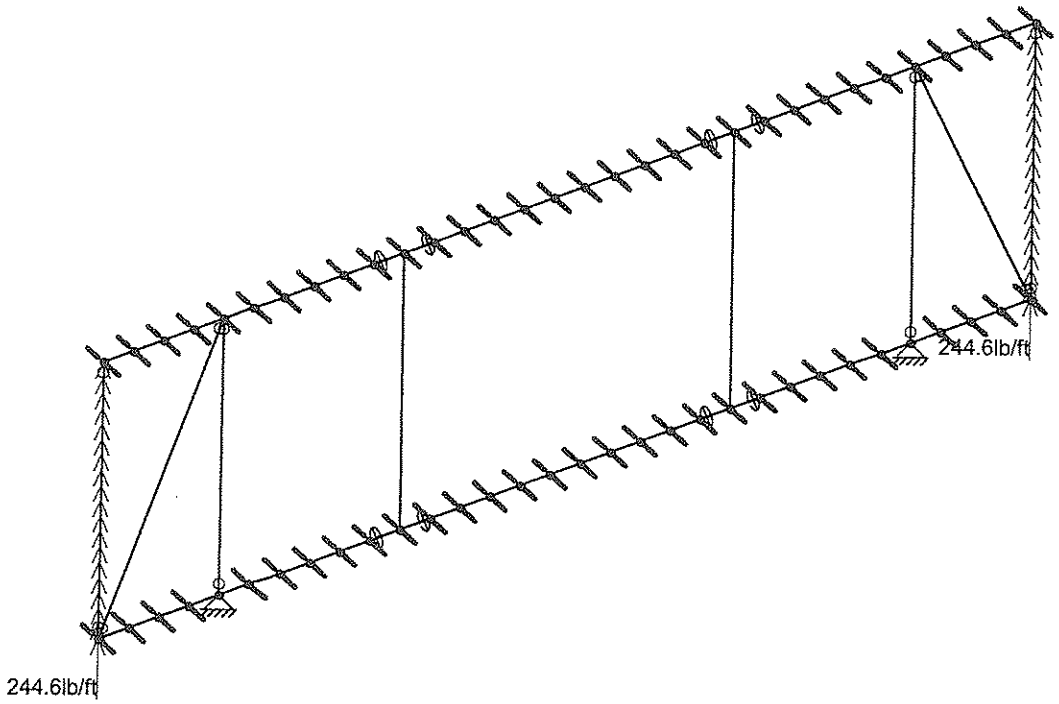




Loads: BLC 9, Lr (Cantilever)
Solution: Envelope

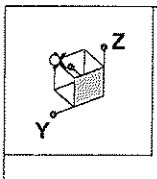
		SK - 10
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

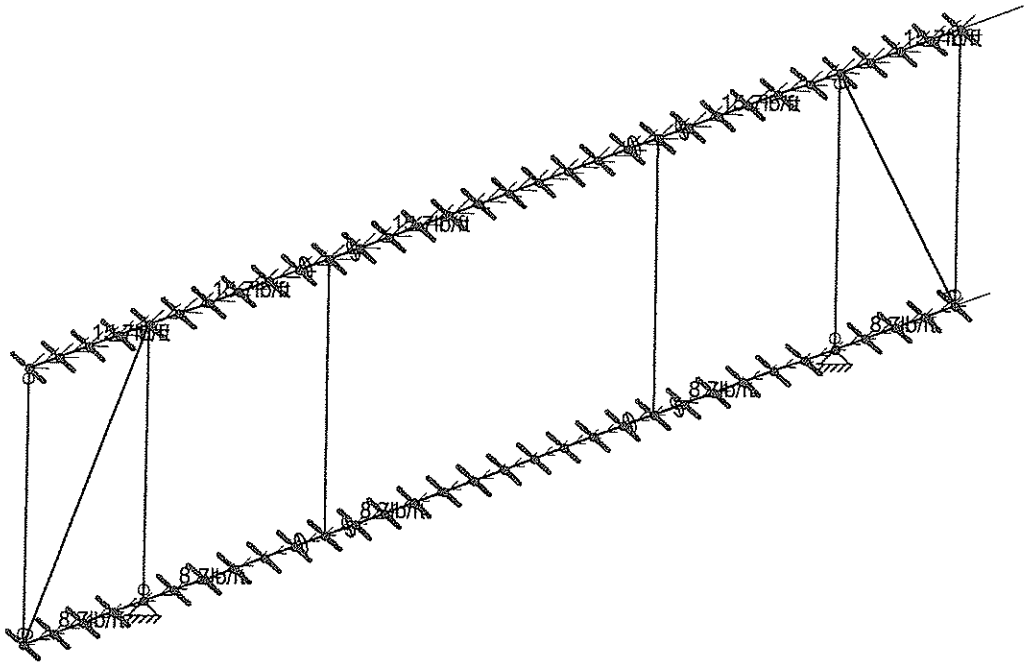




Loads: BLC 10, Wind (X-Dir)
Solution: Envelope

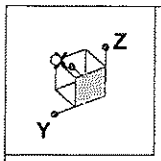
		SK - 11
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

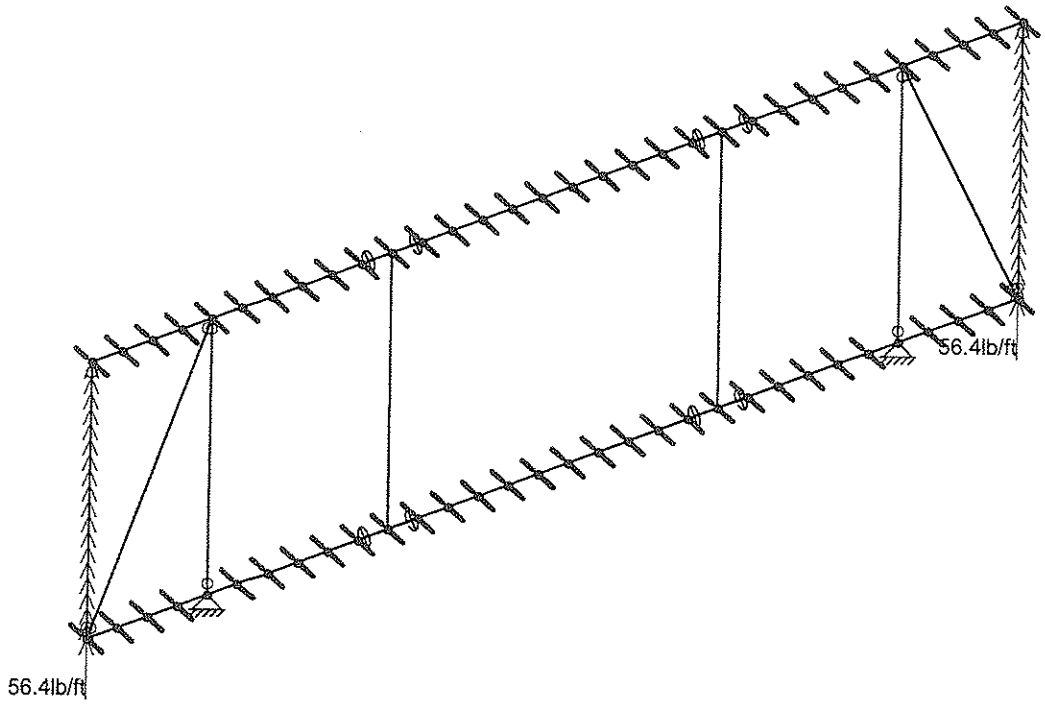




Loads: BLC 11, Wind (Y-Dir)
Solution: Envelope

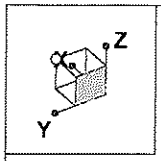
		SK - 12
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

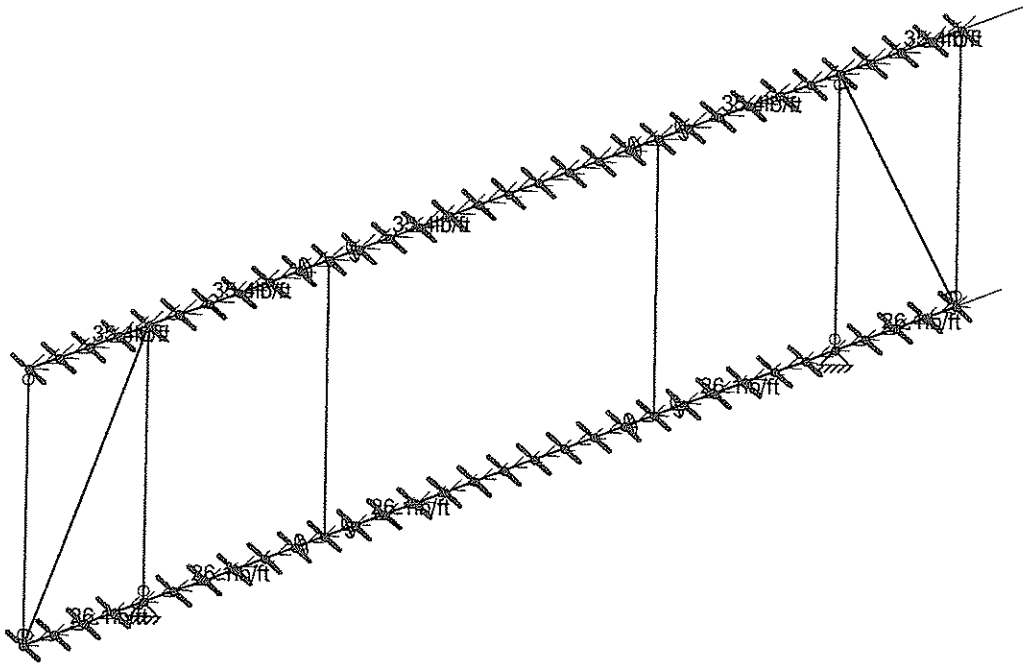




Loads: BLC 12, Seismic (X-Dir)
Solution: Envelope

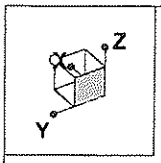
		SK - 13
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

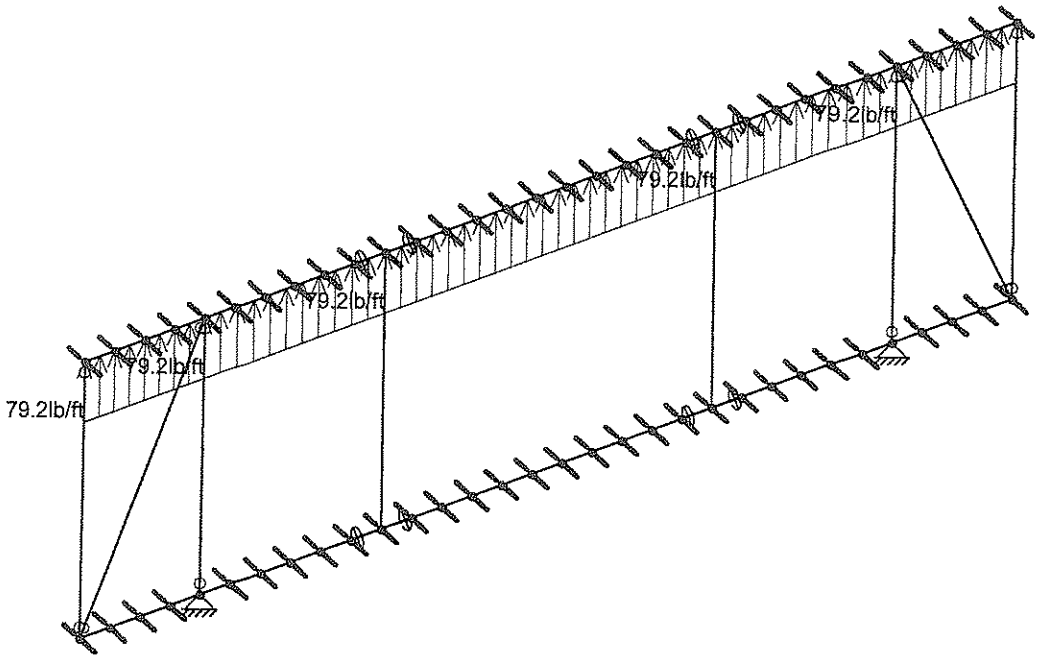




Loads: BLC 13, Seismic (Y-Dir)
Solution: Envelope

		SK - 14
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...





Loads: BLC 14, Wind (Uplift)
Solution: Envelope

		SK - 15
		Feb 4, 2013 at 10:42 AM
		3102BD-20120930-FAR-Risa Anal...

Warning Log

Message
No Data to Print

Global

Display Sections for Member Calcs	20
Max Internal Sections for Member Calcs	39
Include Shear Deformation	Yes
Include Warping	No
Area Load Mesh (in^2)	144
Merge Tolerance (in)	12
P-Delta Analysis Tolerance	0.50%
Vertical Axis	Z

Hot Rolled Steel Code	AISC : ASD 13th
Cold Formed Steel Code	AISI 01: ASD
Wood Code	NDS 2005: ASD
Wood Temperature	< 100F
Concrete Code	ACI 2005
Masonry Code	MSJC 05/IBC 06 ASD

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections	Yes
Bad Framing Warnings	No
Unused Force Warnings	Yes

Footing Overturning Safety Factor	1.5
Check Concrete Bearing	Yes
Self Wt, Overburden in DL for Design	Yes
Footing Concrete Weight	145 k/ft^3
Footing Concrete Fc	3 ksi
Footing Concrete Es	4000 ksi
Footing Steel fy	60 ksi
Minimum Steel	0.0018
Maximum Steel	0.0075
Footing Top Bar	#3
Footing Top Bar Cover	3.5 in
Footing Bottom Bar	#4
Footing Bottom Bar Cover	3.5 in
Pedestal Bar	#3
Pedestal Bar Cover	1.5 in
Pedestal Ties	#3

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (1/E5 F)	Dens[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Design Parameters

	Label	Shape	Length	Lby[ft]	Lbz[ft]	Lcomp,to	Lcomp,bo	Kxy	Kxz	Cm-xy	Cm-xz	Cb	y sway	z sway	Function
1	M1	FB 01	6	Segment		Segment	Segment								Lateral
2	M2	RB 01	6	Segment		Segment	Segment								Lateral
3	M3	WP 01	9.5												Lateral
4	M4	WP 01	9.5												Lateral
5	M5	RB 01	4	Segment		Segment	Segment								Lateral
6	M6	RB 01	4	Segment		Segment	Segment								Lateral
7	M7	FB 01	4	Segment		Segment	Segment								Lateral
8	M8	FB 01	4	Segment		Segment	Segment								Lateral
9	M9	WP 01	9.5												Lateral
10	M10	WP 01	9.5												Lateral
11	M11	WP 01	10.308												Lateral
12	M12	WP 01	10.308												Lateral
13	M13	WP 02	9.5												Lateral
14	M14	WP 02	9.5												Lateral
15	M15	RB 01	6	Segment		Segment	Segment								Lateral
16	M16	FB 01	6	Segment		Segment	Segment								Lateral
17	M17	RB 01	11	Segment		Segment	Segment								Lateral
18	M18	FB 01	11	Segment		Segment	Segment								Lateral

Member Primary Data

	Label	I Joint	J Joint	K Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N2	N41		90	FB 01	Beam	Tube	A500 Gr.46	Typical
2	M2	N4	N28		90	RB 01	Beam	Wide Flange	A992	Typical
3	M3	N2	N4			WP 01	Column	Tube	A500 Gr.46	Typical
4	M4	N1	N3			WP 01	Column	Tube	A500 Gr.46	Typical
5	M5	N6	N4		90	RB 01	Beam	Wide Flange	A992	Typical
6	M6	N3	N8		90	RB 01	Beam	Wide Flange	A992	Typical
7	M7	N5	N2		90	FB 01	Beam	Tube	A500 Gr.46	Typical
8	M8	N1	N7		90	FB 01	Beam	Tube	A500 Gr.46	Typical
9	M9	N5	N6			WP 01	Column	Tube	A500 Gr.46	Typical
10	M10	N7	N8			WP 01	Column	Tube	A500 Gr.46	Typical
11	M11	N4	N5			WP 01	Column	Tube	A500 Gr.46	Typical
12	M12	N3	N7			WP 01	Column	Tube	A500 Gr.46	Typical
13	M13	N59	N51			WP 02	Column	Tube	A500 Gr.46	Typical
14	M14	N41	N28			WP 02	Column	Tube	A500 Gr.46	Typical
15	M15	N51	N3		90	RB 01	Beam	Wide Flange	A992	Typical
16	M16	N59	N1		90	FB 01	Beam	Tube	A500 Gr.46	Typical
17	M17	N28	N51		90	RB 01	Beam	Wide Flange	A992	Typical
18	M18	N41	N59		90	FB 01	Beam	Tube	A500 Gr.46	Typical

Member Advanced Data

	Label	I Release	J Release	I Offset[in]	J Offset[in]	T/C Only	Physical	TOM	Inactive
1	M1						Yes		
2	M2						Yes		
3	M3	BenPIN	BenPIN				Yes		
4	M4	BenPIN	BenPIN				Yes		
5	M5						Yes		
6	M6						Yes		
7	M7						Yes		
8	M8						Yes		
9	M9	BenPIN	BenPIN				Yes		
10	M10	BenPIN	BenPIN				Yes		

Member Advanced Data (Continued)

	Label	I Release	J Release	I Offset[in]	J Offset[in]	T/C Only	Physical	TOM	Inactive
11	M11	BenPIN	BenPIN				Yes		
12	M12	BenPIN	BenPIN				Yes		
13	M13						Yes		
14	M14						Yes		
15	M15						Yes		
16	M16						Yes		
17	M17						Yes		
18	M18						Yes		

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot [k-ft/rad]	Y Rot [k-ft/rad]	Z Rot [k-ft/rad]	Footing
1	N2	Reaction	Reaction	Reaction				
2	N1	Reaction	Reaction	Reaction				
3	N4	Fixed						
4	N3	Fixed						
5	N5	Fixed						
6	N6	Fixed						
7	N7	Fixed						
8	N8	Fixed						
9	N9	Fixed						
10	N10	Fixed						
11	N11	Fixed						
12	N12	Fixed						
13	N13	Fixed						
14	N14	Fixed						
15	N15	Fixed						
16	N16	Fixed						
17	N17	Fixed						
18	N18	Fixed						
19	N19	Fixed						
20	N20	Fixed						
21	N23	Fixed						
22	N24	Fixed						
23	N25	Fixed						
24	N26	Fixed						
25	N27	Fixed						
26	N28	Fixed				Fixed		
27	N29	Fixed						
28	N30	Fixed						
29	N31	Fixed						
30	N32	Fixed						
31	N33	Fixed						
32	N34	Fixed						
33	N35	Fixed						
34	N36	Fixed						
35	N37	Fixed						
36	N38	Fixed						
37	N39	Fixed						
38	N40	Fixed						
39	N41	Fixed				Fixed		
40	N42	Fixed						
41	N43	Fixed						
42	N44	Fixed						
43	N45	Fixed						
44	N46	Fixed						

Joint Boundary Conditions (Continued)

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot [k-ft/rad]	Y Rot [k-ft/rad]	Z Rot [k-ft/rad]	Footing
45	N47	Fixed						
46	N48	Fixed						
47	N49	Fixed						
48	N50	Fixed						
49	N51	Fixed				Fixed		
50	N52	Fixed						
51	N53	Fixed						
52	N54	Fixed						
53	N55	Fixed						
54	N56	Fixed						
55	N57	Fixed						
56	N58	Fixed						
57	N59	Fixed				Fixed		
58	N60	Fixed						
59	N61	Fixed						
60	N62	Fixed						
61	N63	Fixed						
62	N64	Fixed						
63	N21	Fixed						
64	N22	Fixed						

Member Distributed Loads (BLC 2 : DL (Max - Center))

	Member Label	Direction	Start Magnitude[lb/ft,F	End Magnitude[lb/ft,d	Start Location[ft,%]	End Location[ft,%]
1	M2	Z	-110	-110	0	0
2	M1	Z	-65	-65	0	0
3	M1	Z	-155	-155	0	0
4	M15	Z	-110	-110	0	8.5
5	M16	Z	-65	-65	0	8.5
6	M16	Z	-155	-155	0	8.5
7	M17	Z	-110	-110	0	0
8	M18	Z	-65	-65	0	0
9	M18	Z	-155	-155	0	0

Member Distributed Loads (BLC 3 : DL (Min - Center))

	Member Label	Direction	Start Magnitude[lb/ft,F	End Magnitude[lb/ft,d	Start Location[ft,%]	End Location[ft,%]
1	M2	Z	-50	-50	0	0
2	M1	Z	-45	-45	0	0
3	M1	Z	-95	-95	0	0
4	M15	Z	-50	-50	0	8.5
5	M16	Z	-45	-45	0	8.5
6	M16	Z	-95	-95	0	8.5
7	M17	Z	-50	-50	0	0
8	M18	Z	-45	-45	0	0
9	M18	Z	-95	-95	0	0

Member Distributed Loads (BLC 4 : DL (Max - Cantilever))

	Member Label	Direction	Start Magnitude[lb/ft,F	End Magnitude[lb/ft,d	Start Location[ft,%]	End Location[ft,%]
1	M5	Z	-110	-110	0	0
2	M6	Z	-110	-110	0	0
3	M7	Z	-65	-65	0	0
4	M8	Z	-65	-65	0	0
5	M7	Z	-155	-155	0	0
6	M8	Z	-155	-155	0	0

Member Distributed Loads (BLC 5 : DL (Min - Cantilever))

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M5	Z	-50	-50	0	0
2	M6	Z	-50	-50	0	0
3	M7	Z	-45	-45	0	0
4	M8	Z	-45	-45	0	0
5	M7	Z	-95	-95	0	0
6	M8	Z	-95	-95	0	0

Member Distributed Loads (BLC 6 : LL (Center))

	Member Label	Direction	Start Magnitude[lb/ft	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M1	Z	-225	-225	0	0
2	M16	Z	-225	-225	0	8.5
3	M18	Z	-225	-225	0	0

Member Distributed Loads (BLC 7 : LL (Cantilever))

	Member Label	Direction	Start Magnitude[lb/ft	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M7	Z	-225	-225	0	0
2	M8	Z	-225	-225	0	0

Member Distributed Loads (BLC 8 : Lr (Center))

	Member Label	Direction	Start Magnitude[lb/ft	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M9	Z	-90	-90	0	0
2	M15	Z	-90	-90	0	8.5
3	M17	Z	-90	-90	0	0

Member Distributed Loads (BLC 9 : Lr (Cantilever))

	Member Label	Direction	Start Magnitude[lb/ft	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M5	Z	-90	-90	0	0
2	M6	Z	-90	-90	0	0

Member Distributed Loads (BLC 10 : Wind (X-Dir))

	Member Label	Direction	Start Magnitude[lb/ft	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M9	Z	244.6	244.6	0	0
2	M10	Z	244.6	244.6	0	0

Member Distributed Loads (BLC 11 : Wind (Y-Dir))

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M5	Y	15.7	15.7	0	0
2	M2	Y	15.7	15.7	0	0
3	M6	Y	15.7	15.7	0	0
4	M7	Y	8.7	8.7	0	0
5	M1	Y	8.7	8.7	0	0
6	M8	Y	8.7	8.7	0	0
7	M15	Y	15.7	15.7	0	8
8	M16	Y	8.7	8.7	0	0
9	M17	Y	15.7	15.7	0	0
10	M18	Y	8.7	8.7	0	0

Member Distributed Loads (BLC 12 : Seismic (X-Dir))

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M9	Z	56.4	56.4	0	0
2	M10	Z	56.4	56.4	0	0

Member Distributed Loads (BLC 13 : Seismic (Y-Dir))

	Member Label	Direction	Start Magnitude[lb/ft,...	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]

Member Distributed Loads (BLC 13 : Seismic (Y-Dir)) (Continued)

	Member Label	Direction	Start Magnitude[lb/ft	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M5	Y	35.4	35.4	0	0
2	M2	Y	35.4	35.4	0	0
3	M6	Y	35.4	35.4	0	0
4	M1	Y	26.1	26.1	0	0
5	M7	Y	26.1	26.1	0	0
6	M8	Y	26.1	26.1	0	0
7	M15	Y	35.4	35.4	0	8
8	M16	Y	26.1	26.1	0	8
9	M17	Y	35.4	35.4	0	0
10	M18	Y	26.1	26.1	0	0

Member Distributed Loads (BLC 14 : Wind (Uplift))

	Member Label	Direction	Start Magnitude[lb/ft	End Magnitude[lb/ft,d...	Start Location[ft,%]	End Location[ft,%]
1	M5	Z	79.2	79.2	0	0
2	M2	Z	79.2	79.2	0	0
3	M6	Z	79.2	79.2	0	0
4	M15	Z	79.2	79.2	0	8
5	M17	Z	79.2	79.2	0	0

Joint Loads and Enforced Displacements (BLC 4 : DL (Max - Cantilever))

	Joint Label	L,D,M	Direction	Magnitude[lb,k-ft] [in,rad] [lb*s^2/...
1	N5	L	Z	-685
2	N7	L	Z	-685

Joint Loads and Enforced Displacements (BLC 5 : DL (Min - Cantilever))

	Joint Label	L,D,M	Direction	Magnitude[lb,k-ft] [in,rad] [lb*s^2/...
1	N5	L	Z	-430
2	N7	L	Z	-430

No Data to Print ...

No Data to Print ...

No Data to Print ...

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distributed	Area (Member)	Surface ...
1	SWT	DL			-1					
2	DL (Max - Center)	None						9		
3	DL (Min - Center)	None						9		
4	DL (Max - Cantilever)	None				2		6		
5	DL (Min - Cantilever)	None				2		6		
6	LL (Center)	None						3		
7	LL (Cantilever)	None						2		
8	Lr (Center)	None						3		
9	Lr (Cantilever)	None						2		
10	Wind (X-Dir)	None						2		
11	Wind (Y-Dir)	None						10		
12	Seismic (X-Dir)	None						2		
13	Seismic (Y-Dir)	None						10		
14	Wind (Uplift)	None						5		

Load Combinations

	Description	Solve	PDel	SRSS	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa
1	(+ Defl) D	Yes	Y		DL 1	2 1	5 1					
2	(+ Defl) D+L	Yes	Y		DL 1	2 1	5 1	6 1				
3	(+ Defl) D+Lr	Yes	Y		DL 1	2 1	5 1	6 1				
4	(+ Defl) D+0.75L+0.75Lr	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75			
5	(+ Defl) L		Y		6 1							
6	(+ Defl) Lr		Y		8 1							
7	(+ Defl) 0.75L+0.75Lr		Y		6 .75	8 .75						
8	(+ Defl) D+W (+Xdir)	Yes	Y		DL 1	2 1	5 1	10 1				
9	(+ Defl) D+W (-Xdir)	Yes	Y		DL 1	2 1	5 1	10 -1				
10	(+ Defl) D+W (+Ydir)	Yes	Y		DL 1	2 1	5 1	11 1				
11	(+ Defl) D+W (-Ydir)	Yes	Y		DL 1	2 1	5 1	11 -1				
12	(+ Defl) D+0.75L+0.75Lr+0.75W (+X	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	10 .75		
13	(+ Defl) D+0.75L+0.75Lr+0.75W (-X	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	10 -.75		
14	(+ Defl) D+0.75L+0.75Lr+0.75W (+Y	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	11 .75		
15	(+ Defl) D+0.75L+0.75Lr+0.75W (-Y	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	11 -.75		
16	(+ Defl) 0.6D+W (+Xdir)	Yes	Y		DL .6	2 .6	5 .6	10 1				
17	(+ Defl) 0.6D+W (-Xdir)	Yes	Y		DL .6	2 .6	5 .6	10 -1				
18	(+ Defl) 0.6D+W (+Ydir)	Yes	Y		DL .6	2 .6	5 .6	11 1				
19	(+ Defl) 0.6D+W (-Ydir)	Yes	Y		DL .6	2 .6	5 .6	11 -1				
20	(+ Defl) D+W (+Xdir) (Uplift)	Yes	Y		L.8 1	14 1						
21	(+ Defl) D+W (-Xdir) (Uplift)	Yes	Y		L.9 1	14 1						
22	(+ Defl) D+W (+Ydir) (Uplift)	Yes	Y		L.10 1	14 1						
23	(+ Defl) D+W (-Ydir) (Uplift)	Yes	Y		L.11 1	14 1						
24	(+ Defl) D+0.75L+0.75Lr+0.75W (+X	Yes	Y		L.12 1	14 .75						
25	(+ Defl) D+0.75L+0.75Lr+0.75W (-X	Yes	Y		L.13 1	14 .75						
26	(+ Defl) D+0.75L+0.75Lr+0.75W (+Y	Yes	Y		L.14 1	14 .75						
27	(+ Defl) D+0.75L+0.75Lr+0.75W (-Y	Yes	Y		L.15 1	14 .75						
28	(+ Defl) 0.6D+W (+Xdir) (Uplift)	Yes	Y		L.16 1	14 1						
29	(+ Defl) 0.6D+W (-Xdir) (Uplift)	Yes	Y		L.17 1	14 1						
30	(+ Defl) 0.6D+W (+Ydir) (Uplift)	Yes	Y		L.18 1	14 1						
31	(+ Defl) 0.6D+W (-Ydir) (Uplift)	Yes	Y		L.19 1	14 1						
32	(+ Defl) D+E (+Xdir)	Yes	Y		DL 1	2 1	5 1	12 1				
33	(+ Defl) D+E (-Xdir)	Yes	Y		DL 1	2 1	5 1	12 -1				
34	(+ Defl) D+E (+Ydir)	Yes	Y		DL 1	2 1	5 1	13 1				
35	(+ Defl) D+E (-Ydir)	Yes	Y		DL 1	2 1	5 1	13 -1				
36	(+ Defl) D+0.75L+0.75Lr+0.75E (+X	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	12 .75		
37	(+ Defl) D+0.75L+0.75Lr+0.75E (-Xd	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	12 -.75		
38	(+ Defl) D+0.75L+0.75Lr+0.75E (+Y	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	13 .75		
39	(+ Defl) D+0.75L+0.75Lr+0.75E (-Yd	Yes	Y		DL 1	2 1	5 1	6 .75	8 .75	13 -.75		
40	(+ Defl) 0.6D+E (+Xdir)	Yes	Y		DL .6	2 .6	5 .6	12 1				
41	(+ Defl) 0.6D+E (-Xdir)	Yes	Y		DL .6	2 .6	5 .6	12 -1				
42	(+ Defl) 0.6D+E (+Ydir)	Yes	Y		DL .6	2 .6	5 .6	13 1				
43	(+ Defl) 0.6D+E (-Ydir)	Yes	Y		DL .6	2 .6	5 .6	13 -1				
44	(- Defl) D	Yes	Y		DL 1	3 1	4 1					
45	(- Defl) D+L	Yes	Y		DL 1	3 1	4 1	7 1				
46	(- Defl) D+Lr	Yes	Y		DL 1	3 1	4 1	9 1				
47	(- Defl) D+0.75L-0.75Lr	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75			
48	(- Defl) L		Y		7 1							
49	(- Defl) Lr		Y		9 1							
50	(- Defl) 0.75L+0.75Lr		Y		7 .75	9 .75						
51	(- Defl) D+W (+Xdir)	Yes	Y		DL 1	3 1	4 1	10 1				
52	(- Defl) D+W (-Xdir)	Yes	Y		DL 1	3 1	4 1	10 -1				
53	(- Defl) D+W (+Ydir)	Yes	Y		DL 1	3 1	4 1	11 1				
54	(- Defl) D+W (-Ydir)	Yes	Y		DL 1	3 1	4 1	11 -1				
55	(- Defl) D+0.75L+0.75Lr+0.75W (+X	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	10 .75		
56	(- Defl) D+0.75L+0.75Lr+0.75W (-Xd	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	10 -.75		

Load Combinations (Continued)

	Description	Solve	PDel	SRSS	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa	BLCFa
57	(- Defl) D+0.75L+0.75Lr+0.75W (+Y...	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	11 .75		
58	(- Defl) D+0.75L+0.75Lr+0.75W (-Yd	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	11 -.75		
59	(- Defl) 0.6D+W (+Xdir)	Yes	Y		DL .6	3 .6	4 .6	10 1				
60	(- Defl) 0.6D+W (-Xdir)	Yes	Y		DL .6	3 .6	4 .6	10 -1				
61	(- Defl) 0.6D+W (+Ydir)	Yes	Y		DL .6	3 .6	4 .6	11 1				
62	(- Defl) 0.6D+W (-Ydir)	Yes	Y		DL .6	3 .6	4 .6	11 -1				
63	(- Defl) D+W (+Xdir) (Uplift)	Yes	Y		L.51 1	14 1						
64	(- Defl) D+W (-Xdir) (Uplift)	Yes	Y		L.52 1	14 1						
65	(- Defl) D+W (+Ydir) (Uplift)	Yes	Y		L.53 1	14 1						
66	(- Defl) D+W (-Ydir) (Uplift)	Yes	Y		L.54 1	14 1						
67	(- Defl) D+0.75L+0.75Lr+0.75W (+X...	Yes	Y		L.55 1	14 .75						
68	(- Defl) D+0.75L+0.75Lr+0.75W (-Xd...	Yes	Y		L.56 1	14 .75						
69	(- Defl) D+0.75L+0.75Lr+0.75W (+Y...	Yes	Y		L.57 1	14 .75						
70	(- Defl) D+0.75L+0.75Lr+0.75W (-Yd...	Yes	Y		L.58 1	14 .75						
71	(- Defl) 0.6D+W (+Xdir) (Uplift)	Yes	Y		L.59 1	14 1						
72	(- Defl) 0.6D+W (-Xdir) (Uplift)	Yes	Y		L.60 1	14 1						
73	(- Defl) 0.6D+W (+Ydir) (Uplift)	Yes	Y		L.61 1	14 1						
74	(- Defl) 0.6D+W (-Ydir) (Uplift)	Yes	Y		L.62 1	14 1						
75	(- Defl) D+E (+Xdir)	Yes	Y		DL 1	3 1	4 1	12 1				
76	(- Defl) D+E (-Xdir)	Yes	Y		DL 1	3 1	4 1	12 -1				
77	(- Defl) D+E (+Ydir)	Yes	Y		DL 1	3 1	4 1	13 1				
78	(- Defl) D+E (-Ydir)	Yes	Y		DL 1	3 1	4 1	13 -1				
79	(- Defl) D+0.75L+0.75Lr+0.75E (+Xd...	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	12 .75		
80	(- Defl) D+0.75L+0.75Lr+0.75E (-Xdir)	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	12 -.75		
81	(- Defl) D+0.75L+0.75Lr+0.75E (+Yd...	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	13 .75		
82	(- Defl) D+0.75L+0.75Lr+0.75E (-Ydir)	Yes	Y		DL 1	3 1	4 1	7 .75	9 .75	13 -.75		
83	(- Defl) 0.6D+E (+Xdir)	Yes	Y		DL .6	3 .6	4 .6	12 1				
84	(- Defl) 0.6D+E (-Xdir)	Yes	Y		DL .6	3 .6	4 .6	12 -1				
85	(- Defl) 0.6D+E (+Ydir)	Yes	Y		DL .6	3 .6	4 .6	13 1				
86	(- Defl) 0.6D+E (-Ydir)	Yes	Y		DL .6	3 .6	4 .6	13 -1				
87	(- Mom) D	Yes	Y		DL 1	2 1	4 1					
88	(- Mom) D+L	Yes	Y		DL 1	2 1	4 1	6 1	7 1			
89	(- Mom) D+Lr	Yes	Y		DL 1	2 1	4 1	6 1	9 1			
90	(- Mom) D+0.75L+0.75Lr	Yes	Y		DL 1	2 1	4 1	6 .75	7 .75	8 .75	9 .75	
91	(- Mom) L		Y		6 1	7 1						
92	(- Mom) Lr		Y		8 1	9 1						
93	(- Mom) 0.75L+0.75Lr		Y		6 .75	7 .75	8 .75	9 .75				
94	(- Mom) D+W (+Xdir)	Yes	Y		DL 1	2 1	4 1	10 1				
95	(- Mom) D+W (-Xdir)	Yes	Y		DL 1	2 1	4 1	10 -1				
96	(- Mom) D+W (+Ydir)	Yes	Y		DL 1	2 1	4 1	11 1				
97	(- Mom) D+W (-Ydir)	Yes	Y		DL 1	2 1	4 1	11 -1				
98	(- Mom) D+0.75L+0.75Lr+0.75W (+...	Yes	Y		DL 1	2 1	4 1	6 .75	7 .75	8 .75	9 .75	10 .75
99	(- Mom) D+0.75L+0.75Lr+0.75W (-X...	Yes	Y		DL 1	2 1	4 1	6 .75	7 .75	8 .75	9 .75	10 -.75
100	(- Mom) D+0.75L+0.75Lr+0.75W (+...	Yes	Y		DL 1	2 1	4 1	6 .75	7 .75	8 .75	9 .75	11 .75
101	(- Mom) D+0.75L+0.75Lr+0.75W (-Y...	Yes	Y		DL 1	2 1	4 1	6 .75	7 .75	8 .75	9 .75	11 -.75
102	(- Mom) 0.6D+W (+Xdir)	Yes	Y		DL .6	2 .6	4 .6	10 1				
103	(- Mom) 0.6D+W (-Xdir)	Yes	Y		DL .6	2 .6	4 .6	10 -1				
104	(- Mom) 0.6D+W (+Ydir)	Yes	Y		DL .6	2 .6	4 .6	11 1				
105	(- Mom) 0.6D+W (-Ydir)	Yes	Y		DL .6	2 .6	4 .6	11 -1				
106	(- Mom) D+W (+Xdir) (Uplift)	Yes	Y		L.94 1	14 1						
107	(- Mom) D+W (-Xdir) (Uplift)	Yes	Y		L.95 1	14 1						
108	(- Mom) D+W (+Ydir) (Uplift)	Yes	Y		L.96 1	14 1						
109	(- Mom) D+W (-Ydir) (Uplift)	Yes	Y		L.97 1	14 1						
110	(- Mom) D+0.75L+0.75Lr+0.75W (+...	Yes	Y		L.98 1	14 .75						
111	(- Mom) D+0.75L+0.75Lr+0.75W (-X...	Yes	Y		L.99 1	14 .75						
112	(- Mom) D+0.75L+0.75Lr+0.75W (+...	Yes	Y		L.1 1	14 .75						
113	(- Mom) D+0.75L+0.75Lr+0.75W (-Y...	Yes	Y		L.1 1	14 .75						

Load Combinations (Continued)

	Description	Solve	PDel	SRSS	BLCFs	BLCFs	BLCFs	BLCFs	BLCFs	BLCFs	BLCFs	BLCFs
114	(- Mom) 0.6D+W (+Xdir) (Uplift)	Yes	Y		DL 1	W 1						
115	(- Mom) 0.6D+W (-Xdir) (Uplift)	Yes	Y		DL 1	W -1						
116	(- Mom) 0.6D+W (+Ydir) (Uplift)	Yes	Y		DL 1	W 1						
117	(- Mom) 0.6D+W (-Ydir) (Uplift)	Yes	Y		DL 1	W -1						
118	(- Mom) D+E (+Xdir)	Yes	Y		DL 1	E 1	L 4	S 1	Lr 12	R 1		
119	(- Mom) D+E (-Xdir)	Yes	Y		DL 1	E -1	L 4	S 1	Lr 12	R -1		
120	(- Mom) D+E (+Ydir)	Yes	Y		DL 1	E 1	L 4	S 1	Lr 13	R 1		
121	(- Mom) D+E (-Ydir)	Yes	Y		DL 1	E -1	L 4	S 1	Lr 13	R -1		
122	(- Mom) D+0.75L+0.75E+0.75E (+X	Yes	Y		DL 1	E 2	L 4	S 1	L 6	Lr 75	R 7	S 75
123	(- Mom) D+0.75L+0.75E+0.75E (-X	Yes	Y		DL 1	E 2	L 4	S 1	L 6	Lr 75	R 7	S 75
124	(- Mom) D+0.75L+0.75E+0.75E (+Y	Yes	Y		DL 1	E 2	L 4	S 1	L 6	Lr 75	R 7	S 75
125	(- Mom) D+0.75L+0.75L+0.75E (-Y	Yes	Y		DL 1	E 2	L 4	S 1	L 6	Lr 75	R 7	S 75
126	(- Mom) 0.6D+E (+Xdir)	Yes	Y		DL .6	E 2	L .6	S 1	L 6	Lr 12	R 1	
127	(- Mom) 0.6D+E (-Xdir)	Yes	Y		DL .6	E 2	L .6	S 1	L 6	Lr 12	R -1	
128	(- Mom) 0.6D+E (+Ydir)	Yes	Y		DL .6	E 2	L .6	S 1	L 6	Lr 13	R 1	
129	(- Mom) 0.6D+E (-Ydir)	Yes	Y		DL .6	E 2	L .6	S 1	L 6	Lr 13	R -1	
130	Model				DL 1	E 2	L 4	S 1				
131	Wind (+Xdir)				10 1							
132	Wind (-Xdir)				10 -1							
133	Wind (+Ydir)				11 1							
134	Wind (-Ydir)				11 -1							
135	Seismic (+Xdir)				12 1							
136	Seismic (-Xdir)				12 -1							
137	Seismic (+Ydir)				13 1							
138	Seismic (-Ydir)				13 -1							

RSA/Frequencies

No Response Spectra/Frequency Results Available

Envelope Member Section Forces

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k	LC	y-y Mom.	LC	z-z Mom.	LC
1	M1	1	max	678.417	38	-291.965	74	0	1	0	1	0	1	-.496	74
2			min	-408.672	86	-2127.202	124	0	1	0	1	0	1	-4.614	124
3		2	max	672.235	38	-261.293	74	0	1	0	1	0	1	-.32	74
4			min	-400.43	86	-1997.529	124	0	1	0	1	0	1	-3.963	124
5		3	max	666.054	38	-230.621	74	0	1	0	1	0	1	-.243	74
6			min	-392.188	86	-1867.857	124	0	1	0	1	0	1	-3.352	124
7		4	max	659.872	38	-199.949	74	0	1	0	1	0	1	-.175	74
8			min	-383.945	86	-1738.184	124	0	1	0	1	0	1	-2.783	124
9		5	max	653.691	38	-169.275	74	0	1	0	1	0	1	-.116	74
10			min	-375.703	86	-1608.881	124	0	1	0	1	0	1	-2.255	124
11		6	max	647.509	38	-138.603	74	0	1	0	1	0	1	-.068	74
12			min	-367.461	86	-1479.209	124	0	1	0	1	0	1	-1.767	124
13		7	max	641.327	38	-107.931	74	0	1	0	1	0	1	-.018	71
14			min	-359.219	86	-1349.536	124	0	1	0	1	0	1	-1.32	124
15		8	max	635.146	38	-77.261	74	0	1	0	1	0	1	.022	71
16			min	-350.977	86	-1219.99	124	0	1	0	1	0	1	-.915	124
17		9	max	628.964	38	-46.589	74	0	1	0	1	0	1	.066	28
18			min	-342.735	86	-1090.317	124	0	1	0	1	0	1	-.65	124
19		10	max	622.783	38	-15.917	74	0	1	0	1	0	1	.138	39
20			min	-334.493	86	-960.645	124	0	1	0	1	0	1	-.312	81
21		11	max	616.601	38	14.751	74	0	1	0	1	0	1	.34	39
22			min	-326.251	86	-830.933	124	0	1	0	1	0	1	-.166	68
23		12	max	610.42	38	45.423	74	0	1	0	1	0	1	.524	12
24			min	-318.009	86	-701.261	124	0	1	0	1	0	1	-.102	72

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k	LC	y-y Mom.	LC	z-z Mom.	LC
25		13	max	604.238	38	76.095	74	0	1	0	1	0	1	.67	12
26			min	-309.766	86	-571.588	124	0	1	0	1	0	1	-.094	72
27		14	max	598.056	38	106.765	74	0	1	0	1	0	1	.776	12
28			min	-301.524	86	-441.792	124	0	1	0	1	0	1	-.095	72
29		15	max	591.875	38	137.437	74	0	1	0	1	0	1	.841	12
30			min	-293.282	86	-339.408	89	0	1	0	1	0	1	-.106	72
31		16	max	585.693	38	168.109	74	0	1	0	1	0	1	.9	38
32			min	-285.04	86	-263.025	89	0	1	0	1	0	1	-.127	72
33		17	max	579.512	38	267.168	2	0	1	0	1	0	1	.921	38
34			min	-276.798	86	-186.694	89	0	1	0	1	0	1	-.172	74
35		18	max	573.33	38	444.604	2	0	1	0	1	0	1	.931	3
36			min	-268.556	86	-115.007	85	0	1	0	1	0	1	-.24	74
37		19	max	567.149	38	592.04	2	0	1	0	1	0	1	.947	3
38			min	-260.314	86	-84.335	85	0	1	0	1	0	1	-.317	74
39		20	max	560.967	38	739.476	2	0	1	0	1	0	1	.941	89
40			min	-252.072	86	-53.663	85	0	1	0	1	0	1	-.404	74
41	M2	1	max	2394.687	12	-331.007	74	0	1	0	1	0	1	-.561	74
42			min	-1005.813	72	-5484.114	38	0	1	0	1	0	1	-18.977	124
43		2	max	2394.687	12	-341.592	74	0	1	0	1	0	1	-.454	74
44			min	-1005.813	72	-5419.808	38	0	1	0	1	0	1	-17.271	124
45		3	max	2394.687	12	-352.178	74	0	1	0	1	0	1	-.345	74
46			min	-1005.813	72	-5355.503	38	0	1	0	1	0	1	-15.585	124
47		4	max	2394.687	12	-362.763	74	0	1	0	1	0	1	-.232	74
48			min	-1005.813	72	-5291.198	38	0	1	0	1	0	1	-13.92	124
49		5	max	2394.687	12	-373.351	74	0	1	0	1	0	1	-.021	86
50			min	-1005.813	72	-5227.501	38	0	1	0	1	0	1	-12.275	124
51		6	max	2394.687	12	-383.936	74	0	1	0	1	0	1	.249	86
52			min	-1005.813	72	-5163.196	38	0	1	0	1	0	1	-10.65	124
53		7	max	2394.687	12	-394.521	74	0	1	0	1	0	1	.514	86
54			min	-1005.813	72	-5098.89	38	0	1	0	1	0	1	-9.045	124
55		8	max	2394.687	12	-405.111	74	0	1	0	1	0	1	.774	86
56			min	-1005.813	72	-5034.926	38	0	1	0	1	0	1	-7.481	124
57		9	max	2394.687	12	-415.696	74	0	1	0	1	0	1	1.03	86
58			min	-1005.813	72	-4970.622	38	0	1	0	1	0	1	-5.897	124
59		10	max	2394.687	12	-426.282	74	0	1	0	1	0	1	1.281	86
60			min	-1005.813	72	-4906.317	38	0	1	0	1	0	1	-4.353	124
61		11	max	2394.687	12	-436.873	74	0	1	0	1	0	1	1.527	86
62			min	-1005.813	72	-4842.11	38	0	1	0	1	0	1	-2.859	120
63		12	max	2394.687	12	-447.456	74	0	1	0	1	0	1	1.913	35
64			min	-1005.813	72	-4777.804	38	0	1	0	1	0	1	-1.958	77
65		13	max	2394.687	12	-458.043	74	0	1	0	1	0	1	2.979	39
66			min	-1005.813	72	-4713.499	38	0	1	0	1	0	1	-1.472	85
67		14	max	2394.687	12	-468.635	74	0	1	0	1	0	1	4.306	39
68			min	-1005.813	72	-4649.068	38	0	1	0	1	0	1	-1.039	85
69		15	max	2394.687	12	-479.22	74	0	1	0	1	0	1	5.614	39
70			min	-1005.813	72	-4584.761	38	0	1	0	1	0	1	-.61	85
71		16	max	2394.687	12	-489.806	74	0	1	0	1	0	1	6.901	39
72			min	-1005.813	72	-4520.456	38	0	1	0	1	0	1	-.186	85
73		17	max	2394.687	12	-500.398	74	0	1	0	1	0	1	8.168	39
74			min	-1005.813	72	-4455.817	38	0	1	0	1	0	1	.233	85
75		18	max	2394.687	12	-510.983	74	0	1	0	1	0	1	9.414	39
76			min	-1005.813	72	-4391.512	38	0	1	0	1	0	1	.602	73
77		19	max	2394.687	12	-521.568	74	0	1	0	1	0	1	10.64	39
78			min	-1005.813	72	-4327.207	38	0	1	0	1	0	1	.824	72
79		20	max	2394.687	12	-532.154	74	0	1	0	1	0	1	11.846	39
80			min	-1005.813	72	-4262.901	38	0	1	0	1	0	1	1.027	72
81	M3	1	max	8580.481	99	0	1	0	1	0	1	0	1	0	1

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k	LC	y-y Mom.	LC	z-z Mom.	LC
82			min	-972.996	71	0	1	0	1	0	1	0	1	0	1
83		2	max	8573.145	99	0	1	0	1	0	1	0	1	0	1
84			min	-977.386	71	0	1	0	1	0	1	0	1	0	1
85		3	max	8565.829	99	0	1	0	1	0	1	0	1	0	1
86			min	-981.776	71	0	1	0	1	0	1	0	1	0	1
87		4	max	8558.513	99	0	1	0	1	0	1	0	1	0	1
88			min	-986.165	71	0	1	0	1	0	1	0	1	0	1
89		5	max	8551.197	99	0	1	0	1	0	1	0	1	0	1
90			min	-990.555	71	0	1	0	1	0	1	0	1	0	1
91		6	max	8543.881	99	0	1	0	1	0	1	0	1	0	1
92			min	-994.944	71	0	1	0	1	0	1	0	1	0	1
93		7	max	8536.565	99	0	1	0	1	0	1	0	1	0	1
94			min	-999.334	71	0	1	0	1	0	1	0	1	0	1
95		8	max	8529.249	99	0	1	0	1	0	1	0	1	0	1
96			min	-1003.723	71	0	1	0	1	0	1	0	1	0	1
97		9	max	8521.933	99	0	1	0	1	0	1	0	1	0	1
98			min	-1008.113	71	0	1	0	1	0	1	0	1	0	1
99		10	max	8514.617	99	0	1	0	1	0	1	0	1	0	1
100			min	-1012.503	71	0	1	0	1	0	1	0	1	0	1
101		11	max	8507.301	99	0	1	0	1	0	1	0	1	0	1
102			min	-1016.892	71	0	1	0	1	0	1	0	1	0	1
103		12	max	8499.985	99	0	1	0	1	0	1	0	1	0	1
104			min	-1021.282	71	0	1	0	1	0	1	0	1	0	1
105		13	max	8492.669	99	0	1	0	1	0	1	0	1	0	1
106			min	-1025.671	71	0	1	0	1	0	1	0	1	0	1
107		14	max	8485.353	99	0	1	0	1	0	1	0	1	0	1
108			min	-1030.061	71	0	1	0	1	0	1	0	1	0	1
109		15	max	8478.037	99	0	1	0	1	0	1	0	1	0	1
110			min	-1034.451	71	0	1	0	1	0	1	0	1	0	1
111		16	max	8470.721	99	0	1	0	1	0	1	0	1	0	1
112			min	-1038.84	71	0	1	0	1	0	1	0	1	0	1
113		17	max	8463.405	99	0	1	0	1	0	1	0	1	0	1
114			min	-1043.23	71	0	1	0	1	0	1	0	1	0	1
115		18	max	8456.089	99	0	1	0	1	0	1	0	1	0	1
116			min	-1047.619	71	0	1	0	1	0	1	0	1	0	1
117		19	max	8448.773	99	0	1	0	1	0	1	0	1	0	1
118			min	-1052.009	71	0	1	0	1	0	1	0	1	0	1
119		20	max	8441.457	99	0	1	0	1	0	1	0	1	0	1
120			min	-1056.398	71	0	1	0	1	0	1	0	1	0	1
121	M4	1	max	8580.481	99	0	1	0	1	0	1	0	1	0	1
122			min	-972.996	71	0	1	0	1	0	1	0	1	0	1
123		2	max	8573.145	99	0	1	0	1	0	1	0	1	0	1
124			min	-977.386	71	0	1	0	1	0	1	0	1	0	1
125		3	max	8565.829	99	0	1	0	1	0	1	0	1	0	1
126			min	-981.776	71	0	1	0	1	0	1	0	1	0	1
127		4	max	8558.513	99	0	1	0	1	0	1	0	1	0	1
128			min	-986.165	71	0	1	0	1	0	1	0	1	0	1
129		5	max	8551.197	99	0	1	0	1	0	1	0	1	0	1
130			min	-990.555	71	0	1	0	1	0	1	0	1	0	1
131		6	max	8543.881	99	0	1	0	1	0	1	0	1	0	1
132			min	-994.944	71	0	1	0	1	0	1	0	1	0	1
133		7	max	8536.565	99	0	1	0	1	0	1	0	1	0	1
134			min	-999.334	71	0	1	0	1	0	1	0	1	0	1
135		8	max	8529.249	99	0	1	0	1	0	1	0	1	0	1
136			min	-1003.723	71	0	1	0	1	0	1	0	1	0	1
137		9	max	8521.933	99	0	1	0	1	0	1	0	1	0	1
138			min	-1008.113	71	0	1	0	1	0	1	0	1	0	1

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k	LC	y-y Mom.	LC	z-z Mom.	LC
139		10	max	8514.617	99	0	1	0	1	0	1	0	1	0	1
140			min	-1012.503	71	0	1	0	1	0	1	0	1	0	1
141		11	max	8507.301	99	0	1	0	1	0	1	0	1	0	1
142			min	-1016.892	71	0	1	0	1	0	1	0	1	0	1
143		12	max	8499.985	99	0	1	0	1	0	1	0	1	0	1
144			min	-1021.282	71	0	1	0	1	0	1	0	1	0	1
145		13	max	8492.669	99	0	1	0	1	0	1	0	1	0	1
146			min	-1025.671	71	0	1	0	1	0	1	0	1	0	1
147		14	max	8485.353	99	0	1	0	1	0	1	0	1	0	1
148			min	-1030.061	71	0	1	0	1	0	1	0	1	0	1
149		15	max	8478.037	99	0	1	0	1	0	1	0	1	0	1
150			min	-1034.451	71	0	1	0	1	0	1	0	1	0	1
151		16	max	8470.721	99	0	1	0	1	0	1	0	1	0	1
152			min	-1038.84	71	0	1	0	1	0	1	0	1	0	1
153		17	max	8463.405	99	0	1	0	1	0	1	0	1	0	1
154			min	-1043.23	71	0	1	0	1	0	1	0	1	0	1
155		18	max	8456.089	99	0	1	0	1	0	1	0	1	0	1
156			min	-1047.619	71	0	1	0	1	0	1	0	1	0	1
157		19	max	8448.773	99	0	1	0	1	0	1	0	1	0	1
158			min	-1052.009	71	0	1	0	1	0	1	0	1	0	1
159		20	max	8441.457	99	0	1	0	1	0	1	0	1	0	1
160			min	-1056.398	71	0	1	0	1	0	1	0	1	0	1
161	M5	1	max	1.618	38	4586.976	38	0	1	0	1	0	1	0	1
162			min	-1.384	39	122.594	86	0	1	0	1	0	1	0	1
163		2	max	7.411	86	4603.005	38	0	1	0	1	0	1	-.028	86
164			min	-6.669	85	135.728	74	0	1	0	1	0	1	-.867	38
165		3	max	14.864	86	4619.033	38	0	1	0	1	0	1	-.057	74
166			min	-14.121	85	136.26	74	0	1	0	1	0	1	-1.938	38
167		4	max	22.316	86	4635.061	38	0	1	0	1	0	1	-.086	74
168			min	-21.574	85	136.772	74	0	1	0	1	0	1	-2.912	38
169		5	max	29.769	86	4651.089	38	0	1	0	1	0	1	-.115	74
170			min	-29.026	85	137.294	74	0	1	0	1	0	1	-3.89	38
171		6	max	37.222	86	4667.114	38	0	1	0	1	0	1	-.144	74
172			min	-36.479	85	137.813	74	0	1	0	1	0	1	-4.871	38
173		7	max	44.674	86	4683.143	38	0	1	0	1	0	1	-.173	74
174			min	-43.932	85	138.335	74	0	1	0	1	0	1	-5.855	38
175		8	max	52.127	86	4699.171	38	0	1	0	1	0	1	-.202	74
176			min	-51.384	85	138.857	74	0	1	0	1	0	1	-6.842	38
177		9	max	59.579	86	4715.199	38	0	1	0	1	0	1	-.231	74
178			min	-58.837	85	139.378	74	0	1	0	1	0	1	-7.833	38
179		10	max	67.032	86	4731.227	38	0	1	0	1	0	1	-.261	74
180			min	-66.29	85	139.902	74	0	1	0	1	0	1	-8.825	38
181		11	max	74.485	86	4785.624	124	0	1	0	1	0	1	-.29	74
182			min	-73.742	85	140.42	74	0	1	0	1	0	1	-9.826	38
183		12	max	81.937	86	4808.494	124	0	1	0	1	0	1	-.32	74
184			min	-81.195	85	140.942	74	0	1	0	1	0	1	-10.827	38
185		13	max	89.39	86	4851.364	124	0	1	0	1	0	1	-.349	74
186			min	-88.648	85	141.465	74	0	1	0	1	0	1	-11.831	38
187		14	max	96.843	86	4894.235	124	0	1	0	1	0	1	-.379	74
188			min	-96.1	85	141.987	74	0	1	0	1	0	1	-12.839	38
189		15	max	104.295	86	4937.105	124	0	1	0	1	0	1	-.409	74
190			min	-103.553	85	142.509	74	0	1	0	1	0	1	-13.85	38
191		16	max	111.748	86	4980.009	124	0	1	0	1	0	1	-.439	74
192			min	-111.005	85	143.027	74	0	1	0	1	0	1	-14.865	38
193		17	max	119.201	86	5022.879	124	0	1	0	1	0	1	-.469	74
194			min	-118.458	85	143.549	74	0	1	0	1	0	1	-15.883	38
195		18	max	126.653	86	5065.749	124	0	1	0	1	0	1	-.5	74

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
196			min	-125,911	85	144.071	74	0	1	0	1	0	1	-16.804	38
197		19	max	134.106	86	5108.619	124	0	1	0	1	0	1	-.53	74
198			min	-133.363	86	144.593	74	0	1	0	1	0	1	-17.929	38
199		20	max	141.558	86	5151.49	124	0	1	0	1	0	1	-.561	74
200			min	-140.816	85	145.116	74	0	1	0	1	0	1	-18.977	124
201	M6	1	max	141.558	85	-145.116	73	0	1	0	1	0	1	-.561	73
202			min	-140.816	86	-5151.49	125	0	1	0	1	0	1	-18.977	126
203		2	max	134.106	85	-144.593	73	0	1	0	1	0	1	-.53	73
204			min	-133.363	86	-5108.619	125	0	1	0	1	0	1	-17.929	39
205		3	max	126.653	85	-144.071	73	0	1	0	1	0	1	-.5	73
206			min	-125.911	86	-5065.749	125	0	1	0	1	0	1	-16.904	39
207		4	max	119.201	85	-143.549	73	0	1	0	1	0	1	-.469	73
208			min	-118.458	86	-5022.879	125	0	1	0	1	0	1	-15.883	39
209		5	max	111.748	85	-143.027	73	0	1	0	1	0	1	-.439	73
210			min	-111.005	86	-4980.009	125	0	1	0	1	0	1	-14.865	39
211		6	max	104.295	85	-142.509	73	0	1	0	1	0	1	-.409	73
212			min	-103.553	86	-4937.105	125	0	1	0	1	0	1	-13.85	39
213		7	max	96.843	85	-141.987	73	0	1	0	1	0	1	-.378	73
214			min	-96.1	86	-4894.235	125	0	1	0	1	0	1	-12.836	39
215		8	max	89.39	85	-141.465	73	0	1	0	1	0	1	-.348	73
216			min	-88.648	86	-4851.364	125	0	1	0	1	0	1	-11.831	39
217		9	max	81.937	85	-140.942	73	0	1	0	1	0	1	-.32	73
218			min	-81.195	86	-4808.494	125	0	1	0	1	0	1	-10.827	39
219		10	max	74.485	85	-140.42	73	0	1	0	1	0	1	-.29	73
220			min	-73.742	86	-4765.624	125	0	1	0	1	0	1	-9.826	39
221		11	max	67.032	85	-139.902	73	0	1	0	1	0	1	-.261	73
222			min	-66.29	86	-4731.227	39	0	1	0	1	0	1	-8.828	39
223		12	max	59.579	85	-139.379	73	0	1	0	1	0	1	-.231	73
224			min	-58.837	86	-4715.199	39	0	1	0	1	0	1	-7.833	39
225		13	max	52.127	85	-138.857	73	0	1	0	1	0	1	-.202	73
226			min	-51.384	86	-4699.171	39	0	1	0	1	0	1	-6.842	39
227		14	max	44.674	85	-138.335	73	0	1	0	1	0	1	-.173	73
228			min	-43.932	86	-4683.143	39	0	1	0	1	0	1	-5.855	39
229		15	max	37.222	85	-137.813	73	0	1	0	1	0	1	-.144	73
230			min	-36.479	86	-4667.114	39	0	1	0	1	0	1	-4.871	39
231		16	max	29.769	85	-137.294	73	0	1	0	1	0	1	-.115	73
232			min	-29.026	86	-4651.089	39	0	1	0	1	0	1	-3.89	39
233		17	max	22.316	85	-136.772	73	0	1	0	1	0	1	-.086	73
234			min	-21.574	86	-4635.061	39	0	1	0	1	0	1	-2.912	39
235		18	max	14.864	85	-136.25	73	0	1	0	1	0	1	-.057	73
236			min	-14.121	86	-4619.033	39	0	1	0	1	0	1	-1.938	39
237		19	max	7.411	85	-135.728	73	0	1	0	1	0	1	-.028	85
238			min	-6.669	86	-4603.005	39	0	1	0	1	0	1	-.967	39
239		20	max	1.618	39	-122.594	85	0	1	0	1	0	1	0	1
240			min	-1.384	38	-4586.976	39	0	1	0	1	0	1	0	1
241	M7	1	max	1005.783	72	759.518	38	0	1	0	1	0	1	0	1
242			min	-2394.593	12	-451.408	70	0	1	0	1	0	1	0	1
243		2	max	1005.783	72	793.598	38	0	1	0	1	0	1	.086	70
244			min	-2394.593	12	-364.959	70	0	1	0	1	0	1	-.163	38
245		3	max	1005.783	72	827.678	38	0	1	0	1	0	1	.154	70
246			min	-2394.593	12	-278.511	70	0	1	0	1	0	1	-.334	38
247		4	max	1005.783	72	861.758	38	0	1	0	1	0	1	.203	70
248			min	-2394.593	12	-192.062	70	0	1	0	1	0	1	-.512	38
249		5	max	1005.783	72	895.838	38	0	1	0	1	0	1	.235	70
250			min	-2394.593	12	-105.614	70	0	1	0	1	0	1	-.697	38
251		6	max	1005.783	72	930.282	38	0	1	0	1	0	1	.248	70
252			min	-2394.593	12	-35.569	74	0	1	0	1	0	1	-.889	38

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
253		7	max	1005.783	72	964.362	38	0	1	0	1	0	1	.243	70
254			min	-2394.593	12	-5.016	74	0	1	0	1	0	1	-1.089	38
255		8	max	1005.783	72	998.442	38	0	1	0	1	0	1	.219	70
256			min	-2394.593	12	25.537	74	0	1	0	1	0	1	-1.295	38
257		9	max	1005.783	72	1032.522	38	0	1	0	1	0	1	.178	70
258			min	-2394.593	12	56.09	74	0	1	0	1	0	1	-1.509	38
259		10	max	1005.783	72	1109.806	124	0	1	0	1	0	1	.118	70
260			min	-2394.593	12	86.644	74	0	1	0	1	0	1	-1.73	38
261		11	max	1005.783	72	1196.783	124	0	1	0	1	0	1	.075	74
262			min	-2394.593	12	117.202	74	0	1	0	1	0	1	-1.958	38
263		12	max	1005.783	72	1283.231	124	0	1	0	1	0	1	.047	74
264			min	-2394.593	12	147.755	74	0	1	0	1	0	1	-2.194	38
265		13	max	1005.783	72	1369.68	124	0	1	0	1	0	1	.013	74
266			min	-2394.593	12	178.309	74	0	1	0	1	0	1	-2.436	38
267		14	max	1005.783	72	1456.128	124	0	1	0	1	0	1	-.028	74
268			min	-2394.593	12	208.862	74	0	1	0	1	0	1	-2.666	38
269		15	max	1005.783	72	1542.577	124	0	1	0	1	0	1	-.075	74
270			min	-2394.593	12	239.415	74	0	1	0	1	0	1	-2.943	38
271		16	max	1005.783	72	1630.089	124	0	1	0	1	0	1	-.129	74
272			min	-2394.593	12	269.968	74	0	1	0	1	0	1	-3.208	38
273		17	max	1005.783	72	1716.537	124	0	1	0	1	0	1	-.189	74
274			min	-2394.593	12	300.516	74	0	1	0	1	0	1	-3.479	38
275		18	max	1005.783	72	1802.985	124	0	1	0	1	0	1	-.255	74
276			min	-2394.593	12	331.069	74	0	1	0	1	0	1	-3.819	124
277		19	max	1005.783	72	1890.217	88	0	1	0	1	0	1	-.328	74
278			min	-2394.593	12	361.622	74	0	1	0	1	0	1	-4.207	124
279		20	max	1005.783	72	1988.507	88	0	1	0	1	0	1	-.408	74
280			min	-2394.593	12	392.176	74	0	1	0	1	0	1	-4.614	124
281	M8	1	max	1005.783	72	-392.176	73	0	1	0	1	0	1	.408	73
282			min	-2394.593	12	-1988.507	88	0	1	0	1	0	1	-4.614	125
283		2	max	1005.783	72	-361.622	73	0	1	0	1	0	1	.328	73
284			min	-2394.593	12	-1890.217	88	0	1	0	1	0	1	-4.207	125
285		3	max	1005.783	72	-331.069	73	0	1	0	1	0	1	.255	73
286			min	-2394.593	12	-1802.985	125	0	1	0	1	0	1	-3.819	126
287		4	max	1005.783	72	-300.516	73	0	1	0	1	0	1	.189	73
288			min	-2394.593	12	-1716.537	125	0	1	0	1	0	1	-3.479	39
289		5	max	1005.783	72	-269.963	73	0	1	0	1	0	1	.129	73
290			min	-2394.593	12	-1630.088	125	0	1	0	1	0	1	-3.208	39
291		6	max	1005.783	72	-239.415	73	0	1	0	1	0	1	.075	73
292			min	-2394.593	12	-1542.577	125	0	1	0	1	0	1	-2.943	39
293		7	max	1005.783	72	-208.862	73	0	1	0	1	0	1	.028	73
294			min	-2394.593	12	-1456.128	125	0	1	0	1	0	1	-2.686	39
295		8	max	1005.783	72	-178.309	73	0	1	0	1	0	1	.013	73
296			min	-2394.593	12	-1369.68	125	0	1	0	1	0	1	-2.436	39
297		9	max	1005.783	72	-147.755	73	0	1	0	1	0	1	.047	73
298			min	-2394.593	12	-1283.231	125	0	1	0	1	0	1	-2.194	39
299		10	max	1005.783	72	-117.202	73	0	1	0	1	0	1	.075	73
300			min	-2394.593	12	-1196.783	125	0	1	0	1	0	1	-1.958	39
301		11	max	1005.783	72	-86.644	73	0	1	0	1	0	1	.118	69
302			min	-2394.593	12	-1109.806	125	0	1	0	1	0	1	-1.73	39
303		12	max	1005.783	72	-56.09	73	0	1	0	1	0	1	.178	69
304			min	-2394.593	12	-1032.522	39	0	1	0	1	0	1	-1.509	39
305		13	max	1005.783	72	-25.537	73	0	1	0	1	0	1	.219	69
306			min	-2394.593	12	-966.442	39	0	1	0	1	0	1	-1.295	39
307		14	max	1005.783	72	5.016	73	0	1	0	1	0	1	.243	69
308			min	-2394.593	12	-964.362	39	0	1	0	1	0	1	-1.089	39
309		15	max	1005.783	72	35.569	73	0	1	0	1	0	1	.248	69

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
310			min	-2394.593	12	-930.282	39	0	1	0	1	0	1	-.889	39
311		16	max	1005.783	72	105.614	69	0	1	0	1	0	1	.235	69
312			min	-2394.593	12	-895.838	39	0	1	0	1	0	1	-.697	39
313		17	max	1005.783	72	192.062	69	0	1	0	1	0	1	.203	69
314			min	-2394.593	12	-861.758	39	0	1	0	1	0	1	-.512	39
315		18	max	1005.783	72	278.511	69	0	1	0	1	0	1	.154	69
316			min	-2394.593	12	-827.678	39	0	1	0	1	0	1	-.334	39
317		19	max	1005.783	72	364.959	69	0	1	0	1	0	1	.086	69
318			min	-2394.593	12	-793.598	39	0	1	0	1	0	1	-.163	39
319		20	max	1005.783	72	451.408	69	0	1	0	1	0	1	0	1
320			min	-2394.593	12	-759.518	39	0	1	0	1	0	1	0	1
321	M9	1	max	1650.048	72	0	1	0	1	0	1	0	1	0	1
322			min	-5567.371	12	0	1	0	1	0	1	0	1	0	1
323		2	max	1733.356	72	0	1	0	1	0	1	0	1	0	1
324			min	-5482.962	12	0	1	0	1	0	1	0	1	0	1
325		3	max	1596.667	72	0	1	0	1	0	1	0	1	0	1
326			min	-5398.553	12	0	1	0	1	0	1	0	1	0	1
327		4	max	1469.977	72	0	1	0	1	0	1	0	1	0	1
328			min	-5314.144	12	0	1	0	1	0	1	0	1	0	1
329		5	max	1343.288	72	0	1	0	1	0	1	0	1	0	1
330			min	-5229.734	12	0	1	0	1	0	1	0	1	0	1
331		6	max	1216.598	72	0	1	0	1	0	1	0	1	0	1
332			min	-5145.325	12	0	1	0	1	0	1	0	1	0	1
333		7	max	1089.909	72	0	1	0	1	0	1	0	1	0	1
334			min	-5060.916	12	0	1	0	1	0	1	0	1	0	1
335		8	max	963.219	72	0	1	0	1	0	1	0	1	0	1
336			min	-4976.507	12	0	1	0	1	0	1	0	1	0	1
337		9	max	836.529	72	0	1	0	1	0	1	0	1	0	1
338			min	-4892.098	12	0	1	0	1	0	1	0	1	0	1
339		10	max	709.84	72	0	1	0	1	0	1	0	1	0	1
340			min	-4807.689	12	0	1	0	1	0	1	0	1	0	1
341		11	max	583.15	72	0	1	0	1	0	1	0	1	0	1
342			min	-4723.28	12	0	1	0	1	0	1	0	1	0	1
343		12	max	456.461	72	0	1	0	1	0	1	0	1	0	1
344			min	-4638.871	12	0	1	0	1	0	1	0	1	0	1
345		13	max	329.771	72	0	1	0	1	0	1	0	1	0	1
346			min	-4554.462	12	0	1	0	1	0	1	0	1	0	1
347		14	max	203.081	72	0	1	0	1	0	1	0	1	0	1
348			min	-4543.084	38	0	1	0	1	0	1	0	1	0	1
349		15	max	76.392	72	0	1	0	1	0	1	0	1	0	1
350			min	-4550.4	38	0	1	0	1	0	1	0	1	0	1
351		16	max	-50.298	72	0	1	0	1	0	1	0	1	0	1
352			min	-4557.716	38	0	1	0	1	0	1	0	1	0	1
353		17	max	-109.434	86	0	1	0	1	0	1	0	1	0	1
354			min	-4565.032	38	0	1	0	1	0	1	0	1	0	1
355		18	max	-113.623	86	0	1	0	1	0	1	0	1	0	1
356			min	-4572.348	38	0	1	0	1	0	1	0	1	0	1
357		19	max	-118.213	85	0	1	0	1	0	1	0	1	0	1
358			min	-4579.664	38	0	1	0	1	0	1	0	1	0	1
359		20	max	-122.602	86	0	1	0	1	0	1	0	1	0	1
360			min	-4586.979	38	0	1	0	1	0	1	0	1	0	1
361	M10	1	max	1650.048	72	0	1	0	1	0	1	0	1	0	1
362			min	-5567.371	12	0	1	0	1	0	1	0	1	0	1
363		2	max	1733.356	72	0	1	0	1	0	1	0	1	0	1
364			min	-5482.962	12	0	1	0	1	0	1	0	1	0	1
365		3	max	1596.667	72	0	1	0	1	0	1	0	1	0	1
366			min	-5398.553	12	0	1	0	1	0	1	0	1	0	1

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
367		4	max	1469.977	72	0	1	0	1	0	1	0	1	0	1
368			min	-5314.144	12	0	1	0	1	0	1	0	1	0	1
369		5	max	1343.288	72	0	1	0	1	0	1	0	1	0	1
370			min	-5229.734	12	0	1	0	1	0	1	0	1	0	1
371		6	max	1216.598	72	0	1	0	1	0	1	0	1	0	1
372			min	-5145.325	12	0	1	0	1	0	1	0	1	0	1
373		7	max	1089.909	72	0	1	0	1	0	1	0	1	0	1
374			min	-5060.916	12	0	1	0	1	0	1	0	1	0	1
375		8	max	963.219	72	0	1	0	1	0	1	0	1	0	1
376			min	-4976.507	12	0	1	0	1	0	1	0	1	0	1
377		9	max	836.529	72	0	1	0	1	0	1	0	1	0	1
378			min	-4892.098	12	0	1	0	1	0	1	0	1	0	1
379		10	max	709.84	72	0	1	0	1	0	1	0	1	0	1
380			min	-4807.689	12	0	1	0	1	0	1	0	1	0	1
381		11	max	583.15	72	0	1	0	1	0	1	0	1	0	1
382			min	-4723.28	12	0	1	0	1	0	1	0	1	0	1
383		12	max	456.461	72	0	1	0	1	0	1	0	1	0	1
384			min	-4638.871	12	0	1	0	1	0	1	0	1	0	1
385		13	max	329.771	72	0	1	0	1	0	1	0	1	0	1
386			min	-4554.462	12	0	1	0	1	0	1	0	1	0	1
387		14	max	203.081	72	0	1	0	1	0	1	0	1	0	1
388			min	-4543.084	38	0	1	0	1	0	1	0	1	0	1
389		15	max	76.392	72	0	1	0	1	0	1	0	1	0	1
390			min	-4550.4	38	0	1	0	1	0	1	0	1	0	1
391		16	max	-50.298	72	0	1	0	1	0	1	0	1	0	1
392			min	-4557.716	38	0	1	0	1	0	1	0	1	0	1
393		17	max	-109.434	86	0	1	0	1	0	1	0	1	0	1
394			min	-4565.032	38	0	1	0	1	0	1	0	1	0	1
395		18	max	-113.623	86	0	1	0	1	0	1	0	1	0	1
396			min	-4572.348	38	0	1	0	1	0	1	0	1	0	1
397		19	max	-118.213	85	0	1	0	1	0	1	0	1	0	1
398			min	-4579.664	38	0	1	0	1	0	1	0	1	0	1
399		20	max	-122.602	86	0	1	0	1	0	1	0	1	0	1
400			min	-4586.979	38	0	1	0	1	0	1	0	1	0	1
401	M11	1	max	6100.636	12	29.264	77	0	1	0	1	0	1	0	1
402			min	-2933.707	72	17.558	86	0	1	0	1	0	1	-.01	77
403		2	max	6107.852	12	26.183	77	0	1	0	1	0	1	-.009	86
404			min	-2629.318	72	15.71	86	0	1	0	1	0	1	-.015	77
405		3	max	6115.168	12	23.103	77	0	1	0	1	0	1	-.017	86
406			min	-2824.928	72	13.862	86	0	1	0	1	0	1	-.028	77
407		4	max	6122.484	12	20.023	77	0	1	0	1	0	1	-.024	86
408			min	-2620.538	72	12.014	86	0	1	0	1	0	1	-.04	77
409		5	max	6129.8	12	16.942	77	0	1	0	1	0	1	-.03	86
410			min	-2616.149	72	10.165	86	0	1	0	1	0	1	-.05	77
411		6	max	6137.116	12	13.862	77	0	1	0	1	0	1	-.035	86
412			min	-2911.759	72	8.317	86	0	1	0	1	0	1	-.058	77
413		7	max	6144.432	12	10.781	77	0	1	0	1	0	1	-.039	86
414			min	-2607.37	72	6.469	86	0	1	0	1	0	1	-.065	77
415		8	max	6151.748	12	7.701	77	0	1	0	1	0	1	-.042	86
416			min	-2602.98	72	4.621	86	0	1	0	1	0	1	-.07	77
417		9	max	6159.064	12	4.621	77	0	1	0	1	0	1	-.044	86
418			min	-2598.59	72	2.772	86	0	1	0	1	0	1	-.074	77
419		10	max	6166.38	12	1.54	77	0	1	0	1	0	1	-.045	86
420			min	-2594.201	72	.924	86	0	1	0	1	0	1	-.075	77
421		11	max	6173.696	12	-.924	102	0	1	0	1	0	1	-.045	86
422			min	-2589.811	72	-1.54	78	0	1	0	1	0	1	-.075	77
423		12	max	6181.012	12	-2.772	102	0	1	0	1	0	1	-.044	86

Envelope Member Section Forces (Continued)

Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
424		min	-2585.422	72	-4.621	78	0	1	0	1	0	1	-.074	77
425	13	max	6184.325	12	-4.621	102	0	1	0	1	0	1	-.042	86
426		min	-2581.032	72	-7.701	78	0	1	0	1	0	1	-.07	77
427	14	max	6195.844	12	-6.469	102	0	1	0	1	0	1	-.039	86
428		min	-2576.643	72	-10.781	78	0	1	0	1	0	1	-.065	77
429	15	max	6202.96	12	-8.317	102	0	1	0	1	0	1	-.035	86
430		min	-2572.253	72	-13.862	78	0	1	0	1	0	1	-.058	77
431	16	max	6210.276	12	-10.165	102	0	1	0	1	0	1	-.03	86
432		min	-2567.863	72	-16.942	78	0	1	0	1	0	1	-.05	77
433	17	max	6217.592	12	-12.014	102	0	1	0	1	0	1	-.024	86
434		min	-2563.474	72	-20.023	78	0	1	0	1	0	1	-.04	77
435	18	max	6224.908	12	-13.862	102	0	1	0	1	0	1	-.017	86
436		min	-2559.084	72	-23.103	78	0	1	0	1	0	1	-.028	77
437	19	max	6232.223	12	-15.71	102	0	1	0	1	0	1	-.009	86
438		min	-2554.695	72	-26.183	78	0	1	0	1	0	1	-.015	77
439	20	max	6239.539	12	-17.558	102	0	1	0	1	0	1	0	1
440		min	-2550.305	72	-29.264	78	0	1	0	1	0	1	0	1
441	M12 1	max	6100.636	12	-17.558	43	0	1	0	1	0	1	0	1
442		min	-2633.707	72	-29.264	35	0	1	0	1	0	1	0	1
443	2	max	6107.852	12	-15.71	43	0	1	0	1	0	1	.015	35
444		min	-2629.918	72	-26.183	35	0	1	0	1	0	1	.009	43
445	3	max	6115.168	12	-13.862	43	0	1	0	1	0	1	.029	35
446		min	-2624.928	72	-23.103	35	0	1	0	1	0	1	.017	43
447	4	max	6122.484	12	-12.014	43	0	1	0	1	0	1	.04	35
448		min	-2620.538	72	-20.023	35	0	1	0	1	0	1	.024	43
449	5	max	6129.8	12	-10.165	43	0	1	0	1	0	1	.05	35
450		min	-2616.149	72	-16.942	35	0	1	0	1	0	1	.03	43
451	6	max	6137.116	12	-8.317	43	0	1	0	1	0	1	.058	35
452		min	-2611.759	72	-13.862	35	0	1	0	1	0	1	.035	43
453	7	max	6144.432	12	-6.469	43	0	1	0	1	0	1	.065	35
454		min	-2607.37	72	-10.781	35	0	1	0	1	0	1	.039	43
455	8	max	6151.748	12	-4.621	43	0	1	0	1	0	1	.07	35
456		min	-2602.98	72	-7.701	35	0	1	0	1	0	1	.042	43
457	9	max	6159.064	12	-2.772	43	0	1	0	1	0	1	.074	35
458		min	-2598.59	72	-4.621	35	0	1	0	1	0	1	.044	43
459	10	max	6166.38	12	-.924	43	0	1	0	1	0	1	.075	35
460		min	-2594.201	72	-1.54	35	0	1	0	1	0	1	.045	43
461	11	max	6173.696	12	1.54	38	0	1	0	1	0	1	.075	35
462		min	-2589.811	72	.924	105	0	1	0	1	0	1	.045	43
463	12	max	6181.012	12	4.621	38	0	1	0	1	0	1	.074	35
464		min	-2585.422	72	2.772	105	0	1	0	1	0	1	.044	43
465	13	max	6188.328	12	7.701	38	0	1	0	1	0	1	.07	35
466		min	-2581.032	72	4.621	105	0	1	0	1	0	1	.042	43
467	14	max	6195.644	12	10.781	38	0	1	0	1	0	1	.065	35
468		min	-2576.643	72	6.469	105	0	1	0	1	0	1	.039	43
469	15	max	6202.96	12	13.862	38	0	1	0	1	0	1	.058	35
470		min	-2572.253	72	8.317	105	0	1	0	1	0	1	.035	43
471	16	max	6210.276	12	16.942	38	0	1	0	1	0	1	.05	35
472		min	-2567.863	72	10.165	105	0	1	0	1	0	1	.03	43
473	17	max	6217.592	12	20.023	38	0	1	0	1	0	1	.04	35
474		min	-2563.474	72	12.014	105	0	1	0	1	0	1	.024	43
475	18	max	6224.908	12	23.103	38	0	1	0	1	0	1	.029	35
476		min	-2559.084	72	13.862	105	0	1	0	1	0	1	.017	43
477	19	max	6232.223	12	26.183	38	0	1	0	1	0	1	.015	35
478		min	-2554.695	72	15.71	105	0	1	0	1	0	1	.009	43
479	20	max	6239.539	12	29.264	38	0	1	0	1	0	1	0	1
480		min	-2550.305	72	17.558	105	0	1	0	1	0	1	0	1

Envelope Member Section Forces (Continued)

Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
481	M13 1	max	-579.978	86	795.796	39	0	1	0	1	0	1	3.866	125
482		min	-3307.912	2	-26.773	85	0	1	0	1	0	1	-.046	85
483	2	max	-584.848	86	795.796	39	0	1	0	1	0	1	3.47	125
484		min	-3316.028	2	-26.773	85	0	1	0	1	0	1	-.033	85
485	3	max	-589.717	86	795.796	39	0	1	0	1	0	1	3.074	125
486		min	-3324.143	2	-26.773	85	0	1	0	1	0	1	-.019	85
487	4	max	-594.586	86	795.796	39	0	1	0	1	0	1	2.678	125
488		min	-3332.259	2	-26.773	85	0	1	0	1	0	1	-.006	85
489	5	max	-599.456	86	795.796	39	0	1	0	1	0	1	2.282	125
490		min	-3340.375	2	-26.773	85	0	1	0	1	0	1	.007	85
491	6	max	-604.325	86	795.796	39	0	1	0	1	0	1	1.886	125
492		min	-3348.49	2	-26.773	85	0	1	0	1	0	1	.021	85
493	7	max	-609.195	86	795.796	39	0	1	0	1	0	1	1.489	125
494		min	-3356.606	2	-26.773	85	0	1	0	1	0	1	.034	85
495	8	max	-614.064	86	795.796	39	0	1	0	1	0	1	1.093	125
496		min	-3364.721	2	-26.773	85	0	1	0	1	0	1	.047	85
497	9	max	-618.933	86	795.796	39	0	1	0	1	0	1	.697	125
498		min	-3372.837	2	-26.773	85	0	1	0	1	0	1	.061	85
499	10	max	-623.803	86	795.796	39	0	1	0	1	0	1	.337	88
500		min	-3380.953	2	-26.773	85	0	1	0	1	0	1	.057	71
501	11	max	-628.672	86	795.796	39	0	1	0	1	0	1	.088	77
502		min	-3389.068	2	-26.773	85	0	1	0	1	0	1	-.119	35
503	12	max	-633.541	86	795.796	39	0	1	0	1	0	1	.101	85
504		min	-3397.184	2	-26.773	85	0	1	0	1	0	1	-.514	39
505	13	max	-638.411	86	795.796	39	0	1	0	1	0	1	.114	85
506		min	-3405.3	2	-26.773	85	0	1	0	1	0	1	-.912	39
507	14	max	-643.28	86	795.796	39	0	1	0	1	0	1	.128	85
508		min	-3413.415	2	-26.773	85	0	1	0	1	0	1	-1.31	39
509	15	max	-648.15	86	795.796	39	0	1	0	1	0	1	.141	85
510		min	-3421.531	2	-26.773	85	0	1	0	1	0	1	-1.708	39
511	16	max	-653.019	86	795.796	39	0	1	0	1	0	1	.155	85
512		min	-3429.646	2	-26.773	85	0	1	0	1	0	1	-2.106	39
513	17	max	-657.888	86	795.796	39	0	1	0	1	0	1	.168	85
514		min	-3437.762	2	-26.773	85	0	1	0	1	0	1	-2.504	39
515	18	max	-662.758	86	795.796	39	0	1	0	1	0	1	.181	85
516		min	-3445.878	2	-26.773	85	0	1	0	1	0	1	-2.901	39
517	19	max	-667.627	86	795.796	39	0	1	0	1	0	1	.195	85
518		min	-3453.993	2	-26.773	85	0	1	0	1	0	1	-3.299	39
519	20	max	-672.496	86	795.796	39	0	1	0	1	0	1	.208	85
520		min	-3462.109	2	-26.773	85	0	1	0	1	0	1	-3.697	39
521	M14 1	max	-579.978	85	26.773	86	0	1	0	1	0	1	.046	86
522		min	-3307.912	2	-795.796	38	0	1	0	1	0	1	-3.866	124
523	2	max	-584.848	85	26.773	86	0	1	0	1	0	1	.033	86
524		min	-3316.028	2	-795.796	38	0	1	0	1	0	1	-3.47	124
525	3	max	-589.717	85	26.773	86	0	1	0	1	0	1	.019	86
526		min	-3324.143	2	-795.796	38	0	1	0	1	0	1	-3.074	124
527	4	max	-594.586	85	26.773	86	0	1	0	1	0	1	.006	86
528		min	-3332.259	2	-795.796	38	0	1	0	1	0	1	-2.678	124
529	5	max	-599.456	85	26.773	86	0	1	0	1	0	1	-.007	86
530		min	-3340.375	2	-795.796	38	0	1	0	1	0	1	-2.282	124
531	6	max	-604.325	85	26.773	86	0	1	0	1	0	1	-.021	86
532		min	-3348.49	2	-795.796	38	0	1	0	1	0	1	-1.886	124
533	7	max	-609.195	85	26.773	86	0	1	0	1	0	1	-.034	86
534		min	-3356.606	2	-795.796	38	0	1	0	1	0	1	-1.489	124
535	8	max	-614.064	85	26.773	86	0	1	0	1	0	1	-.047	86
536		min	-3364.721	2	-795.796	38	0	1	0	1	0	1	-1.093	124
537	9	max	-618.933	85	26.773	86	0	1	0	1	0	1	-.061	86

Envelope Member Section Forces (Continued)

Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
538		min	-3372.837	2	-795.796	38	0	1	0	1	0	1	-.697	124
539	10	max	-623.803	85	26.773	86	0	1	0	1	0	1	-.057	71
540		min	-3380.953	2	-795.796	38	0	1	0	1	0	1	-.337	88
541	11	max	-628.672	85	26.773	86	0	1	0	1	0	1	.119	34
542		min	-3389.068	2	-795.796	38	0	1	0	1	0	1	-.088	78
543	12	max	-633.541	85	26.773	86	0	1	0	1	0	1	.514	38
544		min	-3397.184	2	-795.796	38	0	1	0	1	0	1	-.101	86
545	13	max	-638.411	85	26.773	86	0	1	0	1	0	1	.912	38
546		min	-3405.3	2	-795.796	38	0	1	0	1	0	1	-.114	86
547	14	max	-643.28	85	26.773	86	0	1	0	1	0	1	1.31	38
548		min	-3413.415	2	-795.796	38	0	1	0	1	0	1	-.128	86
549	15	max	-648.15	85	26.773	86	0	1	0	1	0	1	1.708	38
550		min	-3421.531	2	-795.796	38	0	1	0	1	0	1	-.141	86
551	16	max	-653.019	85	26.773	86	0	1	0	1	0	1	2.106	38
552		min	-3429.646	2	-795.796	38	0	1	0	1	0	1	-.155	86
553	17	max	-657.888	85	26.773	86	0	1	0	1	0	1	2.504	38
554		min	-3437.762	2	-795.796	38	0	1	0	1	0	1	-.168	86
555	18	max	-662.758	85	26.773	86	0	1	0	1	0	1	2.901	38
556		min	-3445.878	2	-795.796	38	0	1	0	1	0	1	-.181	86
557	19	max	-667.627	85	26.773	86	0	1	0	1	0	1	3.299	38
558		min	-3453.993	2	-795.796	38	0	1	0	1	0	1	-.195	86
559	20	max	-672.496	85	26.773	86	0	1	0	1	0	1	3.697	38
560		min	-3462.109	2	-795.796	38	0	1	0	1	0	1	-.209	86
561	M15 1	max	2394.687	12	4262.901	39	0	1	0	1	0	1	11.846	38
562		min	-1005.813	72	532.154	73	0	1	0	1	0	1	1.027	72
563	2	max	2394.687	12	4327.207	39	0	1	0	1	0	1	10.64	38
564		min	-1005.813	72	521.568	73	0	1	0	1	0	1	.824	72
565	3	max	2394.687	12	4391.512	39	0	1	0	1	0	1	9.414	38
566		min	-1005.813	72	510.983	73	0	1	0	1	0	1	.602	74
567	4	max	2394.687	12	4455.817	39	0	1	0	1	0	1	8.188	38
568		min	-1005.813	72	500.398	73	0	1	0	1	0	1	.233	86
569	5	max	2394.687	12	4520.456	39	0	1	0	1	0	1	6.901	38
570		min	-1005.813	72	489.806	73	0	1	0	1	0	1	-.186	86
571	6	max	2394.687	12	4584.761	39	0	1	0	1	0	1	5.614	38
572		min	-1005.813	72	479.22	73	0	1	0	1	0	1	-.61	86
573	7	max	2394.687	12	4649.066	39	0	1	0	1	0	1	4.306	38
574		min	-1005.813	72	468.635	73	0	1	0	1	0	1	-1.039	86
575	8	max	2394.687	12	4713.499	39	0	1	0	1	0	1	2.979	38
576		min	-1005.813	72	458.043	73	0	1	0	1	0	1	-1.472	86
577	9	max	2394.687	12	4777.804	39	0	1	0	1	0	1	1.913	34
578		min	-1005.813	72	447.458	73	0	1	0	1	0	1	-1.958	78
579	10	max	2394.687	12	4842.11	39	0	1	0	1	0	1	1.527	85
580		min	-1005.813	72	436.873	73	0	1	0	1	0	1	-2.859	121
581	11	max	2394.687	12	4906.417	39	0	1	0	1	0	1	1.281	85
582		min	-1005.813	72	426.282	73	0	1	0	1	0	1	-4.353	126
583	12	max	2394.687	12	4970.622	39	0	1	0	1	0	1	1.03	85
584		min	-1005.813	72	415.696	73	0	1	0	1	0	1	-5.897	126
585	13	max	2394.687	12	5034.928	39	0	1	0	1	0	1	.774	85
586		min	-1005.813	72	405.111	73	0	1	0	1	0	1	-7.461	126
587	14	max	2394.687	12	5098.89	39	0	1	0	1	0	1	.514	85
588		min	-1005.813	72	394.521	73	0	1	0	1	0	1	-9.045	126
589	15	max	2394.687	12	5163.196	39	0	1	0	1	0	1	.249	85
590		min	-1005.813	72	383.936	73	0	1	0	1	0	1	-10.65	126
591	16	max	2394.687	12	5227.501	39	0	1	0	1	0	1	-.021	85
592		min	-1005.813	72	373.351	73	0	1	0	1	0	1	-12.275	126
593	17	max	2394.687	12	5291.198	39	0	1	0	1	0	1	.232	73
594		min	-1005.813	72	362.763	73	0	1	0	1	0	1	-13.92	126

Envelope Member Section Forces (Continued)

Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
595	18	max	2394.687	12	5355.503	39	0	1	0	1	0	1	-.345	73
596		min	-1005.813	72	352.178	73	0	1	0	1	0	1	-15.585	126
597	19	max	2394.687	12	5419.808	39	0	1	0	1	0	1	-.454	73
598		min	-1005.813	72	341.592	73	0	1	0	1	0	1	-17.271	126
599	20	max	2394.687	12	5484.114	39	0	1	0	1	0	1	-.561	73
600		min	-1005.813	72	331.007	73	0	1	0	1	0	1	-18.977	126
601	M16 1	max	560.967	39	53.663	86	0	1	0	1	0	1	.941	89
602		min	-252.072	85	-739.476	2	0	1	0	1	0	1	-.404	73
603	2	max	567.149	39	84.335	86	0	1	0	1	0	1	.947	3
604		min	-260.314	85	-592.04	2	0	1	0	1	0	1	-.317	73
605	3	max	573.33	39	115.007	86	0	1	0	1	0	1	.931	3
606		min	-268.556	85	-444.604	2	0	1	0	1	0	1	-.24	73
607	4	max	579.512	39	186.584	89	0	1	0	1	0	1	.921	39
608		min	-276.798	85	-297.168	2	0	1	0	1	0	1	-.172	73
609	5	max	585.693	39	263.025	89	0	1	0	1	0	1	.9	39
610		min	-285.04	85	-168.109	73	0	1	0	1	0	1	-.127	72
611	6	max	591.875	39	339.408	89	0	1	0	1	0	1	.841	12
612		min	-293.282	85	-137.437	73	0	1	0	1	0	1	-.106	72
613	7	max	598.056	39	441.782	125	0	1	0	1	0	1	.776	12
614		min	-301.524	85	-106.765	73	0	1	0	1	0	1	-.095	72
615	8	max	604.238	39	571.588	125	0	1	0	1	0	1	.67	12
616		min	-309.766	85	-76.095	73	0	1	0	1	0	1	-.094	72
617	9	max	610.42	39	701.261	125	0	1	0	1	0	1	.524	12
618		min	-318.008	85	-45.423	73	0	1	0	1	0	1	-.102	72
619	10	max	616.601	39	830.933	125	0	1	0	1	0	1	.34	38
620		min	-326.251	85	-14.751	73	0	1	0	1	0	1	-.166	66
621	11	max	622.783	39	960.646	125	0	1	0	1	0	1	.139	38
622		min	-334.493	85	15.917	73	0	1	0	1	0	1	-.312	62
623	12	max	628.964	39	1090.317	125	0	1	0	1	0	1	.066	28
624		min	-342.735	85	46.589	73	0	1	0	1	0	1	-.55	125
625	13	max	635.146	39	1219.99	125	0	1	0	1	0	1	.022	71
626		min	-350.977	85	77.261	73	0	1	0	1	0	1	-.815	126
627	14	max	641.327	39	1349.536	125	0	1	0	1	0	1	-.019	71
628		min	-359.219	85	107.931	73	0	1	0	1	0	1	-1.32	126
629	15	max	647.509	39	1479.209	125	0	1	0	1	0	1	-.068	73
630		min	-367.461	85	138.603	73	0	1	0	1	0	1	-1.707	126
631	16	max	653.691	39	1608.881	125	0	1	0	1	0	1	-.116	73
632		min	-375.703	85	169.275	73	0	1	0	1	0	1	-2.255	125
633	17	max	659.872	39	1738.184	125	0	1	0	1	0	1	-.175	73
634		min	-383.945	85	199.948	73	0	1	0	1	0	1	-2.783	125
635	18	max	666.054	39	1867.857	125	0	1	0	1	0	1	-.243	73
636		min	-392.188	85	230.621	73	0	1	0	1	0	1	-3.352	125
637	19	max	672.235	39	1997.529	125	0	1	0	1	0	1	-.32	73
638		min	-400.43	85	261.293	73	0	1	0	1	0	1	-3.963	125
639	20	max	678.417	39	2127.202	125	0	1	0	1	0	1	-.408	73
640		min	-408.672	85	291.965	73	0	1	0	1	0	1	-4.614	125
641	M17 1	max	3061.767	12	341.334	74	0	1	0	1	0	1	9.616	39
642		min	-931.127	72	-1389.395	38	0	1	0	1	0	1	-.146	85
643	2	max	3061.767	12	321.928	74	0	1	0	1	0	1	9.979	39
644		min	-931.127	72	-1271.502	38	0	1	0	1	0	1	.195	85
645	3	max	3061.767	12	302.517	74	0	1	0	1	0	1	10.372	39
646		min	-931.127	72	-1153.039	38	0	1	0	1	0	1	.344	73
647	4	max	3061.767	12	283.111	74	0	1	0	1	0	1	10.698	39
648		min	-931.127	72	-1035.146	38	0	1	0	1	0	1	.356	73
649	5	max	3061.767	12	263.702	74	0	1	0	1	0	1	10.955	39
650		min	-931.127	72	-916.526	38	0	1	0	1	0	1	.38	73
651	6	max	3061.767	12	244.296	74	0	1	0	1	0	1	11.143	39

Envelope Member Section Forces (Continued)

Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k	LC	y-y Mom.	LC	z-z Mom.	LC
652		min	-931.127	72	-798.733	38	0	1	0	1	0	1	358	72
653	7	max	3061.767	12	261.706	86	0	1	0	1	0	1	11.263	39
654		min	-931.127	72	-680.168	39	0	1	0	1	0	1	313	72
655	8	max	3061.767	12	288.173	86	0	1	0	1	0	1	11.314	39
656		min	-931.127	72	-561.576	39	0	1	0	1	0	1	279	72
657	9	max	3061.767	12	314.619	86	0	1	0	1	0	1	11.419	12
658		min	-931.127	72	-479.11	129	0	1	0	1	0	1	257	72
659	10	max	3061.767	12	341.089	86	0	1	0	1	0	1	11.466	12
660		min	-931.127	72	-394.088	129	0	1	0	1	0	1	246	72
661	11	max	3061.767	12	394.088	121	0	1	0	1	0	1	11.466	12
662		min	-931.127	72	-341.089	85	0	1	0	1	0	1	246	72
663	12	max	3061.767	12	473.11	121	0	1	0	1	0	1	11.419	12
664		min	-931.127	72	-314.619	85	0	1	0	1	0	1	257	72
665	13	max	3061.767	12	561.576	39	0	1	0	1	0	1	11.314	39
666		min	-931.127	72	-288.173	85	0	1	0	1	0	1	279	72
667	14	max	3061.767	12	680.168	39	0	1	0	1	0	1	11.263	39
668		min	-931.127	72	-261.706	85	0	1	0	1	0	1	313	72
669	15	max	3061.767	12	798.733	39	0	1	0	1	0	1	11.143	38
670		min	-931.127	72	-244.296	73	0	1	0	1	0	1	358	72
671	16	max	3061.767	12	916.626	39	0	1	0	1	0	1	10.955	38
672		min	-931.127	72	-263.702	73	0	1	0	1	0	1	38	74
673	17	max	3061.767	12	1035.146	39	0	1	0	1	0	1	10.698	38
674		min	-931.127	72	-283.111	73	0	1	0	1	0	1	356	74
675	18	max	3061.767	12	1153.039	39	0	1	0	1	0	1	10.372	38
676		min	-931.127	72	-302.517	73	0	1	0	1	0	1	344	74
677	19	max	3061.767	12	1271.502	39	0	1	0	1	0	1	9.979	38
678		min	-931.127	72	-321.928	73	0	1	0	1	0	1	195	66
679	20	max	3061.767	12	1389.395	39	0	1	0	1	0	1	9.516	38
680		min	-931.127	72	-341.334	73	0	1	0	1	0	1	-.148	66
681	M18	1 max	62.158	85	-434.801	86	0	1	0	1	0	1	-.082	80
682		min	-461.189	39	-2567.055	2	0	1	0	1	0	1	-3.229	2
683	2	max	47.048	85	-378.569	86	0	1	0	1	0	1	154	66
684		min	-439.856	39	-2296.757	2	0	1	0	1	0	1	-1.841	38
685	3	max	31.937	85	-322.365	66	0	1	0	1	0	1	357	66
686		min	-428.524	39	-2026.391	2	0	1	0	1	0	1	-.697	38
687	4	max	16.627	85	-266.133	86	0	1	0	1	0	1	886	125
688		min	-417.191	39	-1756.092	2	0	1	0	1	0	1	-.22	85
689	5	max	1.716	85	-209.937	86	0	1	0	1	0	1	1.669	125
690		min	-405.858	39	-1485.675	2	0	1	0	1	0	1	033	85
691	6	max	-13.394	85	-153.705	86	0	1	0	1	0	1	2.313	125
692		min	-394.525	39	-1215.576	2	0	1	0	1	0	1	253	85
693	7	max	-27.241	73	-97.507	86	0	1	0	1	0	1	2.89	88
694		min	-383.192	39	-945.471	2	0	1	0	1	0	1	436	73
695	8	max	-32.278	73	-41.302	86	0	1	0	1	0	1	3.359	88
696		min	-371.859	39	-675.441	2	0	1	0	1	0	1	659	73
697	9	max	-37.315	73	14.93	86	0	1	0	1	0	1	3.672	88
698		min	-360.526	39	-430.654	124	0	1	0	1	0	1	65	73
699	10	max	-38.967	72	71.145	86	0	1	0	1	0	1	3.828	88
700		min	-349.193	39	-193.377	124	0	1	0	1	0	1	708	73
701	11	max	-38.967	72	193.377	125	0	1	0	1	0	1	3.828	88
702		min	-349.193	39	-71.145	85	0	1	0	1	0	1	708	74
703	12	max	-37.315	74	430.654	125	0	1	0	1	0	1	3.672	88
704		min	-360.526	38	-14.93	85	0	1	0	1	0	1	65	74
705	13	max	-32.278	74	675.441	2	0	1	0	1	0	1	3.359	88
706		min	-371.859	38	41.302	85	0	1	0	1	0	1	659	74
707	14	max	-27.241	74	945.471	2	0	1	0	1	0	1	2.89	88
708		min	-383.192	38	97.507	85	0	1	0	1	0	1	436	74

Envelope Member Section Forces (Continued)

Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shear[lb]	LC	Torque[k	LC	y-y Mom.	LC	z-z Mom.	LC
709		15 max	-13.394	86	1215.576	2	0	1	0	1	0	1	2.313	124
710		min	-394.525	38	153.705	85	0	1	0	1	0	1	.253	86
711	16	max	1.716	86	1485.875	2	0	1	0	1	0	1	1.669	124
712		min	-405.858	38	209.937	85	0	1	0	1	0	1	033	86
713	17	max	16.627	86	1756.092	2	0	1	0	1	0	1	.886	124
714		min	-417.191	38	266.133	85	0	1	0	1	0	1	-.22	86
715	18	max	31.937	86	2026.391	2	0	1	0	1	0	1	.357	85
716		min	-428.524	38	322.365	85	0	1	0	1	0	1	-.697	39
717	19	max	47.048	86	2296.757	2	0	1	0	1	0	1	.154	85
718		min	-439.856	38	378.569	85	0	1	0	1	0	1	-1.841	39
719	20	max	62.158	86	2567.055	2	0	1	0	1	0	1	-.082	85
720		min	-461.189	38	434.801	85	0	1	0	1	0	1	-3.229	2

Envelope Joint Reactions

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
1	N2	max	0	1	970.093	72	12531.881	99	0	1	0	1	0	1
2		min	0	1	-2734.979	38	-240.961	71	0	1	0	1	0	1
3	N1	max	0	1	2734.979	39	12531.881	99	0	1	0	1	0	1
4		min	0	1	-970.093	72	-240.961	71	0	1	0	1	0	1
5	Totals:	max	0	1	1906.5	86	25063.762	99						
6		min	0	1	-1906.5	34	-481.923	71						

Envelope Joint Displacements

	Joint		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation	LC	Y Rotation	LC	Z Rotation [	LC
1	N1	max	0	1	0	72	0	71	5.496e-5	86	0	1	0	1
2		min	0	1	0	39	0	99	-8.69e-4	38	0	1	0	1
3	N2	max	0	1	0	38	0	71	8.69e-4	39	0	1	0	1
4		min	0	1	0	72	0	99	-5.496e-5	85	0	1	0	1
5	N3	max	0	1	.037	34	.001	71	5.089e-5	66	0	1	0	1
6		min	0	1	-.036	86	.01	99	-8.406e-4	38	0	1	0	1
7	N4	max	0	1	.036	85	.001	71	8.406e-4	39	0	1	0	1
8		min	0	1	-.037	35	-.01	99	-5.089e-5	85	0	1	0	1
9	N5	max	0	1	0	12	.014	43	2.599e-4	86	0	1	0	1
10		min	0	1	0	72	-.018	77	-5.425e-4	38	0	1	0	1
11	N6	max	0	1	.036	85	.015	35	3.692e-4	35	0	1	0	1
12		min	0	1	-.037	35	-.015	77	-2.755e-4	85	0	1	0	1
13	N7	max	0	1	0	72	.014	42	5.425e-4	39	0	1	0	1
14		min	0	1	0	12	-.018	78	-2.599e-4	85	0	1	0	1
15	N8	max	0	1	.037	34	.015	34	2.755e-4	86	0	1	0	1
16		min	0	1	-.036	86	-.015	79	-3.692e-4	34	0	1	0	1
17	N9	max	0	1	.036	85	.011	39	3.966e-4	39	0	1	0	1
18		min	0	1	-.037	35	-.011	77	-2.621e-4	85	0	1	0	1
19	N10	max	0	1	.036	85	.007	39	4.843e-4	39	0	1	0	1
20		min	0	1	-.037	35	-.008	77	-2.212e-4	85	0	1	0	1
21	N11	max	0	1	.036	85	.003	28	6.318e-4	39	0	1	0	1
22		min	0	1	-.037	35	-.006	52	-1.612e-4	85	0	1	0	1
23	N12	max	0	1	0	12	.011	35	2.525e-4	86	0	1	0	1
24		min	0	1	0	72	-.012	77	-5.124e-4	120	0	1	0	1
25	N13	max	0	1	0	12	.01	39	2.649e-4	43	0	1	0	1
26		min	0	1	0	72	-.006	77	-4.048e-4	77	0	1	0	1
27	N14	max	0	1	0	12	.007	39	4.42e-4	39	0	1	0	1
28		min	0	1	0	72	-.002	85	-2.549e-4	85	0	1	0	1
29	N15	max	0	1	.037	34	.003	28	1.512e-4	86	0	1	0	1
30		min	0	1	-.036	86	-.006	52	-6.318e-4	38	0	1	0	1
31	N16	max	0	1	.037	34	.007	38	2.212e-4	86	0	1	0	1

Envelope Joint Displacements (Continued)

	Joint		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation	LC	Y Rotation	LC	Z Rotation [	LC
32		min	0	1	-.036	86	-.008	78	-4.843e-4	38	0	1	0	1
33	N17	max	0	1	.037	34	.011	38	2.621e-4	86	0	1	0	1
34		min	0	1	-.036	86	-.011	78	-3.966e-4	38	0	1	0	1
35	N18	max	0	1	0	72	.007	38	2.549e-4	86	0	1	0	1
36		min	0	1	0	12	-.002	86	-4.42e-4	38	0	1	0	1
37	N19	max	0	1	0	72	.01	38	4.048e-4	78	0	1	0	1
38		min	0	1	0	12	-.006	78	-2.649e-4	42	0	1	0	1
39	N20	max	0	1	0	72	.011	34	5.124e-4	121	0	1	0	1
40		min	0	1	0	12	-.012	78	-2.525e-4	85	0	1	0	1
41	N21	max	0	1	.037	34	.008	72	2.827e-6	73	0	1	0	1
42		min	0	1	-.036	86	-.117	12	-5.076e-4	39	0	1	0	1
43	N22	max	0	1	0	86	.017	72	-1.697e-4	85	0	1	0	1
44		min	0	1	0	35	-.144	38	-1.217e-3	86	0	1	0	1
45	N23	max	0	1	.036	85	0	71	1.04e-3	39	0	1	0	1
46		min	0	1	-.037	35	-.02	125	4.267e-7	72	0	1	0	1
47	N24	max	0	1	.036	85	-.002	73	1.16e-3	39	0	1	0	1
48		min	0	1	-.037	35	-.034	125	2.585e-5	72	0	1	0	1
49	N25	max	0	1	.036	85	-.003	73	1.203e-3	39	0	1	0	1
50		min	0	1	-.037	35	-.049	39	4.282e-5	72	0	1	0	1
51	N26	max	0	1	.036	85	-.005	73	1.19e-3	12	0	1	0	1
52		min	0	1	-.037	35	-.065	39	5.079e-5	72	0	1	0	1
53	N27	max	0	1	.036	85	-.006	73	1.105e-3	12	0	1	0	1
54		min	0	1	-.037	35	-.08	39	4.92e-5	72	0	1	0	1
55	N28	max	0	1	.036	85	-.007	72	9.495e-4	12	0	1	0	1
56		min	0	1	-.037	35	-.093	39	3.75e-5	72	0	1	0	1
57	N29	max	0	1	.036	85	-.007	72	8.022e-4	12	0	1	0	1
58		min	0	1	-.037	35	-.103	39	2.653e-5	72	0	1	0	1
59	N30	max	0	1	.036	85	-.008	72	6.63e-4	38	0	1	0	1
60		min	0	1	-.037	35	-.111	39	1.806e-5	72	0	1	0	1
61	N31	max	0	1	.038	85	-.008	72	5.076e-4	38	0	1	0	1
62		min	0	1	-.037	35	-.117	12	-2.827e-6	74	0	1	0	1
63	N32	max	0	1	.036	77	-.008	72	3.395e-4	38	0	1	0	1
64		min	0	1	-.037	35	-.122	12	-2.612e-5	86	0	1	0	1
65	N33	max	0	1	.036	120	-.008	72	1.619e-4	38	0	1	0	1
66		min	0	1	-.036	121	-.124	12	-7.268e-5	86	0	1	0	1
67	N34	max	0	1	.036	120	-.008	72	7.268e-5	85	0	1	0	1
68		min	0	1	-.036	121	-.124	12	-1.619e-4	39	0	1	0	1
69	N35	max	0	1	.037	34	-.008	72	2.612e-5	65	0	1	0	1
70		min	0	1	-.036	78	-.122	12	-3.395e-4	39	0	1	0	1
71	N36	max	0	1	0	38	0	72	1.254e-3	39	0	1	0	1
72		min	0	1	0	86	-.014	39	4.281e-5	72	0	1	0	1
73	N37	max	0	1	0	38	-.001	72	1.427e-3	39	0	1	0	1
74		min	0	1	0	86	-.03	39	9.736e-5	72	0	1	0	1
75	N38	max	0	1	0	38	-.002	72	1.448e-3	39	0	1	0	1
76		min	0	1	0	86	-.048	39	1.252e-4	72	0	1	0	1
77	N39	max	0	1	0	38	-.004	72	1.38e-3	125	0	1	0	1
78		min	0	1	0	86	-.065	39	1.392e-4	73	0	1	0	1
79	N40	max	0	1	0	38	-.006	72	1.283e-3	125	0	1	0	1
80		min	0	1	0	86	-.081	39	1.413e-4	73	0	1	0	1
81	N41	max	0	1	0	38	-.008	72	1.204e-3	125	0	1	0	1
82		min	0	1	0	86	-.096	39	1.539e-4	73	0	1	0	1
83	N42	max	0	1	0	34	-.011	73	1.481e-3	86	0	1	0	1
84		min	0	1	0	86	-.112	39	2.565e-4	71	0	1	0	1
85	N43	max	0	1	0	34	-.014	72	1.467e-3	86	0	1	0	1
86		min	0	1	0	86	-.129	39	2.422e-4	74	0	1	0	1
87	N44	max	0	1	0	34	-.017	72	1.217e-3	86	0	1	0	1
88		min	0	1	0	86	-.144	39	1.697e-4	86	0	1	0	1

Envelope Joint Displacements (Continued)

	Joint		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation	LC	Y Rotation	LC	Z Rotation [	LC
89	N45	max	0	1	0	34	-.02	72	8.244e-4	124	0	1	0	1
90		min	0	1	0	86	-.155	2	4.794e-5	86	0	1	0	1
91	N46	max	0	1	0	34	-.021	72	3.59e-4	124	0	1	0	1
92		min	0	1	0	86	-.162	2	-8.058e-5	86	0	1	0	1
93	N47	max	0	1	0	85	-.021	72	8.058e-5	85	0	1	0	1
94		min	0	1	0	35	-.162	2	-3.59e-4	125	0	1	0	1
95	N48	max	0	1	0	85	-.02	72	-4.794e-5	85	0	1	0	1
96		min	0	1	0	35	-.155	2	-8.244e-4	125	0	1	0	1
97	N49	max	0	1	.037	34	-.008	72	-1.806e-5	72	0	1	0	1
98		min	0	1	-.036	86	-.111	38	-6.63e-4	39	0	1	0	1
99	N50	max	0	1	.037	34	-.007	72	-2.653e-5	72	0	1	0	1
100		min	0	1	-.036	86	-.103	38	-8.022e-4	12	0	1	0	1
101	N51	max	0	1	.037	34	-.007	72	-3.75e-5	72	0	1	0	1
102		min	0	1	-.036	86	-.093	38	-9.495e-4	12	0	1	0	1
103	N52	max	0	1	.037	34	-.006	74	-4.92e-5	72	0	1	0	1
104		min	0	1	-.036	86	-.08	38	-1.105e-3	12	0	1	0	1
105	N53	max	0	1	.037	34	-.005	74	-5.079e-5	72	0	1	0	1
106		min	0	1	-.036	86	-.065	38	-1.19e-3	12	0	1	0	1
107	N54	max	0	1	.037	34	-.003	74	-4.282e-5	72	0	1	0	1
108		min	0	1	-.036	86	-.049	38	-1.203e-3	38	0	1	0	1
109	N55	max	0	1	.037	34	-.002	74	-2.585e-5	72	0	1	0	1
110		min	0	1	-.036	86	-.034	124	-1.16e-3	38	0	1	0	1
111	N56	max	0	1	.037	34	0	71	-4.267e-7	72	0	1	0	1
112		min	0	1	-.036	86	-.02	124	-1.04e-3	38	0	1	0	1
113	N57	max	0	1	0	85	-.014	72	-2.422e-4	73	0	1	0	1
114		min	0	1	0	35	-.129	38	-1.467e-3	86	0	1	0	1
115	N58	max	0	1	0	85	-.011	74	-2.585e-4	71	0	1	0	1
116		min	0	1	0	35	-.112	38	-1.481e-3	86	0	1	0	1
117	N59	max	0	1	0	85	-.008	72	-1.539e-4	74	0	1	0	1
118		min	0	1	0	39	-.096	38	-1.204e-3	124	0	1	0	1
119	N60	max	0	1	0	85	-.006	72	-1.413e-4	74	0	1	0	1
120		min	0	1	0	39	-.081	38	-1.283e-3	124	0	1	0	1
121	N61	max	0	1	0	85	-.004	72	-1.392e-4	74	0	1	0	1
122		min	0	1	0	39	-.065	38	-1.38e-3	124	0	1	0	1
123	N62	max	0	1	0	85	-.002	72	-1.252e-4	72	0	1	0	1
124		min	0	1	0	39	-.048	38	-1.448e-3	38	0	1	0	1
125	N63	max	0	1	0	85	-.001	72	-9.736e-5	72	0	1	0	1
126		min	0	1	0	39	-.03	38	-1.427e-3	38	0	1	0	1
127	N64	max	0	1	0	85	0	72	-4.281e-5	72	0	1	0	1
128		min	0	1	0	39	-.014	38	-1.284e-3	38	0	1	0	1

Envelope AISC 13th ASD Steel Code Checks

	Member	Shape	Code C...	Loc[ft]	LC	Shear ...	Loc[ft]	Dir	LC	Pnc/om [lb]	Pnt/om [lb]	Mnx/om ...	Mnz/om ...	Cb	Eqn
1	M1	HSS6X6X5	.150	0	124	.043	0	y	124	165935.8	177113.7	31.218	31.218	1	H1-1b
2	M2	W16X26	.177	0	38	.079	0	y	38	191066.2	229040.12	13.673	110.279	1	H1-1b
3	M3	HSS5X5X4	.048	0	99	.000	0	y	1	93642.835	118443.1	17.468	17.468	1	H1-1b
4	M4	HSS5X5X4	.048	0	99	.000	0	y	1	93642.835	118443.1	17.468	17.468	1	H1-1b
5	M5	W16X26	.172	4	124	.074	4	y	124	191226.1	229040.12	13.673	110.279	1	H1-1b
6	M6	W16X26	.172	0	125	.074	0	y	125	191226.1	229040.12	13.673	110.279	1	H1-1b
7	M7	HSS6X6X5	.153	4	124	.040	4	y	88	172041.83	177113.7	31.218	31.218	1	H1-1b
8	M8	HSS6X6X5	.153	0	125	.040	0	y	88	172041.83	177113.7	31.218	31.218	1	H1-1b
9	M9	HSS5X5X4	.024	0	121	.000	0	y	1	93642.835	118443.1	17.468	17.468	1	H1-1b
10	M10	HSS5X5X4	.024	0	121	.000	0	y	1	93642.835	118443.1	17.468	17.468	1	H1-1b
11	M11	HSS5X5X4	.039	5.425	121	.001	0	y	77	89822.513	118443.1	17.468	17.468	1	H1-1b
12	M12	HSS5X5X4	.039	5.425	121	.001	0	y	35	89822.513	118443.1	17.468	17.468	1	H1-1b
13	M13	HSS6X5X4	.181	0	39	.019	0	y	39	105127.0...	131389.2	20.016	22.656	2	H1-1b

Envelope AISC 13th ASD Steel Code Checks (Continued)

	Member	Shape	Code C...	Loc(ft)	LC	Shear...	Loc(ft)	Dir	LC	Pnc/om (lb)	Pnt/om (lb)	Mnx/om ...	Mazz/om ...	Cb	Eqn
14	M14	HSS6X5X4	.181	0	38	.019	0	y	38	105127.0	131389.2	20.016	22.656	2	H1-1b
15	M15	W16X26	.177	6	39	.079	6	y	39	191066.2	229940.12	13.673	110.279	1	H1-1b
16	M16	HSS6X6X5	.150	6	125	.043	6	y	125	153905.8	177113.7	31.218	31.218	1	H1-1b
17	M17	W16X26	.112	5.5	12	.020	11	y	39	188130.6	229940.12	13.673	110.279	1	H1-1b
18	M18	HSS6X6X5	.124	5.5	88	.052	0	y	2	142178.7	177113.7	31.218	31.218	1	H1-1b

Material Takeoff

	Material	Size	Pieces	Length(ft)	Weight(K)
1	Hot Rolled Steel				
2	A500 Gr.46	HSS5X5X4	6	58.6	.9
3	A500 Gr.46	HSS6X5X4	2	19	.3
4	A500 Gr.46	HSS8X6X5	5	31	.7
5	A992	W16X26	5	31	.8
6	Total HR Steel		18	139.6	2.7

Buro Happold	PROJECT: SOLAR DECATHALON 31023D. PROJECT #:	PAGE #:
	DESCRIPTION: SLIDER	AUTHOR / DATE:
		CHECKED BY / DATE:

SLIDER ANALYSIS

$$R_1 = \frac{(4psf)(33\,ft)(12.5\,ft)}{(2)(8.5\,ft)}$$

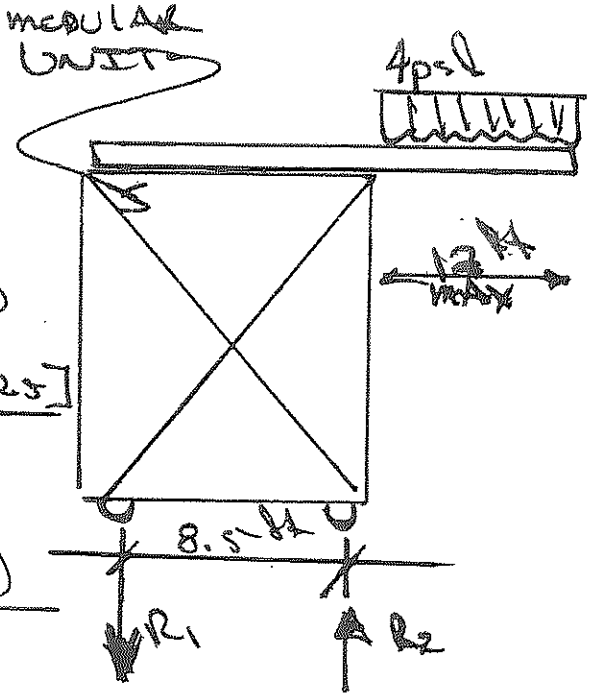
$= 1213\,\#$ (TOTAL)

$= 606\,\#$ (PER SUPPORT)

$$R_2 = \frac{(4psf)(33\,ft)(12.5\,ft)[(2)(8.5)+12.5]}{(2)(8.5\,ft)}$$

$= 2863\,\#$ (TOTAL)

$= 1432\,\#$ (PER SUPPORT)



MAX (UPLIFT) CASE FOR SEISMIC LOAD COMBINATION

$* .83\,E.GD + E(+X\,DIR)$

$= 2775\,\# > 606.\,\#\,(R_1)$

WILL NOT TURN OVER IN EARTHQUAKE

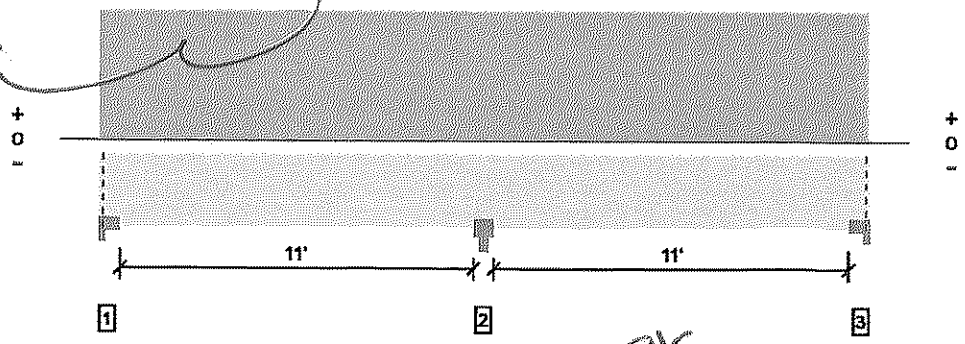
CANOPY MUST BE CLOSED IN HIGH WINDS

FORTE MEMBER REPORT *Level, Floor: Flush Beam* **FAILED**

2 piece(s) 1 3/4" x 11 7/8" 1.9E Microllam® LVL

Deck Beam

Overall Length: 23' 4 1/2"



All Dimensions Are Horizontal; Drawing is Conceptual

OK.

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	15775 @ 11' 8 1/4"	14438	Failed (109%)	--	1.0 D + 1.0 L (All Spans)
Shear (lbs)	6533 @ 12' 10 7/8"	7897	Passed (83%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	-17911 @ 11' 8 1/4"	17848	Passed (100%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.330 @ 5' 8 9/16"	0.378	Passed (L/413)	--	1.0 D + 1.0 L (Alt Spans)
Total Load Defl. (in)	0.354 @ 5' 8 1/16"	0.568	Passed (L/385)	--	1.0 D + 1.0 L (Alt Spans)

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

- Deflection criteria: LL (L/360) and TL (L/240).
- Bracing (Lu): All compression edges (top and bottom) must be braced at 6" o/c unless detailed otherwise. Proper attachment and positioning of lateral bracing is required to achieve member stability.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Total	
1 - Column Cap - steel	5.50"	5.50"	2.21"	512	5301/-710	5813/-710	Blocking
2 - Column Cap - steel	5.50"	5.50"	6.01"	1582	14193	15775	None
3 - Column Cap - steel	5.50"	5.50"	2.21"	512	5301/-710	5813/-710	Blocking

- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Loads	Location	Tributary Width	Dead (0.90)	Floor Live (1.00)	Comments
1 - Uniform(PLF)	0 to 23' 4 1/2"	N/A	100.0	1000.0	Residential - Living Areas

Weyerhaeuser Notes

Weyerhaeuser warrants that the sizing of its products will be in accordance with Weyerhaeuser product design criteria and published design values. Weyerhaeuser expressly disclaims any other warranties related to the software. Refer to current Weyerhaeuser literature for installation details. (www.woodbywy.com) Accessories (Rim Board, Blocking Panels and Squash Blocks) are not designed by this software. Use of this software is not intended to circumvent the need for a design professional as determined by the authority having jurisdiction. The designer of record, builder or framer is responsible to assure that this calculation is compatible with the overall project. Products manufactured at Weyerhaeuser facilities are third-party certified to sustainable forestry standards.

The product application, input design loads, dimensions and support information have been provided by Forte Software Operator

SUSTAINABLE FORESTRY INITIATIVE

Forte Software Operator	Job Notes
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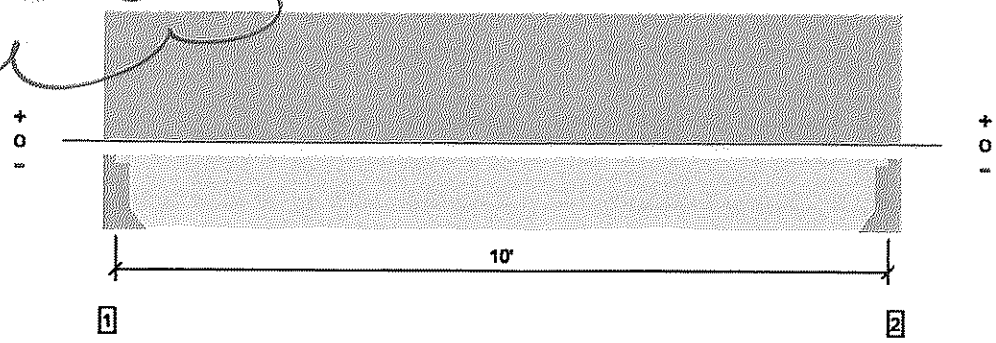
2/7/2013 7:29:21 PM
Forte v3.5, Design Engine: V5.5.3.2
3102BD-20120920-FAR-Deck.4te

FORTE MEMBER REPORT *Level, Floor: Joist* PASSED

1 piece(s) 1 3/4" x 7 1/4" 1.9E Microllam® LVL @ 24" OC

Deck Joist

Overall Length: 10' 7"



All Dimensions Are Horizontal; Drawing is Conceptual

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	1100 @ 3 1/2"	1969	Passed (56%)	--	1.0 D + 1.0 L (All Spans)
Shear (lbs)	967 @ 10 3/4"	2411	Passed (40%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	2750 @ 5' 3 1/2"	3700	Passed (74%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.319 @ 5' 3 1/2"	0.333	Passed (L/376)	--	1.0 D + 1.0 L (All Spans)
Total Load Defl. (in)	0.351 @ 5' 3 1/2"	0.500	Passed (L/342)	--	1.0 D + 1.0 L (All Spans)
TJ-Pro™ Rating	43	40	Passed	--	--

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

- Deflection criteria: LL (L/360) and TL (L/240).
- Bracing (Lu): All compression edges (top and bottom) must be braced at 10' o/c unless detailed otherwise. Proper attachment and positioning of lateral bracing is required to achieve member stability.
- A 4% increase in the moment capacity has been added to account for repetitive member usage.
- A structural analysis of the deck has not been performed.
- Deflection analysis is based on composite action with a single layer of 23/32" Weyerhaeuser Edge™ Panel (24" Span Rating) that is glued and nailed down.
- Additional considerations for the TJ-Pro™ Rating include: None

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Total	
1 - Hanger on 7 1/4" DF beam	3.50"	Hanger[1]	1.50"	106	1058	1164	See note [1]
2 - Hanger on 7 1/4" DF beam	3.50"	Hanger[1]	1.50"	106	1058	1164	See note [1]

- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- [1] See Connector grid below for additional information and/or requirements.

Connector: Simpson Strong-Tie Connectors						
Support	Model	Seat Length	Top Nails	Face Nails	Member Nails	Accessories
1 - Face Mount Hanger	HU7	2.50"	N/A	12-10d common	4-10d x 1-1/2	
2 - Face Mount Hanger	HU7	2.50"	N/A	12-10d common	4-10d x 1-1/2	

Loads	Location	Spacing	Dead (0.90)	Floor Live (1.00)	Comments
1 - Uniform(PSF)	0 to 10' 7"	24"	10.0	100.0	Residential - Living Areas

Weyerhaeuser Notes

Weyerhaeuser warrants that the sizing of its products will be in accordance with Weyerhaeuser product design criteria and published design values. Weyerhaeuser expressly disclaims any other warranties related to the software. Refer to current Weyerhaeuser literature for installation details. (www.woodbywy.com) Accessories (Rim Board, Blocking Panels and Squash Blocks) are not designed by this software. Use of this software is not intended to circumvent the need for a design professional as determined by the authority having jurisdiction. The designer of record, builder or framer is responsible to assure that this calculation is compatible with the overall project. Products manufactured at Weyerhaeuser facilities are third-party certified to sustainable forestry standards.

The product application, input design loads, dimensions and support information have been provided by Forte Software Operator

SUSTAINABLE FORESTRY INITIATIVE

Forte Software Operator	Job Notes
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2/7/2013 7:29:01 PM
Forte v3.5, Design Engine: V5.5.3.2
3102BD-20120920-FAR-Deck.4te

Buro Happold

PROJECT: SCI Arec Solar Deck. | PROJECT #: | PAGE #:

DESCRIPTION: Deck. | AUTHOR / DATE:

CHECKED BY / DATE:

Deck Design: Flat 2x6's

DL = (2/12)(120 pcf) = 20 psf ← Self Weight

LL = 100 psf

$F'_b = (1.0)(900\ psi)(1.3)(1.15)(1.15)$ (Cf, Cr, Cpu)

$= 1545\ psi$

$S_{x\ 2x6\ FLAT} = 2.063\ in^3$

$MOMENT = (1545\ psi)(2.063\ in^3) = (0.117)(8/12)(100+20)\ell^2/(12)$

$\ell = 5'-4''$

$\Delta = (L)(12)/360 = \frac{(5)(8/12)(100+20)\ell^4(12)^3}{(384)(1.6E6)(1.547)}$

$\ell = 3.57'$ ft. → 4 ft

2x6 FLAT @ 2'-0" O/C MAX

LATERAL ANALYSIS AND DESIGN (MAIN STRUCTURAL SYSTEM)

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: SEISMIC DESIGN CRITERIA (ASCE 7-05)		AUTHOR/DATE:
			CHECKED BY/DATE:

Seismic Design Criteria (ASCE 7-05):

Occupancy Category: II
Importance Factor: 1.00
Site Class: D
Building Roof Height (h_n): 10.00 ft
Long-Period Transition (T_L): 8.0 sec

Lateral Category: Building Frame Systems
Basic Seismic Force-Resisting System: Light-framed walls sheathed with wood structural panels rated for shear resistance or steel sheets
Response Modification Factor (R): 7.00

☑ X-Direction ☐ Y-Direction

Spectral Response Acceleration Parameters:

Short Period

Mapped (MCE):
S_S = 1.436 *(Sec. 11.4.1)*

Site Coefficient:
F_a = 1.000 *(Sec. 11.4.3)*

Adjusted (MCE):
$S_{MS} = F_a S_S$ *(Eq. 11.4-1)*
S_{MS} = 1.436

Design Spectral Acceleration:
$S_{DS} = 2/3\ S_{MS}$ *(Eq. 11.4-3)*
S_{DS} = 0.957

1-Second Period

Mapped (MCE):
S_1 = 0.507 *(Sec. 11.4.1)*

Site Coefficient:
F_v = 1.500 *(Sec. 11.4.3)*

Adjusted (MCE):
$S_{M1} = F_v S_1$ *(Eq. 11.4-2)*
S_{M1} = 0.761

Design Spectral Acceleration:
$S_{D1} = 2/3\ S_{M1}$ *(Eq. 11.4-4)*
S_{D1} = 0.507

Fundamental Period:

Building Period Coefficients:
C_t = 0.020 *(Sec. 12.8.2.1)*
x = 0.750 *(Sec. 12.8.2.1)*

Approximate Fundamental Period:
$T_a = C_t h_n^x$ *(Eq. 12.8-7)*
T_a = 0.11 sec

Upper Limit On Calculated Period:
C_u = 1.40 *(Sec. 12.8.2)*
$C_u T_a$ = 0.16 sec *(Sec. 12.8.2)*

Seismic Design Category: D

Seismic Base Shear Coefficient: X-Direction

User Defined Period ($T_{X\text{-}Dir}$)

Strength

Fundamental Period:
T = 0.11 sec *(Sec. 12.8.2)*

Seismic Response Coefficient:
$C_s = S_{DS} / (R / I)$ *(Eq. 12.8-2)*
C_s = 0.137

Need Not Exceed:
$C_s = S_{D1} / T\ (R / I)$ *(Eq. 12.8-3)*
C_s = 0.644

Shall Not Be Less Than:
$C_s = 0.044\ S_{DS}\ I$ *(Supp 2: Eq. 12.8-5)*
C_s = 0.042

C_s = 0.01 *(Eq. 12.8-5)*

Seismic Response Coefficient:
V = 0.137 x W *(Eq. 12.8-1)*

Drift

Fundamental Period:
T = 0.11 sec *(Sec. 12.8.2)*

Seismic Response Coefficient:
$C_s = S_{DS} / (R / I)$ *(Eq. 12.8-2)*
C_s = 0.137

Need Not Exceed:
$C_s = S_{D1} / T\ (R / I)$ *(Eq. 12.8-3)*
C_s = 0.644

Shall Not Be Less Than:
C_s = 0.01 *(Eq. 12.8-5)*

Seismic Response Coefficient:
V = 0.137 x W *(Eq. 12.8-1)*

Seismic Base Shear Coefficient: Y-Direction

MIN Diaphragm
$= (.20)(.507) = .1014 < .137$ ok
SDC

☐ Ignore ASCE Equation 12.8-6 when computing story drift.

☐ Seismic Design Category is determined from Table 11.6-1 alone.

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD	PAGE #:
	DESCRIPTION: SEISMIC DESIGN CRITERIA (ASCE 7-05)		AUTHOR/DATE:
			CHECKED BY/DATE:

Seismic Design Criteria (ASCE 7-05):

Occupancy Category: II
Importance Factor: 1.00
Site Class: D
Building Roof Height (h_n): 10.00 ft
Long-Period Transition (T_L): 8.0 sec

Lateral Category: Building Frame Systems
Basic Seismic Force-Resisting System: Ordinary steel concentrically braced frames
Response Modification Factor (R): 3.25

☐ X-Direction ☑ Y-Direction

Spectral Response Acceleration Parameters

Short Period

Mapped (MCE):
S_S = 1.436 *(Sec. 11.4.1)*

Site Coefficient:
F_a = 1.000 *(Sec. 11.4.3)*

Adjusted (MCE):
$S_{MS} = F_a S_S$ *(Eq. 11.4-1)*
S_{MS} = 1.436

Design Spectral Acceleration:
$S_{DS} = 2/3\ S_{MS}$ *(Eq. 11.4-3)*
S_{DS} = 0.957

1-Second Period

Mapped (MCE):
S_1 = 0.507 *(Sec. 11.4.1)*

Site Coefficient:
F_v = 1.500 *(Sec. 11.4.3)*

Adjusted (MCE):
$S_{M1} = F_v S_1$ *(Eq. 11.4-2)*
S_{M1} = 0.761

Design Spectral Acceleration:
$S_{D1} = 2/3\ S_{M1}$ *(Eq. 11.4-4)*
S_{D1} = 0.507

Fundamental Period:

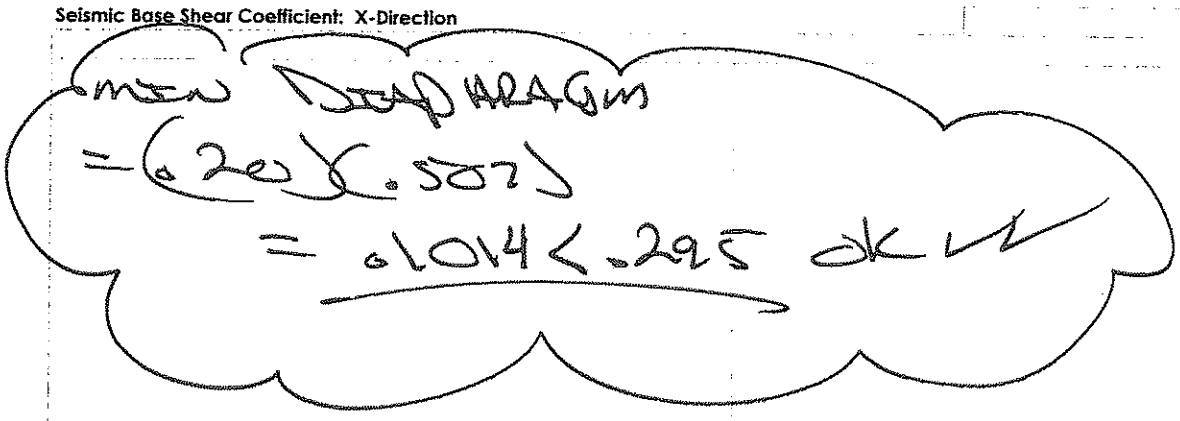
Building Period Coefficients:
C_t = 0.020 *(Sec. 12.8.2.1)*
x = 0.750 *(Sec. 12.8.2.1)*

Approximate Fundamental Period:
$T_a = C_t h_n^x$ *(Eq. 12.8-7)*
T_a = 0.11 sec

Upper Limit On Calculated Period:
C_u = 1.40 *(Sec. 12.8.2)*
$C_u T_a$ = 0.16 sec *(Sec. 12.8.2)*

Seismic Design Category: D

Seismic Base Shear Coefficient: X-Direction



Seismic Base Shear Coefficient: Y-Direction

User Defined Period ($T_{Y\text{-}Dir}$)

Strength	Drift
Fundamental Period: T = 0.11 sec *(Sec. 12.8.2)*	Fundamental Period: T = 0.11 sec *(Sec. 12.8.2)*
Seismic Response Coefficient: $C_s = S_{DS} / (R / I)$ *(Eq. 12.8-2)* C_s = 0.295	Seismic Response Coefficient: $C_s = S_{DS} / (R / I)$ *(Eq. 12.8-2)* C_s = 0.295
Need Not Exceed: $C_s = S_{D1} / T\ (R / I)$ *(Eq. 12.8-3)* C_s = 1.387	Need Not Exceed: $C_s = S_{D1} / T\ (R / I)$ *(Eq. 12.8-3)* C_s = 1.387
Shall Not Be Less Than: $C_s = 0.044\ S_{DS}\ I$ *(Supp 2: Eq. 12.8-5)* C_s = 0.042	Shall Not Be Less Than: C_s = 0.01 *(Eq. 12.8-5)*
C_s = 0.01 *(Eq. 12.8-5)*	
Seismic Response Coefficient: **V = 0.295 x W** *(Eq. 12.8-1)*	**Seismic Response Coefficient:** **V = 0.295 x W** *(Eq. 12.8-1)*

☐ Ignore ASCE Equation 12.8-6 when computing story drift. ☐ Seismic Design Category is determined from Table 11.6-1 alone.

Buro Happold

PROJECT: Solar Pergola | PROJECT #: | PAGE #:

DESCRIPTION: LATERAL DESIGN. | AUTHOR / DATE:

CHECKED BY / DATE:

WIND UPLIFT: (h/L ≤ 0.5)

$q_z = 13.40$ psf

$C_p = -.90$

$P_w = 13.40 psf [(.85)(-.90) + (-.55)]$

$= 17.6$ psf ✓✓

$T_{RIB(WIND)} = (17.6 psf)(9'/2)$

$= 79.2$ plf ✓✓

USE FOR MODULE 1 + 2 + 3

MAX UPLIFT:

.6D + WIND (+ PER) (UPLIFT) = 240#

LOAD COMB #71 RISA ANALYSIS

∴ STRUCTURE WILL NEVER OVERTURN. 240# IS NEG CONFIRMED.

Buro Happold

PROJECT: Solar Decathlon 3102BD | PROJECT #:

DESCRIPTION: Lateral Analyses

PAGE #:

AUTHOR / DATE:

CHECKED BY / DATE:

Seismic Mass: Module 1 and 3

Weight (Roof) = (24 psf)(31 ft)(9 ft)
+ (16 psf)(10 ft/2)(31 ft + 9 ft + 9 ft)
= 10616 # ✓✓

Weight (Floor) = (14.0 psf)(31 ft)(9 ft)
+ (16 psf)(10 ft/2)(31 ft + 9 ft + 9 ft)
= 7826 # ✓✓

Seismic Force: Module 1 and 3

X-Direction:

ASD

F_{EQ} (Roof) = (10616 #)(.137)(.70)
= 1018 # ⇒ 32.8 plf ✓✓

F_{EQ} (Floor) = (7826 #)(.137)(.70)
= 751 # ⇒ 24.2 plf ✓✓

Y Direction:

A.S.D.

F_{EQ} (Roof) = (10616 #)(.295)(.70)
= 2192 # ⇒ 243.6 plf ✓✓

F_{EQ} (Floor) = (7826 #)(.295)(.70)
= 1616 # ⇒ 180 plf ✓✓

Buro Happold

PROJECT: Solar Decathlon 3102BD | PROJECT #: | PAGE #:

DESCRIPTION: LATERAL ANALYSIS | AUTHOR / DATE:

CHECKED BY / DATE:

WIND LOADS: MODULE 1 AND 3

$q_z = (.00256)(.85)(1.0)(.85)(85)^2(1.0)$

K_z K_{zt} K_d V I

Exp C 0-15'

$= 13.40$ psf ✓

X-DIRECTION: ($L/B = .30$)

$P_{WALL} = (13.40\text{ psf})[(.85)(.80) + .55]$

$= 16.50$ psf (Windward controls) (Leeward Enclosed)

$P_{ROOF} = (13.40\text{ psf})(.85)(-.80 + .50)$

$= 14.81$ psf ✓

$W_{(ROOF)} = (16.50\text{ psf})(10'/2) + (14.81\text{ psf})(4')$

$= 142$ plf ✓

$W_{(FLOOR)} = (16.50\text{ psf})(10'/2)$

$= 83$ plf

Y-DIRECTION: ($L/B = 3.3$)

$P_{WALL} = (13.40\text{ psf})(.85)(-.80 + .25)$

$= 12.0$ psf ✓

$P_{ROOF} = 12.0$ psf

$W_{(ROOF)} = (12.0\text{ psf})(10'/2) + (12\text{ psf})(4')$

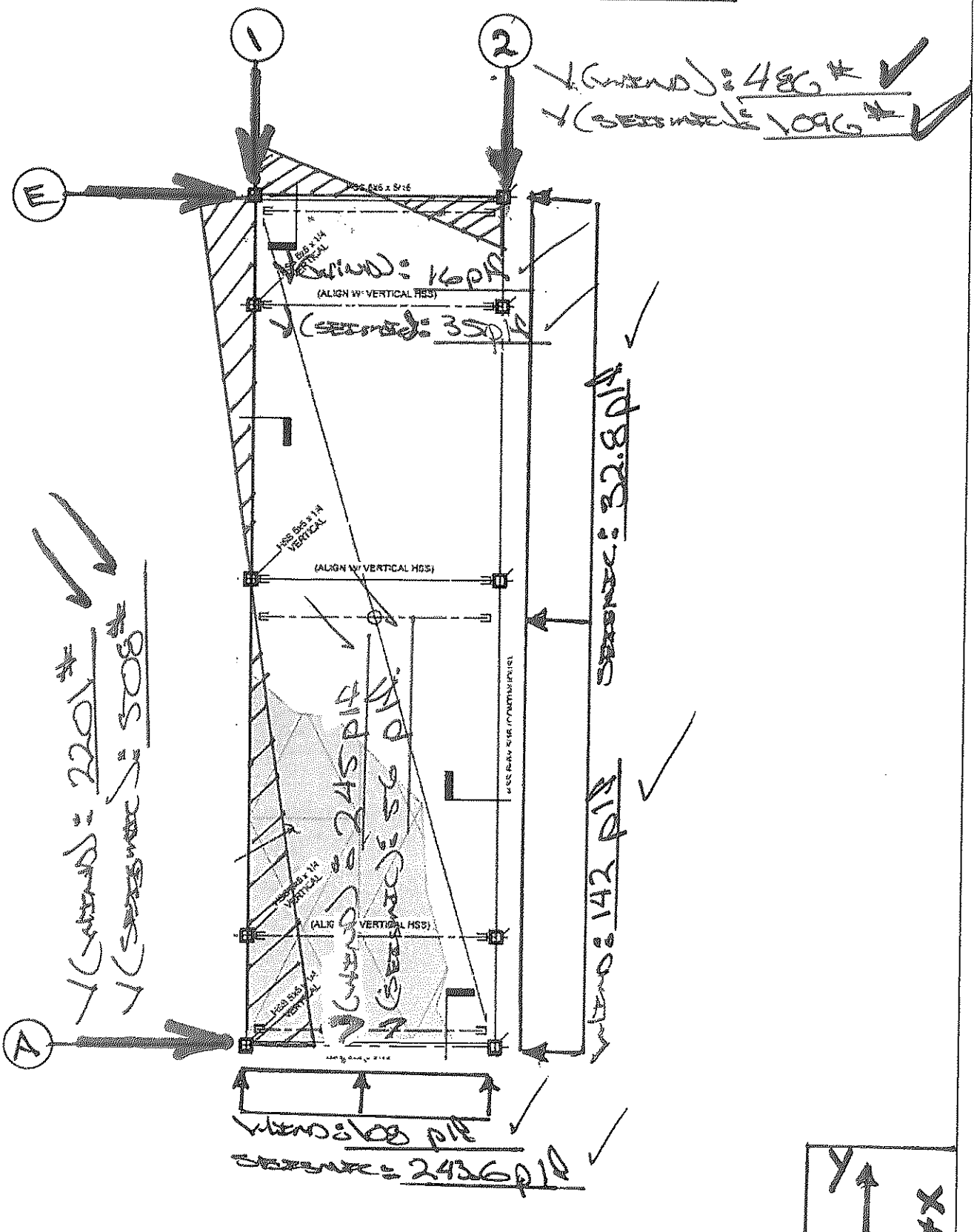
$= 108$ plf

$W_{(FLOOR)} = (12.0\text{ psf})(10'/2) = 60$ plf

Buro Happold

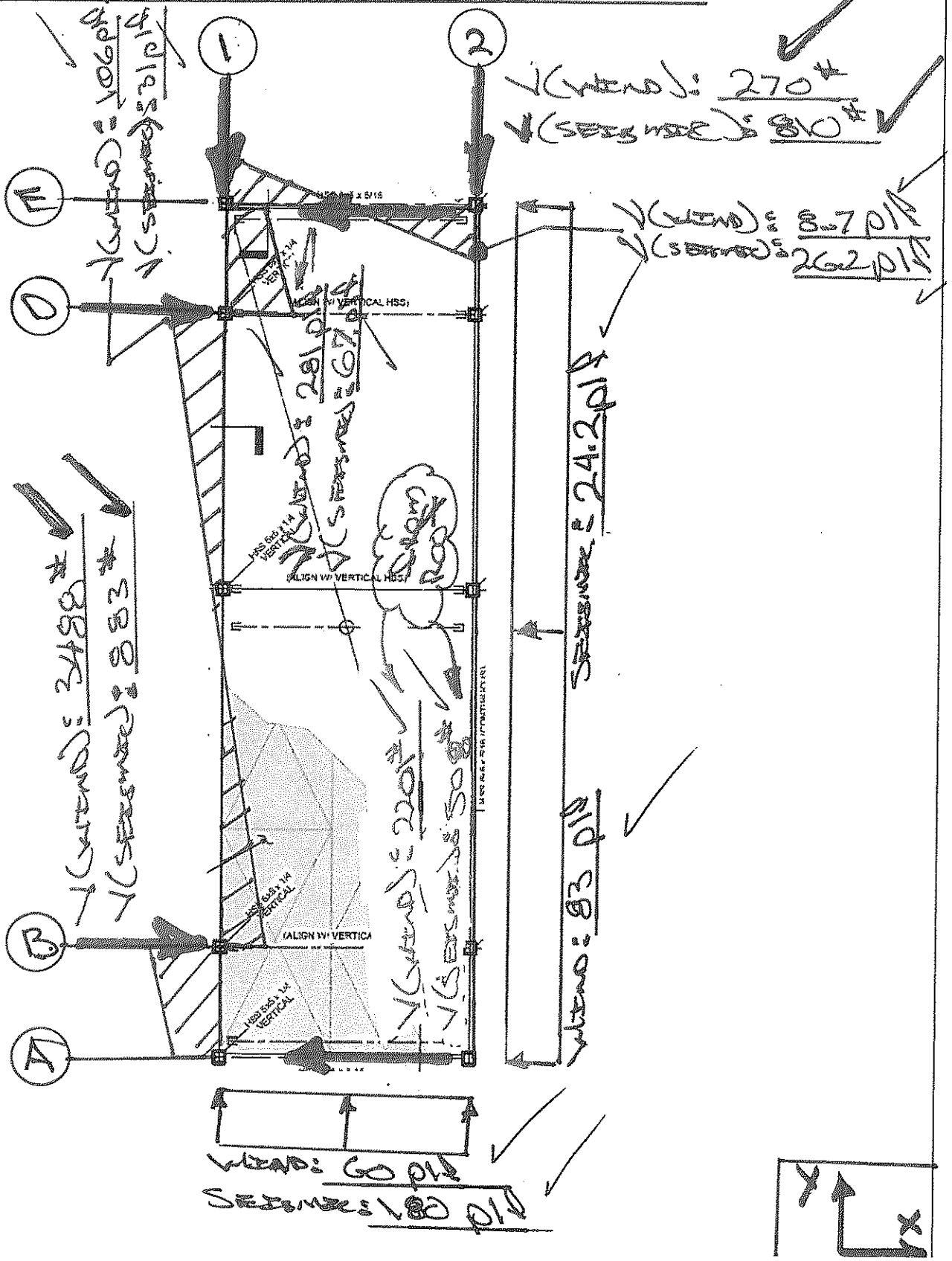
PROJECT:	PROJECT #:	PAGE #:
SOLAR DECATHALON	3102BD	
DESCRIPTION		AUTHOR/DATE:
DIAPHRAGM LOADING		CHECKED BY/DATE:

ROOF DIAPHRAGM: MODULE 1 AND 3



Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD
	DESCRIPTION: DIAPHRAGM LOADING	PAGE #:
		AUTHOR/DATE:
		CHECKED BY/DATE:

FLOOR DIAPHRAGM & MODULE 1 RAMP 3.



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PROJECT: SOLAR DECATHLON PROJECT #: 310230

DESCRIPTION: LATERAL ANALYSES.

PAGE #:

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SEISMIC MASS @ MODULE 2

$W_{EFF\ (ROOF)} = (24\ psf)(31'\times 9') + (16\ psf)(10'/2)(9'+9')$

$= 8136\ \#$

$W_{EFF\ (FLOOR)} = (14\ psf)(31'\times 9') + (16\ psf)(10'/2)(9'+9')$

$= 5346\ \#$

SEISMIC FORCE @ MODULE 2

X-DIRECTION @

$F_{EQ\ (ROOF)} = (8136\#)(.137)(.70)$ Asg

$= 780\# \Rightarrow 25.2\ plf$ ✓✓

$F_{EQ\ (FLOOR)} = (5346\#)(.137)(.70)$

$= 512\# \Rightarrow 16.5\ plf$ ✓✓

Y-DIRECTION @

$F_{EQ\ (ROOF)} = (8136\#)(.295)(.70)$

$= 1680\# \Rightarrow 187\ plf$ ✓✓

$F_{EQ\ (FLOOR)} = (5346\#)(.295)(.70)$

$= 1104\# \Rightarrow 123\ plf$ ✓✓

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PROJECT: Solar Dessalination 3102BD | PROJECT #:

DESCRIPTION: Lateral Analysis

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Design Loads @ Module 2

$q_z = (.00256)(K_z)(K_{zt})(K_d)(V^2)(I)$

$= 13.40$ psf

Exp C 0-15 ft

X-Direction: (L/B = .30)

$P_{wall} = P_{roof} = (13.40 \text{ psf})(.85)(.80 + .50)$

$= 14.81$ psf

$w_{diaphragm\ (roof)} = (14.81 \text{ psf})(6 \text{ ft}) = 89$ plf

$w_{diaphragm\ (floor)} = (14.81 \text{ psf})(2 \text{ ft}) = 30$ plf

Y-Direction: (L/B = 3.3)

$P_{wall} = P_{roof} = (13.40 \text{ psf})(.85)(.80 + .25)$

$= 12.0$ psf

$w_{beam\ (roof)} = (12.0 \text{ psf})(10 \text{ ft}/2) + (12 \text{ psf})(4 \text{ ft}) = 108$ plf

$w_{beam\ (floor)} = (12.0 \text{ psf})(10/2) = 60$ plf

Buro Happold	PROJECT: SOLAR DECATHALON	PROJECT #: 3102BD
	DESCRIPTION: DIAPHRAGM LOADING	

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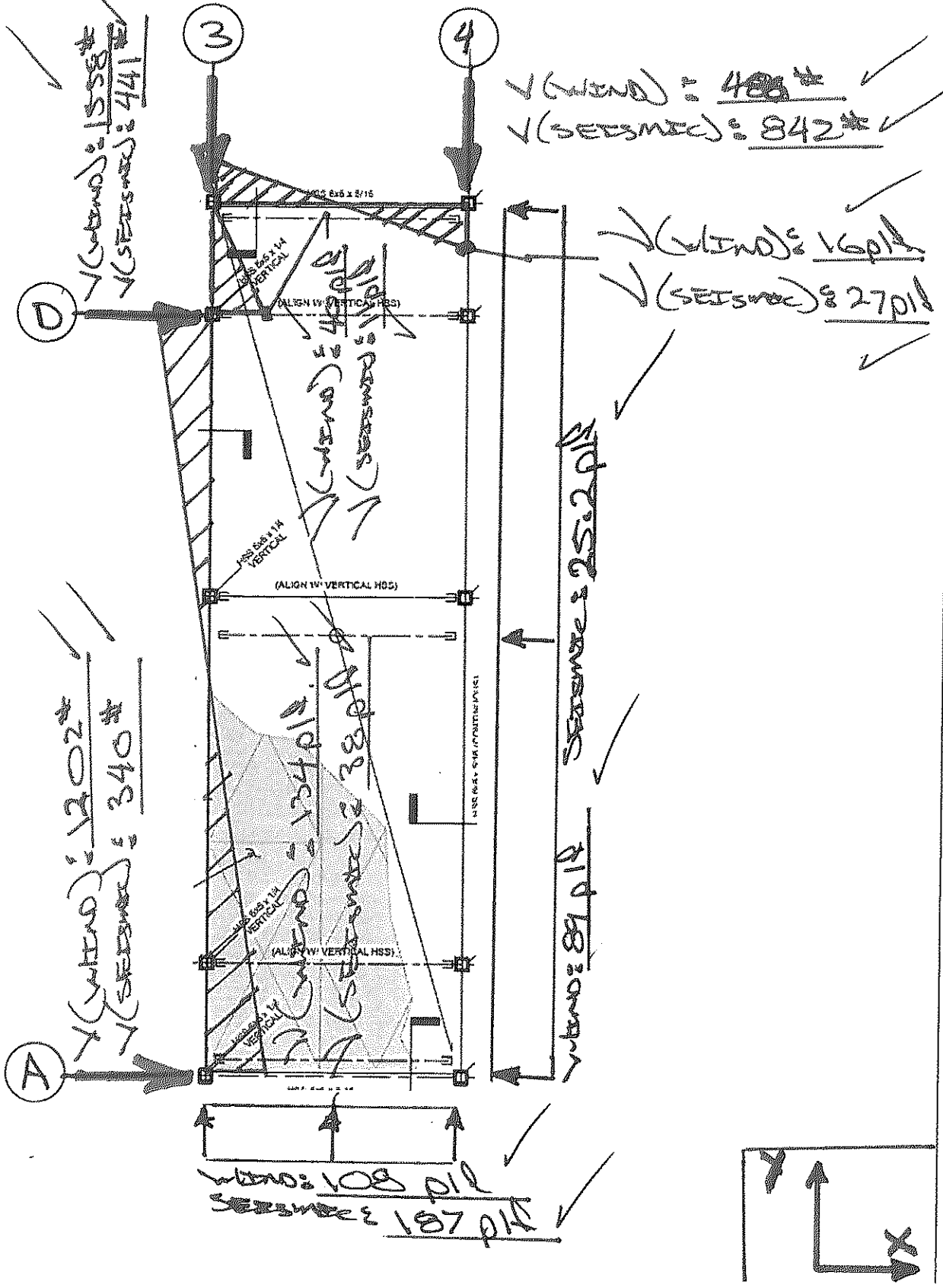
ROOF DIAPHRAGM: MODULE 2



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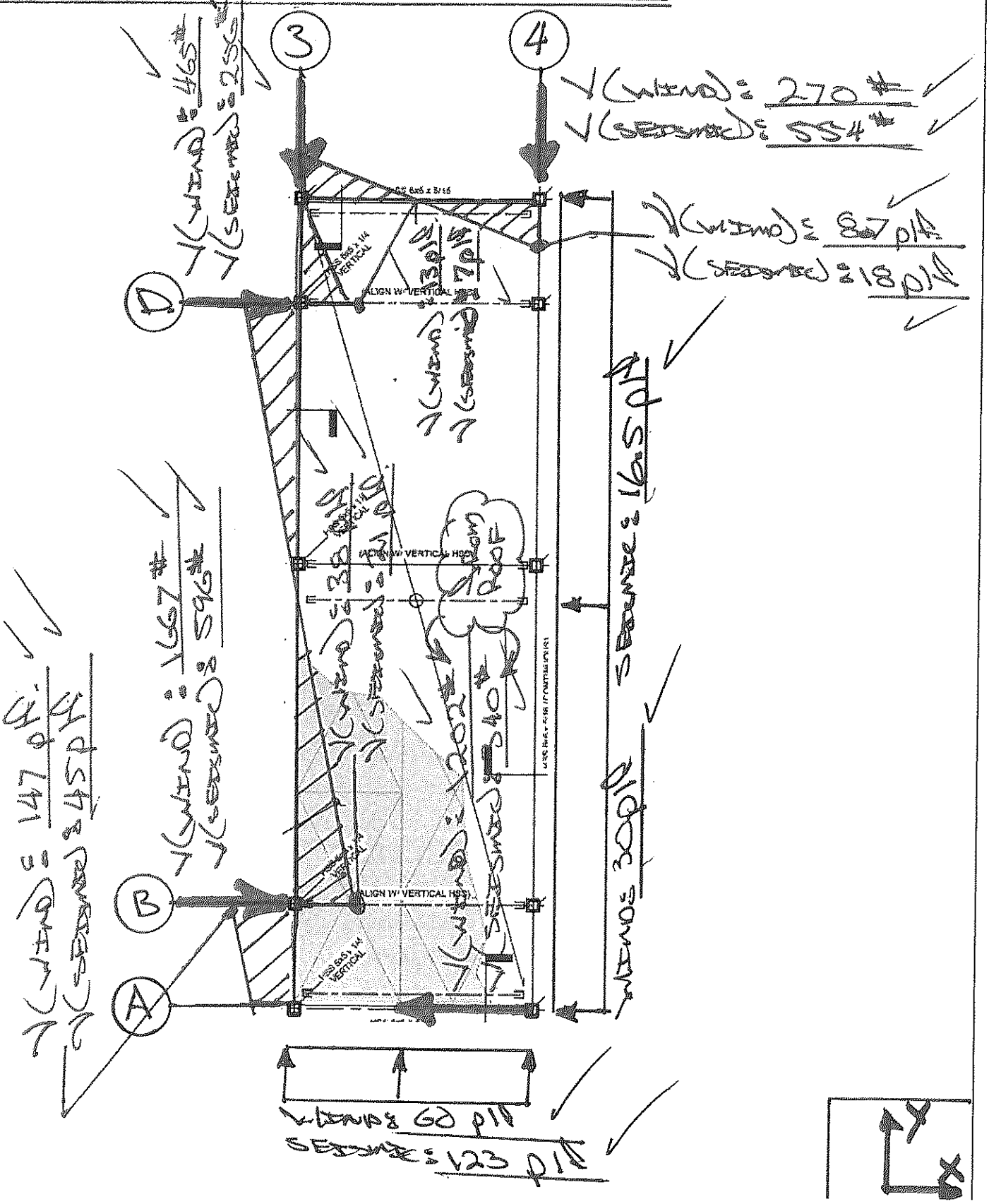
PROJECT:	PROJECT #:	PAGE #:
SOLAR DECATHALON	3102BD	
DESCRIPTION		AUTHOR/DATE:
DIAPHRAGM LOADING		
		CHECKED BY/DATE:

FLOOR DIAPHRAGM @ MODULE 2



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PROJECT: SOLAR DECATHLON

PROJECT #:

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AUTHOR / DATE:

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DIAPHRAGM DESIGN: MODULE 1 AND 3

ROOF DIAPHRAGM X-DIRECTION ← CONTROLS

WIND CONTROLS: $p = 245\ plf < 320\ plf$ ✓

$T = C = \frac{(142\ plf)(31\ ft)^2}{(8)(9\ ft)} = 189\ \#$ ←

STEEL IS ADEQUATE FOR 1.9 kips LOAD

FLOOR DIAPHRAGM: X DIRECTION ← CONTROLS

WIND CONTROLS: $p = 281\ plf < 425\ plf$ ✓

$T = C = \frac{(83\ plf)(23)^2}{(8)(9)} = 60\ \#$ ✓

$T = C = \frac{(83\ plf)(4\ ft)^2}{2(9)} + \frac{(220\ \#)(4\ ft)}{9} = 1052\ \#$ ←

STEEL IS ADEQUATE FOR 1.1 kips LOAD.

BY INSPECTION MODULE 1 + 3 IS CRITICAL FOR DIAPHRAGM DESIGN

TABLE 2306.3.1
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE[a] FOR WIND OR SEISMIC LOADING [h]

PANEL GRADE	COMMON NAIL SIZE OR STAPLE[f] LENGTH AND GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBERS AT ADJOINING PANEL EDGES AND BOUNDARIES[g] (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5, 6)[b]				Fasteners spaced 6″ max. at supported edges[b]	
					6	4	2 1/2[c]	2[c]		
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4)[b]					
					6	6	4	3	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6)
Structural I Grades	6d[e] (2″ × 0.113″)	1 1/4	5/16	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
	1 1/2 16 Gage	1		2	155	205	310	350	135	105
				3	175	230	345	390	155	115
	8d (2 1/2″ × 0.131)	1 3/8	3/8	2	270	360	530	600	240	180
				3	300	400	600	675	265	200
	1 1/2 16 Gage	1		2	175	235	350	400	155	115
				3	200	265	395	450	175	130
	10d[d] (3″ × 0.148″)	1 1/2	15/32	2	320	425	640	730	285	215
				3	360	480	720	820	320	240
	1 1/2 16 Gage	1		2	175	235	350	400	155	120
				3	200	265	395	450	175	130
Sheathing, single floor and other grades covered in DOC PS 1 and PS 2	6d[e] (2″ × 0.113)	1 1/2	5/16	2	170	225	335	380	150	110
				3	190	250	380	430	170	125
	1 1/2 16 Gage	1		2	140	185	275	315	125	90
				3	155	205	310	350	140	105
	6d[e] (2″ × 0.113)	1 1/4	3/8	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
	8d (2 1/2″ × 0.131)	1 3/8		2	240	320	480	545	215	160
				3	270	360	540	610	240	180

(continued)

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PROJECT: SOLAR DECATHLON

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DESCRIPTION: LATERAL

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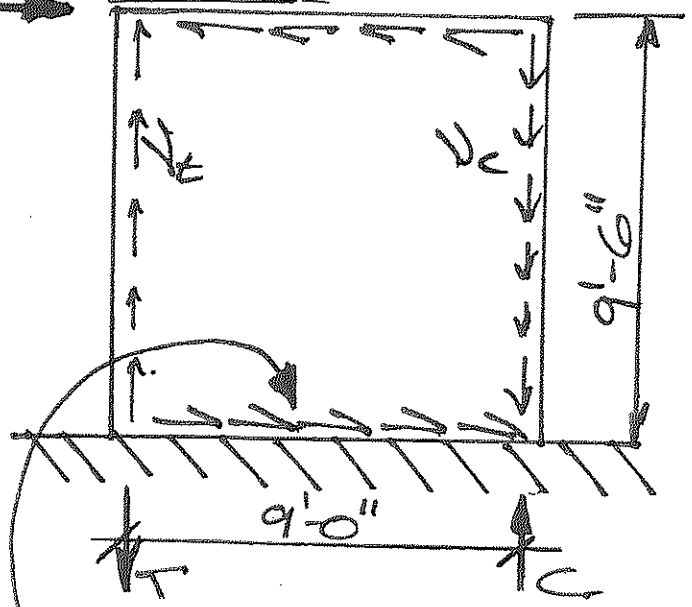
CRITICAL SHEARWALL: X-DIRECTION

MODULE 3: GRIDLINE (A) + (E)

$V_{(WIND)} = 220^{\#}$

$V_{(SEISMIC)} = 508^{\#}$



WIND:

$T = C = (220^{\#})(9.5^{ft}/9^{ft}) = 232.5^{\#}$

$N_t = V = 232.5^{\#}/9.5^{ft} = 24.46\ plf$

SEISMIC:

$T = C = (508^{\#})(9.5^{ft}/9^{ft}) = 536^{\#}$

$N_t = V = 536^{\#}/9.5 = 56.4\ plf$

$V = 220^{\#}/9^{ft} = 24.5\ plf < 340\ plf$

TABLE 2306.4.1
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE[a] FOR WIND OR SEISMIC LOADING[b, h, i, j, l]

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING					PANELS APPLIED OVER 1/2" OR 5/8" GYPSUM SHEATHING				
			NAIL (common or galvanized box) or staple size[k]	Fastener spacing at panel edges (inches)				NAIL (common or galvanized box) or staple size[k]	Fastener spacing at panel edges (inches)			
				6	4	3	2[e]		6	4	3	2[e]
Structural I Sheathing	5/16	1 1/4	6d (2 × 0.113" common, 2" × 0.099" galvanized box)	200	300	390	510	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	200	300	390	510
		1	1 1/2 16 Gage	165	245	325	415	2 16 Gage	125	185	245	315
	3/8	1 3/8	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	230[d]	360[d]	460[d]	610[d]	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	280	430	550[f]	730
		1	1 1/2 16 Gage	155	235	315	400	2 16 Gage	155	235	310	400
	7/16	1 3/8	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	255[d]	395[d]	505[d]	670[d]	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	280	430	550[f]	730
		1	1 1/2 16 Gage	170	260	345	440	2 16 Gage	155	235	310	400
	15/32	1 3/8	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	280	430	550	730	10d (3" × 0.148" common, 3" × 0.1218" galvanized box)	280	430	550[f]	730
		1	1 1/2 16 Gage	185	280	375	475	2 16 Gage	155	235	300	400
		1 1/2	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	340	510	665[f]	870	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	—	—	—	—
Sheathing, plywood siding[g] except Group 5 Species	5/16 or 1/4[c]	1 1/4	6d (2" × 0.113" common, 2" × 0.099" galvanized box)	180	270	350	450	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	180	270	350	450
		1	1 1/2 16 Gage	145	220	295	375	2 16 Gage	110	165	220	285
	3/8	1 1/4	6d (2" × 0.113" common, 2" × 0.099" galvanized box)	200	300	390	510	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	200	300	390	510
		1 3/8	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	220[d]	320[d]	410[d]	530[d]	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	260	380	490[f]	640
		1	1 1/2 16 Gage	140	210	280	360	2 16 Gage	140	210	280	360
	7/16	1 3/8	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	240[d]	350[d]	450[d]	585[d]	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	260	380	490[f]	640
		1	1 1/2 16 Gage	155	230	310	395	2 16 Gage	140	210	280	360
	15/32	1 3/8	8d (2 1/2" × 0.131" common, 2 1/2" × 0.113" galvanized box)	260	380	490	640	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	260	380	490[f]	640
		1 1/2	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	310	460	600[f]	770	—	—	—	—	—
		1	1 1/2 16 Gage	170	255	335	430	2 16 Gage	140	210	280	360
	19/32	1 1/2	10d (3" × 0.148" common, 3" × 0.128" galvanized box)	340	510	665[f]	870	—	—	—	—	—
		1	1 3/4 16 Gage	185	280	375	475	—	—	—	—	—
			Nail Size (galvanized casing)					Nail Size (galvanized casing)				
	5/16[c]	1 1/4	6d (2" × 0.099")	140	210	275	360	8d (2 1/2" × 0.113")	140	210	275	360
	3/8	1 3/8	8d (2 1/2" × 0.113")	160	240	310	410	10d (3" × 0.128")	160	240	310[f]	410

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PROJECT: SOLAR DECATHLON 3102BD

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controls.

$V_{max} = 2735^{\#}$

$V_{min} = 2713^{\#}$

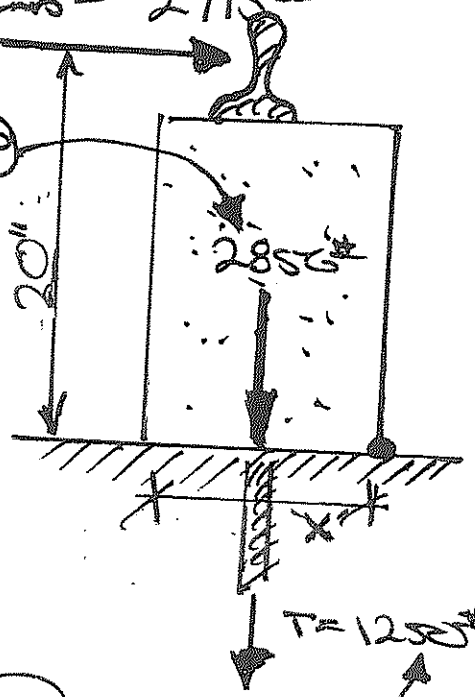
$\Sigma M_{OTR} = \Sigma M_{RM}$

$(2755^{\#})(20'') =$

$(150 psf)(x/12)(18/12)(9^{AT})(x/2)$

$+ (1250^{\#})(x/2) + (2856^{\#})(x/2)$

$\Rightarrow x = 15.00 in.$



"0" INCLUDES 1.5 FACTOR FOR OVERTURNING. DESIGN IS CONSERVATIVE

FROM DESIGN PARAMETERS

1" Ø STEEL BAR DRIVEN INTO GROUND 36"

Steel					
WIDE FLANGE	**Size**	**quantity**	**length in ft**	**weight per LF**	**total weight**
	w16x26	2	30.604	26	1591.408
HSS	**Size**	**quantity**	**length in ft**	**weight per LF**	**total weight**
floor face beam	6x6x5/16"	2	30.604	23.34	1428.59472
floor edge beam	6x6x5/16"	2	8	23.34	373.44
columns	5x5x1/4"	10	8.56	15.6	1335.36
laterals	5x5x1/4"	4	9.25	15.6	577.2
top edge beam	6x6x5/16"	2	9	23.34	420.12
RAILS	**Size**	**quantity**	**length in ft**	**weight per LF**	**total weight**
ASCE 40		2	64	13.33	1706.24
FOOTINGS	**per plate**	**quantity**			**total number**
sole plates 9"x4.5"	1	60			60
separation pads	1	60			60
bolts	4	60			240
clips	2	60			120
END TRUCKS	**manufacturer**	**model**	**capacity**		**quantity**
motorized top running	Saturn	TMD6-3560	3 ton		2
HARDWARE	**type**		**location**		**quantity**
joist hangers	HGI.8j/5		floor		62
joist hangers	BA 237/16		ceiling		36

Lumber	size	quantity	length in ft	total LF	total sq ft
LVL	13/4x51/2"	31	8	248	
TJIPro230	16"	18	9	162	
plywood 1/2"	4'X10'	33			1320

Cement	manufacturer	cubic feet per plate	# of plates		cubic yards
5000 psi	cemex	0.6	34		24

Insulation					
WALL					
(8' assembly)	**manufacturer**	**thinkness (in)**	**LF**	**r-value**	**square ft**
Module 1	ROXUL	5	32	23	256
Module 2	ROXUL	5	42	23	336
FLOOR					
(8' assembly)	**maufacturer**	**type**	**LF**	**total LF**	**square ft**
Module 1	ROXUL	24	30	5	300
Module 2	ROXUL	24	30	5	300
CEILING					
(8' assembly)	**manufacturer**	**type**	**LF**	**total FL**	**square ft**
Module 1	ROXUL	30	30	5	300
Module 2	ROXUL	30	30	5	300

Waterproofing					
MODULE SEAL	**manufacturer**			**Square ft**	**quantity**
Rubber Gasket Seal	Emseal				120
mounting clips					
compressors					2
vinyl coated pvc				1200	1
gutter/drain					3
slope frame					

Galvanized framing	type	size	quantity	LF	weight
louvers					
canopy sliders			10		
canopy motors					
canopy steel	HSS	4"x4"x3/16"	12	10	12.2
canopy steel	HSS	4"x2"x3/16"	20	10	6.85

canopy steel	HSS	4"x2"x3/16"	6	32	6.85
canopy steel	HSS	1.25"x1.25"x1/8"	20	10	1.77
PV mount	**manufacturer**		**quantity**		**LF per module**
S100	SnapNRack				352
Standoffs	SnapNRack		96		
Solar photovoltaics	**manufacturer**	**model #**			**quantity**
Solar Panel	Hanwha Solar	SF160-24-M190			32
Module Maximizer	Tigo Energy	MMES50			32
Inverter	SMA America	SB6000US			1
Framing	**size**	**quantity**	**length in ft**		**total LF**
module 1	2x6" doug fir	44	8		352
module 2	2x6" doug fir	63	8		504
wall covering	**material**	**size**	**color**	**quantity**	**square ft**
interior walls M1	1/2" plywood	4'x8'	natural	10	320
interior walls M2	1/2" plywood	4'x8'	natural	22	704
bathroom backsplash	1/2" plywood	1"X1"	white		5
Flooring	**manufacturer**	**product**	**size**	**color**	**square ft**
module 1	Armstrong	lockhaven	6"x36"	blk walnut	300
module 2	Armstrong	lockhaven	6"x36"	blk walnut	300
Ceiling	**material**	**size**	**color**	**quantity**	**square ft**
module 1	1/2" plywood	4'x8'	natural	10	300
module 2	1/2" plywood	4'x8'	natural	10	300
Cabinets	**material**	**height**	**depth**		**LF**
bathroom lower	wood	34.5"	24"		3
bathroom upper	wood	16"	10"		2
Kitchen lower	wood	34.5"	24"		3.5
kitchen upper	wood	24"	12"		5.5
kitchen island	wood	34.5"	24"		3.5
Pantry	wood	96"	24"		8
Reconfigurable walls	**manufacturer**	**model**	**size**	**LF**	**quantity**
wheel trolley	unistrut	P2950	15/8"x31/2"		8
channel	unistrut	P5000	15/8"x31/4"	100	5
cabinetry			8'x8'x1'		2
Murphey Beds					**quantity**
Master bedroom					1
secondary room					1
Counter tops	**material**	**thickness**	**color**		**square ft**
kitchen	formica	3/4"	white		26
Paint	**manufacturer**	**type**	**finish**	**color**	**square ft**
interior walls		interior	flat	white	1,344
interior ceiling		interior	flat	white	711
stain		exterior	matte	clear	1100
Windows/Doors	**manufacturer**	**series**	**dimension**	**color**	**quantity**
multi-slide metal door	Arcadia	ULT-5820	6'-8" x 2'-8"	white	2
aluminum windows	Arcadia	T200 awning	4'-0" x 1'-6"	white	4
interior doors		pocket door	6-'8" x 2'-8"		2
Appliances	**manufacturer**	**dimensions**	**model #**	**color**	
Refrigerator	Liebherr	w239/16"x24"x833/4"	HC1001	stainless	
dishwasher	Fisher Paykel	w3321/32"x1813/16"x229/16"	DD36ST12	stainless	
stove	BOSCH	w31"x255/8"x36"	NET8054UC	stainless	
oven	BOSCH		HBL8450UC	stainless	
downdraft	BOSCH	3 11/16" x 6 3/8" x 20 1/16"	DHD3014UC	stainless	
remote blower	BOSCH	15 1/2 '' x 14 1/8 '' x 9 7/8 ''	DHG6015DUC		

washer	BOSCH	23 7/16" x 33 3/16" x 23 1/4" (24 1/2" including door)	WAS24460UC	white	
dryer	BOSCH	239/16"x245/8"x333/16"	WTE86300US	white	
HVAC	**manufacturer**	**model**			**quantity**
outdoor unit	Mitsubishi Electric	MXZ-2B20NA-1			1
indoor unit	Mitsubishi Electric	SLZ-KA09NA			2
thermostat control	Mitsubishi Electric	MHK1			2
thermostat control	Honeywell	RIG			1
DHW Heater	AO Smith				
bathroom ventilation fan	Panasonic	FV-08VKM3			1
Plumbing	**manufacturer**		**model**		**quantity**
pressure boosting pump	Grundfos		MQ3-45		
macerator	SaniFlo		Sanigrind Pro		1
sump pump	Little Giant		6EN-CIA-SFS		1
Monitoring	**manufacturer**				
sensors	Digi International				
router	Digi International				
software					
control server	Control4				
Panel		**capacity**	**location**		**circuits**
Load Panel	1 phase	120/240 v/200 A	outdoor	3 wire	35
Wiring	**type**	**guage**			**LF**
AWG	outdoor	#2/0			250
AWG	outdoor	#6			120
AWG	outdoor	#10			100
AWG	indoor	#8			50
AWG	indoor	#10			400
AWG	indoor	#12			600
Safety/Security	**manufacturer**	**model**			**quantity**
smoke detectors					5
laser distance sensor	Allen-Bradley	45LMS-U8LGC3-D4			3
mounting bracket	Allen-Bradley	45LMS-BKT1			3
cordset	Allen-Bradley	889D-F4AC-2			3
micro reflector	Allen-Bradley	92-117			3
480W power supply	Allen-Bradley	1606-XLS480E			1
single phase drive	Allen-Bradley	22F-A2P5N103			2
compact limit switch	Allen-Bradley	802B-CSAD1XSXD4			8
emergency stop	Allen-Bradley	800FM-MT34			1
metal latch	Allen-Bradley	800F-ALM			1
contact block	Allen-Bradley	800F-X01			2
contact block	Allen-Bradley	800F-X10			1
touchscreen panel	Allen-Bradley	2711C-T6T			1
safety limit switch	Allen-Bradley	440P-ARPS11C			2
safety light curtain	Allen-Bradley	440L-P4K0320YD			2
DC cordset	Allen-Bradley	889D-F4AC-10			4
micro cordset	Allen-Bradley	889D-F8AB-10			2
laser emitter	Allen-Bradley	440L-T4F2070-Q			2
laser receiver	Allen-Bradley	440L-R4F0020-Q			2
safety relay	Allen-Bradley	440R-P23071			4
safety edge	Allen-Bradley	440F-E0118S05			1
c-rail	Allen-Bradley	440F-R1212			1
connector and cable	Allen-Bradley	440F-A1185			30
shears	Allen-Bradley	440F-A3084			1
terminating resistor	Allen-Bradley	440F-A1186			2
closing cap	Allen-Bradley	440F-A1318			32
safedge controller	Allen-Bradley	440F-C252D			2
PLC	Allen-Bradley	1766-L32BWA			1
analog input module	Allen-Bradley	1762-IF4			1
DC input module	Allen-Bradley	1762-IQ16			1
relay output module	Allen-Bradley	1762-OW16			1
proximity switch	Allen-Bradley	872C-D3NE12-D4			2

unmanaged switch	Allen-Bradley	1783-US05T			1
Fixtures	**manufacturer**				**quantity**
outlets	Generic				7
weatherproof outlets	Generic				1
GFRC outlets	Generic				8
switches	Control4				9
can lights	Elite Lighting				16
under cabinet	Generic				3
light strips	American Lighting				120
vanity light					1
Lines	**type**	**size**			**LF**
water supply	AceHose	1", 3/4", 1/2"			80
water distribution	Flowguard CPVC	1", 3/4", 1/2"			150
waste water fixed	Flowguard CPVC, ABS	2", 1"			60
waste water mobile	AceHose	1"			65
sprinkler system	Blazemaster CPVC	1"			240
Instalation					
plumbing labor					
Fixtures	**manufacturer**	**color**	**model #**	**collection**	**quantity**
KITCHEN SINK	Kohler	stainless	k-3936-na	vault	1
KITCHEN FAUCET	Kohler	stainless	k-6125-4-vs	torq	1
BATHROOM SINK	Kohler	white	k-4819-0	reve	1
BATHROOM FAUCET	Kohler	polished chrome	k-14660-4-cp	lovre	1
TOILET	Kohler	white	k-3797-0	reve	1
TUB	Kohler	white	k-817-0	reve	1
SHOWER FAUCET	Kohler	polished chrome	k-t14664-4-cp	lovre	1
TP HOLDER	Kohler	polished chrome	k-11583-cp	lovre	1
towel ring	Kohler	polished chrome	k-11587-cp	lovre	1
Mirror	Kohler	polished chrome	k-11579-cp	lovre	1
towel bar	Kohler	polished chrome	k-11581-cp	lovre	1
cabinet pulls	Kohler	polished chrome	k-11575-cp	lovre	2
Wood deck	**size**	**material**	**quantity**	**LF**	**total LF**
exterior wood frame	1.75"x11.875	LVL	12	22	264
exterior wood frame	1.75"x7.25	LVL	55	10.33	568.15
exterior wood decking	3/4"x6"		96	12	1152
sheathing	4"x10'x5/16	plywood	20		
Trays	**size**	**material**	**quantity**	**square ft**	
structure	3/4"x 4'x10"	plywood	18	720	
waterproof membrane				1500	
Ground Cover		**material**		**square ft**	**cubic ft**
soil		planting soil			250
grass		sod		628	
decomposed granite		gray decomposed granite			353
river rocks				144	
Ramps	**width**	**rise**	**run**	**quantity**	
ADA ramps	3'	6"	6'	2	
Cable Carriers	**manufacturer**	**type**			**quantity**
Main Carrier	Gortrac	TS-110			99 links
Module-Module	Gortrac	TS-110			176 links
Module-Canopy	Gortrac	N3-8D			119 links x2